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Design and Selection of a Simple Fuzzy Logic Controller for Maximum-Power Operation of PV System

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Abstract
The PV arrays are characterized with a highly nonlinear I-V curve, which varies with array temperature and solar insolation; such that there is a unique point on each curve that can supply maximum power. This paper presents the design and application of a suggested-six fuzzy logic controllers (FLCs) for the maximum-power operation of the PV arrays; such that the selection of the proper controller is based on the controller simplicity and performance. The simulation results are presented and tabulated.

Keywords: Fuzzy logic, fuzzy control, maximum-power operation, PV array

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1. INTRODUCTION

Fuzzy control is based on a fuzzy logic, which is a logical system which is much closer in sprit to human thinking and natural language than traditional logical systems. The fuzzy logic controller (FLC) based on fuzzy logic provides a means of converting a linguistic control strategy based on expert knowledge into an automatic control strategy [1]. Recently, fuzzy logic based control has been considered as one of the most active research area, that can control most photovoltaic (PV) applications; especially those of maximum-power point tracking (MPPT) of PV arrays. The PV arrays are characterized with a highly nonlinear I-V curve, which varies with the array temperature and solar insolation; such that there is a unique point on each curve that can supply maximum power to the load. Since, the FLC works well for complex ill-defined nonlinear systems, especially where parameter variation problem exists [2]. Therefore, the application of the FLC for the MPPT of the PV arrays is well-suited.

In this article six FLCs are proposed and designed to operate the suggested PV system at the maximum-power point (MPP) for every instant. Where, the proper controller is selected to be the simplest and that of best performance.

2. MAXIMUM-POWER OPERATION OF THE SUGGESTED CONTROL SYSTEM

It is known from a previous paper [3] that the sum of the load line angle and the tangent line angle, of the I-V characteristic curve at MPP, is

$$\gamma = 180^{o} \tag{1}$$

Therefore, adjusting the set-point of the suggested PV control system at $\gamma_{ref} = 180^{o}$ continuously, as shown in Fig. 1, will adjust the operating point of the PV array at its MPP for every instant.
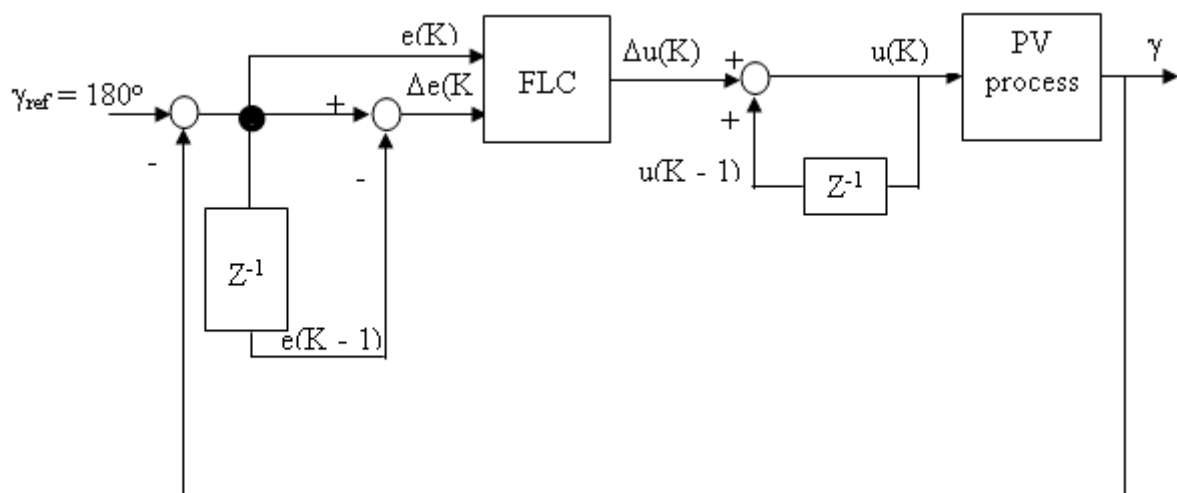
Fig. 1 The suggested PV control system.

Figure 1 shows that the suggested controller is a two-input single-output FLC; where the controller inputs are the error e and the change of error Δe, given by

$$e(k) = 180^o - \gamma(k)$$

$\qquad$ (2)

and

$$\Delta e(k) = e(k) - e(k-1)$$

$\qquad$ (3)

Where k is the sampling instant. While, the controller output is the change in control signal Δu(k), which is added to the previous control signal to give the current control signal u(k) necessary for MPP operation of the PV system, as

$$u(k) = u(k-1) + \Delta u(k)$$

$\qquad$ (4)

3. FUZZY LOGIC CONTROLLER DESIGN

In spit of the advantages in fuzzy control, the main limitation is the lack of a systematic procedure for design and analysis of the control system. Generally, a trial and error iterative approach is taken which may be time-consuming. A few other difficulties in fuzzy control are: (1) Lack of completeness of the rule base. Where, the controller must be able to give a meaningful control action for every condition of the process, (2) There is no definite criteria for selection of the shape of membership functions, degree of overlapping of the subsets and the levels of data quantization [4].

3.1 Fuzzy Partition of the Input-Output Spaces and the Rule Base
The design of the FLC is primary based on a trial and error procedure. The triangular membership function is considered because of its simplicity of implementation and because less computational intensity is required.

3.1.1 Same partitioning of the input-output spaces
In this case same numbers of subsets are used for both the input variables (e and Δe) and for the output control variable (Δu). At first, the three fuzzy variables are quantized into three triangular fuzzy subsets (negative N, zero ZE, and positive P) with 50 % overlapping for the neighboring fuzzy subsets. Therefore, at any given point of the universe of discourse, no more than two fuzzy subsets will have non-zero degree of membership; which ensures the firing of four rules from the entire rule base, for any input data of e and Δe. Further increase in the number of subsets up to seven can be achieved by representing the positive subsets by positive small PS, positive medium PM, and positive big PB. By the same way, the negative subsets are represented by negative small NS, negative medium NM, and negative big NB. In practice, these quantizations can be expanded according to the complexity of the control problem.

3.1.1.1 FLC with three input-three output (3I-3O) fuzzy subsets

When using FLC with three fuzzy subsets to represent the linguistic values of each of the three fuzzy variables (e, Δe, and Δu), the membership function of the three variables is shown in Fig. 2. Also, the rule base given in Table 1, which is heuristically developed, is used. It is to be noted that the improvement of the system response can be achieved by adjusting the scaling factors until the best performance is obtained. The scaling factors of the FLC are set as follows: $K_e = 7.5$, $K_{\Delta e} = 0.2$, and $K_{\Delta u} = 5$.
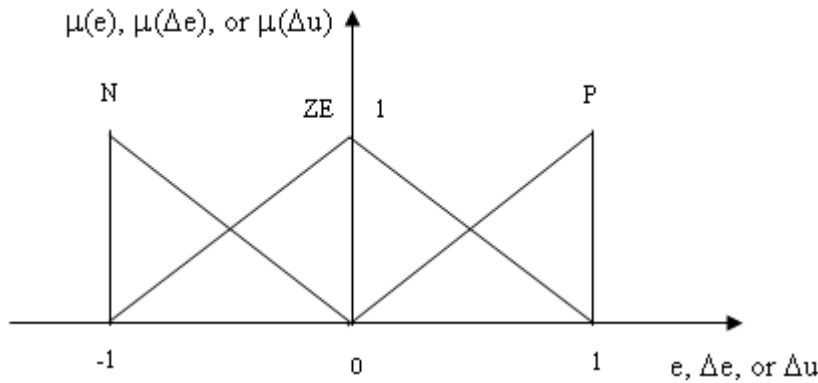
Fig. 2 Membership function with 3I-3O subsets for the three fuzzy variables.

Table 1 Rule base of the FLC using 3I-3O subsets for the three fuzzy variables.

e \ Δe	N	ZE	P
N	N	N	ZE
ZE	N	ZE	P
P	ZE	P	P

3.1.1.2 FLC with five input-five output (5I-5O) fuzzy subsets
As the sensitivity of a variable determines the number of fuzzy subsets associated to it, therefore the number of the fuzzy subsets for the three fuzzy variables is increased to five as shown in Fig. 3. Noting that, the use of a larger number of fuzzy subsets leads to an increase in the number of rules. In this case, 25 rules are used as indicated in Table 2. Also, the scaling factors are set as: $K_e = 11$, $K_{\Delta e} = 1$, and $K_{\Delta u} = 5$.
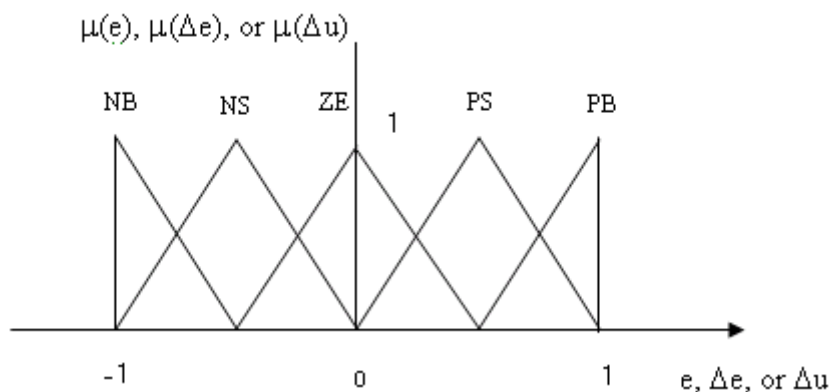
Fig. 3 Membership function with 5I-5O subsets for the three fuzzy variables.

Table 2 Rule base of the FLC using 5I-5O subsets for the three fuzzy variables.

e \ Δe	NB	NS	ZE	PS	PB
NB	NB	NB	NB	NS	ZE
NS	NB	NB	NS	ZE	PS
ZE	NB	NS	ZE	PS	PB
PS	NS	ZE	PS	PB	PB
PB	ZE	PS	PB	PB	PB

3.1.1.3 FLC with seven input-seven output (7I-7O) fuzzy subsets

Now, if the three fuzzy variables are represented by seven fuzzy subsets, as illustrated in Fig. 4. Then, the used rule base will be as shown in Table 3. Also, the scaling factors are set, in this case, as: $K_e = 10.5$, $K_{\Delta e} = 1$, and $K_{\Delta u} = 5$.
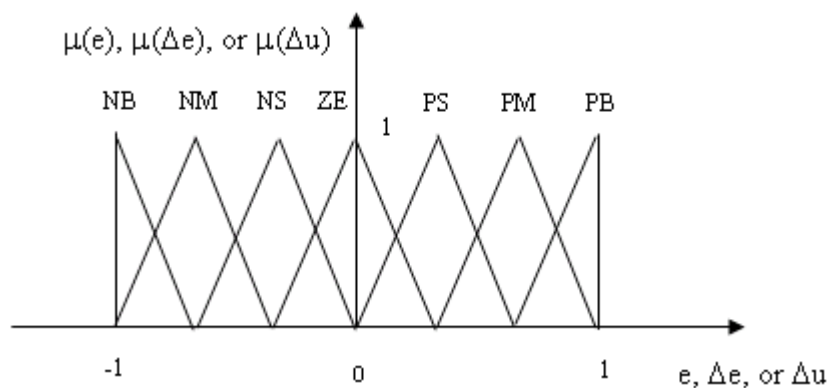
Fig. 4 Membership function with 7I-7O subsets for the three fuzzy variables

Table 3 Rule base of the FLC using 7I-7O subsets for the three fuzzy variables.

e \ Δe	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NB	NM	NS	ZE	PS
NS	NB	NB	NM	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PM	PB	PB
PM	NS	ZE	PS	PM	PB	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

3.1.1.4 Performance-comparison of the FLCs using same partitioning of the input-output spaces

Figure 5 shows a comparison among the responses of γ in case of using FLCs with same partitioning of the input-output spaces. It is to be noted here that the improvement of the system response can be achieved for each case by adjusting the scaling factors of the corresponding FLC, individually, until the best performance is obtained for all cases. Figure 5(a) shows the slowest response of the three, while the responses of the other two figures (i.e., Figs. 5(b) and (c)) are faster and have nearly

the same speed of response. Also, Fig. 5(c) shows a smaller percentage of overshoot and undershoot than that of Fig. 5(b), during the transient state of the PV system. Thus, Fig. 5(c) indicates the best response of the three. Therefore, it is clear from Fig. 5 that the greater the number of subsets, the better the response of the controller. But the number of subsets on the input determines the number of rules; as the number of subsets on the input increases, the number of rules increases too. Hence, the controller complexity will increase by increasing the number of subsets on the input, which indicates that the controller of Fig. 5(c) is the most complex one.

3.1.2 Different Partitioning of the Input-Output Spaces
As the sensitivity of a variable determines the number of fuzzy subsets. Thus, in this case same number of subsets are used for the input variables e and Δe, and different number of subsets for the output variables Δu. Due to the sensitivity of the output variable Δu, a finer partitioning for it is necessary [2,4]. It is to be noted that the number of subsets on the output variable doesn't have an influence on the number of rules, but changes the response of the whole system.

3.1.2.1 FLC with three input-five output (3I-5O) fuzzy subsets
As shown in Fig. 6, three subsets are used to represent the linguistic values of e and Δe. While, five subsets are used for Δu, considering the sensitivity of this variable. In this case, the number of rules in the rule base will not be increased by such an increase in the number of the output fuzzy subsets as shown in Table 4; while some control actions are modified for some input cases. The optimal scaling factors, in this case, are found to be: $K_e = 11.8$, $K_{\Delta e} = 1$, and $K_{\Delta u} = 15$.
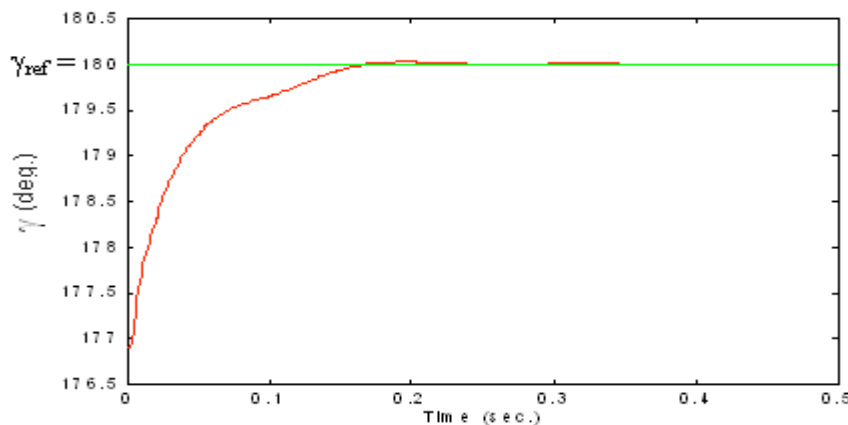
(a) Using 3I-3O subsets for the three fuzzy variables
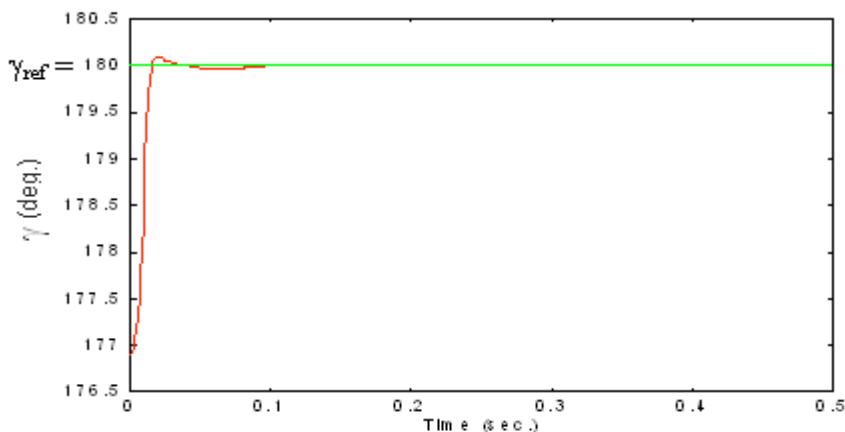
(b) Using 5I-5O subsets for the three fuzzy variables
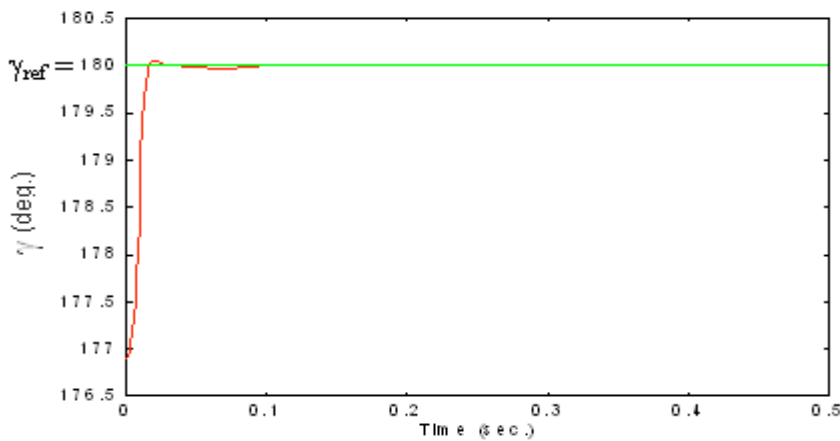
(c) Using 7I-7O subsets for the three fuzzy variables

Fig. 5 Response of γ using same partitioning of the input-output spaces.
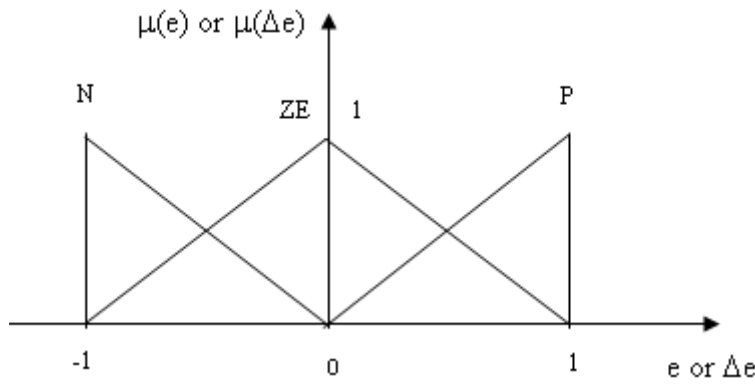
(a) Error or change of error
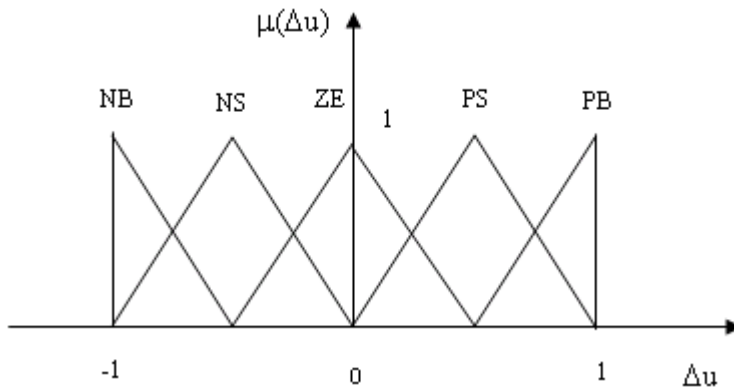
(b) Change in control voltage

Fig. 6 Membership functions with 3I-5O subsets for the three fuzzy variables.

Table 4 Rule base of the FLC using 3I-5O subsets for the three fuzzy variables.

e \ Δe	N	ZE	P
N	NB	NS	ZE
ZE	NS	ZE	PS
P	ZE	PS	PB

3.1.2.2 FLC with five input-seven output (5I-7O) fuzzy subsets

By using five subsets to represent the linguistic values for each of e and Δe, and seven subsets for Δu; the membership functions of the three variables are shown in Fig. 7. Where, 25 rules are utilized as indicated in Table 5, and the best scaling factors, in this case, are set as: $K_e = 13.5$, $K_{\Delta e} = 1$, and $K_{\Delta u} = 15$.

3.1.2.3 FLC with seven input-nine output (7I-9O) fuzzy subsets

The membership functions for the case of using seven subsets for each of e and Δe and nine subsets for Δu are shown in Fig. 8. Also, the number of rules is maintained to be 49, as illustrated in Table 6. While, the optimal scaling factors are set as: $K_e = 11.9$, $K_{\Delta e} = 1$, and $K_{\Delta u} = 15$.
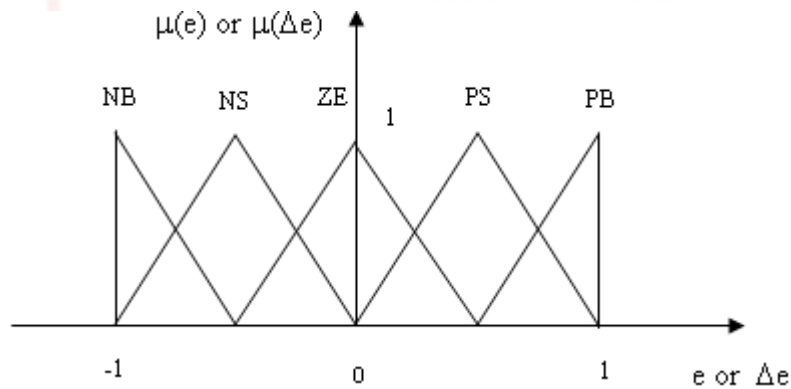
(a) Error or change of error
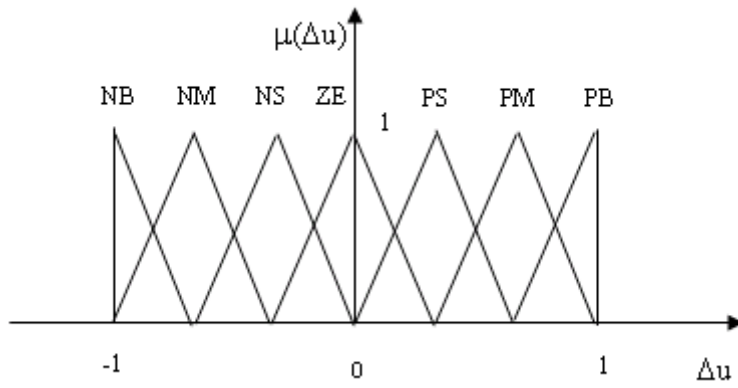
(b) Change in control voltage

Fig. 7 Membership functions with 5I-7O subsets for the three fuzzy variables.

Table 5 Rule base of the FLC using 5I-7O subsets for the three fuzzy variables.

e \ Δe	NB	NS	ZE	PS	PB
NB	NB	NB	NM	NS	ZE
NS	NB	NM	NS	ZE	PS
ZE	NM	NS	ZE	PS	PM
PS	NS	ZE	PS	PM	PB
PB	ZE	PS	PM	PB	PB
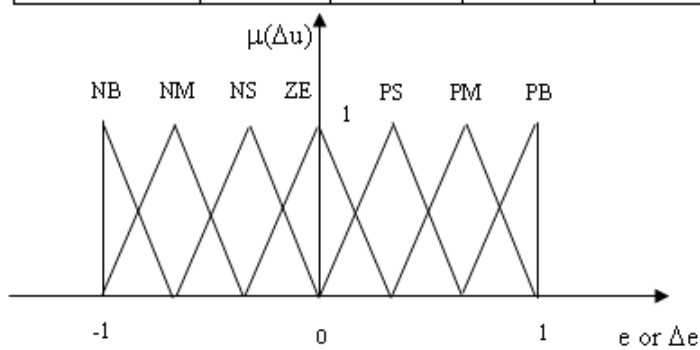
(a) Error or change of error
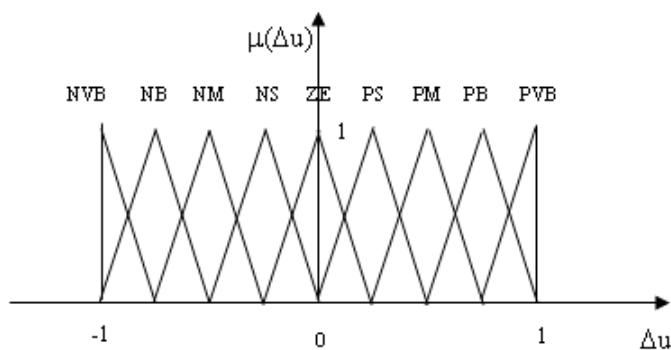
(b) Change in control voltage

Fig. 8 Membership functions with 7I-9O subsets for the three fuzzy variables.

Table 6 Rule base of the FLC using 7I-9O subsets for the three fuzzy variables.

e \ Δe	NB	NM	NS	ZE	PS	PM	PB
NB	NVB	NVB	NVB	NB	NM	NS	ZE
NM	NVB	NVB	NB	NM	NS	ZE	PS
NS	NVB	NB	NM	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PM	PB	PVB
PM	NS	ZE	PS	PM	PB	PVB	PVB
PB	ZE	PS	PM	PB	PVB	PVB	PVB

3.1.2.4 Performance-comparison of the FLCs using different partitioning of the input-output spaces

As small variations in the output variable Δu affects the response of the whole system considerably. Thus, the output variable Δu is more sensitive than the input variables e and Δe. Therefore, a comparison among the responses of γ for the three FLCs, in case of using finer partitioning for Δu, is shown in Fig. 9. It is to be mentioned here that the scaling factors of the three FLCs are set to the optimal values that correspond to each case. It is indicated from Fig. 9 that the greater the number of subsets the better the response of the controller; i.e., the response of Fig. 9(c) is better than that of Fig. 9(b) and the latter is better than that of Fig. 9(a). At the same time the controller complexity is in the same direction; i.e., the controller of Fig. 9(c) is more complex than that of Fig. 9(b) and the latter is more complex than that of Fig. 9(a).
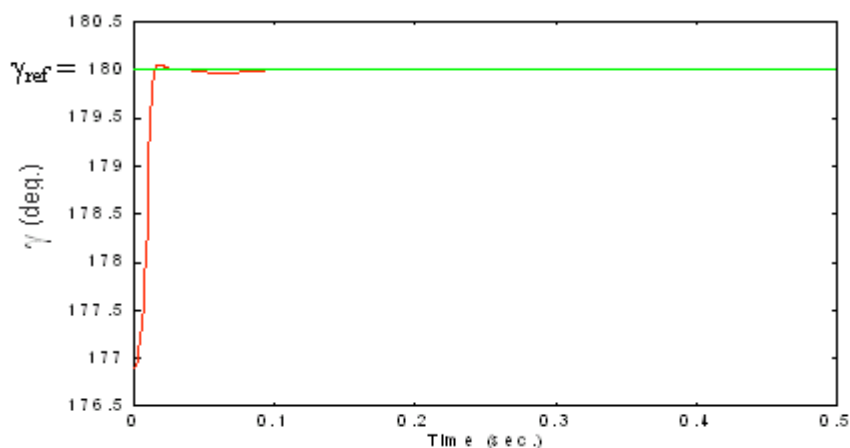
(a) Using 3I-5O subsets for the three fuzzy variables
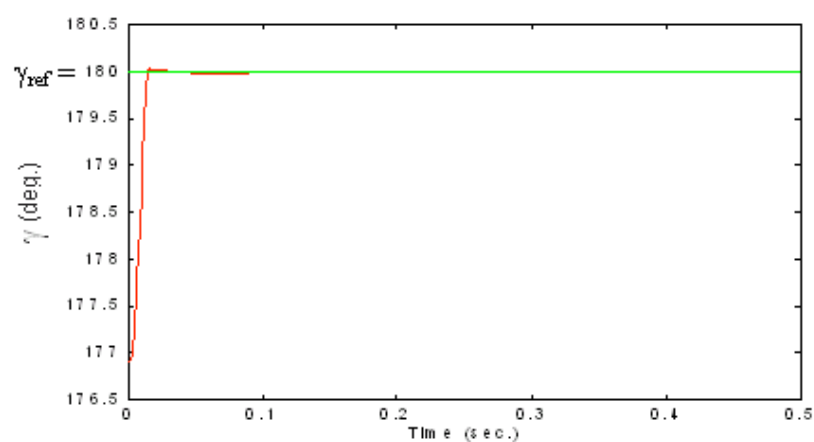
(b) Using 5I-7O subsets for the three fuzzy variables
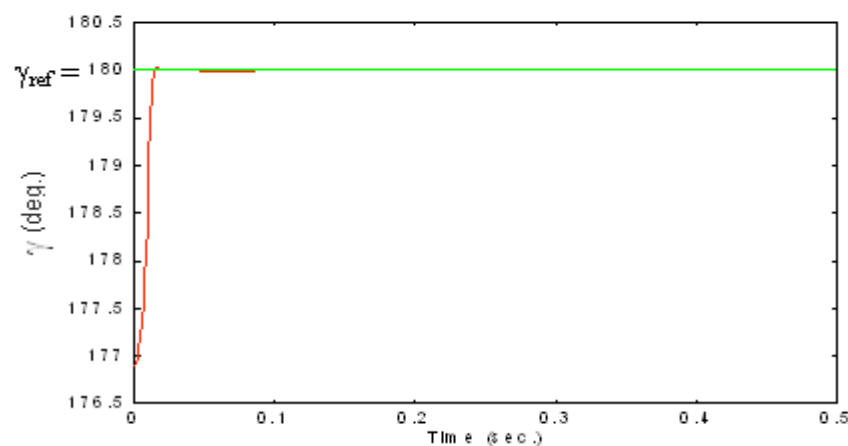
(c) Using 7I-9O subsets for the three fuzzy variables

Fig. 9 Response of γ using finer partitioning of the output variable.

3.2 Selection of the Proper FLC
The FLC that would be selected to be implemented in the practical system must achieve the following features:
1) Be of quick tracking performance (i.e., be of best transient response),
2) Gives no output power fluctuation around the MPP at steady-state (i.e., gives zero steady-state error),

3) Be simple, as possible, to make its software implementation easy and to save memory usage.

To meet these requirements, a performance-comparison table among the considered FLCs is constructed as shown in Table 7. Where, this table includes the different characteristics of each considered FLC. The table indicates that all the considered controllers satisfy the second feature. The first feature is satisfied by the controller number (6), while the third feature is satisfied by the controllers number (1) and number (4). As the controller number (1) has the slowest response, thus it is rejected. Also, the complexity of the controller number (6) makes it undesirable. Since the controller number (4) has nearly the same transient-response characteristics as that of the controller number (6), therefore the controller number (4) satisfies the first feature too. Thus, the only controller that satisfies the three features is the controller number (4). Therefore, the FLC number (4) is selected to be the proper controller.

Table 7 Performance-comparison among the considered FLCs.

Controller number	Number of subsets for e & Δe	Number of subsets for Δu	Number of rules	Rise time t_r(ms)	Settling time t_s(ms)	Maximum overshoot M_P(%)	Steady-state error e_{ss}(deg.)
1	3	3	9	102.9	134.6	1.25	0
2	5	5	25	9.3	14.2	2.92	0
3	7	7	49	9.3	14.2	1.56	0
4	3	5	9	9.3	13.3	1.56	0
5	5	7	25	9.3	13.3	1.15	0
6	7	9	49	9.1	13.3	1.04	0

4. CONCLUSION

The 180° algorithm is used to operate the suggested PV system at the MPP for every instant. The suggested controller is a two-input single-output FLC, which is selected from a six suggested FLCs. The selection of the proper controller is based on the system's best response and on the simplicity of the controller. The 3I-5O FLC is found to be the simplest controller which can, nearly, give the best transient and steady-state responses.

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Sustainability, Silence and Social Responsibility

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Abstract
The results from a recent pilot study investigating consumers' perceptions of the barriers to sustainable consumption show that while the majority of respondents would like to consume more ethically and more sustainably they are not able to. For some, the barrier is related to affordability or accessibility. For most, the barrier is directly related to a lack of information to guide their consumption choices. Where there is information, it is seen as unreliable and untrustworthy. In the absence of information, or its lack of credibility, consumers are disenfranchised and prevented from exercising their democratic rights as citizens by making informed and motivated choices in their consumption behaviour. Such market disruption privileges the imperatives of business and undermines the principles of democratic choice. As corporate citizens, businesses are expected to demonstrate social responsibility by building relationships that are mutually beneficial and publically acceptable. While many businesses make laudable claims emphasising their commitment to Corporate Social Responsibility, the research reported here suggests that the failure to provide adequate information to enable consumers to make informed consumption choices is socially irresponsible and not conducive to developing such relationships. To encourage the synergistic relationships required to achieve long-term sustainability, it is necessary to reconcile the attitudes, motivations and behaviours of individuals with the aims and aspirations of business. Our research suggests that such reconciliation needs to begin with corporations providing the information that consumers need to enact their own commitments to building a more sustainable world.

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Introduction

There is a substantial body of scientific research, and a great deal of public opinion, which suggests that current rates of consumption are unsustainable and, if they are not changed, will have an irreversibly negative impact on the future well-being of society (European Environment Agency 2010; Pollard, Almond, Duncan, Grooten, Hadeed and Jeffries 2010; United Nations Millennium Declaration 2000). In particular, resource depletion, environmental degradation, ecological disruption and social deprivation, are seen as direct consequences of present patterns of consumption which affect people at both macro and micro levels (Held, McGrew, Goldblatt and Perraton 1999). While changes at a macro level are the prerogative of political and international institutions, at a micro level changes can be made by consumers who are increasingly aware of the issues and equally concerned to enact their responsibilities as citizens by making sustainable consumption choices (Leiserowitz, Kates, Parris and Thomas 2006; Baumgartner 2002; Gupta and Sen 2013; Carrington, Neville and Whitwell 2010; Schrader 2007).

However, there are a number of barriers to making sustainable consumption choices, not the least being ready access to reliable information. The research presented here suggests that such information is neither available nor reliable and that consumers overwhelmingly look to companies to resolve it (Thøgersen and Schrader 2012). It is argued that as corporate citizens, companies have a social responsibility to provide such information both to enhance the agency of the consumer and to make transparent the sustainability of their actions.

Sustainability

For the purposes of this paper, we define sustainability as, 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development Report, Brundtland Commission 1987). This definition has provided the basis for subsequent iterations including those enshrined in the United Nations Millennium Declaration (2000) and subsequently endorsed as one of eight development goals at the World Summit in 2005. Phrased in environmental terms, the goal is underpinned by the principle that all living organisms are part of an interrelated and interdependent ecosystem and that any significant interference will have repercussions and consequences for the sustainability of the entire system.

This ecological relationship is conventionally represented in a systematic model that places the environment at the intersection between, and largely subject to, the imperatives of economics, politics and culture (McCarthy, James and Bayliss 2010; Magee, Scerri, James, Padgham, Thom, Deng, Hickmott and Cahill 2013). These imperatives are historically motivated by increased economic growth, expansionist political power and re-newed cultural independence, the cumulative effects of which have resulted in the inexorable growth in human consumption. The consequences of this growth have recently been addressed by the International Resource Panel (2010) promoted by the United Nations Environment Programme (Hertwich, van der Voet, Suh, Tukker, Huijbregts, Kazmierczyk, Lenzen, McNeely and Moriguchi 2010) . In the first global assessment of the critical impact of consumption on the environment, the panel identified resource depletion as a key concern. The greatest threat to

environmental sustainability is the continued increase in human consumption (Jackson and Michaelis 2003; Michaelis and Lorek 2004; Ash, Blanco, Brown, Garcia, Tomich and Vira 2010). For the world's political leaders there is a need to understand that this is a global issue and one which requires concerted action. For consumers there is a need to recognise that changes to their own patterns of consumption can contribute to a more sustainable future. However, for consumers to make such changes they need reliable and accessible information and it is in relation to this that corporations with a societal commitment to Corporate Social Responsibility (CSR) can make a significant contribution.

Attitude/Behaviour Gap

Much research on sustainable consumption behaviour focusses on consumers' intentions. However the assumption that intentions lead to behaviour has been criticized as too simplistic (Carrington, Neville, and Whitwell 2010). Empirical studies such as that by Morwitz, Steckel, and Gupta (2007) suggest that purchase intentions do not always translate into purchase behaviour with one study finding that while 30% of consumers stated they would purchase sustainably, only 3% actually did (Cowe and Williams 2000; Nicholls and Lee 2006). Auger and Devinney (2007) and Calvin and Lewis (2005) have argued that this intention-behaviour gap can be attributed to social desirability bias, while Carrington et al. (2010) consider that this only partially explains the discrepancy and suggest that factors such as purchase contexts and competing demands affect actual behaviour. According to Morwitz et al. (2007), an individual's intention is likely to be farther from reality when predicting behaviour in a new situation such as consuming sustainably. In addition to these explanations for the gap between intention and behaviour, a number of specific barriers have been identified that militate against consuming sustainably. These are price, availability, convenience, quality, a lack of agency, habit, information and a lack of belief in products claims and are discussed briefly below.

Products produced sustainably, frequently described as ethical products and used synonymously in this paper, are generally more expensive than their non-sustainable alternatives and accordingly price has been identified as a major barrier to consuming sustainably (Carrigan and Attalla 2001; Bray, Johns, and Kilburn 2011). A second barrier inhibiting the consumption of sustainable products is availability. Although motivations to consume ethical products may be high, it is impossible to do so if the desired products are not readily available (Vermeir and Verbeke, 2006). De Pelsmacker, Driesen, and Rayp (2003) suggest that sustainable products often have limited availability, are not particularly visible in shops and are usually not adequately promoted. A further barrier is the convenience of purchasing ethical products. There is a general perception, and perhaps a partial reality, that sustainable products are difficult to obtain and require visits to specialized retailers or outlets (Vermeir and Verbeke, 2006). For consumers used to comprehensive choices at single stores, this represents a particular barrier.

Differences in the perceived quality of sustainable products, in comparison to their non-sustainable equivalents, provide a further barrier to consumption. Bray et al. (2011) explain how quality perceptions can take two forms for sustainable products. For some, certain products are perceived to be of higher quality than their non-ethical counterparts, for example, the belief that free-range chicken tastes nicer. Conversely,

some ethical products, for example, "Fair Trade" products, are seen as poorer quality. This perception is based around the idea that when a company is primarily focused on maintaining ethical standards the quality of its products is likely to be lower (De Pelsmacker and Janssens 2007; Bray et al., 2011). Intentions directed towards sustainable consumption, may here by deflected by attitudes towards quality trade-offs.

Consumption habits, and in particular, established brand loyalties are also resistant to change (Bray et al. 2011). Established consumption patterns also tend to make awareness of alternatives less likely (Thφgersen, 1999). While this can be countered by creating ethical retail spaces (Low and Davenport 2007), it also encounters problems of convenience as discussed earlier. The next factor is related to the degree of confidence that consumers have in the sustainability claims regarding the product. The consumer may not believe the ethical claim certain products are making and therefore will not purchase. Consumers' may also recognise inconsistencies in corporate behaviour and believe that 'green washing' is occurring (Moraes, Carrigan, and Szmigin, 2012). Participants in the study by Bray et al. (2011) expressed cynicism about retailers' ethical claims and felt they were marketing ploys that took advantage of consumers' good will by charging a higher price. Participants also believed that the extra premium they paid for ethical products did not reach the end beneficiary as much as promised. Furthermore consumers may have the belief that their personal efforts will not contribute to solving the problem (Vermeir and Verbeke, 2006). In order to motivate behavioural changes in relation to sustainable consumption, a consumer must be convinced that their behaviour has an impact (Roberts, 1996). Therefore, if a consumer is cynical about the sustainability claims made for a product or they do not believe their purchase will make any difference, the opportunity to translate attitude into behaviour is reduced.

The final, and consistently significant barrier to consuming sustainably, is the lack of information about sustainable products. The less information available or the more contradictory it is, the more uncertain consumers will be about purchasing products (Vermeir and Verbeke, 2006). It is noted by Vermeir and Verbeke (2006) that sustainability is a credence attribute, which means consumers are unable to personally evaluate it and have to put their trust in the source that claims sustainability and this can lead to uncertainty. Accordingly, credible and accessible information for sustainable products can be seen as even more important than for their more established counterparts. Research has found that few consumers have a high awareness or knowledge of the characteristics of sustainable products making them more reliant on information provided at point-of-sale (Vermeir and Verbeke, 2006). Sustainable products are often poorly communicated to consumers, which makes it difficult for them to make informed purchase decisions (Vermeir and Verbeke, 2006). In a focus group conducted by Bray et al. (2011) the absence of reliable and accessible product information was raised as a major barrier to consuming sustainably.

In summary, an increasing number of environmentally-motivated consumers would like to consume more sustainably. For these consumers a number of barriers exist that make it difficult to enact the change that they would like and translate ethical consumption intention to ethical consumption behaviour. Once these factors are understood, strategies to overcome them can be developed with the goal of

minimizing the attitude-behaviour gap. A limitation of the literature is that very minimal empirical research has been done specifically regarding the barriers. Therefore, there is no grounding as to which the most influential barriers are or how these differ for different consumers. Research on this would provide a clearer understanding of the attitude-behaviour gap and then focus could be directed towards strategies to overcome the most influential barriers.

Corporate Social Responsibility (CSR)

While definitions of CSR are many and varied (Garriga and Mele 2004; Lee 2008; Diener 2013) most include reference to the importance for businesses to contribute to the common good and to go beyond their own needs to further the social needs of others (McWilliams and Siegel 2001; Lee 2008; Carroll and Shabana 2010; Torelli, Monga and Kaikati 2012; Lin Hi and Muller 2013). According to Garriga and Mele (2004), a corporation's social responsibilities will be determined according to whether its motivations are instrumental or integrative.

Instrumental motivations are characterised by actions that maximise shareholder value and increase competitive advantage (Windsor 2001; McWilliams, Siegel and Wright 2006). Corporate responsibilities in this context are determined by the extent to which they contribute to wealth creation (Jensen 2000). In contrast, integrative approaches to CSR recognise the symbiotic relationship between business and society. These approaches are motivated by a need to balance the demands of the corporation with those of its social constituents. They typically emphasise the importance of honouring their moral as well as their legal responsibilities and are concerned to contribute to the well-being of society in general as well as to that of their immediate stakeholders in particular (Lindgreen, Swaen and Johnston 2009).

This is a more altruistic expectation of the role of business than is generally understood and one which introduces a tension between a company's need to make a profit and its responsibility to profit the needs of others (Carroll 1999). This tension could be resolved by aligning business imperatives with sustainability issues and by seeing business and society as integrated social entities in a symbiotic relationship creating shared value and providing mutual benefit (Maak 2007). Such a relationship would enable corporations to apply their often substantial resources, typically talented management and extensive experience and expertise to address the environmental issues with which they are most aligned (Porter and Kramer 2006) and the dependence on which they mostly rely. The provision of reliable and accessible information to enable consumers to make sustainable consumption choices would be an essential part of this relationship and remove one of the key barriers that affect it.

Research Design

The following research objectives thus guided the current study:
1. To understand consumers ' attitudes to sustainability information
2. To understand the role of information relative to other barriers to sustainable consumption identified in the literature
3. To understand consumers perceived importance and satisfaction with information on a range of sustainability issues

4. To explore demographic differences in attitudes to sustainability information and barriers to sustainable consumption

Purpose

In order to understand consumer's general attitudes to sustainability information, the perceived barriers to sustainable consumption, and the perceived importance and satisfaction with information on a range of sustainability issues, an online survey was designed and administered via an independent research panel.

Materials and Procedure

The survey began by asking respondents to indicate their agreement or disagreement on a 1-5 Likert scale to four attitude statements. These statements were: 1. "It is a corporation's corporate social responsibility to provide information on how sustainable their products are"; 2. "I believe that more information is necessary to make sustainable consumption"; 3. "There should be a standardised labelling system for sustainable products"; and 4. "I think the claims made on sustainable products are credible". The following section of the survey asked respondents to rate how significant (1 = not significant - 5 = very significant), they perceived the following barriers to sustainable consumption to be - price, availability, convenience, product quality, untrustworthiness of sustainability claims, lack of information on product packaging, lack of information on sustainability issues, habit and routine, and the belief that their individual consumption choices would not make a difference. Section Three asked "How important do you think it is for companies to provide information on the following issues on their product packaging?" (1 = not at all important, 5 = very important) and "Generally, how satisfied are you with the quality of information available on these issues?" (1 = not at all satisfied 5 = very satisfied) for the following issues: use of unsafe chemicals, recycling materials, animal rights, fair trade, labour and human rights, pollution, resource and energy conservation, organically produced food. Finally, demographic data was collected including age, gender, education, and household income.

Sample

The final sample totalled 510 respondents aged over 18 years. The average age of respondents (recorded in 5 year brackets) was 40-44 years, and the average household income NZ$40-59,000. There was an even gender split among respondents - 49.4% male and 50.6% female. With regards to education, 1.8% of respondents had no secondary schooling, 35.9% a secondary school qualification, 27.1% a trade or professional qualification and 35.3 a university level qualification.

Data Analysis

SPSS was used to calculate descriptive statistics to describe the level of support for each of the attitude questions, the relative importance of perceived barriers, and the importance of and satisfaction with information on the issues identified. T-tests and ANOVA were used to compare means for the four attitude questions, and perceived barriers, based on age, gender, income and education.

Results

Attitudes to Sustainability Information
The distribution of responses to the four items measuring attitudes to sustainability information are presented in Table 1 below:

	% of people who strongly agree or agree	% of people who are neutral	% of people who disagree or strongly disagree	Mean
It is a corporation's corporate social responsibility to provide information on how sustainable their products are	68.9%	24.3%	3.8%	3.91
I believe that more information is necessary to make sustainable consumption choices	75.7%	21.8%	2.6%	3.97
There should be a standardised labelling system for sustainable products	78.2%	19.2%	2.6%	4.03
I think the claims made on sustainable products are credible	28.6%	54.9%	16.4%	3.14

Barriers to Sustainable Consumption

The most significant perceived barrier to sustainable consumption was price with a mode of 5 (very significant) ($M = 4.23$, $SD = .870$). Also perceived as significant barriers (mode 4) were; availability ($M = 3.83$, $SD = .828$), convenience ($M = 3.79$, $SD = .878$), inferior product quality ($M = 3.69$, $SD = .965$), untrustworthiness of sustainability claims (M 3.67, $SD = .933$), and a lack of information on product packaging (M = 3.60, $SD = .904$). Respondents reported feeling neutral (mode 3) with regards to the significance of a lack of information on sustainability issues ($M = 3.53$, $SD = .927$), habit and routine ($M = 3.43$, $SD = .941$) and a lack of agency ($M = 3.07$, $SD = 1.08$) as barriers to consumption.

Importance and Satisfaction with Sustainability Information

In terms of the importance of companies providing information, those issues considered very important (mode 5) were - use of unsafe chemicals ($M = 4.24$, $SD = .873$) and recycling materials ($M = 4.01$, $SD = .908$). All other issues were considered important (mode 4) including animal rights ($M = 3.92$, $SD = .990$), fair trade ($M = 3.87$, $SD = .964$), labour and human rights ($M = 3.86$, $SD = .982$), pollution ($M = 3.85$, $SD = .955$), resource and energy conservation ($M = 3.77$, $SD = .956$) and organically produced food ($M = 3.65$, $SD = 1.07$).

In terms of satisfaction with the quality of information available on these issues (1 = not at all satisfied - 5 = very satisfied), the mode of 3 for all items suggests respondents were neither satisfied nor dissatisfied.   The following means were reported (in decreasing order): recycling materials (M = 3.28, SD = .940), resource and energy conservation (M = 3.09, SD = .940), organically produced food (M = 3.06, SD = .891), animal welfare (M = 3.05, SD = .966), fair trade (M = 2.97, SD = .895), labour and human rights (M = 2.96, SD = .931), pollution (M = 2.90, SD .951), and use of unsafe chemicals *(M* = 2.70, *SD* = 1.03).

Demographic Differences

An ANOVA, including a test of homogeneity of variance, was performed to test the effect of demographic differences on people's attitudes to sustainability information and the perceived barriers to sustainable consumption.

Gender

An independent-samples t-test was conducted to compare barriers across genders. There was a statistically significant difference in the scores for males and females on availability as a barrier t(503) = -2.85, p = .004, with females (M = 3.93, SD = .791) seeing it as a more significant barrier than males (M=3.72, SD=.853). Females also perceived convenience as a more significant barrier (M = 3.88, SD = .840) than males (M = 3.70, SD = .907) *t*(503) = -2.29 p = .022, as well as lack of information on product packaging t(508) = -2.48, p = .013, females (M = 3.70, SD = .851) and males (M = 3.50, SD = .947). The only barrier perceived as more significant for males (M = 3.19, SD = 1.07) over females (M = 2.950, SD = 1.08) was a lack of agency *t*(508) = -2.61, p = .009.

In terms of gender differences females were more likely to agree with statement two "I believe that more information is necessary to make sustainable consumption choices"(M = 4.05, SD = .773) than males (M = 3.90, SD .782), t(508) = -2.18, p = .030.   Females (M = 3.21, SD = .771) were also more likely to agree with the statement "I think the claims made on sustainable products are credible" than males (M = 3.06, SD = .858), t(508) = -2.02, p = .044.

Age

In terms of perceived barriers to sustainable consumption: price, *Welch's F*(4, 247) = 4.20, p = .003; availability, *Welch*'s *F* (4, 243) = 2.69, p = .032; product quality *Welch's F*(4, 246) = 6.65 p = .000; and lack of information on product packaging *F*(4, 505) = 3.59, p = .007, showed statistically significant differences across age groups. Tamahane post hoc comparison showed price to be perceived as a less significant barrier to those aged 18-30 (*M*= 3.92, *SD* = 1.03) than to those aged 40-49 (*M* = 4.32, *SD* .891) p = .043, those aged 30-39 (*M* = 4.32, *SD* .834) p = .025 and those aged 50-59 (*M* = 4,43, *SD* .685) p = .001. Tamahane post hoc test showed price to be less important to those aged 18-30 (*M* = 3.63 *SD* .943) than those aged over 60 (*M* = 3.99, *SD* = .695) p = .016. Product quality was perceived as a more significant barrier to those aged over 60 (*M* = 4.05, *SD* =.891) than to all other age groups. Tukey post hoc comparisons showed lack of information on product packaging to be perceived as a

more significant barrier to those aged over 60 ($M = 3.82$, $SD = .883$), than to those aged 30-39 ($M = 3.41$, $SD = .894$) p = .008.

With regards to attitudes towards sustainability information age was found to be significantly different for statement one "It is a corporations corporate social responsibility to provide information on how sustainable their products are" *Welch's* $F(4, 242) = 6.72$, p = .000. Tamahane post hoc comparisons showed those aged 18-29 were less likely ($M = 3.56$, *SD* .928) to agree than those in their 40's ($M = 4.06$, *SD* = .795), p = .001 and those over 60 ($M = 4.11$, *SD* = .711), p = .000. Differences were also found for statement two, *Welch's* $F(4, 244) = 3.98$, p = .004, young people ($M = 3.76$, *SD* .927) were again less likely to agree with the statement "I believe that more information is necessary to make sustainable consumption choices" than people in their 40's (M = 4.10, $SD = .696$) p = .030 or people over 60 ($M = 4.12$, $SD = .715$), p = .018. Statement three also showed significant differences, *Welch's* $F(4, 245) = 7.01$, p = .000, Tamahane post hoc revealing people over 60 to be more likely to agree with the statement "there should be a standardised labelling system for sustainable products" ($M = 4.29$, *SD* .681), than those in their 30's ($M = 3.87$, *SD* = .792), p = 000 and those aged 18-30 (M3.80, *SD* .915), p = .000. Significant differences were also found for statement four "I think the claims made on sustainable products are credible" $F(4, 505) = 2.58$, p = .004, Tukey's post hoc comparisons showed people in their 50's to be less likely to agree with this statement ($M = 2.85$, $SD = .722$) than those aged 18-29 ($M = 3.20$, *SD* .808), p = .033, those in their 30;s ($M = 3.25$, SD.841), p = .008, and those over 60 ($M = 3.24$, SD.792), p = .007.

Education

An analysis of variance showed that education was statistically significant for only the perception of product quality as a barrier, *Welch's* $F(3, 38.4) = 4.65$, p = .007. Tamahane post-hoc comparisons showed those with a university degree were less likely to perceive product quality as a barrier ($M = 3.49$, $SD = 1.07$) than those with a trade qualification ($M = 3.88$, $SD = .888$) p=.002.

With regards to attitudes to information no significant differences were found across the four items for education at p < .05.

Income

Income was found to be statistically significantly different for the significance of price $F(6, 503) = 2.19$, p = .043, and agency F(6, 503) = 3.52 p = .002 as barriers to sustainable consumption. Tukey's post hoc comparisons showed those earning $60-80,000 perceived price as a greater barrier ($M = 4.43$, $SD = .671$) than those earning over $120,000 ($M = 3.92$, $SD = 1.03$) p = .021. Those earning $40-60,000 were less likely to perceive a lack of agency as a significant barrier ($M = 2.83$, $SD = 1.08$), compared to those earning $20-40,000 ($M = 3.27$, $SD = 1.03$), p = .038 and those earning $100-120,000 ($M = 3.48$, $SD = 1.07$), p = .019.

With regards to attitudes to information no significant differences were found across the four items for income at p < .05.

With regards to barriers to consumption, price is more significant to middle income earners than to high income earners; and less important to 18-30yrs than other age groups. Females perceive availability, convenience and lack of information on packaging as more significant barriers than males. Lack of agency is less significant to middle income than high or low income earners; and more significant to males. Product quality was a more significant barrier to those aged over 60yrs; and less significant to those with university education than those with trade qualifications.

Discussion

A number of studies show that while many consumers would like to consume more sustainably a variety of barriers prevent them from so doing. These barriers have been identified as price, quality, availability, convenience, information, belief, and habit (Carrington et al; Bray et al. 2011). The present study confirms these factors as barriers, but also investigates their relative importance. Price is shown to be the dominant barrier with availability, convenience, product quality, untrustworthiness of claims and a lack of information also seen as significant. However consumers did not perceive habit and routine, lack of information on sustainability issues, or a lack of agency to be particular barriers. Some demographic differences were found in terms of the barriers to sustainable consumption – price is understandably a less significant barrier to high income consumers. Perceptions of lower quality appear to be changing, with young consumer less likely to see this as a significant barrier. Women perceive availability, convenience and lack of information on packaging as greater barriers than men, perhaps due to their major household shopping role. However women were less likely to perceive a lack of agency as a barrier, this is supported by women's stronger agreement with the statements that more information is necessary and less likely to agree that sustainability claims are credible.

The distinction made in this study between information on sustainability issues and sustainable product information highlights the role that corporations must play in enabling consumers to consume sustainably. While consumers have enough general information and awareness of the issues, they lack the specific product information to guide their consumption choices. This information can only be provided by corporations and this, we argue, is a fundamental part of their commitment to CSR. While barriers such as price and availability are largely managerially-orientated, the provision of information is closely related to a company's ethical orientation and the nature of its commitment to CSR. As corporate citizens, a company's social responsibility would be to respond to its constituents' calls for more information.

The focus of this research was on information as a barrier to consuming sustainably. Our findings show that across a range of sustainability issues considered important by consumers, they were unsatisfied with the quality of information provided on products. Consumers are also overwhelming dissatisfied with the product information available, they believe they need more information to make sustainable choices (76% of respondents), agree it is a corporate's responsibility to provide this information (70%), and desire a standardised labelling system for sustainable products (78%). These attitudes are relatively consistent regardless of income and education, with only small effects for gender and age reflecting widespread support regardless of demographic variables.

Conclusion

In the absence of information, or its lack of credibility, consumers are disenfranchised and prevented from exercising their democratic rights as citizens to make informed and motivated choices in their consumption behaviour (Burchell and Cook 2006). Such market disruption privileges the imperatives of business and undermines the principles of democratic choice. As corporate citizens, businesses are expected to demonstrate social responsibility by building relationships that are mutually beneficial and publically acceptable (Porter and Kramer 2006). While many businesses make laudable claims emphasising their commitment to CSR, the research reported here, suggests that the failure to provide adequate information to enable consumers to make informed consumption choices is socially irresponsible and not conducive to developing such relationships.

To encourage the synergistic relationships that must underpin long-term sustainability and which eschew conflicting priorities, it is necessary to reconcile the attitudes, motivations and behaviours of individuals with the aims and aspirations of business. Our research suggests that such reconciliation needs to begin with corporations providing the product information consumers need to demonstrate their own commitments to building a more sustainable world.

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Rethinking the Urban Fabric to Ensure Urban Lungs:
Case Gulshan Area in Dhaka City, Bangladesh

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Abstract
There cannot be a definition of a phenomenon, such as sustainability, which differs with varying context. Sustainable design intervention has to be adaptive and can only be incorporated successfully after a holistic research approach. In certain places the use of foreign materials is more sustainable to address existing issues than Vernacular materials but sometimes it is vice versa. The application methods for introducing sustainable design and the process of its impacts henceforth will differ for each context. Sustainable architecture generates a certain environment that is efficient, regenerating and provides a healthy effective life.

In the context of Gulshan area in Dhaka the concrete urban morphology became a severe issue. It limits the visual and physical connectivity which hampers continuous access to spaces. In Dhaka the scarcity of land, due to high population density is a threat to existing water bodies; as there is a tendency to encroach low-lying areas to retrieve buildable area. The much neglected Gulshan Lake, if revived, may provide scenic view to the cityscape. The lake is now almost moribund due to unplanned urban interventions; being isolated by the encompassing Gulshan, Mohakhali, Banani and Baridhara Diplomatic Zone. This paper proposes attempts to intervene in the urban fabric; which might revitalise the lake and connect surrounding greenery to propose an urban lung.

Key words: sustainability, Connect green, lake revitalization, rethink façade and urban lungs.

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Introduction

1.1 Background

Bangladesh is encompassed by both interconnected and independent waterways which channels within urban and rural neighbourhoods. This asset, despite of all its' potentialities, is continuously being abused. There has been augmented urban population due to migration from rural areas to the centralized Dhaka city. Due to the increasing population, by 2020 Dhaka will become one of the most densely populated cities in the world with an estimated population of 22.04 million (City Mayors). The capital of Bangladesh, Dhaka city is experiencing a phase of urban growth; this emergent metamorphosis, of a developing economy, is posing chaos to the city fabric. Dhaka will be a megacity by 2020 (State of the World's Cities 2006). There is no particular solution to dictate the mode of influxed population and the changing urban fabric. These resulted in growth of sporadic informal settlements, permanent residences for the economically solvent and commercial enterprises. The population is being accommodated in vertically expanding apartments due to land scarcity. Hence Land is being retrieved, through sedimentation of water bodies, for further construction. The augmented urban issues faced by Dhaka, due to lack of initiative for design confrontation, are deteriorating the cityscape. In 1975 Dhaka had 44.8% green which by 2005 reduced to 24.1% (Dewan et al., 2009). Dhaka city is now a concrete fabric lacking sufficient breathing zones such as parks.

The situation is precarious as the water bodies are threatened by land filling, garbage disposal, sewage dumping and diffusion of acidic industrial waste. Due to this the culverts are clogged, which hampers continuous water thoroughfare. The concrete cityscape is flooded in monsoon due to lack of water absorption area. The use of private motor vehicle, shortage of trees and lack of open spaces consequently amplifies the heat island effect in the city. Dhaka is now stressed with a deteriorating environment due to pollution, population, unplanned growth, inadequate green and maltreated water bodies. The study is aimed at developing context based sustainable approach, from an urban design perspective, to introduce urban lungs.

There are still some existing water bodies scattered throughout Dhaka city, which if retrieved may aid to restore a healthy environment. Catherine Dee stated that, aims of development are to conserve, protect, enhance and regenerate the ecosystems which have been contaminated (Page 8, 2001). Gushan Lake was selected due to the variety in zoning, income groups and activities it is exposed to.

Comprehensive lake revitalization may promote the following:
- Encourage walking, through connectivity of spaces, to reduce vehicular traffic.
- Introduce civic facilities to aid social integration.
- Promote green for urban relief, water retention and reduce heat island effect.
- Make the lake pollutant free and suitable for water transport.

1.2 Methodology

The Modus operandi, of the proposed holistic architectural endeavour, is aimed at sustainability. The design considerations attempted to analyse the aspects of site history, socio cultural context, climate, environmental constraints, economic

potentials, aspirations, current trend and the existing urban issues. This was done through subjective observation during site survey and taking informal interviews of neighbourhood people. The field survey comprised of frequent site visits. The most effective way was to walk through the road networks encompassing the lake and leading to the lake. This aided informed design decisions, considering legible reasoning, respecting the site. According to Kevin Lynch, "Effective adaptability depends on the dissemination of information, so that decision makers can take advantage of the adaptability that in fact exists" (Page 183, 1984).

The road networks and streets nodes were experienced for the following reasons:
- To know the reasons behind maltreatment of lake and poor maintenance of surrounding.
- Feel the texture of the prevailing urban fabric.
- Comprehend the scale of street space created through building height variation.
- Identify the activity pattern, in the street, at different times of the day
- Record the means of transport and the time of traffic congestion
- Identify streets with direct view towards the lake and know the condition of the lake edge.
- Know the crowd and their access route to the public realm.
- Conceive the required landscape elements.
- Collect information on the site biodiversity.
- Note the strength, weakness, threats and opportunities.

A digitalized study area map was made to understand the built- open space ratio, specify the various land use patterns, locate interconnected or interdependent areas, know the accessible networks, register the discontinued paths and calculate the percentage of existing green.

1.3 Limitations

This paper is from a single perspective and requires view of other individuals from a variety of fields. A proper study would take longer time to understand demands of users, changing character of the place, analyze impact of each structure and locate the potential points for intervention.

Site

2.1 Site history
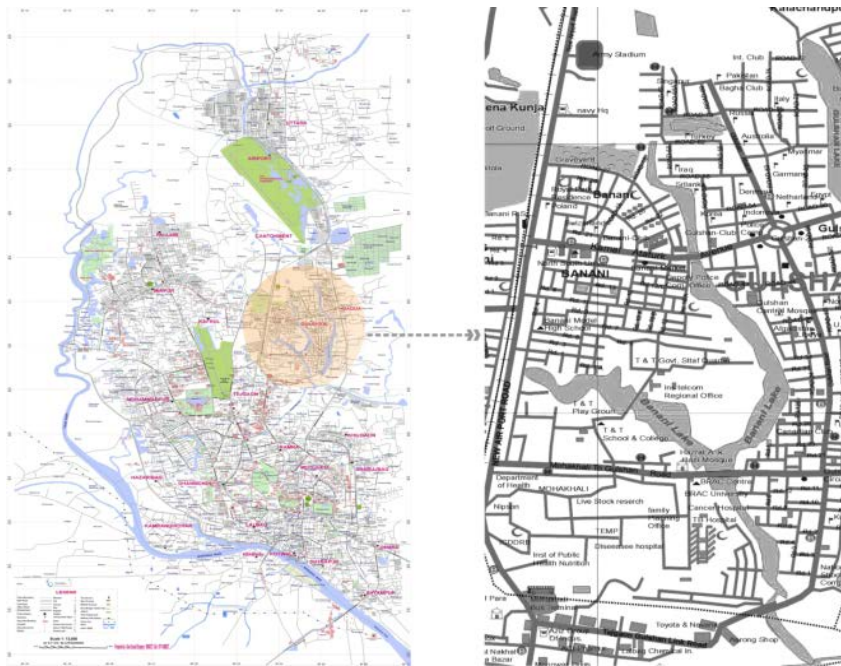
Figure – 1: Location Map of site from Dhaka Map (Source: Rajuk Office)

The places that contain perneable and imperbeable green are:

Parks and playgrounds

Gulshan Ladies Park
Gulshan Tank Park
Adeal Field
Man power ground
Chairman Bari field
Banani Road-7 park
BWDB Cricket ground
Gukshan South park
T and T field
WASA plot

Institutions

American club
The Gulshan club limited
Banani Club
Gulshan police barrack
Gulshan police station
Bangladesh food safety forest office
International telecom regional office

Housing

Niketan Housing
Customs quarter
Rajuk Colony
Civil Aviation quarter
BNP Palli
Dipayon housing limited

Religious Buildings

Banani society mosque
Banani catholic church
Customs quarter mosque
Gulshan central mosque
Jame mosque
Gausul Azam mosque
Banani Graveyard

Schools

Gulshan Model school
Banani Vidya Niketan
Banani Model school
T and T school and collage

Universities

Bangladesh collage of physicians and sugeons
Titumir collage field

Hospitals

Bangladesh Hospital
Infectious Disease Hospital
Cancer Hospital
TB Hospital

Height of Urban Fabric
9' Slums
50'-60' Apartments
100'-200' High rise office buildings

- Existing Parks
- Green area inside institutes
- Potential green spaces
- Institution
- Hospital
- University
- School
- Graveyard
- Lake Hatch
- Middle Income Residences
- Housing
- Higher income group
- Korail Slum
- Mixed Use
- Religious Building

North

Figure – 2: Land use

Gulshan area planned around 1961, as a model town, slowly got engulfed into Dhaka. Though it was planned for residential purpose, with changing demands, it evolved into a mixed residential and commercial zone since 1990. The area moulded into a heterogeneous character; but negligible attention was given to the capacity of the existing infrastructure to accommodate such diversity. Most mixed developments were saturated adjacent to major roads. The land use pattern of the site is shown in figure-2. It is an affluent neighbourhood comprising of foreign embassies,

headquarters of local or multinational companies, clinics, hospitals, religious institutes, restaurants, modern shopping centres and posh residences.

The Gulshan Lake was initially a canal of River Balu, situated on the east of Dhaka, connected with the Dhanmondi Lake, Hatirjheel, Begun bari khal and Rampura water body. It is now disconnected through land appropriation. This is a consequence of high population density and an unplanned growth of urban morphology. The disconnected canal has two distinct parts. One part is called Gulshan-Bananni Lake and the other part is called Gulshan-Baridhara Lake. The current location of the lakes can be seen in figure-1.

2.2 Observations derived from site analysis
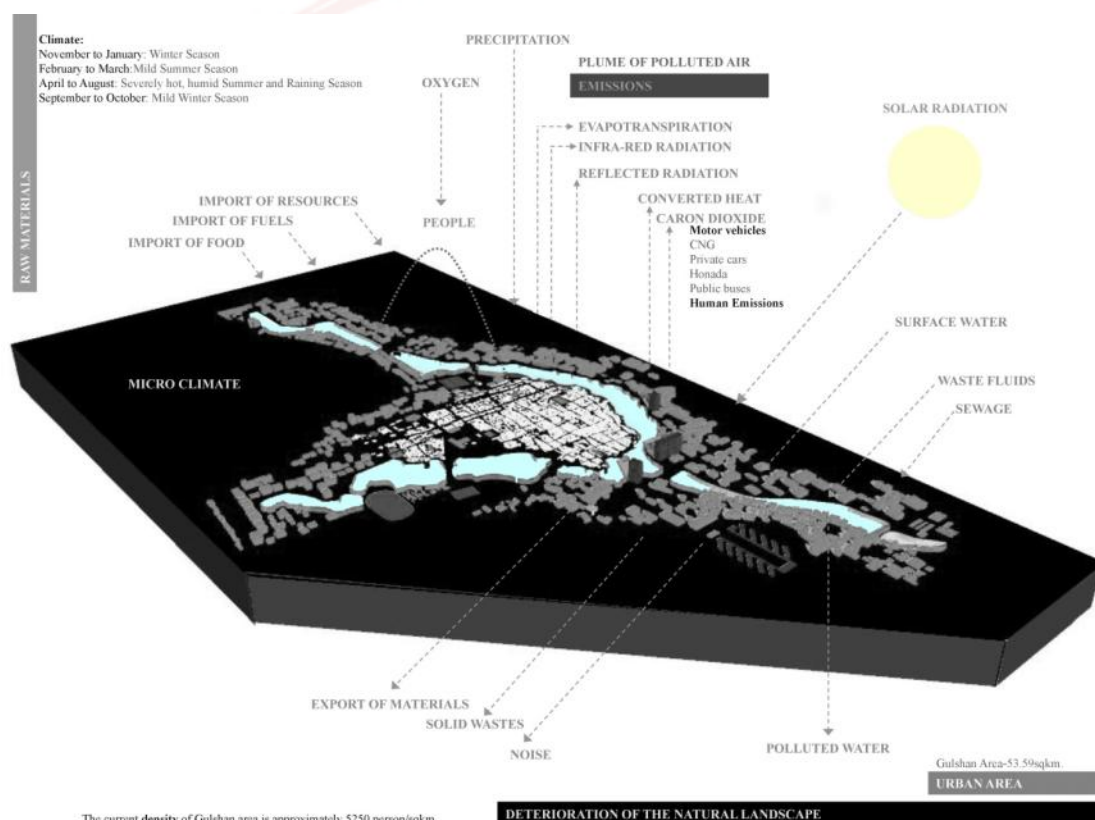
Figure – 3: Current site environment

The paper is focused on one part of the lake that is the Gulshan-Bananni Lake. The scenario of the lake, around 2011, is as follows:
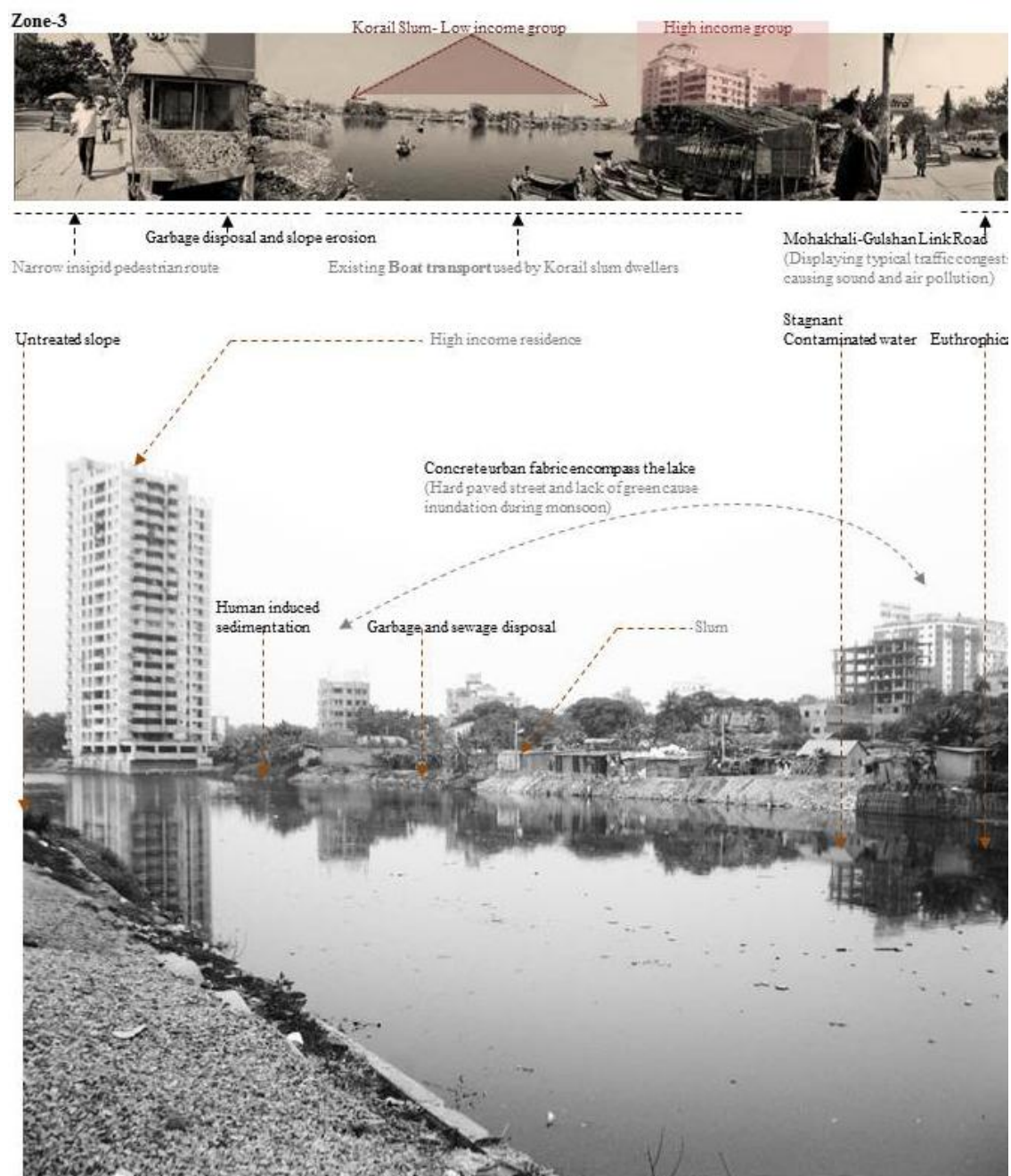
Figure – 4: Site image showing typical lake edge

The site, due to rapid urbanization and population growth, has transformed into a salmagundi of issues. These include concrete urban fabric, discontinuous walkways, negligible maintenance, inadequate public amenities, imbalanced biodiversity, lack of green area, heat generation, air and sound pollution. During monsoon roads are inundated due to hard paved cityscape with no green for water absorption. These narrow roads suffer vehicular traffic congestion. As shown in figure-3 and 4, the isolated lake is maltreated with industrial toxic discharge, sewage disposal, improper drainage, untreated garbage (organic and inorganic) from surrounding residences and encroached by illegal sedimentation. It is becoming an epitome of environmental degradation with eutrophication, sedimentation and acidification resulting in contaminated toxic water.

Existing green areas inside institutes, parks, play ground and unclaimed lands

Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6
American club,	Adeal field	Gulshan central mosque	International Telecom	Chairman Bari field	Niketan Park
Gulshan Ladies Park	Man power ground	Dipayon housing complex	Regional office		
Banani society mosque field		BWDB cricket ground	T and T field		
Banani Graveyard		Jamae mosque	T and T school and college		
Banani Catholic Church		Banani road- 7 Park	Titumir collage field		
Wasa plot		Banani model school			
Customs quarter		Gusul Azam mosque			
Rajuk colony					
civil aviation quarter					
Banani club field					
Banani Vidya niketan					
Gulshan club					
Gulshan police barrack					

The continuous pedestrian route along the lake edge encompass the green areas, comprised by these zones, forming promenade.

Figure – 5: Zones of intervention

The issues are discussed in detail for each zone (refer to figure-5)

2.2.1　Zone-1:

It is a secluded residential zone with minimal vehicular traffic. This zone is the terminating point of the proposed water front development. The recently constructed Banani Bridge and Kamal Attaturk culvert ensured a continuous pedestrian walkway around the lake. These walkways are not well maintained; a significant numbers of low-income settlements occupy these footpaths and slopes. The lake has green spaces in close proximity comprised within government and private institutes as specified in figure-5. But it is encompassed by visually impermeable boundary walls, depriving the locality of a continuous green view and spaces of relief. There are other unclaimed lands adjacent to the lake to propose green. The abandoned Wasa plot, for example, can be a green urban court to give relief in the monotonous concrete jungle. The facades have backside towards the lake, as the design was not lake sensitive. There

are temporary gathering spots in the area, such as tea stalls and vendors, at particular time of the day.

2.2.2   Zone-2:

The recently constructed Banani Bridge has become a public gathering spot due its extensive contribution in surrounding cityscape development. The Gulshan area of the lake is residential but the side opposite to it is commercial. A Sculpture park has been recently built adjacent to the Airtel tower in the commercial part. Even though nominal in approach, it became a buffer space from the busy street. But the pedestrian walkways are narrow with vendors setting movable food stalls over it. The green areas in this zone, mentioned in figure-5, are with partial visual permeability.

2.2.3   Zone-3:

The Mohakhali-Gulshan link road is the major artery leading to this zone. The zone is characterised by the shear contrast between Korail slum on one side and high income residences on the other side. korail slum, the largest slum in Bangladesh, occupies approximately 90 acres of land with a population of around 120000 people. The expanding part of Korail slum is now encroaching the lake edge. Since the lake is a vital need for the daily activities of slum inhabitants their abode design considers the lake. The many uses of the lake, by the slum dwellers, are water for bathing or washing, transport and sewage disposal; as there is inadequate infrastructure to serve the Korail population. The poverty stricken slum dwellers tend to rely heavily on natural ecosystem depleting it. The high income residences remain oblivious to the lake; settled in enclosed introverted spaces encompassed by high walls. The façade backside, of these residences, is towards the lake. Such design has made the lake visually impermeable to the passerby. These residences have further encroached the lake edge walkways to expand the plots. The narrowed discontinued footpaths are not always accessible to the lake. It has no sitting area and accommodates temporary tea stalls or food kiosks. Such activities abuse the lake edge with garbage disposal.

A boat stop exists on the Mohakhali-Gulshan link road; primarily used by Korail slum dwellers as a transport to work places and university students for recreation. The recreational aspect of the boat is still unexplored and pursued informally. If it is promoted as a business venture it has potential to be a major source of earning for the lower income group. Such an intervention may produce a celebrated urban realm; serving various income groups by same facilities ensuring social equity. A proposed deck may stage cultural programs and room handicraft stalls. This might be executed by the lower income group as an income source. It will become a conglomeration of commercial and cultural possibilities.

The zone comprise of green spaces constituted within institutes, religious structures and housing as mentioned in figure-5; often with limited visual permeability from road. The unclaimed lands adjacent to lake can be designed to enhance green.

2.2.4   Zone-4:

It is an active zone comprising numerous, small scale, makeshift shops on the roads sides and culverts; to serve the local community. These small scale commercial

activities include vendors of vegetables, chickens, wielding workshops for rickshaws or motor cycles, tea stalls and plantation nursery. It has a suffocating environment, with narrow roads, congested by shop customers and cars. Due to the shops the garbage disposal in this zone is higher. These shops hamper visual connectivity to the lake. Some institutes in the area consists green spaces, as mentioned in figure-5, but encompassed by high boundary walls. Among these the T and T field remains active, as the local youngsters play sports here. The lake of zone-4 and 5 has been divided by a vehicular road; which if replaced by a culvert or bridge, may give access to water transport underneath it.

2.2.5 Zone-5:

It is comprised of introverted high income residences. A significant portion of the residences belongs to NAM village housing, allocated for government officials. The lake edge has promoted sprawl of makeshift automobile workshops. The unreserved land and existing green areas can be proposed as green relief. One such area is the Chairman Bari field. The lake edge has maintained wide walkways.

2.2.6 Zone-6:

The neighbourhood is a planned residential area. Niketan Housing Project is situated in this zone. Banani Lake merges with Hatirjheel at the tip of the lake; the Niketan Bridge and Niketan Park is located at this point. A small scale temporary business of fruits is located on the bridge. The Niketan Park design is not Lake Sensitive; enclosed by high fences which disrupts the view and has sitting which is not directed towards lake view. The footpath is at one side of the zone and do not envelop the park; it is discontinuous, unmaintained and narrowed by makeshift tea stalls on the sides.

2.3 SWOT analysis of the six zones proposed to be intervened:

Strengths:
- The neighbourhood has various economic classes and age groups influencing the site with diversified activities.
- There are ample green areas, though scattered; which is an advantage for the waterfront development.
- There is potential to develop an income generating water transport facility.
- The primary roads are wide.
- The newly constructed Banani Bridge by Vitti Sthapati Brindo Ltd. has set a standard for the entire waterfront development.
- The lake is still visible from the streets due to open but narrowed pocket spaces.
- The lake, during flood, acts as flood control reservoirs.

Weaknesses:
- High income residences remain oblivious to the lake. They have no lakefront terraces and block lake view by impermeable high walls.
- The Korail slum is expanding. The slum dwellers rely on the lake for water supply, transport and sewage disposal. Untreated sewage is also disposed from the residential apartments.

- The drainage system is not adequate for the dense neighbourhood.
- The garbage disposal system is not planned and remains scattered and exposed in the streets.
- Narrow discontinuous pedestrian walkways, with no seating area, encourage illegal settlements.
- There are not enough pedestrian walkways to ensure safe movement adjacent to vehicular roads.
- In Dhaka most lands are used for constructions, leaving little area for green, threatening existing water bodies of land-filling. The present Dhaka has only 8% tree coverage while 20% green spaces are required for an ideal city (Dewan et al., 2009). The absence of green is increasing the heat island effect and air pollution.
- Lack of interactive space in site. According to Zareen Habiba Islam, "in Dhaka a vertically expanding apartment culture has emerged with no interaction between dwellers (CAA)".
- There are no allocated parking lots for cars, rickshaws and other vehicles. They are parked in streets and pocket spaces. The situation is getting worse as the number of private schools, universities and commercial complex are increasing; with no parking in the institute complex.

Opportunities:
- Scope for large-scale water transport.
- Bio-diversity can be enhanced through green belts and water treatment.
- Has potential to be a celebrated waterfront if intervened with rational objectives.
- Introduce a culture of walking, throughout the lake and surrounding green, reducing motor vehicle usage.
- The low income group might be aided by creating job and business opportunities for them in the development. This may include boat transport management, shop keepers of handicraft and food kiosks.

Threats:
- Growth of Korail slum and prevailing unemployment threatens social equity.
- Polluted water affects biodiversity of terrestrial and aquatic life; posing threat to human health as well.
- Dark and unsafe streets encourage illegal activities.
- The lake slope is not treated and suffers soil erosion during monsoon. It is a threat for pedestrians.
- It will take time to divert people to a different mode of transport such as boats, walking and cycles rather than motor run vehicles; as people may choose luxury over environmental benefits.

3   Design Interventions

According to Spiro Kostof, "If we still believe that cities are the most complicated artifact we have created, if we believe further that they are cumulative, generational artifacts that harbor our values as a community and provide us with the setting where we can learn to live together, then it is our collective responsibility to guide their design" (1999).

3.1

The waterfront development embodies several experiential typologies of infrastructural, recreational and commercial elements. These elements are juxtaposed in the myriad of urban elements to create a public realm. The lake oriented intervention is to develop a healthy, habitable and accessible neighbourhood; making it permeable to lake through physical and visual connectivity rendered by recreational spaces. The public realm should be durable, accessible, recreational and aesthetically pleasing. The proposed design elements are intended to have inherent adaptability, suggesting minimal hindrance to the existing fabric. This may aid the evolving urban development with sustainable solutions. The proposed public places are complimentary to the waterfront development. According to Matthew Carmona et al., temporal dimension in public realm is defined by heterogeneous public activities it offers at different time cycle of the day or simultaneously (Page 193, 2003). These spaces were evolved from existing public gathering areas which had changing activities at different times of the day; in order to sustain the identity of the place.

Design elements are placed in hierarchy of spatial types but in proximity. These spaces are ensured accessibility through designed water, vehicular, pedestrian and cycle route, in the existing city grid. Thus various scales in circulation are introduced through these multiple transport routes.
The sequence of similar elements is repeated in design to give familiarity and a perceived scale. The vitality in space will reduce crime, illegal encroachment and garbage disposal; to produce a green environment and revive the lake. It will give the users an incentive to keep the water edge maintained. The revitalized lake will act as a breathing space or an urban lung in the concrete cityscape.

3.2 The master plan incorporates the following design elements
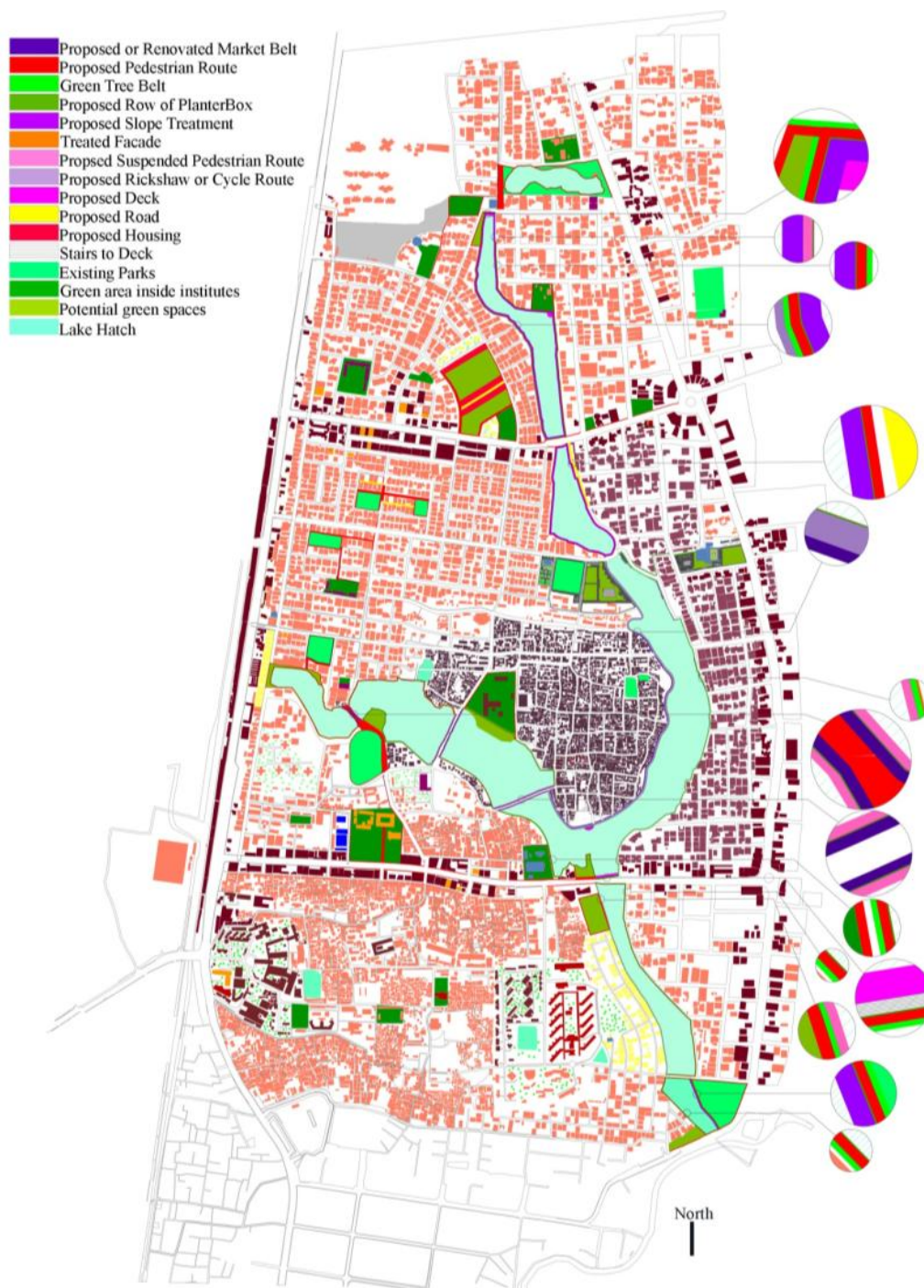
Figure – 6: Proposed Master Plan

3.2.1 Green spaces or urban courtyard

(Steffen Lehman statement, "A city that preserves and maximizes its open spaces, natural landscapes and recreational opportunities is a more healthy and resilient city" (Page 7, 2012).

The proposed master plan differentiated three types of green. These are:

- Existing green spaces constituted within academic institutes, religious structures, housing, offices and clubs. It is proposed to be made visually permeable by treating the boundary walls.
- Parks and play grounds are to be redesigned to integrate with waterfront development.
- Potential green spaces are generated from unutilized or encroached lands; which might become public gathering spots. The structural Plan Policies of Dhaka Metropolitan Development Plan (DMDP), states that it would seek to increase recreational facilities by manipulating vacant government land within established urban area (Rajuk, 2006). The land is proposed to accommodate green, small-scale vegetation and nursery. Such areas can be furnished with kiosks selling food, fruits and flowers. If the zone already has green areas, the space can be utilized for cultural activities or neighbourhood meetings. Other use of such empty plots is to accommodate rickshaw or bicycle stands.
-

3.2.2 The primary layer (Employed in Zones-1, 2, 3 and 6 referred in figure-5)

The layer comprises of continuous pedestrian route bordered with a row of planter box and shaded by the green tree belt.

(i)   The pedestrian walkway

A continuous pedestrian corridor, maintaining the topography of the existing site, connects all parks, playgrounds, green areas in various institutes, treated unclaimed areas and decks. This relates pedestrians to each other and also with nature. This generates a culture of walking in the existing scenario of vehicular dominance. Through walking one is intimate with the urban fabric perceiving the urban scale. Rational placement of public activity areas, in channels of pedestrian movement, will animate the space to make it inviting. The wide pedestrian routes are continuous but divert, encompassing varying scales of spaces; linking green spaces and the ecological pedestrian corridor with pubic amenities. This creates pause to evade monotony with changing vistas.

Some tertiary roads, which have other substitutes for vehicular access, might be converted to wide pedestrian walkways linking surrounding green areas. The promenade proposed, can be a vibrant waterfront edge; serving as interface or buffer between the open lake and urban fabric. The pedestrian, through this transition, is delivered to a green public realm and waterfront development; with experiences of visual and physical connection.

Zone-01   Zone-03 Part Plan   Zone-06

· Potential zone for small convinient shops catering to community needs
■ View of Pocket Spaces from tertiary roads linked directly to secondary road
■ Secondary Road
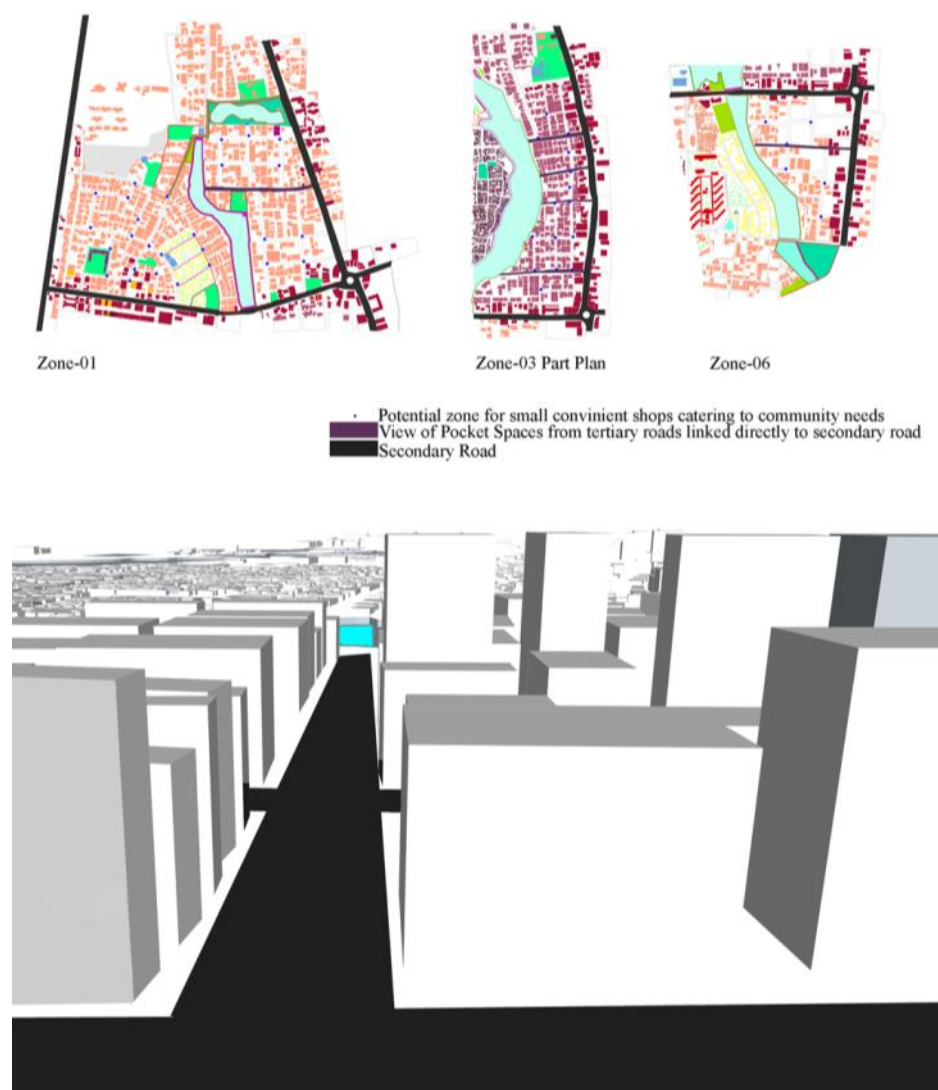
Figure – 7: Part plans and 3D view showing direct view to pocket spaces

The soft paving employed in walkways, will infiltrate rain water. It is grain textured to aid various speed of walking. The corridor is furnished to direct pedestrian towards the lake by light, litter bin, sitting instalments and kiosks. The kiosks will serve as convenient stores for the locality. Probable locations of kiosks are shown in figure 7. Street lights provide protection, to the neighbourhood, from illegal activities. Lights, in such locations will give direction, towards pocket spaces and surrounding green, from the road network. The pocket spaces are accessed by tertiary roads, which possess Lake vista. The tertiary roads can be seen directly from secondary roads or parks as shown in figure 7. The pocket spaces and decks act as plazas facilitated by small shops. The use of movable food shops is recommended to avoid permanent space appropriation. These may generate more income by transferring the shop to different location, at specific times, were the purchasing crowd is maximum.

(ii)   Planter box

Planter box, placed at 3feet intervals, will render paths with flower beds and act as safety boundary from lake. Having a height of 1'6" it also provides the sitting purpose, faced towards the lake. Such planter box concept, containing low height

plants, can be employed as road dividers in busy vehicular roads. In Zone-4 it demarcates the commercial and pedestrian space.

Figure 8: Planter box designed for sitting
   (iii)   Tree belt

A memory of gathering under tree, in rural practice, formulates the green tree belt. The trees placed 6feet from each other give a shadow of 10feet diameter scaling down the expanse. The leaf ceiling or canopy subdues the daylight in pedestrian routes, reducing heat and air pollution. Trees are often disposed freely to relax the space. Intimidating avenues with tall trees on both sides are avoided in the design. A green gradient is formed as shown in figure 9, in the primary layer, due to the low height planter box at one side and tall trees on the other side. This is initiated to soften the contrast between urban and lake edge; providing a buffer space from urban chaos. Such treatment also intends to discourage encroachment.
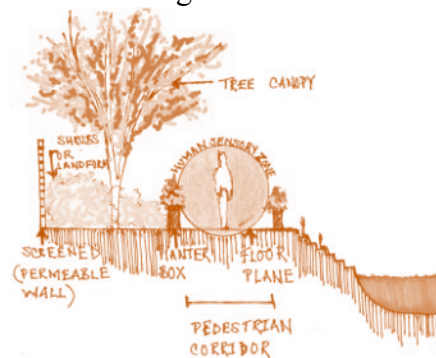
Figure 9: The pedestrian walkway

3.2.3 Suspended pedestrian (Employed in Zone-1, 3, 4, 5 and 6 referred in figure-5)
It is situated over lake, at places, due to lack of ground surface availability. It later connects to the pedestrian route. In zone 3 and 6 the route is shaded by trees. The suspended pedestrian route connects with market belt roof, in zone 3 and 4, to give multiple level lake view as shown in figure-11. This will aid pedestrians during monsoon flood when the upper level walkway might be used.
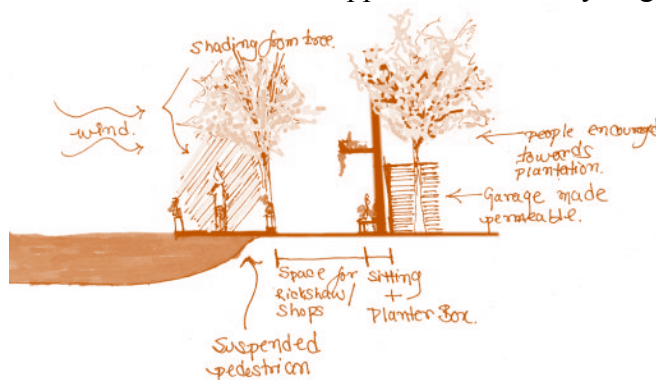
Figure 10: The suspended pedestrian

3.2.4 Bicycle or rickshaw route (Employed in Zone-1 and 3 referred in figure-5)

It circulates the lake edge, along the pedestrian walkway, and later connects to the tertiary road. It is 6feet wide but widened to 20feet in zone 3. The alternative pedestrian, rickshaw and bicycle route will reduce pollution by discouraging fuel run vehicles for short distances.

3.2.5 Proposed road (Employed in Zone-2 referred in figure-5)

A small length of vehicular road has been proposed, to be surgically installed, to continue the tertiary road from Banani Bridge to Kamal Ataturk road.

3.2.6 Market belt (Employed in Zone-3, 4 and 5 referred in figure-5)

The proposed market belt will promote small-scale business. The existing and new, 9feet wide, belt is made visually permeable through innovative shop design as shown in figure 11; to promote connectivity between lake and the customers. If the shops were evicted, it would widen the road; but it might have a negative social impact, instigating shop owners to create chaos. This renovation, rather than evacuation, will generate income for the slum dwellers. These existing shops usually sell fruits, vegetables, chickens, nursery plants, handicraft and serve as wielding workshops for rickshaws or motor cycles. The tea stalls and street food shops are also incorporated in the market belt, as they are public gathering areas. This market belt is accessible from rickshaw, cycle, pedestrian and vehicular routes.

Double layered walkway

Visually permeable shops
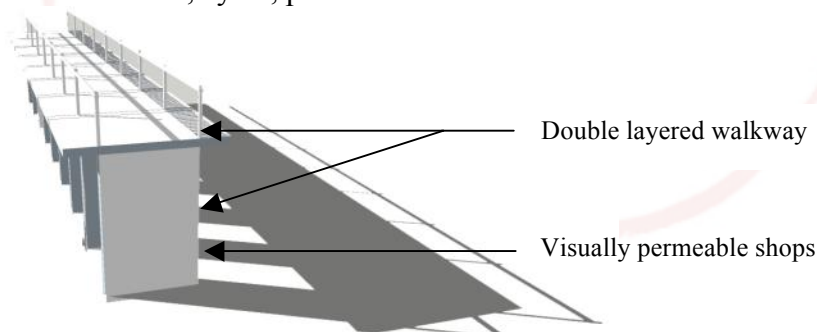
Figure 11: Proposed market belt shops

3.2.7 Façade treatment (Employed in Zone-3 referred in figure-5)

The building facades, is an identity of the social structure. It provides spatial definition to the street from one or both side. The current façade morphology, in Dhaka, indicates increasing archetype of enclosed high-rise apartments. The building heights in Gulshan area vary from nine feet (1 storey) for low income residences of Korail slum, to around two hundred feet (20storeys) for commercial offices. The residences are around 6 storeys high. In order to visually relate urban forms to natural lake settings, the apartment buildings are suggested to have lakefront terraces in façade and construct visually permeable ground floor. The terraces may shade the lake edge sitting areas. The external façade may grow creeper plants, to evolve into a continuous green façade, to increase the green coverage. Heights of boundary walls,

enveloping green areas, are reduced to 1feet 6inches. These will become sitting areas with visually permeable fences above.
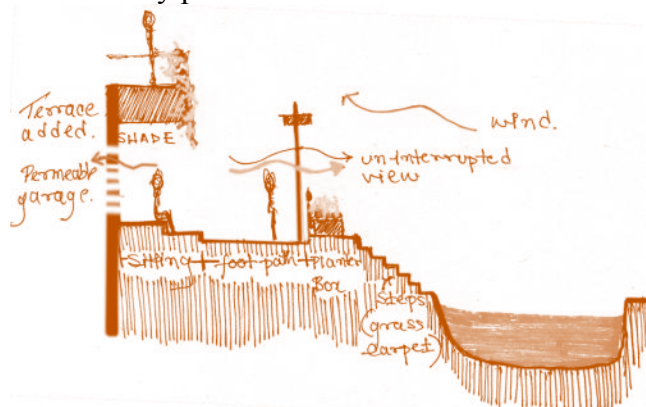
Figure 12: Suggested façade treatment

3.2.8 Slope Treatment (Employed in Zone-1 and 6 referred in figure-5)

The lake edge is unprotected for pedestrians due to untreated slope condition. The existing slope is proposed to be made 15feet wide, taking into consideration the natural topography. The soil erosion is treated by planting Durba grass carpet. The slope is stepped at intervals for multi-level sitting, fishing, social gathering, resting, viewing and waiting for boat rides.

3.2.9 Water treatment

The lake is an animated foci element. Lake edge acts as a transition, delivering pedestrians from hard to soft landscape. It is a permeable threshold, in the contrasting urban realm, promoting social activities. The lake is treated with hydrogen peroxide, oxygen, water purifying aquatic plants and an improved drainage infrastructure. The sewage disposal pipes should deliver away from the lake. Adequate garbage collection facilities have to be introduced. Excess rainwater should be harvested to reduce direct lake water usage. The purified lake water will improve the biodiversity.

3.2.10 Water transport

A boat transport exists in zone-3, on Mohakhali-Gulshan Link road, primarily used by low-income group. The garbage accumulated clogged culverts are to be cleaned, for a continuous water transport route. The recreational aspect of boating has tremendous potential to be a successful business venture for the low-income group. It will be desirable for the various university students in the locality. This might stop further abuse of lake as the users will then want to preserve the environment.

3.2.11 Decks (Employed in Zone -1 and 3 referred in figure-5)

The deck is the terminating point of the intended water transport route. The decks will stage cultural activities like folk music, theatre, encourage community gathering, display photo, exhibit art and sculpture. Permeable shops are designed on deck to sell handicraft items. Movable food shops are also encouraged in these spaces. The deck stairs are waiting areas of the water transportation facility.

4. Conclusion

Let us make sustainability a movement, by first understanding the term and how it can be innovatively implemented in varying contexts. Sustainability has no definition and cannot be confined within words; as it formulates different meanings with varying context. This research intends to give clarity to the complex urban pattern by introducing sustainable interventions. According to Matthew Carmona et al., such interventions render the urban fabric visually and physically permeable. This permeability increases access to various activities (Page 64, 2003). The designed public realm strata when imposed over the existing layers, as shown in figure 13, the urban fabric becomes permeable as mentioned by Carmona; it increases social, recreational and commercial activities. According to Matthew Carmona et al., temporal dimension in public realm is defined by heterogeneous public activities it offers at different time cycle of the day or simultaneously (Page 193, 2003). The design elements are adaptive, durable and can be integrated to the existing morphology; this renders the development sustainable. The Context based development introduced in the design is equitable, affordable, green, passively ventilated for thermal comfort, naturally illuminated and accessible. This process if implemented will act as an example to change orthodox mindset, that to develop is to demolish and rebuild.

Proposed Interventions Map
- Proposed or Renovated Market Belt
- Proposed Pedestrian Route
- Green Tree Belt
- Proposed Row of PlanterBox
- Proposed Slope Treatment
- Treated Facade
- Propsed Suspended Pedestrian Route
- Proposed Rickshaw or Cycle Route
- Proposed Deck
- Proposed Road
- Proposed Housing
- Stairs to Deck

Types of Green Map
- Existing Parks
- Green area inside institutes
- Potential green spaces

Kamal Ataturk Avenue
Banani-11 Road

Mohakhali-Gulshan Link Road

Types of Existing Road Map
- Primary Road-Width-100'
- Secondary Road-Width 50' to 60'
- Tertiary Road-Width15' to 20'

Land Zone Map
- Institution
- Hospital
- University
- School
- Graveyard
- Lake Hatch
- Middle Income Residences
- Housing
- Higher income group
- Korail Slum
- Mixed Use
- Religious Building

Dhaka- Mymensingh Highway
Gulshan Avenue

Topography Map
Height varies from 2' to 5'
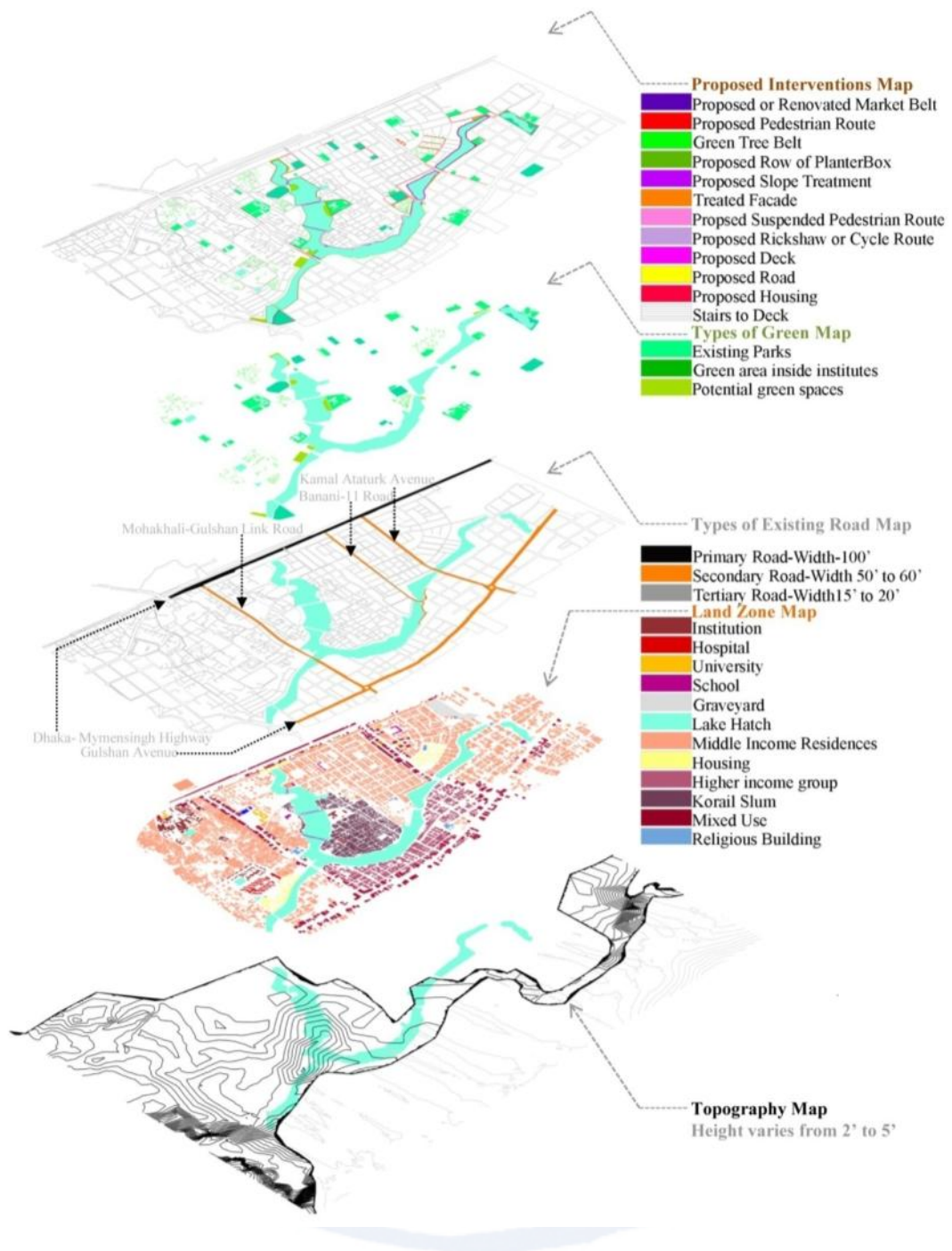
Figure 13: The public realm strata

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Life Cycle Assessment and Cost Benefit Analysis for Food Waste Diversion Systems

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Abstract

Food waste becomes a big environmental issue in terms of greenhouse gas emission and contamination of local soil and groundwater. When food waste rots in landfills, it generates methane and acid. Methane is a heat-trapping greenhouse gas that has 21 times more global warming potential than carbon dioxide and acid leaches into soil and groundwater causing soil and groundwater contamination. There are various ways to divert food waste into valuable resources through special treatment such as aerobic and anaerobic digestions. However, selecting an optimal diversion system for a specific site is not a simple process and varies depending on local conditions. The purpose of this study is to gain a better understanding of the relative environmental burdens and economic benefits of alternative food waste diversion systems (i.e., composting and anaerobic digestions) and the current system (i.e., landfilling) by conducting a case study in Boone, NC, U.S. Quantified data of environmental impacts and economic benefits over the life cycle of all three options were obtained during preliminary research. The results show strong indications that anaerobic digestion is the most environmentally beneficial food waste diversion system in Boone due to the avoidance of fossil fuel use for electricity generation. However, composting becomes more economically beneficial system when the total organic waste is less than 10,000 tons annually because of relatively cheaper electricity rate in the U.S. The results of this study can be beneficial for decision makers to select a rational food waste management system for their specific sites.

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INTRODUCTION

According to the United States Environmental Protection Agency (USEPA, 2013a), approximately 35 million tons of food waste, which is 21% of the total waste stream after recovery, was disposed in landfills, and only 3% of food waste was diverted from landfills and incinerators by composting in 2010. Landfills are the third largest source of human activity-related methane (CH_4) generation (Figure 1). When food waste rots in landfills under anaerobic conditions, it generates methane and acid. Methane is a heat-trapping greenhouse gas that has 21 times more global warming potential than carbon dioxide (USEPA, 2013b), and acid leaches into soil and groundwater causing soil and groundwater contamination in many old unlined landfills (Ahmed & Sulaiman, 2001).
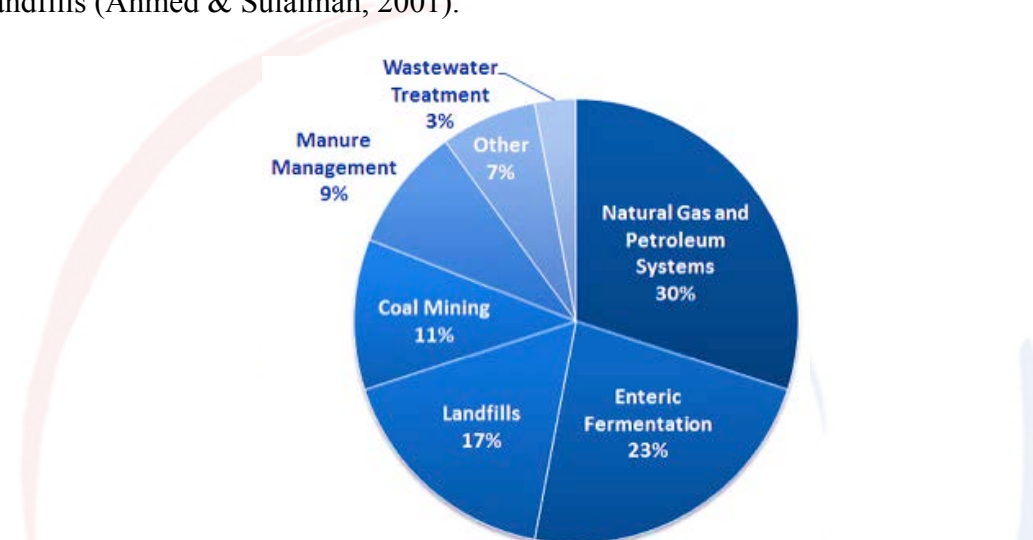
Figure 1. Methane emissions by source in the US, 2010 (USEPA, 2013c).

Around 40% of edible food is wasted in the United States (Hall, Guo, Dore, & Chow, 2009), and the average American throws away about 20 pounds of edible food every month (Gustavsson, Cederberg, Sonesson, van Otterdijk, & Meybeck, 2011). If we generated approximately 15% less food waste, 25 million more people in the US could have adequate diets (Hall et al., 2009). We also generate inevitable food waste such as peels of potato, onion, fruit, egg, and so on. These kinds of food waste could be diverted through special treatments such as aerobic digestion (commonly called composting) and anaerobic digestion, yielding value-added products: compost and biogas (USEPA, 2013a; USEPA, 2014).

The North Carolina Department of Environment and Natural Resources (NCDENR) found that more than 1.1 million tons of food waste is generated annually in North Carolina (2012). Scott Mouw, the director of the state's recycling program, mentioned that food waste diversion represents a major opportunity for the state to increase material recovery and should become an increasing priority for local and state recycling programs (Oakes, 2012). In fact, Watauga County does not have any county-driven food waste collection or diversion system. In the county, only Appalachian State University (ASU) has a food waste composting facility and the town of Boone provides compost bins for town residents (Watauga County Sanitation Department (WCSD), 2012).

ASU's composting facility, originally student-driven project was started with 18 tons of the school's food waste in 1999 and remodelled to 275-ton capacity in 2011 (ASU, 2014). The university is the only entity that is able to take advantage of this facility. In order to protect nature and meet one of university's goals, direct collaboration and connection with the community for its social and economic well-being, it would be worthwhile for the university to consider adding a larger size food waste diversion system that can treat the community's food waste as well. As a starting point toward initiating the state's food waste recycling program, this study will be a useful resource to help municipalities predict the more beneficial future food waste diversion system in terms of environment and economy.

The purpose of this study is to gain a better understanding of the relative environmental burdens and economic benefits of alternative food waste diversion systems (composting and anaerobic digestion) and the current system (landfilling), and to provide baseline information for deciding the most appropriate food waste diversion system in Boone. By conducting a life-cycle Assessment and cost analysis, environmental impacts and economic benefits can be quantified over the life cycle of all three of these options. In addition, the methodology developed in this study could be a model to other communities that seek to build effective food waste diversion systems.

METHODOLOGY

Even though this study focused on a food waste diversion system, it is common to add yard waste to food waste as a bulking agent for composting (Levis & Barlaz, 2011). Since the mixing ratio of the ASU composting facility is typically 50:50 by mass, the baseline waste stream for the study is the mixture of food waste and yard waste at a 50:50 mixing ratio with the assumption of 5% leaves and 95% branches of yard waste composition. Currently, the town of Boone does not have a food waste collection program, so most food waste generated in the Boone area is sent to the Foothills Landfill in Lenoir, NC. Residential yard waste collected by the town is ground and stockpiled at the waste transfer station and then provided to the public as mulch (WCSD, 2012). For the purpose of this study, the current system in Boone was defined as landfilling and mulching, and this was set as the baseline scenario for both life cycle analysis (LCA) and cost benefit analysis (CBA) (scenario L1 and C1).

Covered aerated bay (Figure 2) was the model used for the composting option (scenario L2 and C2), because it is the type of composting facility that ASU owns currently. For the anaerobic digestion (AD) option, a high-solid batch-type AD system was selected as a model. High-solid batch-type AD could be more beneficial than continuous type AD in the US, where cost saving may be more influential than biogas yield on investment decisions (Williams, 2012). Also, land limitation is not a significant factor in the US (Rapport et al., 2008). Four AD scenarios were set for LCA based on energy recovery options: electricity only (scenario L3); electricity and heat, or combined heat and power (CHP; scenario L4); heat recovery only (scenario L5); and renewable compressed natural gas (R-CNG, scenario L6). AD scenarios for CBA are based on the revenue availability of value-added products. There are eight different AD scenarios for CBA in this study: electricity only available (scenario C3); electricity and digestate (scenario C4); electricity and heat (scenario C5); electricity,

heat, and digestate (scenario C6); heat only (scenario C7); heat and digestate (scenario C8); R-CNG only (scenario C9); and R-CNG and digestate (scenario C10).

Figure 2. Covered aerated bays at Green Mountain Compost (Green Mountain Compost, 2014).

Table 1 is the summary of scenarios considered in this research. While five scenarios are set for LCA depending on the recovered energy from AD system, the CBA has eight scenarios defined by the value-added products. Note that the environmental impact of scenarios C3 and C4 can be found from the scenario L3. In the same manner, scenarios C5 and C6 are equivalent to the scenario L4, the C7 and C8 are equivalent to the L5, and the C9 and C10 are equivalent to the L6. Before performing LCA and CBA, the commercial food waste generation in the Boone area was estimated to set a reference waste flow.

Table 1. Summary of Scenarios for LCA and CBA.

System	LCA		CBA	
Landfill + Mulching	Scenario L1		Scenario C1	
Composting	Scenario L2		Scenario C2	
AD	Scenario L3	Electricity + Digestate	Scenario C3	Electricity
			Scenario C4	Electricity + Digestate
	Scenario L4	Elecricity + Heat (CHP) + Digestate	Scenario C5	Electricity + Heat
			Scenario C6	Electricity + Heat +Digestate
	Scenario L5	Heat (Boiler) + Digestate	Scenario C7	Heat
			Scenario C8	Heat +Digestate
	Scenario L6	R-CNG + Digestate	Scenario C9	R-CNG
			Scenario C10	R-CNG + Digestate

Boone is a small town with a population of 18,089 (Town of Boone, 2014), but many tourists visit Boone for seasonal sports and beautiful scenery all year round; therefore, many restaurants are located in the downtown. There is also one university (i.e., Appalachian State University), two public schools (i.e., Hardin Park School & Watauga High School), six supermarkets, one hospital (i.e., Watauga Medical Center), and one company with a large in-house cafeteria (i.e., Samaritan's Purse) as relatively larger size facilities. In order to use the formulas for food waste generation estimation shown in Table 2, six categories of commercial food waste generators were identified: universities, public schools, restaurants, supermarkets, hospitals, and companies with a cafeteria.

Data for the number of students at ASU (http://www.appstate.edu/about/) and in the public schools (www.publicschoolreview.com) and the number of beds in Watauga Medical Center (https://www.apprhs.org) were collected through these entities' web sites. Personal visits were carried out to obtain the number of employees in supermarkets and at Samaritan's Purse. The number obtained for restaurant employment in the Boone area was acquired from the Watauga County Database (www.wataugaedc.org) using NAICS 722511 (full-service restaurant) and 722513 (limited-service restaurant). The summary of categories, formulas, and sources used for this study is described in Table 3.

Table 2. Formulas for Commercial Food Waste Generation Estimation (Draper & Lennon, 2002; Mercer, 2013).

Category	Formula
Universities	**Residential** = 0.35 lbs/meal * N of students * 405 meals/student/yr **Non-residential** = 0.35 lbs/meal * N of students * 108 meals/student/yr
Public Schools	= N of students * 0.14 lbs/students/day * 180 day/yr
Hospitals	= N of beds * 5.7 meals/bed/day *0.6 lbs food waste/meal * 365 days/yr
Resorts/ Conference Properties	=1.0 lbs/meal * N of meals/seat/day* N of seats * 365 days/yr
Restaurants	= N of employees * 3,000 lbs/employee/yr
Supermarkets	= N of employees * 3,000 lbs/employee/yr
Nursing homes	= N of beds * 3.0 meals/bed/day *0.6 lbs food waste/meal * 365 days/yr
Correctional facilities	= 1.0 lb/inmate/day * N of inmates * 365 days/yr

Note: N is number.

Table 3. Summary of Food Waste Generation Methods.

Category	Name of facility	Formula	Data Collection
Universities	ASU	= 0.35 lbs/meal * N of students * 405 meals/student/yr	Internet
Public Schools	Hardin Park School Watauga High School	= N of students * 0.14lbs/students/day * 180day/yr	Internet
Hospitals	Watauga Medical Center	= N of beds * 5.7 meals/bed/day *0.6 lbs food waste/meal * 365 days/yr	Internet
Companies with a cafeteria	Samaritan's Purse	= N of students * 0.14lbs/students/day *250day/yr	Personal Interview
Restaurants		= N of employees * 3,000 lbs/employee/yr	Internet
Supermarkets	Walmart Food Lion 1 Food Lion 2 Harris Teeter Ingles Earth Fare	= N of employees * 3,000 lbs/employee/yr	Personal Interview

Note: N is number.

The program for life cycle analysis of greenhouse gas (GHG) emissions from organic waste management was developed using Microsoft Excel, following the method

described in the 3rd Edition of Solid Waste Management and Greenhouse Gases (USPEA, 2006). The boundary for this study was from waste generation to waste disposal. In order to calculate emissions from the waste collection and transportation, the waste collection plan was designed for the shortest travelling distance using Google Maps. In fact, the residential yard waste in Boone is collected by the town of Boone on a call-in basis currently, so the travelling distance for yard waste collection varies. The travelling distance from the transfer station to the landfill in Lenoir, NC is approximately 4686 km per year.

GHG emissions from processing include the emissions from electricity and from diesel fuel used by the facility. The data on electricity and diesel use by the ASU composting facility was gained from Eddie Hyle, superintendent of ASU landscaping. The same diesel use data was applied to the AD scenarios. Also, the methane and N2O emissions from biogas combustion were included, while the biogenic CO2 emissions were excluded.

The avoidance of fossil fuel emissions (e.g., natural gas and electricity) was included for AD options. Carbon storage factors for landfilling and the composting of yard and food wastes were developed by USEPA (2006). These composting carbon factors were applied to AD. The USEPA (2011a) reported GHG emission factors of various sources and these data were used in this study. The Life Cycle Inventory database from the National Renewable Energy Laboratory (NREL) also provides gas emissions from various sectors (e.g., waste collection, diesel extraction, and truck transportation).

Because Watauga County does not operate a landfill, the costs for the current landfilling and mulching system are tipping fees and mulching costs. The costs for a composting facility or an AD facility include capital costs and operation costs. The capital costs for both alternative options include system design and engineering, system materials and equipment, and construction. Even though the capital costs of AD scenarios may vary (e.g., with CHP or with R-CNG systems), the capital cost of the AD with CHP system was used for all AD scenarios due to the lack of data about the various system types. The benefits from each system may vary depending on what and how much of the value-added products are generated; therefore, the estimated amounts of value-added products and their market prices should be studied. There is no specific economic benefit of organic waste landfilling. Organic compost is a value-added product generated from a composting facility. The value-added products from AD systems in this study were defined as biogas, electricity, heat, R-CNG, and digestate. In addition, some AD options (C3, C4, C5, C6, C9, and C10) are eligible for renewable energy certificates (RECs) or renewable identification numbers (RINs).

The cost data for each option were gained through personal interviews, emails, and literature review. The data about costs and value-added products for AD options were collected from Zero Waste Energy (2013). The report contains detailed information for a 10,000 tons per year (TPY) AD system with combined heat and power, and 20,000 TPY and 40,000 PTY AD systems with compressed natural gas. After qualifying the value-added products, these were monetized based on the market price of compost and the avoided cost rate of electricity generation. The current market price of organic compost was adopted from Danny's Dumpster in Asheville, NC (http://dannysdumpster.com/). The avoided cost was calculated based on the rates

stated in the power purchase agreement (PPA) between Watauga County and Duke Energy.

The cash flows for each scenario over a 20-year timeframe were built, and net present values (NPVs) of each scenario were computed using Microsoft Excel. Due to the lack of data for discounts rates of each option, various discount rates of 4%, 6%, 8%, 10%, and 12%, were applied.

FINDINGS

Table 4 shows the estimated food waste generation of each sector, using the formulas from Draper and Lennon (2002) and Mercer (2013). Total estimated commercial food waste generation for Boone is 4,990 TPY. For simplicity, the estimated food waste generation was rounded up to 5,000 TPY. After adding the same mass of yard waste to the food waste, the reference flow of available organic waste becomes 10,000 TPY in this study.

Table 4. Estimated Commercial Food Waste Generation in Boone, NC.

Category	Name of facility	Formula	N (number)	Food Waste (lb/yr)
Universities	ASU	= 0.35 lbs/meal * N of students * 405 meals/student/yr	17,344	2,458,512
Public Schools	Hardin Park School	= N of students * 0.14lbs/students/day * 180day/yr	773	19,480
	Watauga High School		1,420	35,784
Hospitals	Watauga Medical Center	= N of beds * 5.7 meals/bed/day *0.6 lbs food waste/meal * 365 days/yr	117	146,051
Companies with a cafeteria	Samaritan's Purse	= N of students * 0.14lbs/students/day * 250day/yr	500	17,500
Restaurants		= N of employees * 3,000 lbs/employee/yr	1,649	4,947,000
Supermarkets	Walmart	= N of employees * 3,000 lbs/employee/yr	785	2,355,000
	Food Lion 1			
	Food Lion 2			
	Harris Teeter			
	Ingles			
	Earth Fare			
Total annual food waste generation				4,990 tons/yr

In case of L1, landfill gas emissions should be included in the subtotal of CH4 emissions. Then, biogenic CO2, avoided emissions, and carbon storage were subtracted from the subtotal. In order to characterize global warming impact with CO2 equivalent, the global warming potential (GWP) numbers of each GHG were multiplied by total emissions of each gas and summed. Note that the avoided fuel for AD with heat energy is natural gas in this study. Microsoft Excel was used to develop a LCA tool for this study.

AD with CHP option (scenario L4) shows the best result (Table 5 & Figure 3), which means the least GHG emissions. All AD scenarios are advantageous mainly due to avoided fossil fuel emissions by renewable energy production. The reason why the AD with R-CNG option is less advantageous than the other AD option is that the amount of biogas combusted for energy, which makes the AD option superior, is less than in other scenarios. In this scenario, only a small amount of electricity is

generated for the parasitic loads, and most biogas is compressed. Note that the final product, R-CNG, is not a form of energy but a form of fuel. If the boundary of this study is extended to R-CNG combustion in a vehicle, it will emit less GHG than diesel combustion; however, conversion factors from a diesel vehicle to a natural gas vehicle should be considered in this case.

Scenario L5, which generates only heat energy, has less advantage than AD options with electricity generation in terms of GHG emissions. This is caused by the fact that electricity generation emission factors are greater than natural gas combustion. In other words, AD with heat option obtains less benefit from fossil fuel avoidance.

Table 5. Breakdown GHG Emissions of Each Scenario.

Scenario	L1	L2	L3	L4	L5	L6
CO_2 (kg)	6,617,243	(214,505)	(2,015,018)	(2,399,484)	(1,561,720)	(662,372)
CH_4 (kg)	12,316	143,458	136,544	136,537	136,559	136,516
N_2O (kg)	0.24	9.93	(4.77)	(5.49)	15.65	3.30
MT CO2 equiv.	6876	2801	851	466	1311	2205

Note. Numbers in parentheses are negative values.
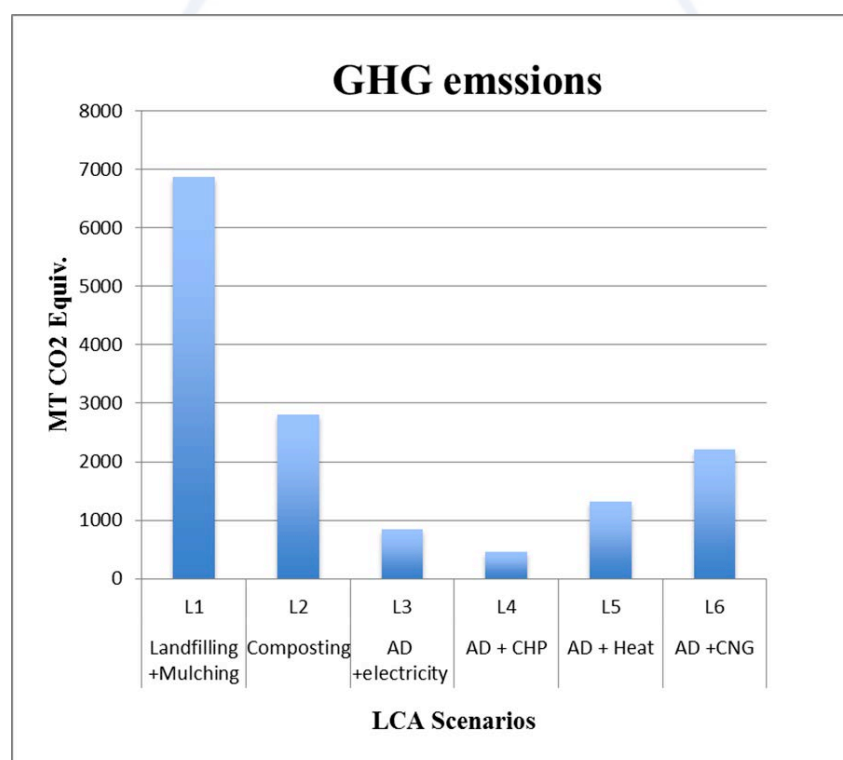
Figure 3. GHG emissions from each scenario in MT CO2 equivalent.

The cost data used for this study are shown in Table 6. The tipping fee and the mulching fee listed in Table 6 are the rates that Watauga County paid in 2011/2012. The capital cost for the 10,000 TPY covered aerated bay composting facility is estimated with the data from Green Mountain Compost and Amboy Compost (D. Goossen, personal communication, February 14, 2014; Onondaga County Resource Recovery Agency (OCRRA), 2011). Note that the cost data from Green Mountain Compost are the actual costs while the capital cost of Amboy Compost is the

estimated cost. Since the Amboy Compost system operates without a roof, the roof structure cost from Green Mountain Compost was added to Amboy Compost capital cost to estimate the capital cost of a 10,000 TPY facility. The capital cost of $1,223,085 was estimated and used for scenario C2.

The O&M costs for the composting option were collected from the ASU composting facility through interviews with Edward A. Hyle, Superintendent of Landscape Services at ASU. It was assumed that two employees work for 32 hours a week each for a 10,000 TPY facility, and three employees work for a 20,000 TPY facility.

Table 6. The Capital Costs and the O&M Costs Used for this Study (D. Goossen, personal communication, February 14, 2014; E. Hyle, personal communication, January 27, 2014; L. Doty, personal communication, Sep 4, 2013; OCRRA, 2011; Zero Waste Energy, 2013).

System		Capacity (TPY)	Capital Cost	O&M Cost	
Landfilling & Mulching	Watauga County			Tipping $38.45/ton Mulching $22.57/ton	
Composting	Green Mountain Compost	20,000	$2,228,082	ASU	Electricity $9.75/ton
					Diesel $4.62/ton
	Amboy Compost	9,600	$1,200,000		Labor $21.32/hr
					Main. $1.54/ton
AD	Zero Waste Energy	10,000	$5,862,000	$147,000	
		20,000	$8,098,250	$375,000	

The prices for monetizing the value-added products are listed in Table 7. USEIA (2014a, 2014b) reports the average electricity price and natural gas price for the commercial sector by state on their website. The grid electricity price represents an average North Carolina electricity price for the commercial sector (USEIA, 2014b), and this number was used to calculate the additional electricity cost for AD with boiler option. The avoided cost rate for selling electricity to the grid was calculated according to the power purchase agreement (PPA) contracted between the Watauga County Landfill and Duke Energy in 2011. The compost price was adopted from the business Danny's Dumpster, located in Asheville, NC. Their compost rate is $40 per cubic yard, so $100 per ton of compost was calculated with a density of 880 pounds per cubic yard from California Department of Transportation (2014).

The average CNG price of $2.07 per gasoline gallon equivalent (GGE) from Piedmont Natural Gas was converted to $2.35 per diesel gallon equivalent (DGE). For more accurate CBA results over time, the prices for energy were adjusted yearly based on energy price inflation rates from USEIA and the US Department of Energy (USEIA, 2014a; USEIA, 2014c; USDOE, 2014). Renewable energy credits (RECs) applied is $0.003 per kWh (Jason Hoyle, personal interview, March 17, 2013), and $1.35 per DGE was used for Renewable Identification Number (RIN) (ZWE, 2014).

Table 7. The Unit Prices of Value-Added Products Used for the Study.

	Rates	*Inflation*	*Environmental Attributes*	
Electricity	$0.09/kWh	0.4%/yr		
Avoided Cost	$0.07/kWh	0.4%/yr	*RECs*	$0.003/kWh
Compost	$100/ton			
Natural Gas	$9.21/10^6 Btu	1.8%/yr		
CNG	$2.35/DGE	8%/yr	*RINs*	$1.35/DGE

Figure 4 describes the NPVs of all scenarios with various discount rates over a 20-year system lifetime. Several economic analysis studies on AD systems adopted 8% or 10% discount rates (Enahoro & Gloy, 2008, Giesy, Wilkie, de Vries, & Nordstedt, 2009; Moriarty, 2013;), while a 5% discount rate was used for Teague's composting research (2011). The composting option (scenario C2) exhibits greater NPVs than the other scenarios, because of the lower capital cost of the composting facility. The higher inflation rate of CNG prices makes scenario C10 more profitable than other AD options with a discount rate lower than 10%. The dotted lines in Figure 4 are AD scenarios with digestate sales included. The common factor for positive NPV in Figure 4 is the digestate, which means that the revenue availability of digestate is critical to making the AD option profitable. None of the AD scenarios without digestate exhibit positive NPVs over any of the discount rates.
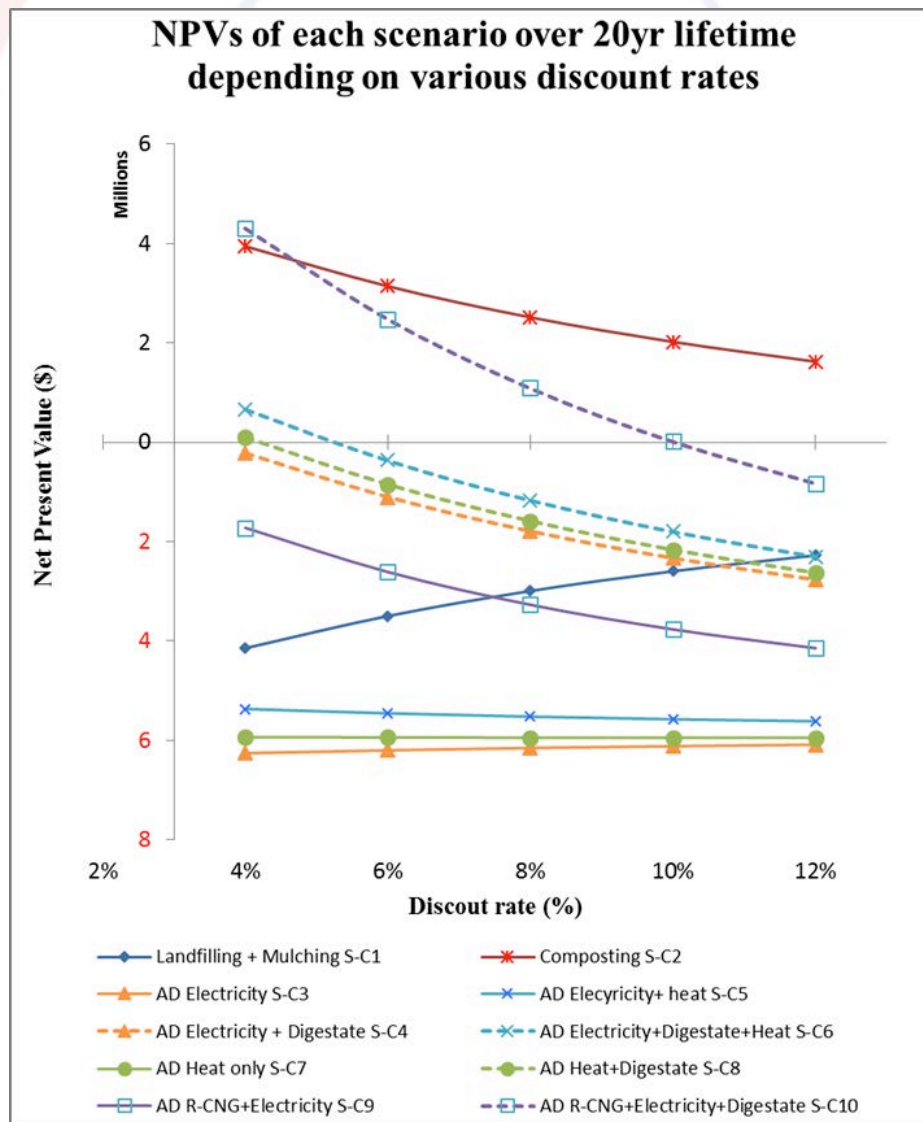
Figure 4. NPVs depending on various discount rates.

Both CNG options (scenario C9 and C10) show significant positive shifts due to the large RIN ($1.35/DGE) for CNG, while REC ($0.003/kWh) does not greatly influence the electricity options (Figure 5).
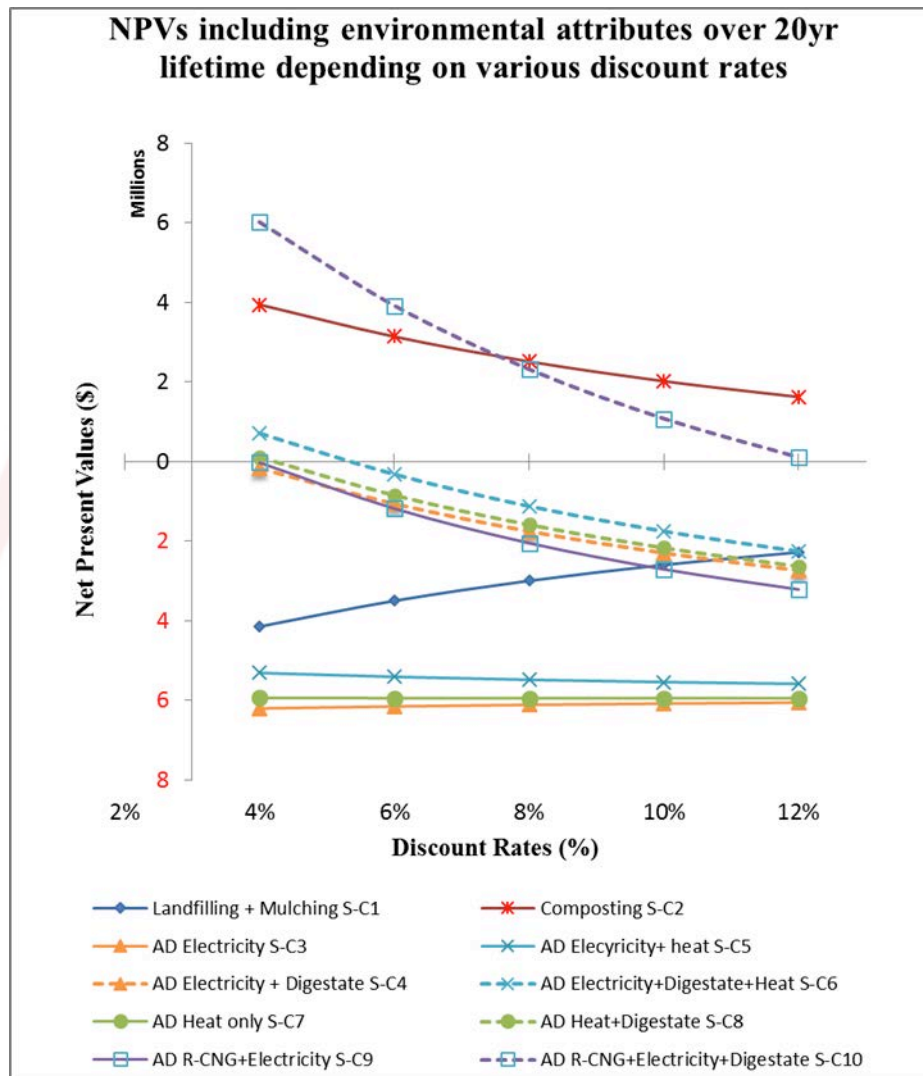
Figure 5. NPVs including environmental attributes (RIN and REC) depending on various discount rates.

CONCLUSIONS

This study focused on environmental and economic analyses for decision making regarding choice of food waste diversion systems in Boone, NC, USA. The alternative systems, composting and anaerobic digestion, were compared to the current system, landfilling and mulching.

Environmental impact was analyzed by performing life cycle assessment of greenhouse gas emissions. Anaerobic digestion options present lower GHG emissions than the composting option because anaerobic digestion produces biogas that could be

used for renewable energy production. Anaerobic digestion with the combined heat and power system shows the least GHG emissions since it generates electricity as well as heat energy using waste heat.

Cost-benefit analysis with net present values was conducted for economic analysis. Due to the lower capital cost and higher organic compost price, the composting option presents the greater net present value. In other words, energy generation from the AD system does not overcome the higher capital cost of the AD system. Since energy prices are relatively cheap in the US, the revenue availability from digestate is a critical factor for anaerobic digestion systems; however, producing renewable compressed natural gas presents the higher net present value among other AD options due to the higher inflation rate of CNG fuel. Anaerobic digestion with an R-CNG system can have comparable net present value with the composting system if it gains income from digestate and RINs.

Since the best options analyzed by LCA and CBA differ, the final decision on the best food waste conversion system would depend on who invests money in the project. For Example, AD options would be better in the Boone area if an investor such as ASU, who cares about GHG reduction, education, and community outreach, was the primary supporter.

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Waste Management and Pollution Control in the Lake Malawi Basin: Harnessing Synergies from Various Sectors for Sustainable Lake Basin Management

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Abstract

Lake Malawi hosts the greatest freshwater fish biodiversity in the world, and is world's third deepest and ninth largest lake by surface area. The lake and its basin offer a wide variety of values to the Malawi population including supporting urban centers, rain-fed and irrigated agriculture, hydropower generation, mineral resources provision, and abundant fisheries resources. Associated activities result in the generation of wastes and pollutants that also impact on the lake basin. Management of waste is a big challenge in Malawi, in addition to deforestation and the associated soil erosion. This paper assesses the waste management and pollution control situation in the Lake Malawi Basin from a governance perspective, as a rough indication of the management status of water resources in Malawi. The focus is on understanding how synergies from various related sectors such as agriculture, sanitation, forestry, mining, industry and others can be harnessed for better lake basin management. The study also assesses the degree of point source pollution control, and solid waste management in the major cities within the lake basin. The methods employed are documents review, key informant interviews and site observations. Results show weak enforcement of regulations and standards, poor solid waste management especially due to challenges in collection and final disposal facilities, and while there are some efforts with respect to non-point source pollution, deforestation and soil erosion remain a problem.

Keywords: Lake Malawi Basin, pollution control, waste management, water resources management, sustainability

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1. Introduction

Lake Malawi hosts the greatest freshwater fish biodiversity in the world, and is world's third deepest and ninth largest lake by surface area (Bootsma & Hecky, 1999, 2003). The lake and its basin are shared among Malawi, Mozambique and Tanzania with the largest portions of both the basin and lake in Malawi. This paper focuses on the lake and basin in the Malawi side. The lake and its basin offer a wide variety of benefits to the Malawi population including supporting urban centres, rain-fed and irrigated agriculture, hydropower generation, mineral resources provision, and abundant fisheries resources. The lake is Malawi's most dominant water body and stores the bulk of the renewable surface water resources in the country, with an average of $90km^3$ of live storage (GoM 2008). Its importance therefore cannot be ignored especially with the fact that Malawi is a water stressed country with total renewable water resources per person of less than $1,400m^3$/year (GoM, 2008). In addition, water is central to poverty alleviation (Pérez-Foguet & Garriga, 2011), and in Malawi in particular, water resources are an important driver of the economy. For instance, Lake Malawi supports hydropower generation on its only outlet, the Shire River which generates about 95% of all electricity in the country (Chafota, Burgess, & Johnson, 2005).

Activities associated with the benefits the lake and its basin offer however, result in the generation of wastes and pollutants that also impact on the lake and basin. If not properly managed, these wastes and pollutants can lead to the degradation of the lake basin with negative consequences on the country's economy and the people's well-being. The Malawian side of the basin is largely rural and agriculture is the main land-use activity. The basin contains two major urban centres, Lilongwe the capital of Malawi and Mzuzu, the country's third major city. These cities have the highest population densities in the basin and it is assumed that they also generate the most waste. Generally, management of both solid and liquid waste is a big challenge in Malawi, in addition to deforestation and its associated soil erosion. Management of both solid and liquid waste is currently the responsibility of city councils but there are plans to transfer the management of wastewater to water utilities. Within the Lake Malawi Basin, wastewater treatment works are done in Lilongwe and Mzuzu Cities. The dominant existing treatment types only removes 30% of the organic wastes and 50% of bacteria and suspended solids (Msilimba & Wanda, 2012). This causes concern of nutrient and pollutant loading to water bodies and public health risk. Although the country has national effluent standards in place (for both domestic and industrial wastewater), their enforcement is generally poor. Solid waste management services within the lake basin are also mainly provided in the cities of Lilongwe and Mzuzu. Table 1, provides information on land area, population and waste generation rates of the two major cities. The city councils are only able to collect and dispose of a small fraction of the generated waste.

Table1 City Information

City	Land Area*	Population*	Population Density*	Daily Waste Generation** (tons)
Lilongwe	456 Km²	674,400	1,479/Km²	350
Mzuzu	48 Km²	133,900	2,791/Km²	67

*Land area and population data from 2011 National Statistical Yearbook
**Waste generation rates provided by the city councils

2. Why Waste Management and Pollution Control?

Waste, both solid and liquid has an impact on water resources (Yamada & Muhandiki, 2007; Falkenmark, Anderson, Castensson & Sundblad, 1999). This impact is mainly on nutrient load, pollution risk and suspended solids. High nutrient loads to water bodies interfere with the biochemical structure of the water bodies and leads to eutrophication. This may cause excess growth of alga, shifts in species composition, changes in the food web, limitations to light penetration and public health concerns, among others. Previous studies by other researchers in Lake Malawi identified the main issues as; (1) Water level fluctuations; (2) Changes in phytoplankton composition; (3) Threat to biodiversity; (4) Contamination; (5) Threat to fishery; and (6) Pathogens. Figure 1, shows causal chains of these main issues (except fishery), considering only the main linkages.
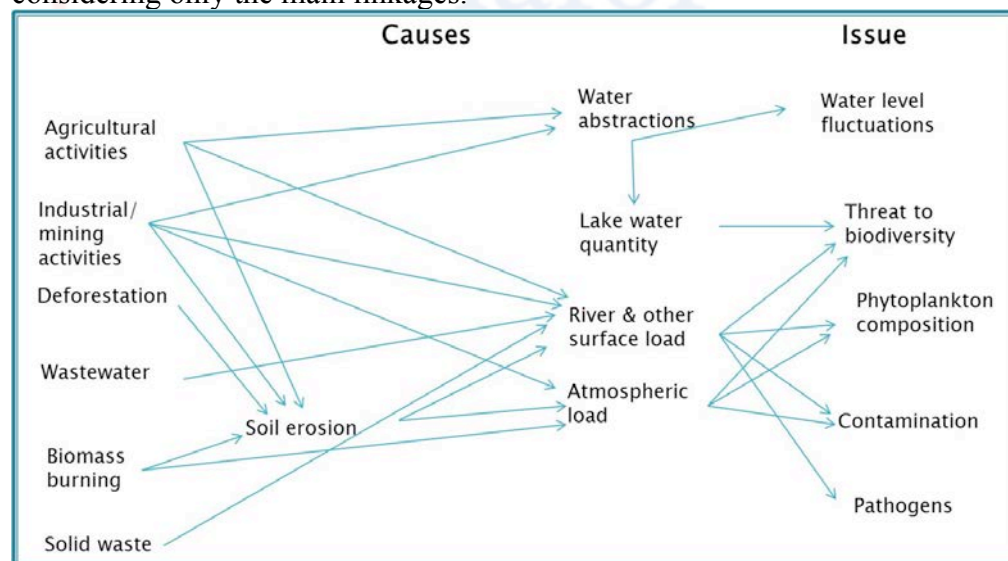
Figure 1. Causal Chains of the main issues in Lake Malawi

The root causes of these issues as shown in Figure 1 are agricultural activities, industrial/mining activities, deforestation, wastewater, biomass burning and solid waste. We did not show fishery in this figure because it is linked with most of the issues and thus its root causes are similar to the root causes of the other issues. These six root causes are our main areas of concern and they are all in some way related with waste and pollution issues. This is the reason our paper is focusing on waste management and pollution control in the lake basin. We grouped the main areas of

concern into two main categories of drivers of point source pollution and drivers of nonpoint source pollution as shown in Table 2 below.

Table 2 Main Areas of Concern

Drivers of Nonpoint Source Pollution	Drivers of Point Source Pollution
Deforestation	Wastewater
Agricultural activities	Industrial activities
Biomass burning	
Solid waste	

A closer look at the drivers of nonpoint source pollution category however, shows that all areas except solid waste are closely related with the agriculture and forestry sectors. Consequently, we have isolated solid waste into its own category for better assessment.

In view of the issues highlighted, this paper assesses the waste management and pollution control situation in the Lake Malawi Basin from a governance perspective, as a rough indication of the management status of water resources in Malawi. Our main objectives are to assess;
1. The degree of point source pollution control in the lake basin.
2. The degree of non-point source pollution control in the lake basin.
3. Solid waste management in the major cities within the lake basin.
Our overall objective is to understand how synergies from various related sectors such as agriculture, sanitation, forestry, mining, industry and others can be harnessed for better lake basin management.

3. Methodology

In addition to reviewing several documents and publications, we conducted key informant interviews in various institutions to understand how various mandated institutions are implementing the national policies that govern utilization and management of the various aspects of the lake basin. These were the Departments of Water Resources, Environmental Affairs, Irrigation, Land Resources Conservation and Development (agriculture), Fisheries, Forestry, Energy and the City Councils of Lilongwe and Mzuzu in April and May 2014. We also carried out site observations in the same period. Our assessment utilized indicators which we selected based on the main areas of concern highlighted in previous sections and guided by literature review. The indicators are directly linked to the objectives of this paper and each indicator has several measures or sub-indicators. Table 2 presents the indicators and measures that we used.

Table 2 Indicators and Measures

Indicator	Measures
1. Degree of Point Source Pollution Control	1.1 Percentage of Households in Lilongwe & Mzuzu Cities connected to the public sewer line 1.2 Sewage effluent standards compliance rate of sewerage treatment plants 1.3 Wastewater sludge disposal compliance rate in cities and towns 1.4 Compliance of industries & mines with standards
2. Degree of nonpoint source pollution control	2.1 Proportion of land covered by forests 2.2 Reduction in hectares destroyed by bush fires 2.3 Farm area under good farming practices 2.4 Protection of catchment & littoral wetlands (swamps & marshes) & lagoons
3. Extent of solid waste management in the cities of Lilongwe & Mzuzu	3.1 Waste collection rate 3.2 Industrial solid waste disposal compliance 3.3 Sanitary condition of final disposal facilities 3.4 Percentage of solid waste recycled

The indicators presented in Table 2 represent all the areas considered important in this study. However, due to data limitations that we encountered, we couldn't assess measures 1.2, 1.3, 1.4, 2.2 and 3.4.

4. Findings

Before we present our findings, we would like to explain the rating system we have applied to the indicators. We used a scale of 1 to 5 for every indicator, where 1 is very low and 5 is very high as shown in Table 3 below. Finally, we averaged the individual indicator rates to obtain an overall rate for waste management and pollution control in the lake basin.

Table 3 Rating Scale

Rate	Translation
1	Very Low ($\leq 20\%$)
2	Low (21- 40%)
3	Moderate (41 – 60%)
4	High (61-80%)
5	Very High ($\geq 81\%$)

The following subsections provide the findings.

4.1 Degree of Point Source Pollution Control

Percentage of households connected to the public sewerage system was the only measure assessed under this objective, as indicated in the previous section. Table 4 provides the rate of this indicator.

According to the Lilongwe City Council (LCC) only 9% of the households in the city are connected to the public sewerage system. The majority rely on pit latrines (75%) and septic tanks (UN-HABITAT 2011). When the septic tanks are full, the waste is pumped out and discharged at the sewerage treatment plant. Wastewater sludge from

the treatment plants is collected by local residents for use as manure or fertilizer. Challenges LCC is facing in relation to wastewater management include low staffing levels, insufficient facilities, vandalism and theft of infrastructure.

There is no public sewerage system in the City of Mzuzu and residents rely on pit latrines and septic tanks. Mzuzu City Council (MCC) is lacking machinery and technical capacity for proper sewage treatment.

Table 4 Rating for Degree of Point Source Pollution Control

Measure	Lilongwe	Mzuzu	Rate
1.1 Public sewerage connection	9%	0	1
Indicator Rate			**1 (very low)**

While noting the significant data limitations we faced in assessing this objective, our findings show that the control of point source pollution in the lake basin is very weak.

4.2 Degree of Nonpoint Source Pollution Control

In this measure, we adopted the national level forest cover. Malawi's target for forest cover in the Millennium Development Goals (MDGs) is 50% of land area. Forests and woodlands are estimated to cover about 34% of the total land area (FAO, 2010). This estimate is considered outdated and the 2010 State of Environment and Outlook Report for Malawi suggests that the current extent of forest cover is likely much lower. However, due to the absence of a more recent estimate, this paper adopts the FAO 2010 estimate. This is 68% of the MDGs target and is given a high rating according to our criteria. In addition, reforestation activities as well as forest and tree protection efforts have been increasing in recent years. Households and communities have also been encouraged to grow their own trees to meet household demands for cooking energy and construction materials, among others. Community forest areas and regenerated forests were evident in some places during our site observation. That being said however, many other places are still undergoing rapid deforestation.

Malawi classifies 30% of its land as arable. The Department of Land Resources Conservation and Development estimates that about 50% of the country's land is under cultivation, including marginal areas such as river banks and steep slopes. Of the arable land, the Department estimates that 30-40% is currently under good agricultural practices (i.e. minimal disturbance of soil, retention of crop residues and weeds on the soil surface, crop rotation etc).

Protection of lagoons and wetlands (swamps and marhes) in the lake basin is partial. Those that are currently under protection are the ones within national parks and wild life reserves e.g. wetlands within Nyika National Park, Vwaza Marsh Game Reserve, Kasungu National Park and Nkhotakota Wildlife Reserve. The lake's littoral wetlands are not protected. Most wetlands in the basin have been modified by anthropogenic activities (GoM 2010). We rated this measure moderate because national parks and wildlife reserves cover a considerable area of the lake basin. Table 5 presents the ratings for each of the measures and the indicator. Overall, the findings show moderate control of nonpoint source pollution.

Table 5 Rating for Degree of Nonpoint Source Pollution Control

Measure	Data	Rate
2.1 Proportion of land covered by forests	34% (FAO, 2010) – national level	4
2.3 Farm area under good agricultural practices	30-40% of Arable land	2
2.4 Protection of lagoons & wetlands (swamps & marshes)	Some protected (Under national parks & wildlife reserves)	3
Overall Indicator Rate		**3 (moderate)**

4.3 Extent of solid waste management in the cities of Lilongwe and Mzuzu

According to LCC, Lilongwe generates about 350 tons of solid waste every day. Mzuzu generates about 67 tons every day, estimated based on Population. Figure 2 provides an indication of the categories and proportions of the solid waste generated in Mzuzu City.
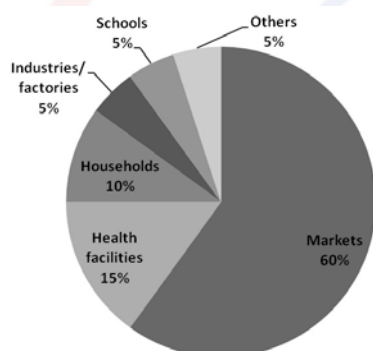
Figure 2 Waste Generation Categories in Mzuzu City (based on data provided by MCC)

As can be seen in Figure 2, most of the waste is generated by markets, health facilities and households. Information on actual waste composition is currently unavailable but generally the majority of the waste is organic. Both cities are only able to collect 30% of the waste generated. Challenges include insufficient waste management machinery, and low stakeholder awareness and participation.

Both cities are practicing open dumping and all waste is finally disposed of at the cities' dumpsites. Industrial waste is disposed of in the same way. Although industries/factories generate less waste compared to the other categories as Figure 2 indicates (assuming the situation in Lilongwe is similar), the indiscriminate disposal of waste calls for concern as some of the industrial waste maybe hazardous. The measure for industrial solid waste compliance is rated very low.

As both cities are practicing open dumping and not much control is exercised, the sanitary condition of the final disposal facilities leaves a lot to be desired. Key informants at the city councils described the condition as appalling, deplorable and pathetic. Figure 3 shows the situation when we visited the sites. Some waste is dumped along the roads to the sites and because of that, we could not access the Mzuzu City dumpsite because the road was blocked with waste.

Figure 3 Lilongwe City Dumpsite (above), and Mzuzu City Dumpsite (below)

Our assessment of the sanitary condition of final disposal facilities was based on the four basic sanitary landfill conditions proposed by Thurgood et al., 1998 and we rated this measure very low because none of the conditions is met in both cities. Table 6 shows the criteria we used in assessing this aspect. A summary of the rates of all the measures under this objective is provided in Table 7.

Table 6 Scoring Criteria

The Four Basic Conditions for a Landfill to be Sanitary		Score for Both Cities		Average Score
		Yes	No	
1. Full or partial hydrogeological isolation	Leachate collection system	1	0	
	Leachate treatment system	1	0	
2. Formal engineering preparations	Waste disposal plan	1	0	
	Final restoration plan	1	0	
3. Permanent control	Trained supervision staff based at site	1	0	
4. Planned waste emplacement & covering	Layering & compacting	1	0	
	Daily covering	1	0	
Total average score				
Rate				**1 (very low)**

Table 7 Rating for Extent of Solid waste Management in the Major Cities

Measure	Data		Rate (Average for both cities)
	LL	**Mz**	
3.1 Waste Collection rate	30%	30%	2
3.2 Industrial solid waste disposal compliance	All waste dumped without categorization	All waste dumped without categorization	1
3.3 Sanitary condition of final disposal facilities	Open dumping	Open dumping	1
Overall Indicator Rate			**1.3 (very low)**

Overall rate for this indicator is very low showing that solid waste management in the major cities in the lake basin is very weak.

4.4 Summary of Findings

In summary, our findings show very weak control of point source pollution and moderate control of nonpoint source pollution in the lake basin. We also find that solid waste management in the major cities in the basin is very weak. Table 8 presents the summarized scores. Overall, waste management and pollution control in the lake basin is very weak.

Table 8 Summary of Indicator Rates

Indicator	Rate
1. Degree of Point Source Pollution Control	1
2. Degree of non-point Source Pollution Control	3
3. Extent of solid waste management in the cities	1.3
Overall Rate (average)	**1.8**

5. How Can Synergies be Harnessed for Better Lake Basin Management?

The findings show very weak control of point source pollution and this is mainly attributed to the weak capacity of institutions that are responsible for managing wastewater. For general point source pollution control, indications show weak capacity for monitoring and enforcement of regulations by the institutions with mandate e.g. the Department of Environmental Affairs. These challenges are due to low staffing levels in the institutions and insufficient resources and equipment.

For non-point source pollution control, the major challenges are weak coordination among sectors especially at local level of implementation. All the main sectors of concern in our study in this regard (forestry, fisheries and agriculture) have local community institutions in place responsible for management of local resources. However, we observed that there is no cross-sector cooperation among these local institutions. Considering the fact that there are some cross-cutting activities that would be better managed jointly at the local level, this may be an opportunity that is

not being embraced and thereby losing some synergies that could be harnessed. For example, river bank protection activities are one area where joint implementation by farmer clubs, forestry management clubs and fisherfolk clubs can be pursued. There is need to make local people aware of how linked and interdependent their various activities are and why joint effort is required to ensure sustainability of the lake basin and their well-being. This needs to be encouraged by the relevant institutions e.g. the Ministries and Departments of Agriculture, Forestry and Fisheries. This also requires traditional leaders in the communities to play a role of helping their subjects see the bigger picture and encouraging them to work together for mutual benefit.

Challenges leading to the very weak management of solid waste management may be attributed to weak institutional capacity resulting from insufficient resources and equipment. More importantly, this may also be due to weak participation of stakeholders and communities/households in overall waste management. Both city councils have plans to promote stakeholder participation in managing waste at source, recycling and other aspects of waste management. LCC for example, indicated that they are to implement their plans by 2016. There is need for the city councils to vigilantly implement their plans so that overall solid waste management may be improved as soon as possible.

It has been shown that most of the main challenges are boiling down to weak institutional capacity and ultimately insufficient resources and equipment. Figure 4 shows a causal loop diagram that figuratively portrays the linkages among the main challenges and issues, and important action points if the situation is to be improved.
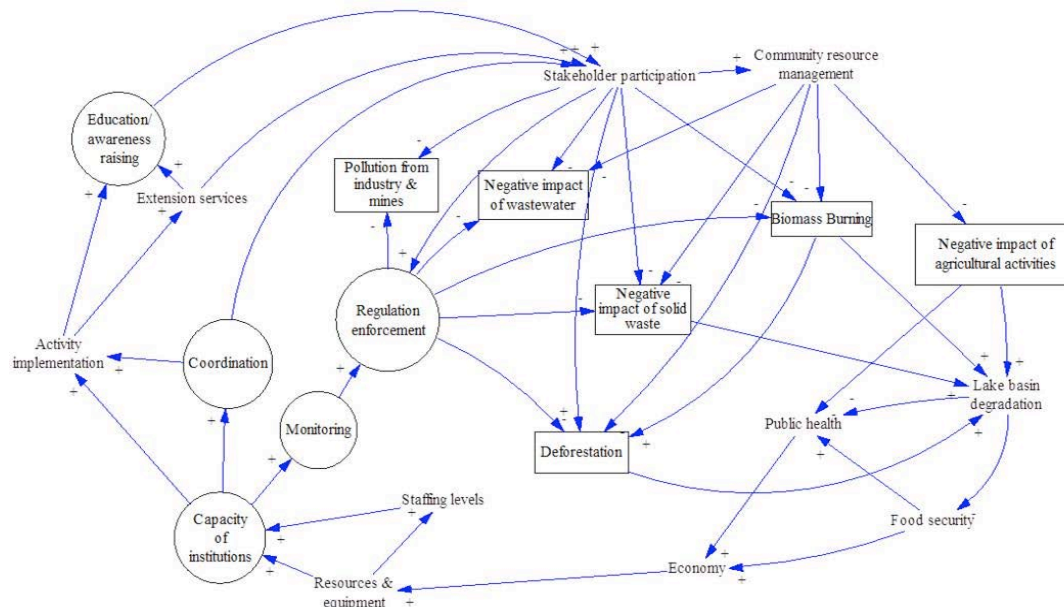
Figure 4 Causal loop diagram showing the interaction of challenges and issues in the Lake Malawi Basin

The items in boxes are the main issues in the lake identified by previous researchers, items in circles are the main challenges identified in this study and the remaining items are factors that are interacting to affect the main challenges and issues.

The item at the tail of the arrow causes a change in the item at the head of the arrow. A + sign at the head of the arrow indicates that change occurs in the same direction and a − sign indicates that change occurs in the opposite direction.

There are several loops in Figure 4 but we explain only one to aid understanding. A decrease in resources and equipment will result in a decrease in the capacity of institutions and this will cause a decrease in coordination among various institutions and stakeholders. In turn, stakeholder participation will decrease and result in a decrease in community resource management. This will cause an increase in the negative impact of agricultural activities and lake basin degradation will also increase. This will cause a decrease in food security and a decrease in the economy which will consequently cause a decrease in the availability of resources and equipment. This loop has a reinforcing effect i.e. we started with a decrease in resources and equipment and ended up with a more decrease in resources and equipment. This effect indicates that a change in resources and equipment leads to an amplified change when the effects are traced around the loop (similarly, if there is an increase in resources, it will lead to more resources being available if we trace the effects around the loop).

From the loop diagram, we identified three main factors as the main action points to better harness synergies for attaining sustainable management and utilization of the lake basin. These action points are stakeholder participation, regulation enforcement and capacity of institutions. These factors are either affecting many other factors, or are being affected by many factors or both. If efforts concentrate at improving these areas, overall waste management and pollution control will improve and consequently, lake basin management will be more sustainable. Ultimately, all these three action points are affected by availability of resources. Therefore, ensuring that sufficient resources are available to the various mandated institutions is crucial for sustainable lake basin management. One very key factor in realizing this is support of political leaders as they play a very important role in setting priorities. Muhandiki and Ballatore (2007) pointed out that "For lake basin management to be successful, it is important to cultivate political will, support, and commitment at the highest political level". Table 9 presents the actions we recommend under each of these main action points. It should be noted however that our list of recommended actions is meant to act as a guide and is not exhaustive.

Table11 Recommended Actions

Action Point	Recommended Actions
Stakeholder participation	1. Raise awareness 2. Strengthen coordination among related institutions & other stakeholders 3. Strengthen extension services 4. Pursue integrated implementation of activities at local level (encourage inter-sectoral interaction of local community institutions) 5. Encourage alternative financing mechanisms where feasible e.g. "Payment for Ecosystem Services (PES)" etc.
Regulation enforcement	1. Strengthen monitoring capacity & encourage participation of the general public 2. Bring offenders to book to discourage potential offenders 3. Revise regulations as necessary
Capacity of institutions	1. Ensure sufficient & timely Government funds for institutions 2. Explore innovative ways of accessing supplementary funds e.g. PES, co-management practices, Public Private Partnership (PPP) etc.

6. Conclusion

We find that overall, waste management and pollution control in the Lake Malawi Basin is very weak and threatens the sustainability of water resources in general and the lake Malawi basin in particular. This poses possible consequences on the well-being of Malawians and the economy of the country. There is need to improve capacity of institutions, enforcement of regulations and stakeholder participation. Availability of sufficient resources is necessary to improve the situation and support of political leaders is needed to ensure that resources are available for the country to move towards sustainable management and utilization of water resources and the lake basin.

Acknowledgement
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"Walkable Pedestrian Circulation": Enhancing Sustainable Development of Chittagong Metropolitan City, Bangladesh

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Abstract

For the rapid urbanization, developing countries like Bangladesh is experiencing several unplanned urban growth which broke down the mobility of non-motorized transport modes and in particular walking. In daily life, mass people are hassled to move within a hazardous and uncomfortable living environment. Walking as primary mode of travel is dominant in all age groups and income classes. It is more prevalent for low income groups, nearly 80 percent. Indeed the extent of walk mode in urban areas of Bangladesh is much more compared with other Asian mega cities. In Bangladesh, owing to the limited area of pedestrian ways and less scope of walking spaces, residents are either forced to walk on streets or use rickshaws for short trip. As a result, they are often faced to exceedingly vulnerable situations by high extreme level of vehicles. It's very common phenomena for our country. In view of the above situation, a study of walkable development of pedestrian circulation with adequate qualities of a major city like Chittagong in Bangladesh is considered timely, which is not only the commercial capital city but also the second largest city of Bangladesh and that is having environmental pressures for its rapid expansion. This study will attempt to analyze both the realistic status and the sensitivity of pedestrian circulation pattern by selecting the indicators of sustainable development of Chittagong Metropolitan City, Bangladesh.

Keywords: Walkable Pedestrian, Urbanization, Sustainable Development, Chittagong City, Bangladesh.

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Introduction

In the glow of decreasing global resources and much ecological degradation, the outlook of a new century raises serious issues about the health and livability of upcoming cities. In the last century, the extensive transformation process of our cities and towns from low density suburbia not only impacted adversely our natural environment, but also exhausted the vitality of traditional urban spaces (Kazimee, 2013). Throughout that impact, the livability of the urban environment has become worse for the constant increase of private vehicular traffic and its invasive character that have contributed to a decrease in the share of the non motorized transport modes, and in particular of walking (Martincigh, 2013).

Grounding approach to urban mobility mainly developed into the field of transportation studies, had ignored pedestrian activities for a long time, and no specific plans or design rules did not follow. However, walking is the most fundamental mean of transport that reduce the enormous environmental costs of the motorized vehicles. On the other hand, in the Sixties by the Buchanan Report, the application of walking into the transport system of any city was already documented (Ministry of Transport, 1963). To break these negative approaches, and to make it more sustainable, saving energy and land, less polluting and endangering, everybody's rights of using the shared public space with more equitable and more respectful. Moreover, it is necessary to rebalance the mobility system and that would be enhancing the real essence of the city (Martincigh, 2013). The development of the pedestrian and cycling mobility, especially in urban areas, is an essential action to reduce the huge environmental costs of the motorized transport which is still today the main transport mode for urban and regional travels. This action constitutes a segment, even though remarkable, of wider strategies targeted to promote sustainable mobility, especially in urban areas.

By the mid Nineties, the Aalborg Charter, 1994 (as cited in Galderisi, A and Ceudech, A, 2009), signed by many European cities to promote sustainable urban development where mainly focused on the improvement of sustainable mobility, especially walking, cycling and public transport (2009, P. 21). Starting from the end of the Nineties, by encouraging walking and cycling, many initiatives took place in Europe with spreading demoralization of car use (Galderisi, 2007). In 2004, during the Fourth European Conference on Sustainable Cities, the Aalborg Commitments have been accepted (Galderisi, A and Ceudech, A, 2009). Until today, in fact, the various involvements of pedestrian patterns on individual streets or squares have included mixed results, depending on the different initial conditions. Whereas, pedestrian spaces are the main transport mode for urban and regional trips but implementation of proper authority was not able to trigger an effective improvement of pedestrian travels in the urban area (Gabellini and Bonfantini 2005).

The paper has six sections, including this introduction. Section 2 addresses the definition of walkability, and also deals with importance of pedestrian movement for the citizens and urban sustainability. Sections 3 discuss the study area on Chittagong metropolitan city area and highlights presents scenario of pedestrian circulation situations here. Section 4 discusses about Sustainable development process. Section 5 indicates to sustainable indicators of walkable pedestrian circulation how can we develop. Section 6 presents the paper's conclusions.

A walkable pedestrian circulation

A walkable pedestrian circulation is basically means of walkability on pedestrian ways. Nowadays the word walkability refers by Litman (2003) (as cited in Funk, 2012) that, 'the quality of walking situations, including safety, comfort and convenience' (p. 3). Some cities have started wide studies and area plans to rise up walkability. Transport for London (2004) (as cited in Leather, et al. 2011) defines walkability as "the extent to which walking is readily available to the consumer as a safe, connected, accessible and pleasant activity" (p. 9). Still today, when a new concept of inquiry arrives that research is suggesting particular elements of built environment that effect the pedestrian environment's quality (Saelens and Handy, 2008). Street connectivity, sidewalk width, roadway width, street furniture and articulations of building facade are examples of some of the physical characteristics believed to influence the walkability of a street and neighborhood (Funk, 2012). For New Zealand, it was clarified as walking-friendly built environment that is still the second most popular type of travel (New Zealand Transport Authority 2007). Abu Dhabi has urbanized an Urban Street Design Manual whereas overall street composition incorporates with the conception of the pedestrian realm. Other cities, particularly in Europe, have arranged strategies and incorporated sustaining policies mainly to improve the walkability and cyclability of the whole city (Leather, et al. 2011).

A walkable pedestrian path, as an alternative transport mode for short transit, can be rebalancing mobility in urban areas through a sustainable way (Martincigh, 2013). On the other hand, a slower pace of pedestrian gather experiences on an environment that means able to observe more visual details differently than a person moves 60km per hour (Funk, 2012). This center of attentions for pedestrian mobility in urban areas formulating methods for planning and design networks of urban public space, such as residential streets and public squares, dedicated to exclusive pedestrian use (Galderisi and Ceudech, 2009). However, Tiwari (1999) presented "if a huge community cannot afford to use motorized transport either personal vehicles or city buses, they also have preferred to walk or cycle to reach their work places." Sustainable mobility design creates the ability of community's interaction and encourages reducing automobiles or public-transports to improve public health and safety. It would reduce transit costs and inaugurate other economic benefits (Kazimee, 2013; WALSH, 2012).

Therefore, attractiveness, comfort, accessibility and overall implementation processes and safe pedestrian environments provide numerous benefits (Prassas, 1999; Komanoff, 2004; Centers for Disease Control, 2011; Martincigh, 2013). From Health Inequities in British Columbia, Discussion Paper (2000) where Housing and Healthy Built Environments division has declared to enhance a healthy environment for neighborhood with ensuring accessible walkways in urban residents area. To maintain a good health, walking is the unique and most usual transport mode (UDC-1, 2007). As little as 30 minutes daily walking can avoid the onset of several diseases as like lack of physical activity (OECD/ITF, 2011).

As the weak relationship between physical design and system, pedestrian environments have faced complexity. In the term of physical designs like the quality of pedestrian facilities, roadway conditions, and land use patterns are affecting our

walking environment, as well as inadequate funds, operate and proper preservation are affected that environment by inappropriate policy making (WALSH, 2012).

Study area

In Chittagong context, absence of walkable pedestrian ways is one of the major problems for urban residents and urban transportation network, which are also quite common in other mega cities in Bangladesh. Because of the significant expansion of Karnaphuli river and seaside port with export-import trade, ship breaking commerce and many other industrial developments, Chittagong city experienced fast urban growth during the last few years (DAP, 2009). Consequently, migrated extra populations are threatening their limited urban infrastructures which lead to unplanned urbanization with a lack of sensible professional approaches. That is going to create pressure on existing city's pedestrian ways. A lack of pedestrians-friendly planning with absence of sustainable mindset has increased high level of motorized vehicles and in excessive traffic congestion as well (Karim, 2006). Belonging to different income groups, traffic problems are creating complexity not an easy task to solutions in the mega-cities of developing countries. Even unplanned and inadequate pedestrian spaces are occupying by roadside window shopping and hawkers, presence of construction materials on pedestrians, absence of awareness, that's way urban residents are discomfort to use of pedestrians for walking or shorter trips (Azad, 2000).

Hoque, et al, (n.d.), states:

> "Pedestrians apparently form by far the single largest group of road users in terms of total catered number of trips in urban areas of Bangladesh between 20-60 percents and that is particularly prevalent (about 65 percent) for short trips up to one mile. Walking as a primary mode of travel is dominant in all age groups and income classes. It is more prevalent for low income groups, nearly 80 percent. Indeed the extent of walk mode in urban areas of Bangladesh is much more compared with other Asian mega cities."(p. 3)

In Bangladesh, low level of motorization, mode of walk is moderately significant in urban areas (Hoque, et al, n.d.). In Chittagong City, various authorities, such as, CDA (Chittagong Development Authority), CCC (Chittagong City Corporation) have made some efforts to enhance urban neighborhood facilities like transportation systems, road networking, and parks develop, build up walking pedestrian and many of public awareness activities (Majumder, et al. 2007).

The detail area master plan of Chittagong Metropolitan City (DAP, 2009) has proposed only six feet wide pedestrian for respective urban inhabitants and have also suggested wider pedestrian path around major street road but not proper indication about that. The residents of lower-income inhabitants faced a serious problem for narrow access roads and also for an absence of wide pedestrians in Chittagong (Rahman, 2010). It also results in a pedestrian fatality hazard with traffic congestion and vulnerable road accidents (Rosén and Sander, 2009). The effects of the vulnerable situation are straightforwardly affecting our country's national economy (Azad, 2000).

From Hoque, M.M, Mahmud, S.M. Sohel, Qazi, A. Shakur:

> "Over 80% of fatalities are vulnerable road users e.g. pedestrian, bicyclists, motorcyclists and users of informal and unsafe motorized and non-motorized transport. Accident type analysis showed 'hit pedestrian' as the dominant accident type both in urban and rural areas, 45 percent involvement in fatal accidents. Further analysis revealed that most of the pedestrian's fatalities occur while crossing the road (41%) and is closely followed by walking on the road (39%), and standing on the road (14%). In Current prices, road accident in Bangladesh costs community at least Tk. 7,500 crore/US$ 1000 million per annum (Nearly 2 % of Gross Domestic Product -GDP)" (2013, p. 5-6).

With particular regards to urban areas, the purpose of this study will be realized the sustainable pedestrians networking system design at Chittagong City that will be provided mobility and accessibility to all urban residents.

Sustainable development process

Sustainable agendas require a comprehensive and integrated expression that concern about unique human and environmental resources of the city. Vieria (as citied in Kazimee, 2013) defines that, "sustainability identifies strategies that look at the community's on-site natural resources as integral aspects of the design."

A report by Martincigh (2006) summarized that:

> "When speaking of urban quality, it is necessary to deal contemporarily with two different aspects, on one side with the people's expectations and cultural habits, and on the other one with the urban environment's propositions; the more these two aspects meet, and the higher level of overall quality is reached. The expectations belong to two different levels: one related to the urban structure, the other related to the intermediate space" (p. 4).

On the other hand, the quality of city's living environment spaces depend on the principles of sustainable urban planning within the means of the environments, social and economic foundations (UDC-1, 2007; Brundtland, 1987; UNCED, 1992). Moreover, the sustainable guidelines would not only be implemented all right now, but also executed throughout the city. New development areas should be planned to follow the guidelines, but old, built-up areas should be considered to enhancement when opportunities begin from urban revival (UDG, 2006).

Design guidelines for Sustainability

Many communities around the country have decided to take on various regulatory, administrative, and financial aspects, and otherwise help to safer pedestrian facilities and activities. These attempts have been packaged and branded under few concepts, such as livability, sustainability, context-sensitive solutions, and other movements that promote comfortable accessibility especially for all users of pedestrians (WALSH, 2012).

From some literature reviews, such as Bentley, et al, (1985); Boodlal (n.d.); Fessl, et al. (2013); ILUPT (2008); Koenigsberger, et al, (1973); Kazimee (2013); Martincigh (2006); PFG (1997); Simonds (1961) and Urban Design Compendium 1 & 2 (2007); we have discovered and indicated various sustainable indicators that might be implemented to develop a walkable pedestrian circulation in Chittagong Metropolitan City.

The designs indicators of sustainable development are discussed below and that are:

Zoning system: (integrated boulevard corridor)

Walkways in urban business areas need to be designed to accommodate larger volumes of pedestrian traffic by integrated boulevard corridor than in residential areas. Streetscapes in these areas often add in multiple functions, and usually consist of the following regions are shown in Figure 1, that are the building frontage zone, the pedestrian zone, the planter/furniture zone, and the curb zone (Boodlal, n.d.).
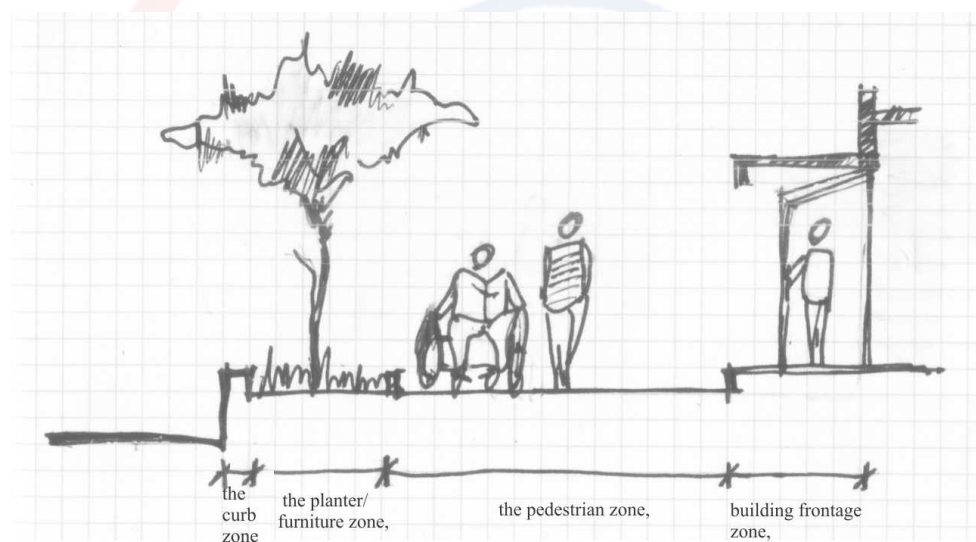
Figure 1. The zoning system divides the boulevard walkway passage into four zones to ensure those pedestrians have an adequate clear space to walk.

No steps or level changing

To avoid uneven walking and uninterrupted movement, no steps or level changes are necessary to provided on pedestrian circulation, otherwise using ramp to minimize any significant reasons (Fessl, et al. 2013).

Disable accessibility

To ensure sustainability on pedestrian way for all pedestrians, especially for disabled persons, it's so important to scope disable accessibility when end up the way or merge with any intersections roads (Figure 2).
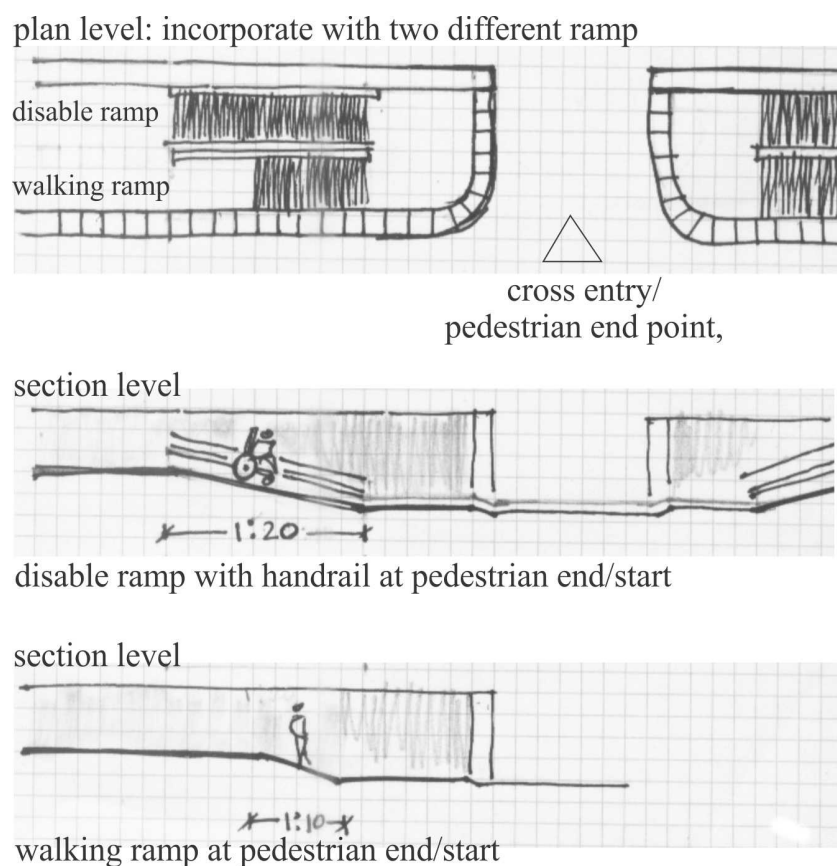
plan level: incorporate with two different ramp

disable ramp

walking ramp

cross entry/
pedestrian end point,

section level

1:20

disable ramp with handrail at pedestrian end/start

section level

1:10

walking ramp at pedestrian end/start

Figure 2. Incorporate with two different ramps with handrail for disabled person and general users.

No obstacles

Sufficient widths for passageway along footpaths should be maintain through the removal of obstacles such as rocks, trees, branches and undergrowth, advertising billboards and commercial displays.

Barrier-free mobility

Coherent path networks of at least 2.5m (Fessl, et al. 2013) in width are essential for barrier-free mobility.

Pocket park with books stall and tea corner

From an ecological standpoint in an urban area, pocket parks, at best, act as tiny spaces that can be tucked into and scattered throughout the urban fabric where they serve the immediately local pedestrians. As they need be sited in areas of heavy pedestrian traffic, so they remain safe and functioning, potential use by many other urban eco-system is negligible. Here we can provide facilities for recreation, rest and relaxation that are available to all pedestrians in every pace of life (figure 3 & figure 4).
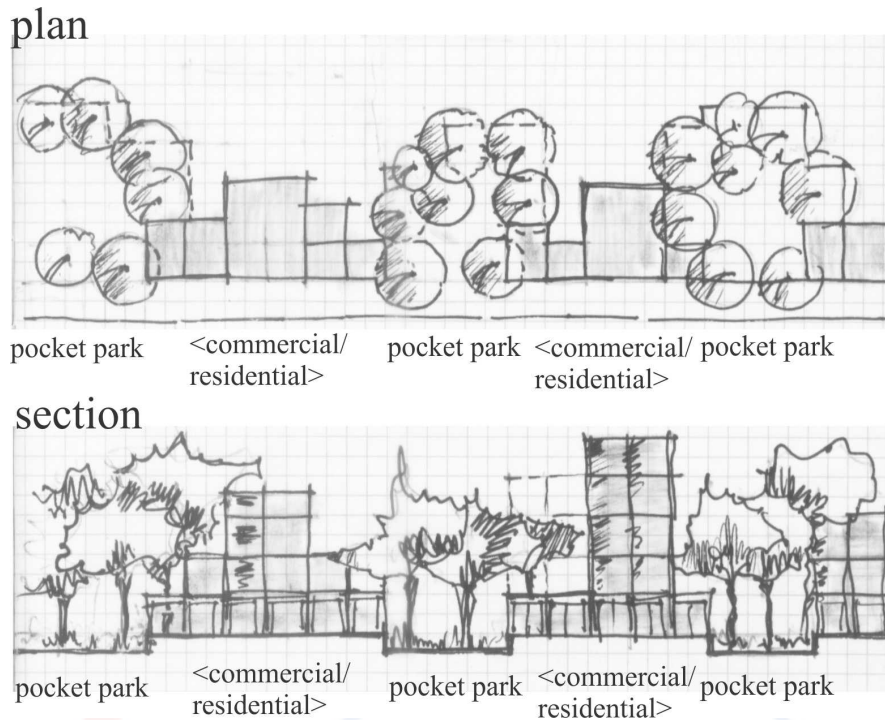
plan

pocket park   <commercial/   pocket park <commercial/ pocket park
                residential>   residential>

section

pocket park   <commercial/   pocket park <commercial/ pocket park
                residential>   residential>

Figure 3. To develop pocket parks in between footpath side commercial/residential build form maintain comfort distance of pedestrians.
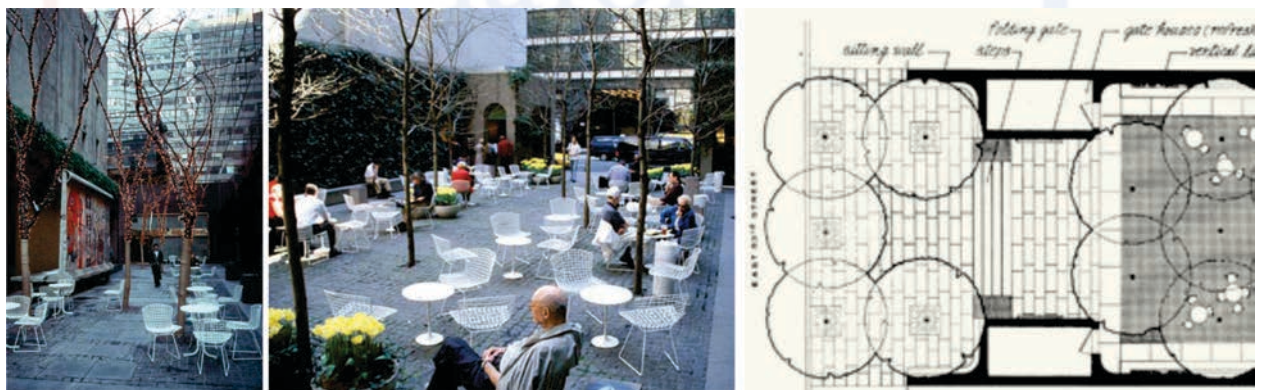
Figure 4. Few examples- Greenacre Park, New York City (View 01) and Paley pocket Park, New York City (View 02 & Plan) (source: Blake, A., n.d.).

Legibility or easy to locate

An apparent and easy growth pattern within an urban area permits inhabitants and visitors to understand how an area is organized and to create their way around by easy to locate.

Enhance a sense of community by Provide for pedestrian priority connections

Pedestrian-scale design is the development that balances pedestrian – and auto-transit needs while providing healthy environments and places for people to assemble, plan

and associate with others (Kazimee, 2013) to the best extent possible. For example, Dan Burden of Walkable Communities Inc. (ILUPT, 2008) suggests the following standards:

> "homes within ¼ mile of most services; neighborhood elementary schools within ¼ mile of homes; high schools accessible to most children within one mile of most homes; parks within 1/8 mile of homes; public transit access within ¼ to ½ mile of most homes; town center/downtown should provide a balance of retail and commercial stores and services, e.g., hair salon, hardware store, pharmacy, grocery/deli, restaurants, clothing, specialty, post office, library, town/city hall, within ¼ mile walk of the absolute center." (p-323)

Pedestrian way Continuity

Continuity can be undoubtedly useful to boost up the effectiveness of sustainable walkable movement of pedestrians in Chittagong area. This walkway's continuity should connect to suitable transit stops and should have uninterrupted asphalt road patterns across driveways and streets.

Landscaping

By proper planning of landscaping and variety of trees can create a pedestrian environment more sustainable to use. It can be helped to filter noise from the street (figure 5) and surrounding air quality that can restore the crucial oxygen producing cycle (Kazimee, 2013). Appropriate position of tree plantation reduces pedestrian area's temperature (figure 6) for walker (ILUPT, 2008).

Figure 5. Trees can be improved surrounding air quality and can restore the crucial oxygen.
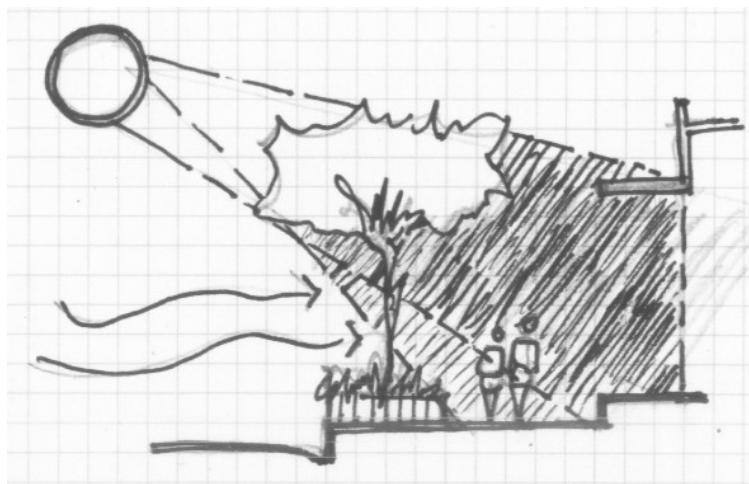
Figure 6. Proper location of tree plantation reduces pedestrian area's temperature.

Localize the economy

Provide family gardening, craft sales, and produce markets, pottery shops adjacent (figure 7) to the units as well as encourage workshops to foster interest and awareness in the benefits of neighborhood and pedestrians to experiences of local conditions (Kazimee, 2013).
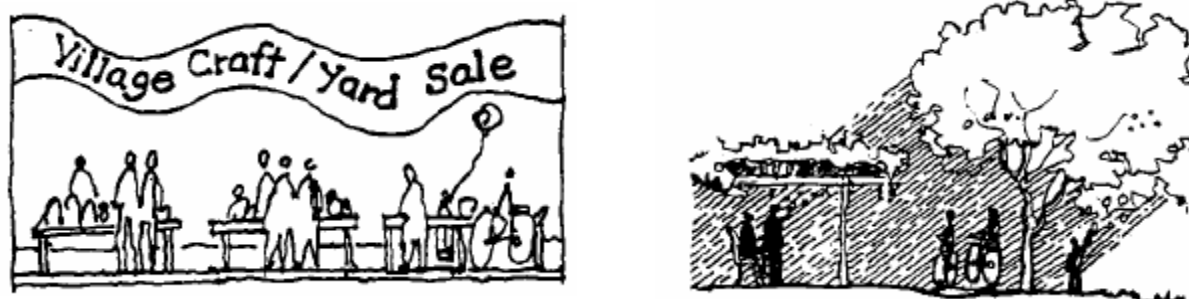
Figure 7. Pedestrians experiences of local conditions by neighborhood's business.

Organized Hawker's business environment with Extension on window shopping

In Bangladesh especially at Chittagong city, window shopping and hawkers business are so acceptable functions for pedestrians that are thoroughly contextual and not likely to neglect. That's why; own space allotment and extension on the pedestrian path should be thinkable so that pedestrian movement can be enhanced (Figure 8).

section

perspective view
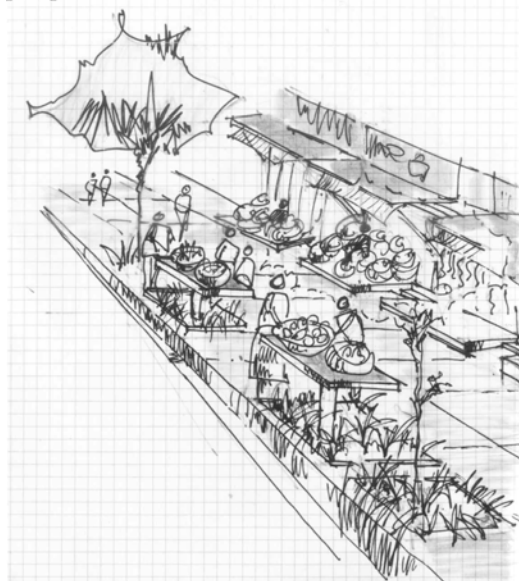
Figure 8. Integrated space of hawker's business area with extension of window shopping.

Integrated green divider

To make travel safer on pedestrian, it's necessary to provide separation between busy roads and walkways, so that green dividers make walkers ways safer and more suitable (figure 9).
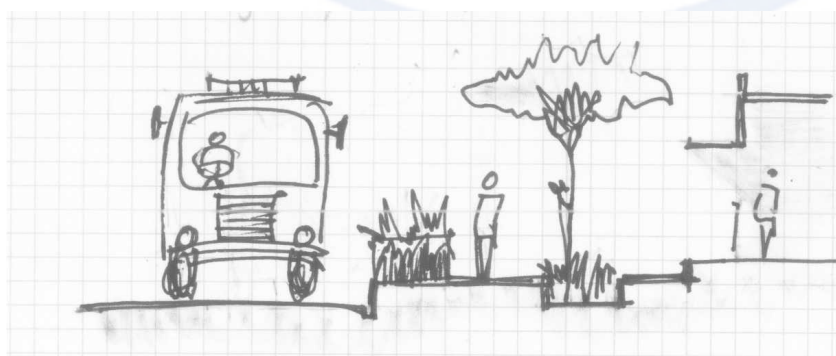
Figure 9. Green divider to provide pedestrian's safety.

Provide public utility functions

Pure drinking water is so necessary for passerby to make relax when feel them thirsty into movement and also by providing proper placement of public toilet facilities, make pedestrian's way relaxed and healthy.

Define Public bus stoppage with shading/tent

To avoid accidents and hazards from street, need to indicate proper public transit services or school bus stoppage with shading.

Pavement materials

By the selection of paving and surfacing materials to safety, accessibility, long-term durability, cost, and maintenance that are typically the most critical issue. In general, surfacing materials for pathways in urban areas should be paved or consist of other hard-surfaced materials (PFG, 1997).

Dedicated wall surface for different public use

In locally, pedestrians are enjoying to adding or overlapping poster on a wall surface, street wall painting and traditionally they are enjoying to reading daily local newspaper lapping on pedestrian wall. To continuing and respect this context, we could provide that kinds of dedicated wall spaces for pedestrians as well as an exhibit contextual flavor (figure 10).
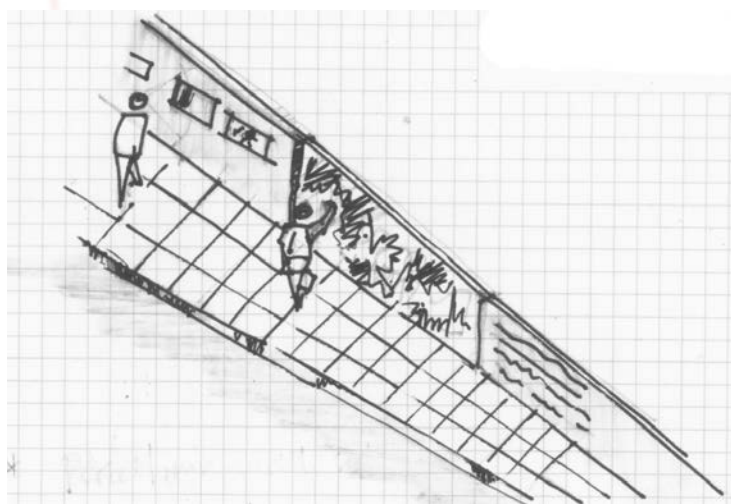
Figure 10. Dedicated street wall to enjoy reading daily local newspaper.

Commonly used garbage cans

In the action, garbage cans are must frequently placed to use it or keep pedestrian way clean. That also be made walker bad habit to dirty here and there.

Used Ramp for overhead or underpass pedestrian on road crossing

Tunnels and underpasses or Overpasses and bridges should be simple and convenient for pedestrians to access (OBPP, 1995; PFG, 1997). With accessibility requirements, by using a ramp, all passageways must be assumed to provide service to both pedestrians and bicyclists (figure 11 & figure 12).
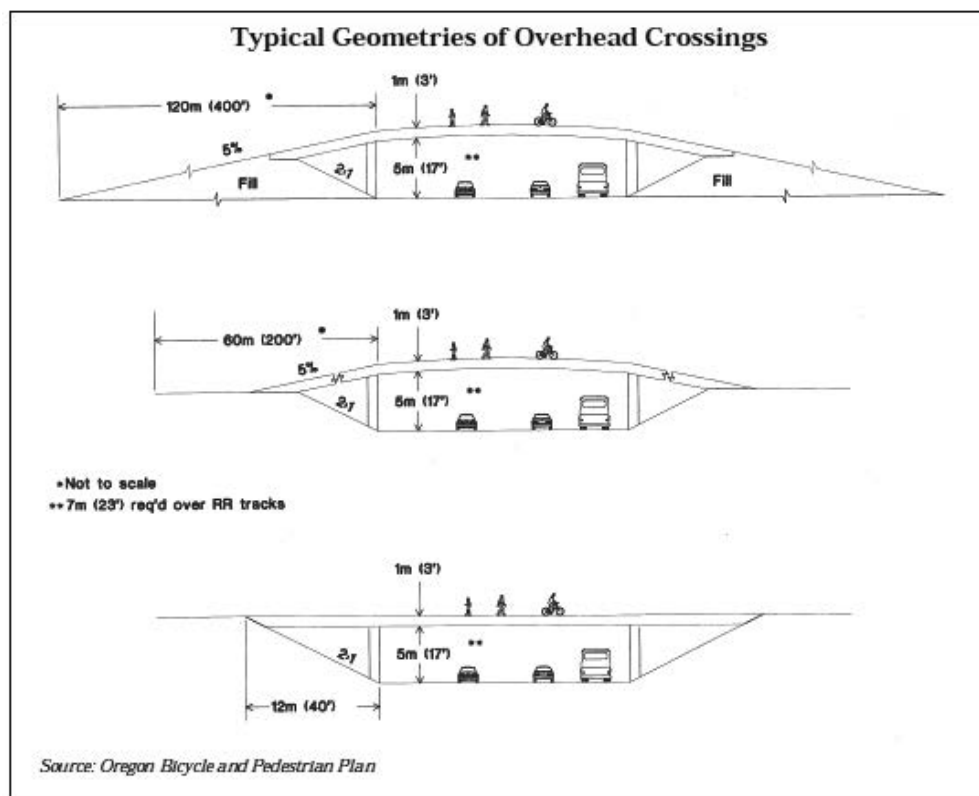
Figure 11. Used pedestrian ramp for overhead crossing (OBPP, 1995; PFG, 1997).

Typical Geometries of Underpasses
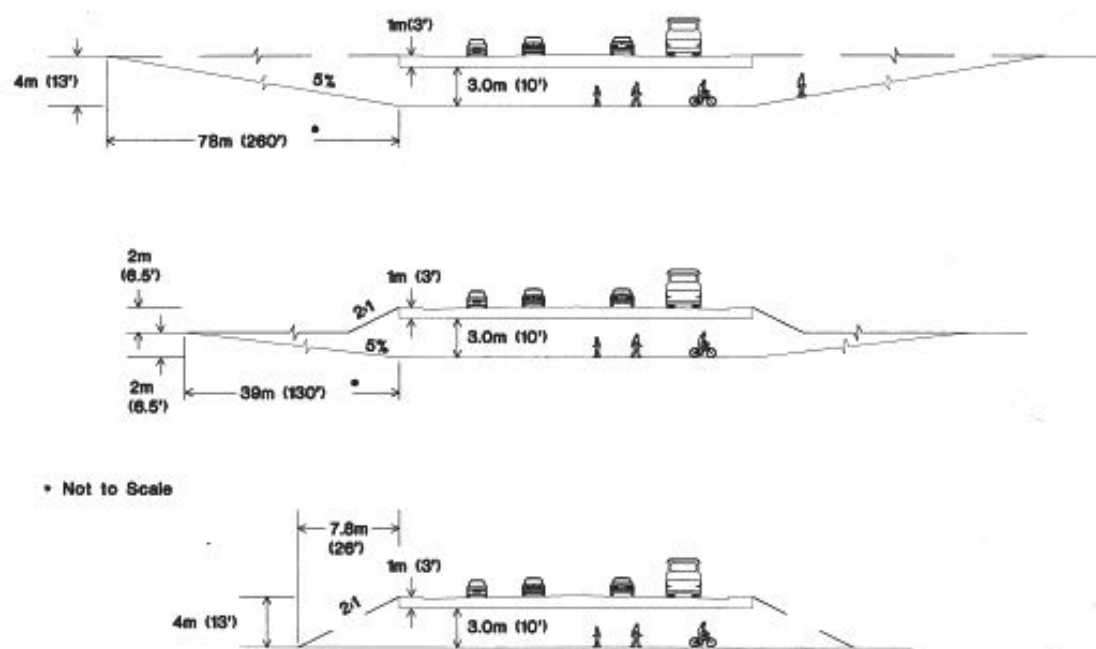
Source: Oregon Bicycle and Pedestrian Plan

Figure 12. Used pedestrian ramp for underpasses crossing (OBPP, 1995; PFG, 1997).

Enhancing Streetscape

New developments of urban areas can and should incorporate pedestrian flow into site layouts by providing human-scale landscaping, street furniture as seating, lighting and other features that endorse a sense of security and push people to make use of pedestrian amenities. Junctions and street crossing areas have to be considered to be simple and easily observable. Whereas faced difficulties, that should be equipped with proper measures such as traffic lights (Fessl, et al. 2013).

Parking lot design

Street side parking areas should be considered to minimize breaks in the pedestrian environment beside the public street and create secure and comfortable passage for pedestrians.

Conclusion

Cities are becoming increasingly contingent on motorized transport as they fast expand in ways that contribute to urban sprawl. Proper planning and design guidelines are required to decrease motorized transport use and promote alternative transportation approaches. To develop metropolitan environments like as Chittagong Metropolitan City, must consider to awareness about the necessity of pedestrians so that people can easily walk or move to and from their chosen destinations. The sustainable design strategies are an efficient tool for representative the theory, quality and application of a sustainable program to an urban area. These integrated planning strategies permeate various frameworks of walkable pedestrian circulation design with its neighborhood context. Especially in Chittagong city, these sustainable

indicators are enhancing city's living environment and driving people to walking more. The implementation of a sustainable plan to develop pedestrian-friendly walkable environments to leads Chittagong city's sustainability and that will require collaboration with government, city planners, civic organizations and private individuals.

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Figure Captions

Figure 1. The zoning system divides the boulevard walkway passage into four zones to ensure those pedestrians have an adequate clear space to walk.

Figure 2. Incorporate with two different ramps with handrail for disabled person and general users.

Figure 3. To develop pocket parks in between footpath side commercial/residential build form maintain comfort distance of pedestrians.

Figure 4. Few examples- Greenacre Park, New York City (View 01) and Paley pocket Park, New York City (View 02 & Plan) (source: Blake, A., n.d.).

Figure 5. Trees can be improved surrounding air quality and can restore the crucial oxygen.

Figure 6. Proper location of tree plantation reduces pedestrian area's temperature.

Figure 7. Pedestrians experiences of local conditions by neighborhood's business.

Figure 8. Integrated space of hawker's business area with extension of window shopping.

Figure 9. Green divider to provide pedestrian's safety.

Figure 10. Dedicated street wall to enjoy reading daily local newspaper.

Figure 11. Used pedestrian ramp for overhead crossing (OBPP, 1995; PFG, 1997).

Figure 12. Used pedestrian ramp for underpasses crossing (OBPP, 1995; PFG, 1997).
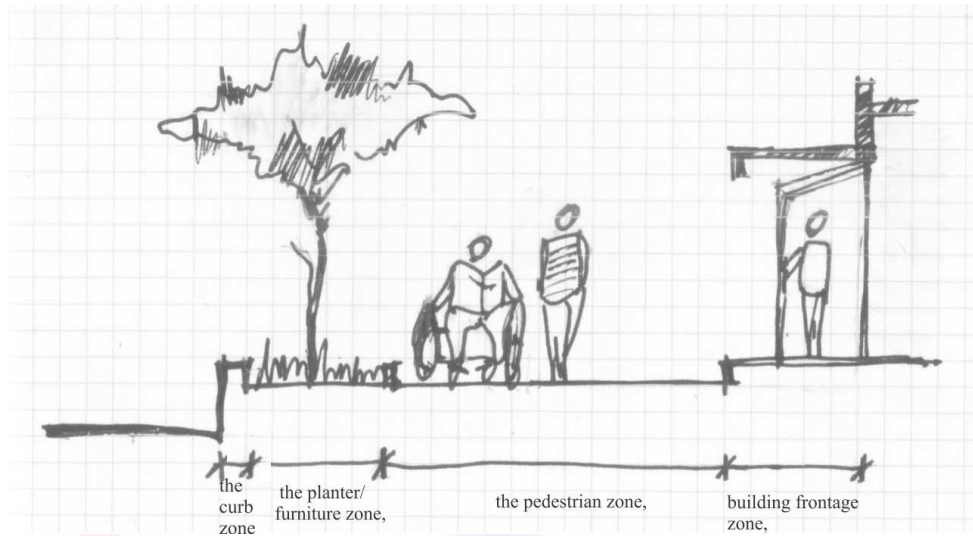
[Figures]

the
curb
zone

the planter/
furniture zone,

the pedestrian zone,

building frontage
zone,

Figure 1. The zoning system divides the boulevard walkway passage into four zones
to ensure those pedestrians have an adequate clear space to walk.

plan level: incorporate with two different ramp

disable ramp

walking ramp

cross entry/
pedestrian end point,

section level

1:20

disable ramp with handrail at pedestrian end/start

section level

1:10

walking ramp at pedestrian end/start

Figure 2. Incorporate with two different ramps with handrail for disabled person and
general users.

plan

pocket park   <commercial/ residential>   pocket park   <commercial/ residential>   pocket park

section

pocket park   <commercial/ residential>   pocket park   <commercial/ residential>   pocket park

Figure 3. To develop pocket parks in between footpath side commercial/residential build form maintain comfort distance of pedestrians.

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Typical Geometries of Underpasses

Source: Oregon Bicycle and Pedestrian Plan

Figure 12. Used pedestrian ramp for underpasses crossing (OBPP, 1995; PFG, 1997).

Determining Critical Success Factors in Low Carbon Construction: A Review

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Abstract
Construction sector failed to restrain the rapid increase of carbon dioxide emissions by every year into atmosphere. However despite the advent made in assessing green buildings, not much had been done to determine the critical success factors of low carbon construction in Malaysia. This studies attempts to review the literatures in relation to critical success factors and low carbon construction. Previous studies conducted by researchers had revealed that there are six groups of critical success factors for low carbon construction which are based on project, project manager, project team, material and equipment, client and external factors.

Keywords: critical success factors, low carbon construction, project success

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INTRODUCTION

Malaysia involvement in sustainable development started since the launch of four important policies commencing in the 80's which are National Energy Policy 1979, National Depletion Policy 1980, Four Fuel Diversification Policy 1981 and Fifth Fuel Policy 2000 (Chua and Oh 2011). The formulation of these policies further followed by signing of Kyoto Protocol to the United Nation Framework Convention on climate change on 12 March 1999 and further ratified on 4 September 2002 to control and combat global warming by Malaysia. (C.S Ho, W.K. Fong, 2007). However, the total amount of carbon dioxide emission in Malaysia are increasing at higher rate each year although Malaysia is ranked in 58th place of carbon dioxide emission per capita per year country in 2007 (Kettha 2011), and earned 38th position or ranking among 146 countries worldwide in Environmental Sustainable Index (ESI) with regards to environmental sustainability (Yale University, 2005). According to WDI (2010), carbon dioxide emission has increased from 160,266 kilo tonnes to 208,267 kilo tonnes from the year 2003 to 2008. Therefore, as one of the corrective measures, the National Green Technology Policy was launched on 24th July 2009 in Malaysia concomitant with the sustainable development in the country where the country committed to achieved 40% reduction of carbon emission intensity per GDP (Gross Domestic Product) by year 2020 through the announcement in Copenhagen on 17 December 2009 by the Malaysia Prime Minister. Besides that, Malaysian Government also launched the Low Carbon Cities Framework and Assessment System in September 2011(Kettha, 2011).

As there are various green building rating schemes across the world such as Green Star, LEED and BREEM, (Kibert, 2008), Green Building Index was introduced by Green Building Index Sdn Bhd since certification of Malaysian Energy Centre as first green certified building on 24 July 2009. Besides that, there are other foreign green rating system that have issued certification to buildings in Malaysia which are by The US Green Building Council (LEED) from United States and BCA Green Mark from Singapore.

LOW CARBON AND SUSTAINABLE DEVELOPMENT IN MALAYSIA

Hezri and Hasan, (2006) said that Malaysia driven to involved in sustainable development as the leader of Group 77. Besides that according to Brosius (1999), Malaysia forced to counter allegation of the international community of uncontrolled forest clearing in Sarawak (Brosius, 1999) by exploring sustainable development. Green Building Index Sdn Bhd established Green Building Index (GBI) system through the Malaysian Architect Association and the Association of Consulting Engineers Malaysia (ACEM) in 2009. In Malaysia, GBI classification are based on points and rating given to individual building or structure as shown below.

GBI Classification	
Points	**GBI Rating**
86+ Points	Platinum
76 to 85 Points	Gold
66 to 75 Points	Silver
50 to 65 Points	Certified

Table 1.1 GBI Classification Chart, (Source: Green Building Index Sdn Bhd, 2012)

According to Green Building Index Sdn Bhd (2012), Pusat Tenaga Malaysia or Malaysia Energy Centre is officially Malaysia's first Green Building Index (GBI) certified building. Pusat Tenaga Malaysia was certified on 24 July 2009 under the "Certified" GBI rating which counts points between 50 to 65 points.

Iskandar Development Region (IDR) which functioned as green or low carbon city in Malaysia covers an area of about 2,216.3km2 and was developed in 2006 (Rizzo and Glasson, 2011) Initially, as reported by Ho and Matsuoka 2011, Iskandar Development Region (IDR) was chosen by group of Malaysian and Japanese low carbon research group as the first research opener in low carbon city development in the country. The research team consists of researchers from University Teknologi Malaysia, Iskandar Regional Development Authority, Kyoto University, Okayama University, National Institute for Environment Studies and Science and Technology Research Partnership for Sustainable Development. Ho and Matsuoka (2011), also added that the research still in preliminary study in the year 2012 where involving process in identifying the amount of carbon emission of Iskandar Malaysia and mitigation measures towards achieving low carbon region. Besides that, according to Hezri (2005), Malaysia is still in initial stage in term of sustainable development if compare with other developing countries.

SUSTAINABLE DEVELOPMENT GLOBALLY

In United Kingdom, BREEAM assessment system being used as green rating tool for building in term of building environmental performance where certified 200,000 building until mid of 2012 since the launched in 1990. According to BRE Global Limited, (2011), nine categories used for project evaluation which are management, energy, transport, health and well being, water, materials, waste, land use and ecology and pollution

Rating	Percentage Score
Unclassified	>30
Pass	≥30
Good	≥45
Very Good	≥55
Excellent	≥70
Outstanding	≥85

Table 1.2 BREEAM Rating (Source: BRE Global Limited, (2011)

Since the enactment of Climate Change Act 2008, United Kingdom has committed to reduce carbon emission to 26% by 2020 and by no less than 80% by 2050 and try to establish five years of carbon budget until the year 2050 (Innovation and Growth Team from UK construction industry, 2010

While in Australia, building accounted around 18% of greenhouse emission in 2010 (Climate Works Australia, 2010) While, Dopita and Williamson (2010), mentioned that the government has pledged to provide 20% of the nation's energy from renewable energy source by the year 2020 and expecting to increase the percentage in future aligned with the Howard government which introduced a Mandatory Renewable Energy Target (MRET) scheme in 2001 which requires 20% of electricity supply from renewable energy sources by year 2020. Besides that, in term of carbon certification, The Carbon Reduction Institute was established in Australia for overall carbon reduction activities. Some other sustainable development event which took place in Australia is the launching of Australian Carbon Tax on 1st July 2012 to enforce companies to buy carbon permits as a corrective action to reduce greenhouse gas emission in Australia by 80% in 2050. Furthermore, Australia's greenhouse pollution can be greatly reduced by the year 2040 by combination of several energy efficiency technologies such as wind turbines, solar thermal, solar photovoltaic, biomass combustion, fuel cells, geothermal, wave energy and tidal energy (A Clean Energy Future for Australia by the Clean Energy Future Group, 2004)

While in Asian continent, China has created its own green rating tool named 'Three Star Rating' in the year 2011. Three Star Rating created by cooperation of several organizations such as China Housing Industry Association, Tsinghua University and Chinese Academy of Building Research to reduce emission of carbon dioxide, to assess the building sustainability and to improve the design quality of building (IBE,2013). Besides that, green buildings in China also rated by another international green building rating system named LEED which managed by the US Green Building Council . As of July 2009, there were 30 buildings that have achieved green building certification under LEED Green Building Rating System. There are another 10 buildings have been certified under other green building certification system while 210 buildings are pursuing to get certification once construction process completed (Crachilov et al 2009). Besides that, China has pledged to reduce carbon dioxide emission per unit of gross domestic product by 40-45% by 2020 compared with the level in 2005 (Los Angeles Times, 2009), Chmutina (2010) has summarized that commercial buildings in China is less energy saving if compared with other developed countries pursuing in sustainable building. Zhu and Lin (2003), added that most of the buildings in China consuming huge amount of energy where residential building in Beijing are estimated to consume 50-100% more energy for space heating as compared to other buildings in similar cold climates in Western Europe or North America where heat consumption of Beijing recorded at 20.6W/m^2 than in Sweden, Denmark and Finland at 11W/m^2. Liu et al. (2014), concluded that China is still insufficient of effort, clear objectives and proper method of measurement for sustainable development.

India has emitted 1.6 billion tons of carbon dioxide in the year 2005 and expected to release five to six billion tons of carbon dioxide between year 2025 and 2030 (Mckinsey, 2009).As a counter measure, India stepped towards sustainable development where committed to reduce the carbon intensity of its economy by less

than 24% beginning year 2005 to 2020 in Copenhagen (Makhijani and Ochs, 2010). Although, India has a relatively low carbon footprint as estimated 400 million people still lack of access to electricity and 456 million in 2005 were still living at US$1.25 a day (South Asia Sustainable Development Department Report, 2009), emission of carbon dioxide in India getting increased from year to year as per capita GDP bound to double up in 10 years of time frame as indicated in India's 11th Five Year Plan for 2007 until 2012 (Energy Sector Management Assistance Programme Report, 2011

Indian cities such as Bhopal city have annual energy growth rate of 10% where most of the non-residential and commercial buildings which are newly constructed have higher energy usage than the existing buildings Sathaye et al, (2010). Bhopal city equipped with energy efficiency improvements, development of renewable energy and other regulation and policy to promote sustainable development where expected to reduce 40% of Greenhouse Gases by the year 2035 (Deshpande et al, 2011).

CRITICAL SUCCESS FACTORS

There are several definitions given by researchers around the globe for critical success factors where according to Rockart and Bullen, (1981), critical success factors referring to factors which will ensure satisfactory results in term of performance for the individual, department or organization. While as explained by Leidecker and Bruno (1984) critical success factors referring to elements that will ensure success to an organization in particular industry.

CRITICAL SUCCESS FACTORS IN LOW CARBON CONSTRUCTION

This study discussed about the six groups of critical success factors for low carbon construction which are based on project, project manager, project team, material and equipment, client and external factors.

Factors Related to Project

Factors related to project referring to critical success factors which generated by various components and stages of construction process and related to overall project structure which may influence the success of low carbon construction. There are total of 18 number of critical success factors identified by authors grouped into factors related to project which are;

    i)   Construction Cost
    ii)   Acceptable Level of Quality
    iii)   Proper Project Schedule
    iv)   Better Process Checklist
    v)   Support of Top Management
    vi)   Type of Contractual Term
    vii) Method of Procurement
    viii) Method of Construction Process
    ix)   Integration of Project Objective
    x)   Focused on Energy Modelling
    xi)   Effective Project Management
    xii) Defined Project Mission

xiii)   Proper Monitoring of Project Stage Implementation Process
xiv)   Availability of Technical Capabilities
xv)   Effective Financing Method
xvi)   Simplify Work Processes for Highly Technical Matter
xvii)   Effectiveness of Approval Processes
xviii)   Initial Green Aspect Finalised

Construction Cost

Yang (2006) has said that construction cost for building which is furnished with natural environmental protection equipment or system tend to have higher environment friendly value compare to conventional building. Meryman and Silman (2004) also have contended that cost is primary obstacle for green implementation. According to Tagaza and Wilson (2004), initial capital cost for green projects range from 1 to 25%. According to journal wrote by Zhang et al (2011), the Urban Land Institute has said that usage of green materials may cost 3% to 4% more than the conventional construction materials

Acceptable Level of Quality

Besides cost, acceptable level of quality from overall result of project is essential for the success of low carbon construction. Quality is also considered as one of the part of traditional 'iron triangle' criteria to achieve success in overall construction process (Iyer and Jha 2005). Odusami K.T (2002) also has listed down quality management in construction activities as one of the important skills for construction professional.

Proper Project Schedules

Existence of proper project schedules also important for achieving success in low carbon construction. Munns and Bjeirmi (1996) have mentioned that proper project schedule before the commencement of the project is vital. Besides that, project schedule is highlighted as one of the five critical success factors identified for a project (Sayles and Chandler, 1971)

Better Process Checklist

Besides that, Parfitt and Sanvido (1993) have strongly encouraged using better process checklist to check the progress of the project. They also added that it is essential to equipped with proper process checklist to validate the correct techniques or method used for the all construction activities which may ensure the success of project.

Support of Top Management

Pinto and Slevin (1989) has stressed the important of assistance and support of the top management in ensuring success in all stages of construction activities. Through the research studies conducted by Iyer and Jha (2005), proper support and coordination with the top management will result in overall achievement in project activities.

Type of Contractual Term

Some researchers such as Tagaza and Wilson (2004) had also stated that success of green or low carbon construction depended greatly on the type of contract selected for the delivery of projects. They elaborated that type of contract used in green projects must reflect the full detail the green oriented design before the design confirmed for construction. While another researcher, Korkmaz et al.(2010) has pointed out other important success factor to deliver green projects includes type of contractual term used for project delivery system

Method of Procurement

Besides type of contractual term, Korkmaz et al.(2010) also stated that method of procurement also plays its role as one of the element of critical success factors in low carbon construction. Meanwhile, Chan and Kumarasamy (1997) also agreed that method of procurement as the one of the factor for success of construction activities.

Method of Construction Process

Method of construction process is different between conventional and low carbon construction. According to Korkmaz (2010), in low carbon construction, proper type or method of construction process need to identified to smoothen the process of construction activities (Korkmaz et al. 2010)

Integration of Project Objectives

Enanche-Pommer and Horman (2009), explained the importance of integration of project objective in reducing wastage in construction process which will eventually move the project towards success.

Focused On Energy Modelling

Enanche-Pommer and Horman (2009), also added that in low carbon construction, project participant need to be well focused on the energy modelling where it will save the level of energy usage and enhance the building technical standard and overall move the project towards success.

Effective Project Management

Existence of effective project management in the project may help to deliver success in advance projects (Isik et al 2009)

Defined Project Mission

Pinto and Slevin (1989) clarified the important of clear defined project mission among the project participant. Munns and Bjeirmi (1996) also pointed out the necessary of clear project objective to ensure overall success in the project.

Proper Monitoring of Project Stage Implementation Process

Pinto and Slevin (1989) also stressed that throughout the research study, proper monitoring of project stage implementation process may speed up the project activities in all stages without restraint.

Availability Technical Capabilities

Besides that, Pinto and Slevin (1989) have also identified technical capabilities throughout the project stages as one of the critical success factors for the construction activities.

Effective Financing Method

Roodman and Lenssen (1995) reported that effective financing method will ensure the successful implementation of green building as many financial institution providing low interest loan or preferential lending rates for the construction of green building. Besides that, in overseas, water and electricity supply utilities are offering fee rebates on payment for services applied inside energy efficient buildings.

Simplify Work Processes for Highly Technical Matter

Meryman and Silman (2004) also has identified that act of simplification of work processes for highly technical matter in low carbon construction as one of critical success factors for success in low carbon construction. They explained that technical barrier may removed by changing the conventional method in simplifying the work process in low carbon construction.

Effectiveness of Approval Processes

Planning approval processes in green or low carbon projects tend to consume more time than conventional projects which may jeopardize the smooth progress of a project towards success. Systematic and planned approval process needed to ensure schedule and approve progress payment to vendor and suppliers are done on timely (Ling, 2003). According to Tagaza and Wilson (2004), process of approving the usage of new green technologies and recycled materials may consume more period of time. Besides that, Zhang et. al (2011) and Eisenberg et. al (2002) also mentioned that more period of time needed for approval process.

Initial Green Aspect Finalised

Hwang and Tan (2010) said that all green features to be incorporated in early stage and to avoid multiply changes at later stage to minimize the increase of overall project cost.

Factors Related to Project Manager

Factors related to project manager referring to critical success factors which generated through project managers in a project which may influence the success of low carbon construction. There are total of 5 number of critical success factors identified by authors grouped into factors related to project manager which are;

i) Competent project manager
ii) Timely and Effective Decision
iii) High Abilities in Troubleshooting
iv) Incentives System for Employees
v) Possession of Higher Technical Knowledge

Competent project manager

There are several researchers such as Ahadzie, Frank, Fryer, Edum-Fotwe and McCaffer contributed their thoughts on competent project manager towards success of project. Ahadzie (2007) confirmed that project manager must possess with high level of competencies to achieve success in their projects. Frank (2002) also added that project manager must have the basic skills and knowledge and may influence the success of the project which is rated in between 34 to 47% in a project. According to Fryer (1985) a project manager must possessed with social skills, decision making skills, problem handling skills, ability to recognize opportunities and management of changes to unsure success in project. Leadership is also given priority as a skill to achieve success in project (Edum-Fotwe and McCaffer, 2000).

Timely and Effective Decision

Timely and effective decision is vital where solution need to be identified quickly after reviewing matter related to project which will smoothen the construction process towards success (Isik et al, 2009).

High Abilities in Troubleshooting

The project managers also must be aware about the correct techniques to troubleshoot problem encounter during the construction process. The project manager should understand and aware about the important of possessing troubleshooting skill by project manager in the construction project (Pinto and Slevin, 1989)

Incentives System for Employees

Motivation activities such as incentives system practiced in the project by project manager to project team may motivate workers to contribute more towards success in low carbon construction (Munns and Bjeirmi, 1996)

Possession of Higher Technical Knowledge

Eisenberg et al. (2002) stressed that project manager need to be possessed with high technical expertise, product familiarities, material, system and design of product. Ahadzie et al.(2008) agreed that project manager need to well aware of product specification and the delivery process.

Factors Related to Project Team

Factors related to project team referring to critical success factor originated through project team such as executives, engineers, architects and construction workers in a project which may influence the success of low carbon construction. There are total of 15 number of critical success factors identified by authors grouped into factors related to project team which are;

    i)   Coordinated project participant
    ii)   Characteristic of project team
    iii)   Experienced project team
    iv)   Utilised resources available by project team
    v)   Proper relationship among project team
    vi)   Proper green consultation from project team
    vii)   Proper work related training for project team
    viii) Proper recruitment for project team
    ix)   High level of communication among project team
    x)   Effective project team
    xi)   Adequate information flow among project team
    xii)   Better green design innovation from project team
    xiii) Better green design features included by project team
    xiv) Awareness of green rating tools by project team
    xv)   Effective cooperation among project team

Coordinated Project Participant

Coordination between project participants is essential to ensure success in low carbon construction. Iyer and Jha (2005) through their research studies conducted on Indian construction companies concluded that coordination between the project participants identified as one of the critical success factors in construction activities.

Characteristic of Project Team

Project team characteristics and interaction among members is also part of the critical factors for low carbon construction. Syal et al. (2007) noted that to efficiently manage a green building project to achieve success, cooperation and communication among decision makers in a project is important.

Experienced Project Team

According to Enanche-Pommer and Horman (2009), existence of reliable project team members especially in term of exposures in previous green project may help drive project towards achieving success in low carbon construction.

Utilised Resources Available by Project Team

Isik et al (2009) concluded that to succeed a project there must be a better usage of resources and capabilities by construction companies.

Proper Relationship among Project Team

Isik et al. (2009) also added in that proper long term strategies and relationship with other parties for individual projects is essential for project success.

Proper Green Consultation from Project Team

Pinto and Slevin (1989) also added about the importance of obtaining green consultation from project team member especially from consultant.

Proper Work Related Training for Project Team

Pinto and Slevin (1989) also stressed about the benefits adequate training and proper recruitment to project participant and the influence towards projects success.

High Level of Communication among Project Team

Communications among team members are essential to convey the sustainable practises to all level of workforce in a green or low carbon projects. Communication is considered a very important factor not only among project workers but also to project managers (Edum-Fotwe and McCaffer ,2000). Iyer and Jha (2005) said that communication between project manager and project team members is vital for project success.

Effective project team in Utilization Stage

Munns and Bjeirmi (1996) discussed about the involvement of effective project team in utilization stage in construction process.

Adequate information flow among project team

Munns and Bjeirmi (1996) also pointed out that adequate information flow among the project participants are necessary to ensure every personnel aware about the project progress and the major issues surrounding the project which may lead towards success.

Better green design innovation from project team

Pulaski et.al (2006) also had elaborated his statement that, research shows that sustainable design may able to reduce waste of building projects beside set a high level of project performance and quality assurance for a green projects. This statement proofed that innovative green design will eventually move the low carbon construction towards success.
Again Pulaski et.al (2006), pointed out that the process of delivering green projects requires design and features which need to repeat throughout the construction process until achieved the goal.

Factors Related to Material and Equipment

Factors referring to critical success factor based on material and equipment in a project which may influence the success of low carbon construction. There are total of 4 number of critical success factors identified by authors grouped into factors related to material and equipment which are;
   i)   Durability of Building Material
   ii) Effectiveness of Computer Software
   iii) Usage of Latest Equipment for Evaluation
   iv) Execution of Life Cost Analysis On Green Materials

Durability of Building Material

Berge and Henley (2000) said that the performance and life span of new materials are difficult to determine for low carbon construction. Therefore, selection of proper materials for low carbon construction is essential for driving the project into success.

Effectiveness of Computer Software

Zhu et.al (2004) clarified that computer stimulation and software may help designers throughout building design process to improve the quality of outdoor and indoor physical environment, thermal performance of the envelope and the energy system with the ideal of sustainable design by stimulation at different stages.

Usage of Latest Equipment for Evaluation

Hwang and Tan (2010) said that building or structure design can be more complicated for the green projects than the conventional projects as involves evaluation of alternative materials and systems using latest equipment.

Execution of Life Cost Analysis on Green Materials

Enanche-Pommer and Horman (2009) said that conducting life cost analysis may help project participant to enquiry detailed explanation about project operational cost for the success of low carbon related project.

Factors Related to Client

Factors related to client referring to critical success factor originated through client in a project which may influence the success of low carbon construction. There are total of 5 number of critical success factors identified by authors grouped into factors related to client which are;
   i)   Competent Client
   ii) Committed Client
   iii) Level of Acceptance of Client
   iv) Level of Effectiveness of Client

Competent Client

Iyer and Jha (2005) noted in their research studies that client competence as one of the critical success factors for accomplishing project with flying colours.

Committed Client

Pommer and Horman (2009) stressed that to achieve project success in green construction, commitment from the client of the project is required for better project performance.

Level of Acceptance of Client

Florence (2005) mentioned that customer or client will decide the level of standard of requirement for quality aspect for a building to be constructed which is one of the main factors to ensure success in construction. Pinto and Slevin (1989) also agreed that willingness of client to accept final project as one of critical success for construction activities.

Level of Effectiveness of Client

While, Munns and Bjeirmi (1996) said that, for a project to become successful, client of the project need to effective by involving deeper in the planning and production stage of the project.

Factors Related to External

Factors related to external factors referring to critical success factor based on external factors in a project which may influence the success of low carbon construction. There are total of 5 number of critical success factors identified by authors grouped into factors related to external which are;
- i)　Economic Stability
- ii)　Green Environmental Requirement
- iii)　Flexible Government Policies
- iv)　Political Stability

Economic and Political Stability

Iyer and Jha (2005) had mentioned that economic and political stability in a country may steer construction projects towards great achievements.

Green Environmental Requirement

While some researchers such as Pulaski has mentioned about the high environmental aspects requirement as one of the factors to determine success in a green or low carbon project. According to Pulaski et.al (2006), environmental aspects on green or low carbon projects are more challenging than conventional projects. Pierce (2000) has commented that aesthetics issues driven by regulation by preservation could create problems to engineers. Proper fulfilment of green environmental requirement

by regulators is essential to move towards achievement success in low carbon projects.

Flexible Government Policies

While, Hwang and Ng (2012) have mentioned that government policies related to green construction processes also influenced the success of green construction. The elaborated that government policy which consists of strict policies and regulation of environment may cause trouble for the developers to comply although under the green consultant supervision due to lack of understanding by project managers. Failure of obeying the regulation may ends the project to delay, termination and fines.

DISCUSSIONS AND RECOMMENDATIONS

Low carbon and sustainable development construction started to gain popularity since the 1980's in leading nation such as USA, United Kingdom, Australia and developing countries such as Malaysia, Singapore, India and China. Identification of critical success factors for low carbon construction through this research study will encourage more developers to start building low carbon units rather than conventional units which may compromise its design in term of environmental aspects.

Figure 1 illustrates the theoretical relationships between the group of critical success factors and the success of low carbon construction. After the literature reviews have been completed, the critical success factors have been examined, identified, selected, and synthesized. The factors are being represented by these variables: (1) factors related to project, (2) factors related to project manager, (3) factors related to project team, (4) factors related to material and equipment, (5) factors related to client, and (6) factors related to external.
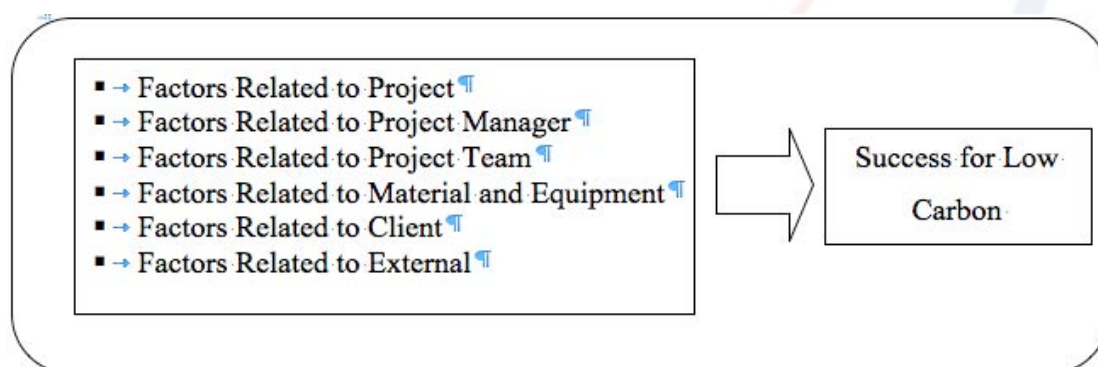
Figure 1: Group of Critical Success Factors Influencing Success for Low Carbon Construction

CONCLUSIONS

Malaysian government has taken initiative in embracing sustainable development is visible through the formulation of several environmental policies and establishment of low carbon cities across the country as par as other leading nation such as United Kingdom and United States. Furthermore, in future, this study suggests that identification of the critical success factors related to project, project manager, material and equipment, project team, client and external may help Malaysian

construction industry towards achieving great success in low carbon construction as par as leading nations in the world.

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Difficulties in Achieving Social Sustainability in a Biosphere Reserve

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Abstract

In the management of resources, the cost of opportunity plays an important role in the decision making process, especially when resources are finite and their use restricted. This is the case of natural protected areas, where restrictions can lead to social issues when the local economy suffers. Such issues include the displacement of people, unsupportive attitude towards conservation or illegal activities. This conflicting situation becomes particularly important in biosphere reserves, which are supposed to become learning laboratories for sustainability, integrating economy, society, culture and environment in the management process. This paper analyzes the example of Danube Delta Biosphere Reserve in Southeastern Romania, in an attempt to identify a correlation between social and environmental issues. The results indicate that, even though the correlation is not statistically significant, urbanization, deforestations and abandonment of agriculture are the leading transitional dynamics of environmental degradation, and ageing and migration of population (especially from rural areas) to better job opportunities are the main societal challenges; they seem to be inversely correlated. Social issues are experienced by rural communities, with a better environmental status, while environmental impacts concentrate around the urban areas, with a better socio-demographic status. Moreover, spatial analyses show that isolation, essential condition for safeguarding the pristine environmental status (especially in the context of aggressive tourism), seems to be also a major obstacle for its development. The most likely solution consists of needs-based policies aimed at preserving the traditional values, and increasing the awareness of local communities towards them through education.

Key words: conflicts, conservation, development, demography, society.

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1. Introduction

When dealing with natural resources, including ecosystem services, a key concept is the opportunity cost, which measures the impact of assigning a certain resource to a given economic activity; this procedure allows for choosing the most cost-effective use (Pearce and Markandya, 1987; Norton-Griffiths and Southey, 1995). When such resources are finite or the impact of assignment to a certain use becomes irreversible, such as for different land uses of the same parcel (Petrişor, 2012b) or between neighboring parcels (Tudor *et al.*, 2014), the importance of finding the optimal opportunity cost becomes crucial. This is also the case of natural protected sites, where the conservation status limits the total number of possible uses for most natural resources (James *et al.*, 2001; Chomitz *et al.*, 2005). According to many authors, the main benefits of conservation include ecosystem services (Adams and Hutton, 2007; Tallis *et al.*, 2008; Andam *et al.*, 2010; Busch and Grantham, 2013), tourism revenues (Andam *et al.*, 2010; Ferraro *et al.*, 2011) and an improvement of the infrastructure (Andam *et al.*, 2010; Ferraro *et al.*, 2011).

The conflict between conservation and economic development becomes pregnant in developing countries or during economic crises (Bennett *et al.*, 2007). Many authors consider that environmental issues resulting from the lack of environmental awareness are a consequence of poverty or at least associated to it (Reichel-Dolmatoff, 1982; Rozelle *et al.*, 1997; Jehan and Umana, 2003; Tallis, 2008), particularly in developing countries with low or no environmental awareness (Leonard and David, 1981; Ianoş *et al.*, 2009) or when natural resources are not seen as solutions for reducing poverty through sustainable use (Sayer *et al.*, 2012).

Generally, there is a controversial debate between conservation and its effects on humans (Wilkie *et al.*, 2006; Andam *et al.*, 2010). Some authors believe that conservation can reduce poverty (Kušová *et al.*, 2005; Kothari, 2006; Adams and Hutton, 2007; Tallis *et al.*, 2008; Andam *et al.*, 2010; Ferraro *et al.*, 2011), while others believe that in fact conservation induces poverty (de Sherbinin, 2008), is not aimed at its alleviation (Andam *et al.*, 2010) or there is a conflict between the socio-economic and environmental management objectives (Anthony and Szabo, 2011). When looking at the roots of the conflict, some authors point to the temporal and spatial scale; conservation is aimed at future generations and, for this reason, it is locally unfair for the current generation (Ohl *et al.*, 2008). Moreover, its scope is more general and expands over the local borders (Buhociu *et al.*, 2013); Upton *et al.* (2008) believe that the relationship might differ at different scale and the conflicts are local, but not national.

Among the causes of conflicts, economic activities are the dominant ones (Frys and Nienaber, 2011); in particular, agriculture seems to be especially affected (Andam *et al.*, 2010; Anthony and Szabo, 2011; Frys and Nienaber, 2011), but generally conflicts appear due to restricting access to resources (Bell *et al.*, 2001; Cernea and Schmidt-Soltau, 2003; Browman *et al.*, 2004; Adams and Hutton, 2007; Dhakal *et al.*, 2007; Ohl *et al.*, 2008; Andam *et al.*, 2010; Iojă *et al.*, 2010; Anthony and Szabo, 2011; Ferraro *et al.*, 2011), reduction of rights derived from ownership (Cernea and Schmidt-Soltau, 2003; Wilkie *et al.*, 2006; Adams and Hutton, 2007), ignored particularities of the local culture (Singh *et al.*, 2012) or an unfair distribution of revenues (Kothari, 2006; Wilkie *et al.*, 2006; Ohl *et al.*, 2008). The economic causes

generate social issues (Iojă *et al*., 2010). Some authors also mention conflicts between humans and the wildlife (Adams and Hutton, 2007; Anthony and Szabo, 2011). Other causes are political; they include the opposition to top-down approaches (Adams and Hutton, 2007; Kušová *et al*., 2008; Mackelworth and Caric, 2010; Anthony and Szabo, 2011; Grodzinska-Jurczak and Cent, 2011), especially to internationally imposed restrictions (Nelson and Vertinsky, 2005) and lack of or reduced involvement of local communities in the management of protected areas (Walpole and Goodwin, 2001; Campbell and Vainio-Mattila, 2003; Kothari, 2006; Petre, 2012; Sugandi, 2014). Moreover, low accessibility (Andam *et al*., 2010), lack of funding (Shultis, 2005; Iojă *et al*., 2010), lack of planning and design (Singh *et al*., 2014) and the pressure of tourism (Shultis, 2005) are possible sources of conflict.

As it has been mentioned above, tourism generates conflicts due to the behavior of tourists (Pérez-Salom, 2001), particularly cultural differences and lack of interaction with the locals (Wearing and Darcy, 2011), which ultimately determines an erosion of the local traditions (Walpole and Goodwin, 2001), but also due to an uneven return of benefits (Walpole and Goodwin, 2001). Tourism attracts jobseekers (Pérez-Salom, 2001) and even immigration to protected areas (Scholte and de Groot, 2010). Nevertheless, Walpole and Goodwin (2001) found out that a positive attitude towards tourism may be likely to determine a local supportive attitude towards conservation. The number of tourists visiting protected areas is conditioned by infrastructure (Purice *et al*., 2013); while their remoteness (Andam *et al*., 2010) usually prevents massive tourism, the development of infrastructure resulted from the protection status (Andam *et al*., 2010; Ferraro *et al*., 2011) can generate potential threats.

The effects of the conflict between conservation and local people are discussed by Cernea and Schmidt-Soltau (2003), who identified eight possible consequences: "landlessness, joblessness, homelessness, marginalization, food insecurity, increased morbidity and mortality, loss of access to common property, and social disarticulation". As a consequence, people move away (Rangarajan and Shahabuddin, 2006; Adams and Hutton, 2007; Di Ciommo, 2007; de Sherbinin, 2008), are less supportive to conservation (Kothari, 2006) (although Dolnicar (2010) suggests that regional identity is a decisive factor determining the support), react against it (Ferreira, 2002; Torri, 2011; Grodzinska-Jurczak and Cent, 2011) or simply ignore the conservation status. The last situation leads to environmental degradation through illegal activities (poaching and harvesting of resources) despite of the conservation status (Fiallo and Jacobson, 1995; Laurance, 2004; O'Neal Campbell, 2005; Agrawal *et al*., 2008; Iojă *et al*., 2010). Due to the population shifts, many protected areas face depopulation and ageing due to maintaining a rural economy (Simoni, 2008; Florian, 2011), or ageing and unemployment (Vaishar *et al*., 2013).

While the challenge of reconciling economy, society and the environment is a core requirement of sustainable development (Vipin, 2010), this issue becomes prominent in biosphere reserves, seen as sustainability learning sites (Kušová *et al*., 2008; Nguyen *et al*., 2011), i.e., human settlements situated within biosphere reserves must be managed such that they achieve equally social, economic and environmental sustainability.
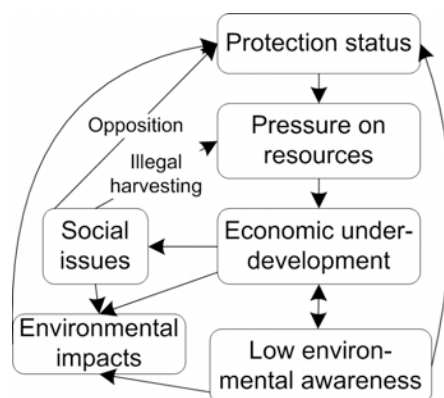
Fig. 1. The economy – society – conservation nexus
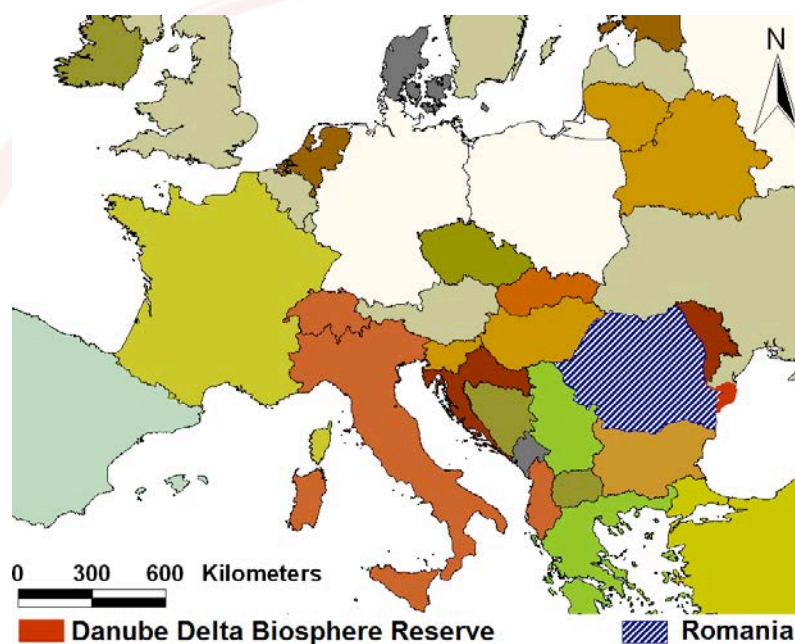
Fig. 2. Position of Danube Delta Biosphere Reserve in Romania and Europe (Meiţă *et al*., 2014, with changes)

The economy – society – conservation nexus resulted from the literature review presented before is summarized in the conceptual model presented in Fig. 1. Nevertheless, this paper is focused on the relationship between society and the environment in a biosphere reserve, choosing the Danube Delta Reserve of Biosphere as a case study. The reserve, situated in southeastern Romania (Fig. 2), covers two level 2 units of the Nomenclature of Units for Territorial Statistics – NUTS (counties) and 30 NUTS level 5 units (cities and communes), summing 58 km^2; due to the surface, the area is ranked as second largest wetland and largest biosphere reserve (Meiţă *et al*., 2014). The study aimed to test whether there is a relationship between the long-term societal and environmental challenges experienced by the human settlements within the territory of the reserve.

2. Data and methods

The methodology used in this study was a geostatistical analysis carried out at the level of territorial units (NUTS level 5) looking at the dynamic of their demographic and social profile in relationship with the environmental changes. Geographical

Information Systems (GIS) were chosen due to their ability to provide a superior modeling of spatial reality (Peptenatu *et al.*, 2011).

Environmental impacts were assessed through the long term changes of land cover and use using CORINE data. These data are effective in assessing long term transitional dynamics, especially those determined by economic changes (Petrişor *et al.*, 2010b). In this particular case, areas were summed up by transitional dynamics (using positive values for positive impacts and negative values for negative impacts) for each administrative unit separately, and a ranking of settlements was produced for the two periods covered by CORINE data – 1990-2000 and 2000-2006. Among the impacts identified, the regeneration of forests (by afforestation or reforestation) was the only positive one, while the negative ones included urbanization, deforestation, desertification, floods and abandonment of agricultural land.

Demographic and social analyses used raw 2002-2011 data on births, deaths, migration, people moving permanently in and out, and structure of population by age and gender; the indicators were chosen due to their relevance in the planning process (Petre, 2014). These data were aggregated into complex indexes, sometimes requiring complex computations:

(1) Trend analysis: the method is a variation of the approach developed by Petrişor *et al.* (2010a), consisting of assessing trends at the level of each unit (in this case, administrative units), and then summarize the results using a statistical test. The difference is that the original paper assessed trends based on the slope of the regression line; here, the coefficient of determination (square root of the coefficient of correlation) is used instead. The regression parameters were computed for particular indicators (global ageing index, percentage of elderly people – people aged 65 and over) against time.

(2) Other analyses were carried out for separate periods or years, based on the availability of data: 2007 and 2011 for density, 2004-2005 and 2008-2009 for migration, 2004 and 2011 for the ageing index.

(3) All values were ranked for the administrative units. When trends were analyzed (ageing index, percentage of elderly people), values were ranked based on the quintiles using the values of the coefficient of determination. In other situations, particular classes were used for density (1 – less than 10/km^2, 2 – 10.1 - 20 /km^2, 3 – 20.1 - 40 /km^2, 4 – 40.1 - 70 /km^2, 5 – over 70/km^2), net migration rate (1 – increase over 10%, 2 – increase by 2.1% - 10%, 3 – stagnation – (–2)% - 2%, 4 – decrease by (–2.1)% - (–10)%, 5 – decrease more than (–10)%), dynamics of population (1 – increase over 10%, 2 – increase between 2.1 and ten, 3 – stagnation between (–2)% and (+2)%, 4 – decrease between (-2)% and (-10)%, 5 – decrease over (-10)%), and ageing index for each period (1 – young: <40%, 2 – mature: 40.1%-50%, 3 – old: 50.1%-60%, 4 – very old: 60.1%-100%, 5 – extremely old: >100.1%).

(4) Overall ranking – the values of ranks were computed such that high values indicate a "bad" situation. The overall rank resulted from ranking the weighted sums of ranks (e.g., the share of population over 65, global ageing index and ageing indices for the two periods formed a group), including mortality and natality in addition to the indices discussed above, and using the quintiles of the resulting distributions.

(5) To test whether the socio-demographic and environmental issues are correlated, rankings for the land cover and use changes occurred during 2000-2006 were

correlated with the ones of the overall ranking with respect to socio-demographic issues, computed in the previous step (covering the period 2002-2011).
In all cases, classes were defined such that high values indicate local problems.

3. Results and Discussion

The analyses aimed to investigate the social and environmental issues of Danube Delta Biosphere Reserve. Environmental issues were analyzed based on the transitional dynamics reflected by land cover and use changes using CORINE data. The spatial distribution of changes by administrative units is displayed in Fig. 1a (1990-2000) and Fig. 1b (2000-2006). The results indicate that the most important transitional dynamics affecting negatively the area were urbanization, abandonment of agricultural land, floods, deforestation, and desertification during 1990-2000, and urbanization and deforestations during 2000-2006. The positive changes were represented by the regeneration of forests during both periods; however, without local information, despite of the fact that ecological restoration projects were developed in the area, these changes cannot be assigned to the two possible explanations: afforestation represents the conversion of other land uses into forest, or the increase of canopy coverage over 10% through plantations or natural regeneration, while reforestation is the re-establishment of forests after a temporary condition decreasing the canopy coverage below 10% due to human-induced or natural perturbations (Dutcă and Abrudan, 2010).
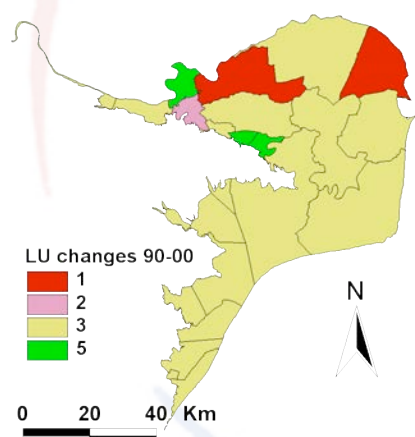
Fig. 3a. Land cover and use changes in the administrative units of Danube Delta Biosphere Reserve during 1990-2000. Numbers indicate the ranks, high values suggesting local problems.

Fig. 3b. Land cover and use changes in the administrative units of Danube Delta Biosphere Reserve during 2000-2006. Numbers indicate the ranks, high values suggesting local problems.
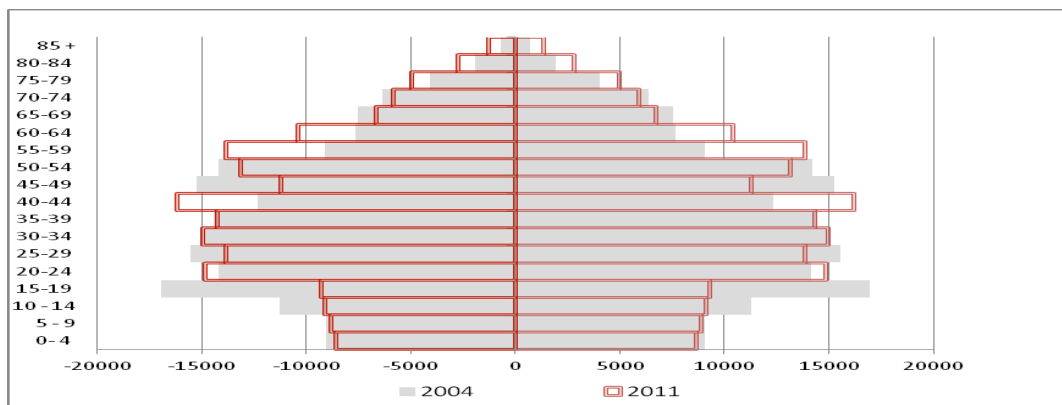
Fig. 4. Population of Danube Delta Biosphere Reserve by age

These results are consistent with the findings of other studies (Petrişor *et al.*, 2010b; Petrişor, 2012a, 2013; Meiţă *et al.*, 2014), which showed that urbanization, deforestations and abandonment of agriculture are the leading causes of land cover and use changes in Romania, but also to transition countries in general (Ehrhardt-Martinez, 1998; Jorgenson and Burns, 2007; DeFries *et al.*, 2010).

The analysis of socio-demographic changes pinpointed several phenomena. One of them is demographic ageing. While the age pyramid (Fig. 4) reveals an overall declining population, there are differences in the trends between 2002-2004 and 2004-2011 (Fig. 4), and important territorial differences. These are shown in Fig. 5a (displaying the distribution of population aged 65 and over), Fig. 5b (displaying the distribution of the cumulate ageing index), and Fig.5c and Fig.5d (displaying the distribution of the ageing index for 2004-2006 and 2009-2011). Again, these results are consistent with previous findings (Bell *et al.*, 2001); while such phenomena are a general characteristic of Europe (Nancu *et al.*, 2010), they seem to be exacerbated in Romania (Heller, 2000; Nancu *et al.*, 2010) due to the emigration of workforce, especially in the rural areas, where they produce radical transformations in conjunction with the increased shared of the elderly and poverty (Nancu *et al.*, 2010). Moreover, unemployment is an additional cause of migration from the Danube Delta villages (Bell *et al.*, 2001).
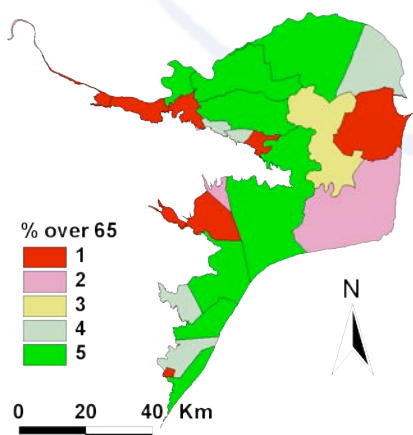
Fig. 5a. Distribution of people age 65 and over in the administrative units of Danube Delta Biosphere Reserve. Numbers indicate the ranks, high values suggesting local problems.
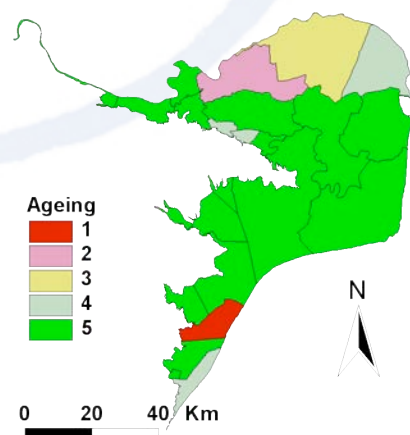
Fig. 5b. Distribution of the global ageing index in the administrative units of Danube Delta Biosphere Reserve. Numbers indicate the ranks, high values suggesting local problems.
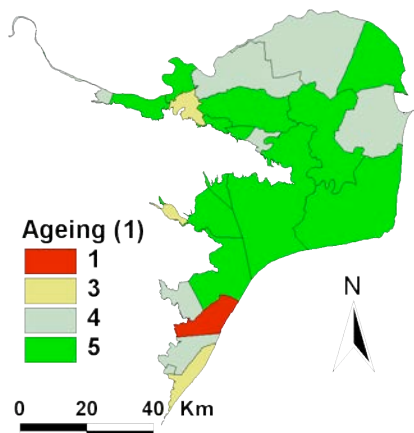
Fig. 5c. Distribution of the ageing index in the administrative units of Danube Delta Biosphere Reserve in 2004. Numbers indicate the ranks, high values suggesting local problems.
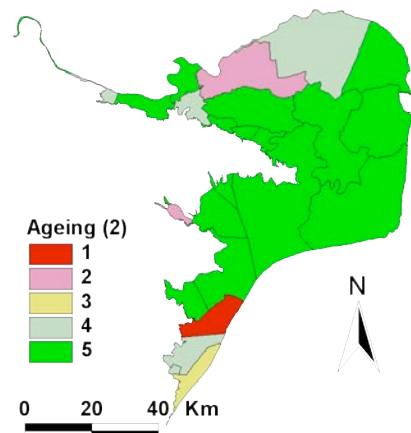
Fig. 5d. Distribution of the ageing index in the administrative units of Danube Delta Biosphere Reserve in 2011. Numbers indicate the ranks, high values suggesting local problems.

Another important characteristic of the population of Danube Delta Biosphere Reserve is the uneven distribution of density, which is higher in the urban areas (Fig. 6). The evolution of settlements and density of population are conditioned by the geographic characteristics of the area (Gâştescu, 1993). The distribution shows slight differences between the two periods, 2002-2007 (Fig. 6a) and 2008-2011 (Fig. 6b).
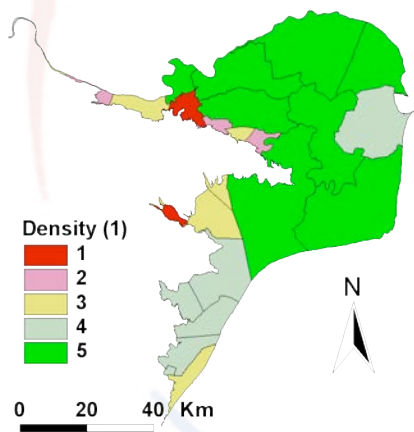
Fig. 6a. Population density in the administrative units of Danube Delta Biosphere Reserve in 2007. Numbers indicate the ranks, high values suggesting local problems.
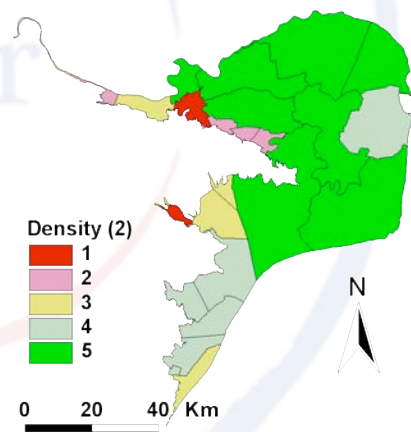
Fig. 6b. Population density in the administrative units of Danube Delta Biosphere Reserve in 2011. Numbers indicate the ranks, high values suggesting local problems.

As its has been shown before, the reduction of population was determined by migration; in the Danube Delta, its causes include poverty, lack of education and training, and unemployment (Damian and Dumitrescu, 2009), and also the rural status of most settlements – given the trends of migration from Romanian rural areas (Nancu *et al*., 2010). While the results indicate differences in migration between the periods 2004-2005 (Fig. 7a) and 2008-2009 (Fig. 7b), the overall trend suggests that migration is higher in the rural areas and lower in the urban areas.
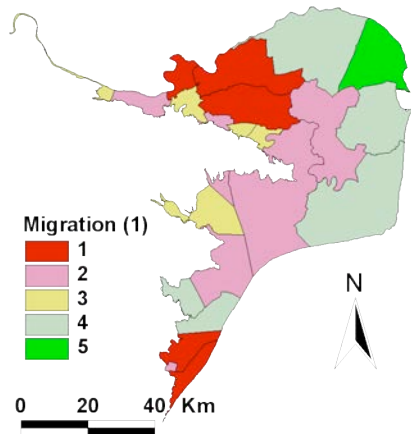
Fig. 7a. Migration of population in the administrative units of Danube Delta Biosphere Reserve during 2004-2005. Numbers indicate the ranks, high values suggesting local problems.
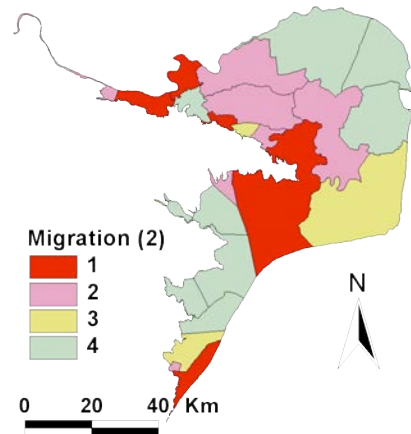
Fig. 7b. Migration of population in the administrative units of Danube Delta Biosphere Reserve during 2008-2009. Numbers indicate the ranks, high values suggesting local problems.

The overall results are showed in Fig. 8 (dynamic of population) and Fig. 9 (overall socio-demographic ranking). The spatial distribution suggests that the disfavored areas are the rural ones. The urban areas have a better status. If this spatial distribution is compared with the one of environmental changes, similarities can be easily noticed. Environmental impacts induced by urbanization or tourism occur close to the urban settlements, since they offer better infrastructure for tourism, and also attract the job seeking population of rural settlements (Bell *et al*., 2001), who eventually move closer. The incoming local migration determines additional environmental impacts. The spatial pattern supports the findings of Andam *et al*. (2010), who considered that the remoteness of protected areas could result into a decline of the economical activities within their boundaries. In this particular case, the urban settlements were favored by access to the Black Sea (the western side) and upstream navigation on the Danube (eastern side), while the ones situated in the central part maintained their rural status due to the fact that navigation was the only access gate; in the Danube Delta, weather conditions (ice) prevent navigation during the cold season (Mikhailov *et al*., 2008; Zsideková *et al*., 2013).
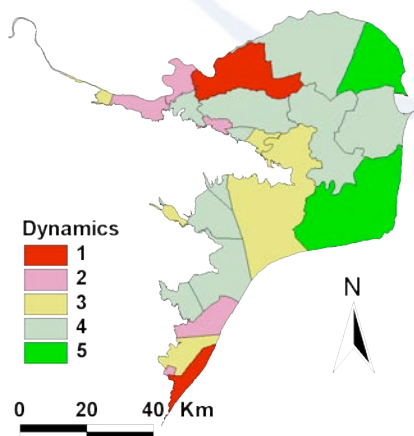
Fig. 8. Dynamics of population in the administrative units of Danube Delta Biosphere Reserve during 2004-2005. Numbers indicate
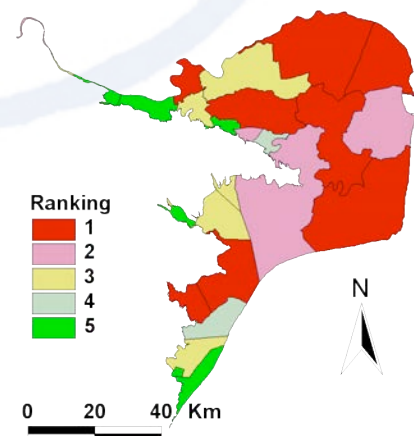
Fig. 9. Overall socio-demographic ranking of administrative units of Danube Delta Biosphere Reserve during 2002-2011. Numbers indicate
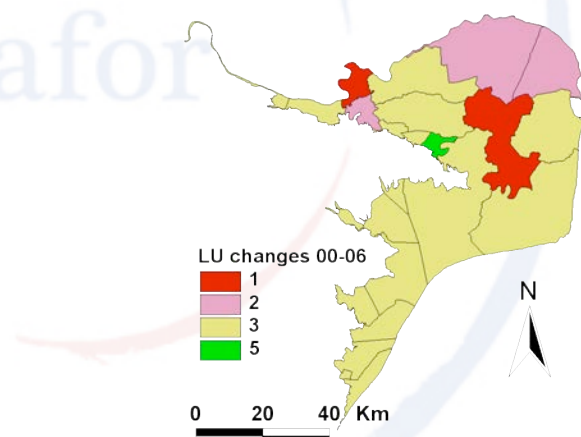
the ranks, high values suggesting local
problems.

Another possible explanation consists of the development of tourism (Bell *et al*., 2001; Honţuş, 2013). Traditional cultural values are lost along with the housing and architectural principles that worked for centuries, leaving room for an invasion of aggressive tourism and its equally forceful infrastructure. If the socialist period created an unsustainable local economy based on industry, the recent 'democratic' tourism-based economy seems to have deleterious effects too; new estranged constructions seem to take over the natural and cultural landscapes (Meiţă, 2010; Meiţă and Petrişor, 2012; Meiţă *et al*., 2014).
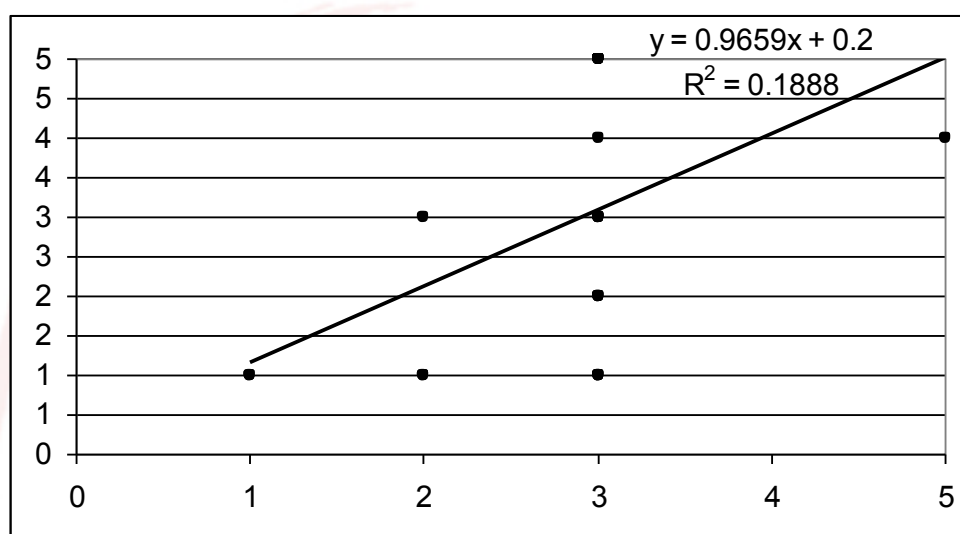
Fig. 10. Correlation of the rankings of Danube Delta Biosphere Reserve territorial units with respect to environmental and socio-demographic issues.

The correlation of the two distributions was tested using the linear correlation of ranks (Fig. 10). The coefficient of correlation was $R^2 = 0.189$. The value is not significant at 0.05. The explanation can consist in the low sample size (values were available only for 28 units). Nevertheless, the negative correlation supports the arguments, showing that administrative units with social problems did not experience significant environmental impacts; environmental issues are characteristic to urban settlements, with a better socio-demographic status.

Possible limitations of the study include:
(1) This study was carried out as an ecological study, meaning that the units of analysis were territorial units. In this case, correlations do not necessarily involve causality, but can be the result of spurious associations (Petrişor, 2010).
(2) The small sample size and lack of data for certain units or periods could have affected the power of statistical test, preventing the detection of a significant correlation.
(3) As it has been mentioned before, the methodology cannot provide sufficient evidence for causality. While the urban areas seem to concentrate population and impacts and rural areas have a better environmental status, but experience socio-demographic issues, the analysis does not allow for testing whether socio-

demographic issues are a consequence of poverty resulting from the restriction imposed to the use of resources by the conservation status.

(4) From a spatial perspective, the Danube Delta covers entirely the territory of certain administrative units and embeds parts of other units. Assigning the overall values for the units included partially in the territory of the reserve to the parts included in its territory does not necessary reflect the reality.

3. Conclusions and recommendations

The study aimed to test whether there is any correlation between socio-demographic and environmental issues at the level of administrative units within the Danube Delta Biosphere Reserve. While the statistical analysis was unable to detect a significant correlation, most likely due to the reduced sample size, the spatial analyses suggest that rural areas have a better environmental status, but experience the loss of population through migration and demographic ageing, due to poverty and unemployment. There is no sufficient evidence that the protection status led to this situation through the restrictions imposed to the use of natural resources.

Nevertheless, this study has pointed out several issues of the area. From an environmental perspective, the most important impacts induced by transitional dynamics are due to urbanization, deforestation, and abandonment of agricultural land. Additional pressure was induced by tourism; the aggression of the new tourism played a key role in this process. From a socio-demographic perspective, ageing and migration are the leading cause of the potential depopulation of the area.

Recommendations for the authorities focus on addressing the economic, societal, and environmental issues in an integrated approach, granting them equal priorities. The literature suggests that the involvement of local population, in conjunction with educating them and increasing their environmental awareness, is crucial for achieving the sustainable development of the area. This goal could be achieved if the traditions and practices of the local culture become an integrant part of the development strategies, and if sufficient emphasis is placed on the local needs in the planning process.

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Financial Performance Assessment of Major Electric Power Companies in Germany

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Abstract

European power companies have been experiencing drastic changes in their business environments due to market reforms implemented under the three-time gas and electricity Directives of European Commission's energy packages. These Directives were issued and became effective in 1996, 2003 and 2009, respectively. Under the Directives, competition was introduced in wholesale and retail electricity markets. In addition, transmission unbundling of vertically integrated electric power companies was conducted in a step-by-step manner. The reforms significantly influenced German major electric power companies not only on their corporate structures but also on their business performance. This study discusses the influence from a perspective of financial performance of these companies. For the purpose, this study uses various financial measures such as ROE (Return on Equity), ROA (Return on Assets) and PBR (Price Book-value Ratio), all of which represent profitability and other important aspects of companies' business performance. Based on an observed data set and some statistical tests, this study discusses the impacts of reforms on major electric power companies in Germany. The results of financial performance assessment, along with a recent trend of electricity rates, indicate that both major electric power companies and electricity consumers have not gained an expected benefit from the market reforms.

Key Words: Electricity, Germany, Financial Performance

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Introduction

European countries, belonging to European Union (EU), have gradually progressed toward the creation of an internal energy market under a common policy promoted by European Commission (EC) and the legislation of European Parliament and of the European Council. EU's internal energy market consists of electricity and gas markets, each of which has been instructed by the directives, respectively. On the electricity, the European Parliament and the Council adapted the directive (Directive 96/92/EC; European Parliament and the Council, 1996) on common rules on the internal market in December 1996. That was superseded by Directive 2003/54/EC (European Parliament and the Council, 2003) in June 2003 and further replaced by Directive 2009/72/EC (European Parliament and the Council, 2009) in July 2009.

Germany, like the other EU Member States (MS), advanced electricity market liberalization in line with the EU Directives so that it introduced further competition in both a wholesale power market and a retail market. It is easily imagined that the reforms influenced the management of major electric power companies in Germany. The purpose of this study is to examine such influences on the management from a perspective of financial performance.

The reminder of this paper is structured as follows. Section 2 describes the progress of market liberalization of EU MS. Section 3 examines various financial measures and ratios of major electric power companies in Germany. Section 4 summarizes our empirical results obtained from this study.

Electricity market liberalization in EU Member States and Germany

The 1996 Directive established common rules among MS in generation, transmission, distribution and retail supply of electricity. The Directive also refers to regulation, network unbundling, ownership and international trade. A main reason for the enforced network unbundling is that there is a concern of market distortion in such a manner that vertically integrated companies may use their network ownership powers to unfairly give advantage to their own and/or affiliated generation and retail businesses compared to the third party market participants. Therefore, to maintain the market fairness, the Directive required separation between network and generation/retail activities in a form of accounting unbundling. Under the unbundling, network companies had to have separate accounts for their network activities to demonstrate that any generation or retail activities had not being unfairly subsidized by their network activities. As a consequence of the 1996 Directive, the Transmission System Operators (TSOs) and Distribution System Operators (DSOs) were established but allowed to be part of a company that operated other electricity businesses such as generation and retail sales. However, TSOs and DSOs needed to keep neutrality and be managed by objective and non-discriminatory procedures that did not give a favor to their generation and retail businesses.

On the market competition, the Directive had required the MS to introduce competition in about 33% of the total retail market by February 2003. However, some MS had actively adapted to the policy and opted to open their retail market

more quickly than required by the Directive. This encouraged the EC to introduce new Directive that accelerated market opening. In analogy with the first Directive, the new Directive 2003/54/EC established common rules for generation, transmission, distribution, and retail supply of electricity. However, the unbundling requirements were substantially strengthened in such a manner that legal separation or corporate separation was required for TSOs and DSOs from generation and retail sales activities. This indicated that TSO and DSO activities had to be carried out by legally separated companies, although an incumbent vertically integrated company with generation and retail businesses could still own a TSO and/or DSO company(s). It is expected by the legal separation that the TSO and DSO determine a usage and development plan of the network with an objective and independent decision-making process from an integrated company.

In addition, to further promote retail competition, the second Directive had required MS to fully open their markets so that all consumers were eligible to access retail suppliers from July 2007. However, energy consumers in most countries were already eligible to choose their electricity suppliers at the time so that the deadline of the requirement of full retail liberalization was not actually influential. Even today, many MS still maintain regulated electricity prices for end-users because of political reasons in the aim of consumer protection although an opportunity for market entrants in retail business were fully liberalized.

After a few years of experience with the second Directive, EC undertook an Inquiry in the electricity market in June 2005 to review the effectiveness of the Directive. The Sector Inquiry aimed to examine five important areas in the European electricity market: (a) market concentration, (b) vertical foreclosure or insufficient unbundling, (c) lack of market integration, (d) lack of transparency, and (e) price formation. As a result of the Inquiry (European Commission, 2007), the EC concluded that competition in the energy sector was limited and prepared a proposal for the third Directive in fall of 2007.

The most recent Directive, Directive 2009/72/EC, was adapted in July 2009 and enacted in September 2009. The main changes of the 2009 revision from the second Directive included (a) further separation of the transmission network from generation, distribution and retail supply businesses and (b) all countries must have independent national regulatory authorities for electricity and gas. Although the EC and European Parliament advocated full ownership unbundling on the transmission network regime, there was a political pressure from MS, opposing ownership unbundling, particularly from France and Germany. The two options on unbundling regime were resulted in the compromise such as Independent System Operator (ISO) model and Independent Transmission Operator (ITO) model.

The ISO model is standard in regions in the United States such as PJM, ERCOT in Texas and California ISO. However, it is unpopular among EU MS probably because the model contains inconsistency or discrepancy between system operation and asset ownership. Another rationale may be found in the discrepancy between authority to make investment planning and responsibility to finance for investment projects. Meanwhile, the ITO model can maintain TSO in a group company, along with the other businesses, so that there are no such discrepancies, as indicated above. However, instead of the ownership structure, TSO needs to

comply with very strict rules and regulations to ensure that the transmission business and the other businesses are operated independently. Such rules and regulations include various measures in personnel affairs and financing treatments applied to TSOs.

Newly established national regulatory authorities for electricity and gas are expected to ensure competitive, secure and environmentally sustainable EU internal markets in electricity and gas sectors. They are required to review the investment plan proposed by TSOs, to monitor network security and reliability, to monitor transparency obligations, to monitor a level of market opening and competition, and to ensure that consumer protection measures are effective. They have to be legally distinct and functionally autonomous from any other public and private entities.

In addition to these processes, existence of a well-functioning wholesale power market should be an essential factor to realize effective competition in the electricity market. In EU MS, power exchanges were established in the early stage of market liberalization and they made an effort to increase their trading liquidity and market participants by enhancing their products and services. For example, in 2009 when the third Directive was published and enacted, the trading volume of spot markets for power exchange, calculated by a percentage of electricity consumption, was approximately 11% in France and 25% in Germany (European Commission, 2011).

To view the progress of the market reforms among EU MS, Figure 1 visually describes the reform process from the first to third Directives.
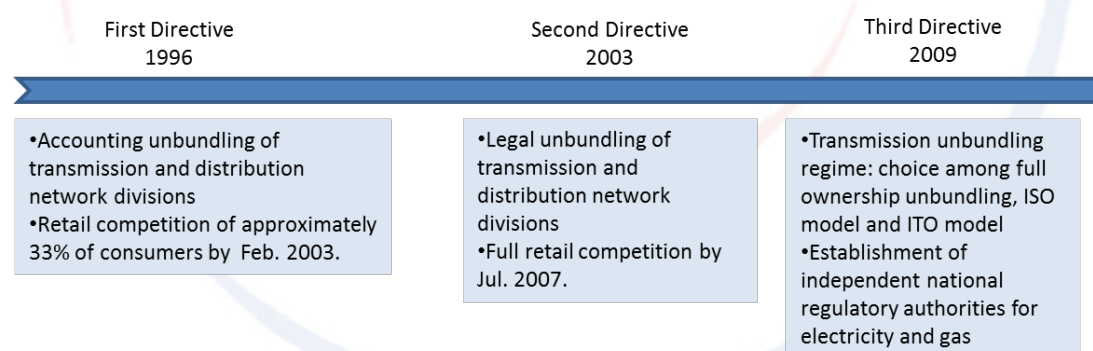
Figure 1: Time schedule of electricity market reform in EU

To comply with the Directives, each MS transposed the Directives into national law. With the process, German electricity market was gradually liberalized by introducing competition into generation and retail sectors. In 1998, German government amended Energy Industry Act and implemented accounting unbundling of transmission and distribution network division. In addition, full retail competition was introduced into the market ahead of the deadline of the EU requirement. In 2005, Energy Industry Act was amended again in order to remedy a high level of network tariff and establish an independent regulatory authority whose tasks cover the electricity transmission and distribution network regulation. Meanwhile, German major electric power companies took different steps in terms of separation of transmission division. Such a direction will be overviewed in the

next section.

Assessment of financial measures and ratios of German power companies

Overview of German electric power companies
In Germany, there are four major electric power companies as of June 2014; EnBW (Energie Baden-Württemberg AG), RWE (Rheinisch-Westfälisches Elektrizitätswerk AG), E.ON (E.ON SE) and Vattenfall Europe (Vattenfall Europe AG).

EnBW was formed on January 1 in 1997 from the merger of two utilities companies; Baden-Württemberg, Badenwerk AG and Energieversorgung Schwaben AG (EVS). The number of employees is around 20,000 and it supplies electricity, gas, water and energy-related products and services to 5.5 million customers. The company is majority owned by the Federal State of Baden-Württemberg and Oberschwäbische Elektrizitätswerke, a municipal special-purpose association.

RWE is one of Europe's five leading electricity and gas companies based in Essen, North Rhine-Westphalia. Through its expertise in oil, gas and lignite production, in electricity generation from gas, coal, nuclear and renewables, and in energy trading as well as electricity and gas distribution and supply, RWE is active at all stages of the energy value chain. Around 66,000 employees supply over 16 million electricity customers and more than seven million gas customers with energy. The revenue in 2013 was approximately EUR54 billion. RWE's operation area includes the Netherlands and the United Kingdom, where it is among the largest suppliers of both fuels. In the Czech Republic, RWE is No. 1 in the gas business.

E·ON is a European holding company based in Düsseldorf, North Rhine-Westphalia. It runs one of the world's largest investor-owned electric utility service providers. E.ON owns about 61 Gigawatt (GW) generation capacities and is one of the world's leading renewables companies. It supplies energy over 35 million customers. At facilities across Europe, Russia, and North America, E.ON's more than 62,000 employees generated revenue approximately EUR122.5 billion in 2013. E.ON's diversified business consists of renewables, conventional and decentralized power generation, natural gas, energy trading, retail and distribution.

Vattenfall Europe primarily engages in generation, procurement, distribution, trading, and sale of electrical energy, gas, district heating, and steam in Germany. The company generates energy from coal, water, nuclear power, and wind, as well as offers energy services. It also locates, extracts, processes, and refines raw materials, including lignite; and establishes and operates water extraction and treatment units, as well as procures and sells water for drinking and other purposes. As of December 31, 2007, Vattenfall Europe provided electricity, gas, and energy related services to approximately 2.7 million customers in Berlin and Hamburg; and operated a circuit length of approximately 9,500 kilometers of 380 kV and 220 kV high voltage lines. The company is based in Berlin, Germany. Vattenfall Europe AG is a subsidiary of Vattenfall AB. Vattenfall AB is a Swedish power company, wholly owned by the Swedish government. Beyond Sweden, the

company generates power in Denmark, Finland, Germany, the Netherlands, Poland, and the United Kingdom.

Financial performance of major electric power companies

To examine influence of market reforms on the major electric power companies in Germany, this study focuses on their financial performance after reviewing key financial measures and ratios of the companies. Note that we exclude Vattenfall Europe for this review because the company is a wholly-owned subsidiary of Swedish company Vattenfall AB, which makes us difficult to access financial measures at the same level of the other companies.

First of all, Figure 2 presents a trend of total revenue per employee (RPE) of three major electric power companies in Germany. This index is often used to represent the productivity of a company, indicating how much revenue an employee can earn. Whereas the trend was relatively stable before the second Directive in 2003, it has changed to an increasing trend after the Directive. Such increasing trend is particularly obvious for E.ON, exhibiting a drastic growth of the numbers from 0.5 in 2003 to 2.1 in 2012. This is a result of active Merger and Acquisitions (M&A) of E.ON during the period. The company came into existence in 2000 through the merger of energy companies VEBA and VIAG. After that, E.ON extended its business scale by using M&A in foreign countries, in particular focusing on businesses associated with gas and electricity. The other two companies, RWE and EnBW, also increased the numbers during the same period, although they were relatively moderate, compared to that of E.ON.
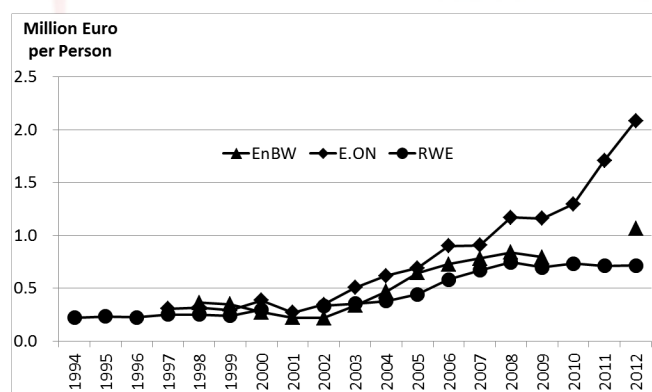
Figure 2: Trend of RPE of three major electric power companies in Germany

Next, this study examines profitability measures. Figure 3 depicts return on assets (ROA), which is calculated by income after tax divided by total assets. Figure 4 shows return on common equity (ROE), which is calculated by income excluding extraordinary items divided by common equity.
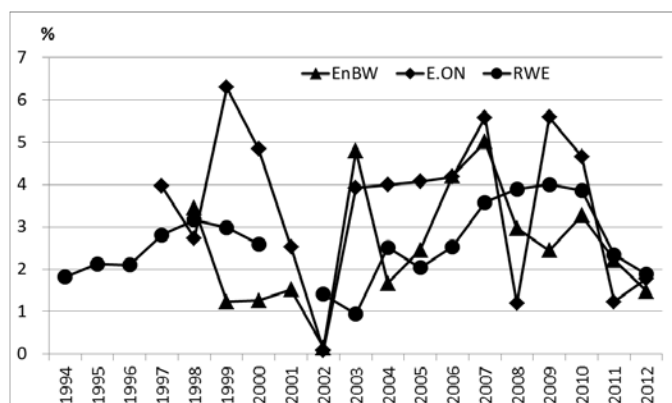
Figure 3: Trend of ROA of three major electric power companies in Germany
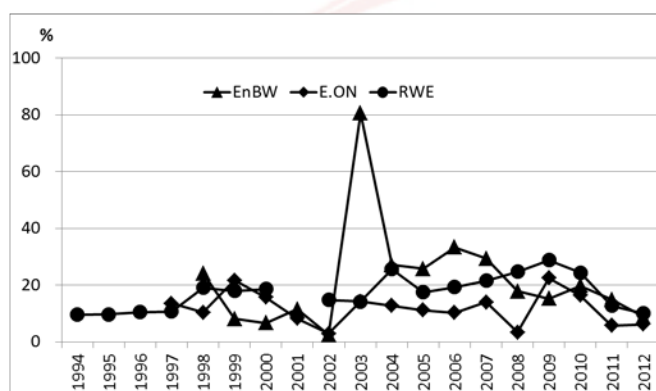
Figure 4: Trend of ROE of three major electric power companies in Germany

The two figures indicate there are no clear upward or downward trends during the period, although we observe fluctuations every year, in particular on ROA. The rationale on the relatively strong fluctuations in ROA exits in the numerator of the measure, which is an income after tax that is influenced by extraordinary items. An observed spike of ROE of EnBW in 2003 was presumably caused by the company's merger with Neckarwerke Stuttgart AG in the year.

Furthermore, this study examines corporate value with two measures; (a) enterprise value divided by revenue (EVR) and (b) price to book value ratio (PBR). They are influenced by share prices and represent corporate values. The two measures are depicted in Figure 5 and Figure 6, respectively. Both ratios indicate how much a company is evaluated by investors compared to its revenue or book value of shares. If the value is large, the company's future growth potential or success is highly evaluated by shareholders, and vice versa.
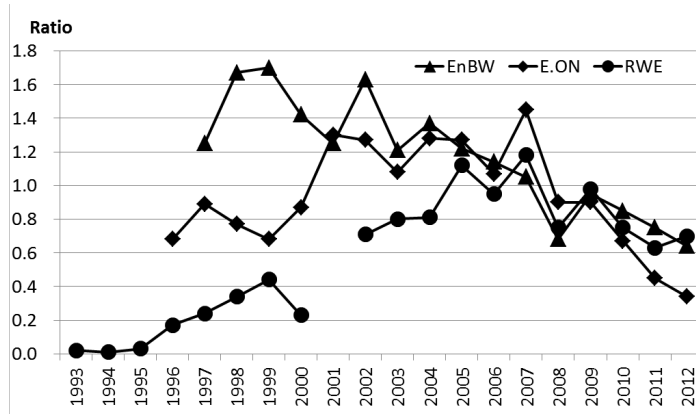
Figure 5: Trend of EVR of three major electric power companies in Germany
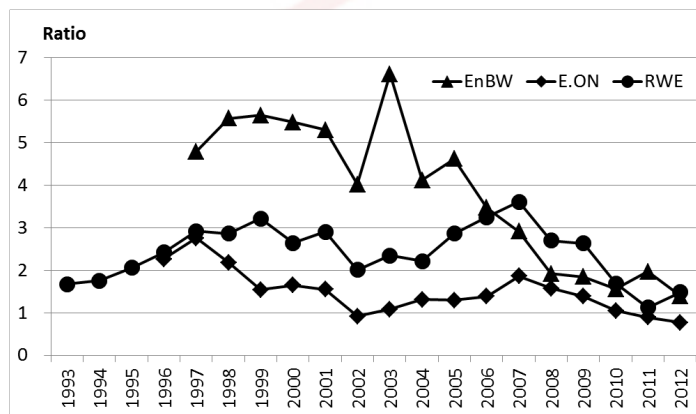
Figure 6: Trend of PBR of three major electric power companies in Germany

The two figures reveal that measures of corporate value once increased toward 2008 with some up-and-down changes and then, they decreased since 2008. The exception was EnBW that indicated the general trend of constant decrease over the period. These figures show that corporate values of the three companies has not increased, rather they have decreased or mostly stable over the entire period.
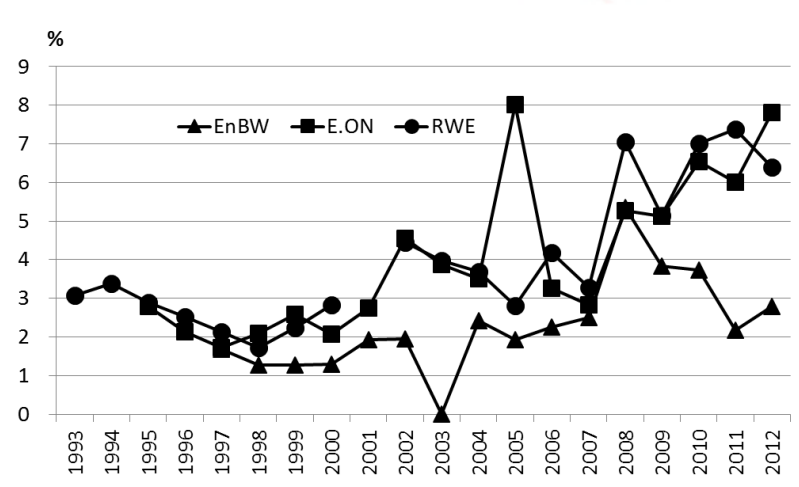
Figure 7: Trend of DY of three major electric power companies in Germany

Figure 7 depicts a trend of risk measure for each company. This study uses dividend yield (DY) for examining the company's risk level, which is calculated

by annual dividends per share divided by price per share. Because a high risk company cannot pay enough dividends to shareholders, the lower DY indicates the higher financial risk of the company, and vice versa.

Statistical test of financial measures

In Section 3.2, this study simply observed a general trend of financial measures and ratios. This section uses a statistical test whether the characteristics of changes are confirmed with statistical significance or not. Tables 1, 2 and 3 indicate results of the t-test to examine whether there are statistical differences in financial performance or not for each company before and after the Directives. We conduct two comparisons: (a) comparison between periods before and after the second Directive and (b) comparison between periods before and after the third Directive. Financial performance compares between the two periods: (a) a period from the initial year of the data to 2002 and a period from 2003 and 2012, and (b) a period from the initial year of the data to 2008 and a period from 2009 to 2012. The Welch's t-test is utilized for the examinations.

Table 1: t-test of financial measures on EnBW

Financial Measures		-2002 vs. 2003-2012			-2008 vs. 2009-2012		
		Averages		p-values	Averages		p-values
Productivity	RPE	0.28	0.71	0.0008***	0.47	0.93	0.1232
Profitability	ROE	10.59	27.26	0.0417**	24.26	14.67	0.1839
	ROA	1.52	3.05	0.0494**	2.61	2.35	0.6807
Corporate Value	EVR	1.49	0.99	0.0010***	1.30	0.80	0.0005***
	PBR	5.13	3.04	0.0038***	4.54	1.69	0.0000***
Risk	DY	1.57	2.70	0.0338**	1.99	3.14	0.0633**

Results of t-test on EnBW indicate that all measures are different before and after the second Directive at least at the 5% significance level. Productivity (RPE) and profitability (ROE and ROA) improved after the Directive, while corporate value (EVR and PBR) decreased. Risk (DY) decreased because the value of DY increased. The result implies that the company has a financial ability to provide with more dividends to shareholders after the second Directive, compared to before the Directive. Meanwhile, such differences are not perfectly clear in terms of the comparison before and after the third Directive. In particular, changes in productivity and profitability are not statistically significant. However, the changes in the other factors indicate a same trend to those of the comparison before and after the second Directive. They are significant at least at 5% level of significance where corporate value has decreased and risk has decreased after the third Directive, compared to those before it.

Table 2: t-test of financial measures on E.ON

Financial Measures		-2002 vs. 2003-2012			-2008 vs. 2009-2012		
		Averages		p-values	Averages		p-values
Productivity	RPE	0.32	1.10	0.0007***	0.56	1.56	0.0109**
Profitability	ROE	12.06	11.65	0.9004	11.52	12.67	0.8042
	ROA	3.41	3.62	0.8384	3.61	3.32	0.8119
Corporate Value	EVR	0.92	0.94	0.9064	1.04	0.59	0.0245**
	PBR	1.84	1.26	0.0477**	1.64	1.02	0.0091***
Risk	DY	2.59	5.22	0.0016***	3.39	6.37	0.0039***

Table 2 describes changes in financial measures or ratios of E.ON. General characteristics of changes in E.ON's financial performance are similar between the two comparisons with respect to the second and third Directives. Those are summarized by the following five findings. First, productivity increased and it was statistically significant in both comparisons. Second, profitability measures are not significant on both ROE and ROA. Third, corporate values decreased and were statistically significant with the exception of EVR before and after the second Directive. They were statistically not significant. Fourth, risk decreased and was statistically significant. Finally, all those changes are mostly similar to those examined on EnBW in Table 1, although there are some differences in results of statistical tests between the two companies

Table 3: t-test of financial measures on RWE

Financial Measures		-2002 vs. 2003-2012			-2008 vs. 2009-2012		
		Averages		p-values	Averages		p-values
Productivity	RPE	0.26	0.60	0.0000***	0.37	0.71	0.0000***
Profitability	ROE	13.88	19.89	0.0269**	16.71	18.99	0.6570
	ROA	2.37	2.76	0.3428	2.46	3.02	0.3880
Corporate Value	EVR	0.24	0.87	0.0000***	0.52	0.77	0.0786*
	PBR	2.44	2.39	0.8579	2.59	1.73	0.0679*
Risk	DY	2.81	5.09	0.0024***	3.35	6.49	0.0017***

Table 3 indicates changes in financial performance of RWE. An overall trend is similar to those of EnBW and E.ON. However, corporate value measures of RWE reveal unique feature of the company. That is, the corporate value increased after the second and the third Directives, compared to the periods before those Directives when we assessed it by EVR. They were both statistically significant at 1% and 10% levels, respectively. Such increases in corporate value were not observed in the other two companies. This may be associated with another characteristic of RWE, that is, profitability improved and statistically significant after the second Directive when it was measured by ROE. Meanwhile, the change in PBR after the second Directive was not statistically significant. In addition, PBR even decreased after the third Directive and the change was significant at the 10% level. Therefore, corporate value of RWE indicates mixed or inconsistent results, depending upon which measures we focus. Therefore, the trend of corporate value over the period is inconclusive on RWE. Meanwhile, the changes in risk measure are similar to those of EnBW and E.ON in the manner that it decreased on both comparisons after the second and the third Directives,

compared to those before the Directives.

Figure 8: Trend of electricity rate for household consumers
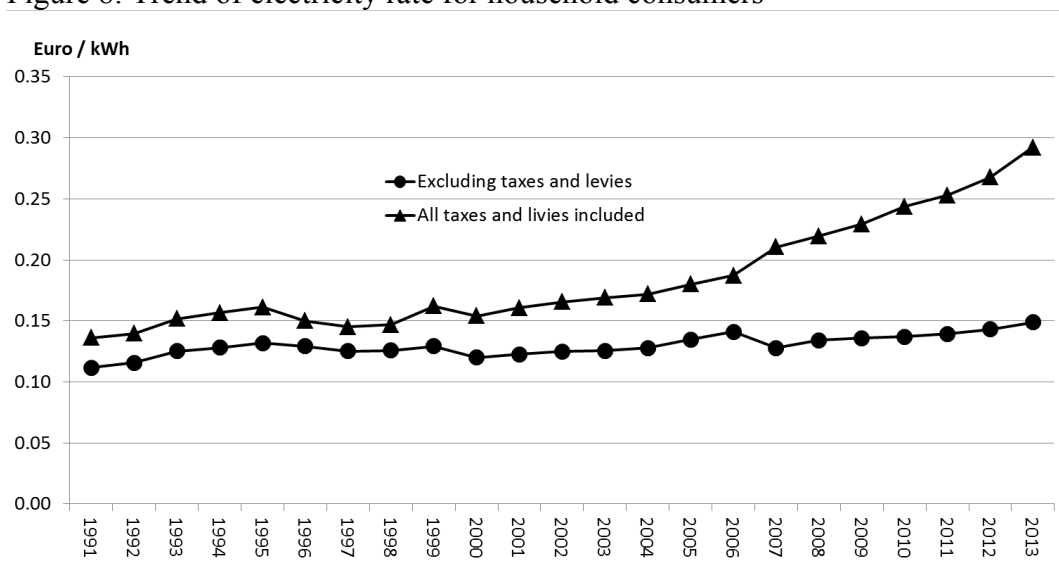
Besides observing the financial performance of three major electric power companies, this study reviews changes in electricity rates for household consumers in order to examine to what extent the benefit was given to consumers by the electricity market reform. Figure 8 depicts a trend of electricity rate for household consumers. The data source is Eurostat. The model category of household consumers is "households with annual consumption: 3,500 kWh of which night 1,300" before 2007 and "households band: 2 500 kWh < Consumption < 5,000 kWh" since 2007. Because the difference in consumer definition is due to Eurostat statistics policy, this study regards that these categories are almost same so that these statistics consist of the same series of data.

As shown in Figure 8, electricity rates for household consumers are relatively stable when taxes and levies are excluded. In contrast, those rates with all taxes and levies move in a parallel manner with the former until 2006, but change to an increasing trend since 2007. Such a finding was because market liberalization contributed to curb a possible increase in costs of electricity, but could not avoid influences on rates from a large increase in taxes and levies, in particularly those for expensed to the support scheme of renewable energy, or Feed in Tariff (FIT). The increased financial burden incurred by the FIT influenced the total electricity rates for household consumers to increase after 2007. Although the effect is not a direct consequence of market liberalization, it indicates that electricity consumers in general are not winners of the market reforms and related implementation of German energy policy.

Summary

This study reviewed a progress of EU electricity market liberalization that was promoted through the three-time electricity Directives since 1996 as well as market reforms with amendments of Energy Industry Act in Germany. To adapt such changes and survive in a competitive market, German major power companies, particularly E.ON, expanded its business scale in 2000' by using M&A opportunities in abroad. Such a scale extension improved company productivity measured by revenue per employee. This was because the companies did not increase the number of employees after the market liberalization while the revenue increased by the business scale extension. However, as a common trend among the three companies, statistically significant changes in profitability were not observed after the second and third Directives. That is, market liberalization has not provided any remarkable influence on profitability of the companies. In addition, corporate value has not improved over the period and rather it has decreased or constant for all companies with an exception of EVR of RWE. On the other hand, all three companies decreased risk or increased payment of dividends for shareholders. That indicates that electric power companies are positive for increasing shareholder compensation even though their profitability has not improved over the periods. This is probably a result of competition pressure imposed on electric power companies under the market liberalization.

These results indicated that electricity market liberalization did not improve financial performance of the major electric power companies in Germany, although the scale extension of the business contributed to the productivity increase during the period through the market liberalization. Meanwhile, electricity rate for household consumers increased particularly since 2007 mainly due to the growth of taxes and levies under the energy and environment policy in Germany. These findings indicate both major electric power companies and electricity consumers have not gained expected benefit from the market reforms.

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The Prototype of Road Power Generator

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Abstract

This paper presents the prototype of Road Power Generator (RPG) to convert the compression force from the traffic into the electricity. The RPG consists of two main parts: the mechanical part and the generator part. The mechanical part comprises of three compartments: ramp-up plate, flat plate and ramp-down plate. A folded plate is embedded into the center of the flat plate with slope of slightly less than 26 degrees. It transfers the compression force to drive the generator. The generator part uses the evaporator motor as a generator. The RPG is tested by riding a motorcycle passing RPG. The RPG test is divided into two tests including no-load test and resistance load test. For no-load test, it was found that the induced voltage from a generator will increase when the weight increases. For load test, the motorcycle with a weight of 170 kilograms is riding pass along the RPG which connects the resistance load varying from 43 to 787ohms. The results showed that the RPG produces the maximum power of 10.98W at load 43ohms while the speed, the induced voltage, and the current are 489.33 RPM, 27.67V, and 0.397mA, respectively. In addition, the RPG produces a maximum voltage of 82V at load more than 579ohms and speed 522-535RPM.

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1. Introduction

Nowadays, alternative energy has become an interesting topic for the researchers. The several alternative energies such as solar energy, wind energy, wave energy etc. have been developed for supporting the comfortable of the human life. The road power generator is the one of the alternative energy sources. The compression force could be taken from the vehicle traffic every places on the road. Therefore, the utilization of converting the compression force to the electrical energy plays an important role in determining an actual and acceptable performance.

Road Power Generator (RPG) is the device for converting the compression force from the traffic into the electricity. The apparatus for converting inertia of moving vehicles into power was discovered by Wiggins Earl B [1] since 1933. He provide the apparatus including a plurality of depressible plates interconnected with a series of links and levers arranged in such a manner as to impart rotation to a power take of shaft through passage of a motor vehicle or the like-over said plates. After that, various techniques of road power generator have been invented from many inventor [2-12]. The conversion techniques of compression force to electrical can be separated into two types including mechanical mechanism source and piezoelectric source. The mechanical mechanism source [1-9, 11-12] will use the mechanical mechanism received the compression force and then drive the shaft of generator while the piezoelectric source [10, 13] use the piezoelectric device for converting the compression force to electricity.

From the above mention, RPG is used and developed continuity. However, it is rarely to found in Thailand. So, this paper presents a road power generator prototype. The electrical power, voltage and current generations of a RPG were investigated. The paper will proceed as follows. In Section 1, the introduction of road power generator are proposed. The basic concept of RPG is explained in section 2. In Section 3, the road power generator system is mentioned. In Section 4, the system overview of road power generator experiment is provided. Section 5 describes the results of the research and includes a discussion of the experimental data. Finally, the summary of the paper are presented in Section 6.

2. Concept of Road Power Generator

The RPG is a device capable of converting the compression force from the vehicle traffic into the electricity. The concept of road power generator can be shown in figure 1.
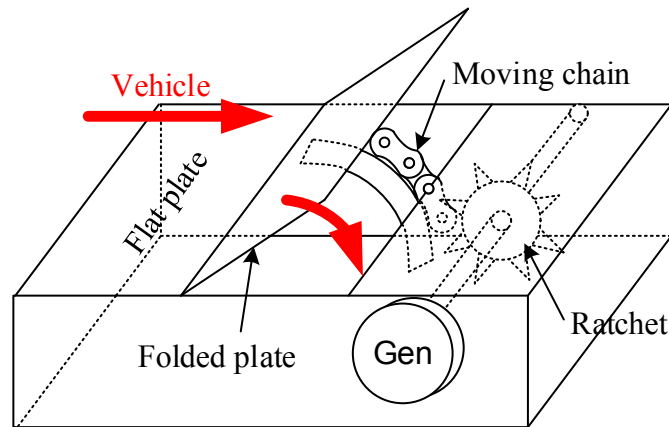
Figure 1. Basic concept of RPG

From the figure 1, if the motorcycle moves through along the RPG the folded plate will be pressed on the flat plate. Then, the moving chain drives the ratchet which attached on the spindle with generator too. Therefore, the generator can generate the electricity output to the connected load.

3. Road Power Generator

The RPG is a new device capable of converting the compression force from the vehicle traffic into the electricity. The device can be split into two parts including the mechanical part and the generator part.

3.1 The Mechanical Part of RPG

The mechanical part consists of three compartments: ramp-up plate, flat plate and ramp-down plate as shown in figure 2. A folded plate is embedded into the centre of the flat plate with slope of slightly less than 26 degrees. It transfers the compression force to drive the generator. The size of the flat and folded plates are shown in figure 3.
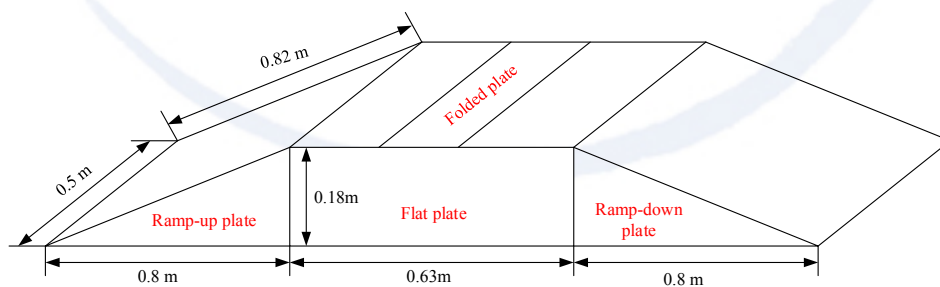
Figure 2. Ramp-up plate, flat plate and ramp-down plate
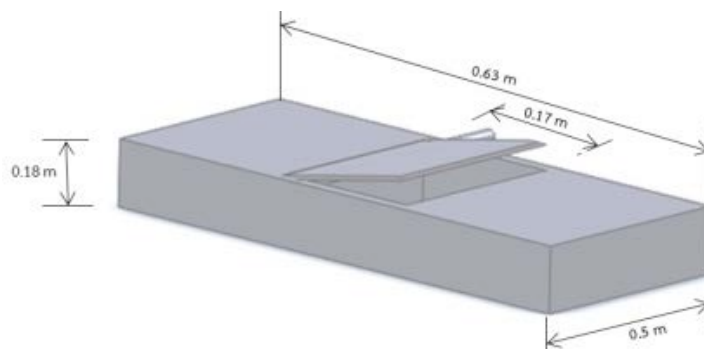
Figure 3. Flat plate and folded plate

3.2 The Generator Part of RPG

The dc evaporator motor is used as a generator in RPG. The details of dc evaporator motor can be shown in figure 4.

Figure 4. DC evaporator generator

(a) Construction of RPG prototype

(b) Completely RPG   (c) Mechanism of RPG
Figure 5. Road Power Generator

4. Methodology

4.1 Equipment

The voltage, current and power generating from the RPG was measured by TRMS&POWER CLAMP METER (CHAUVIN ARNOUX F09). The speed of the generator was measured by CT100OS Hand-Held Tachometer.

4.2 Test Method

In this experiment, the YAMAHA fino is used as the motorcycle. The weight of the motorcycle is about 96 kilograms. The speed of the motorcycle is 10km/hr. The weight of the driver is varied from 45 – 75 kilograms. The RPG test can be divided into 2 parts, such as no load test and load test. The output voltage and speed of generator are measured for showing the relationship in no load test. While the output voltage, current and power of the generator are measured by varying the resistance load (R_{load}) from 43 to 787 ohms. The experiment can be shown in figure 6.

Figure 6. Test RPG by the motorcycle

5. Results and Discussions

The RPG test is divided into two tests including no-load test and resistance load test. The result of RPG with no-load is shown in figure 7 - 8. Figure 9 - 10 show the result of the RPG with resistance load.

5.1 No-Load Test
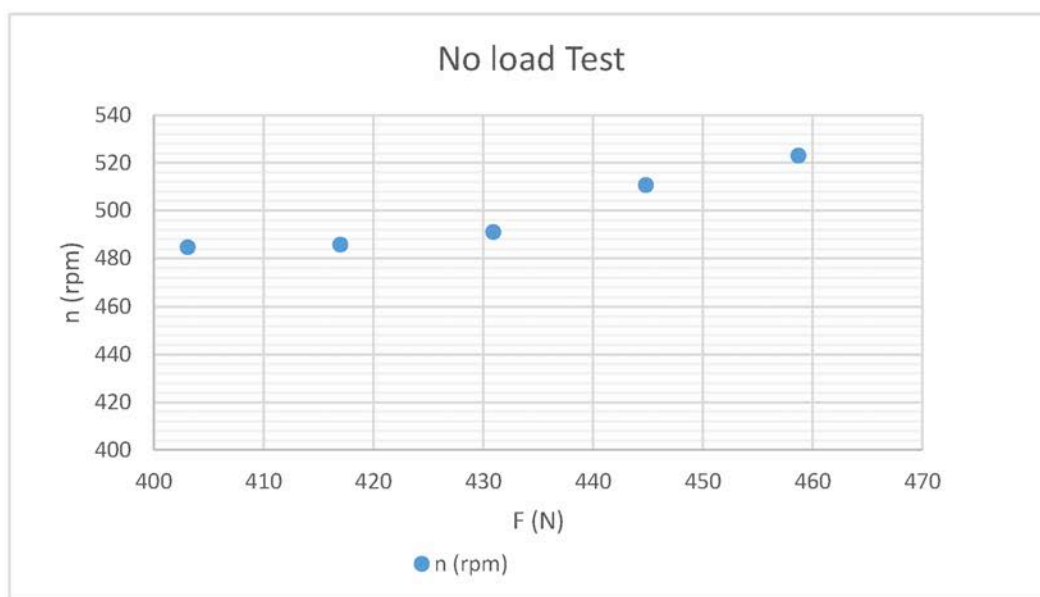
Figure 7. The speed of a RPG versus different force with no load

Figure 7 shows that if the compression force increases in the range of 400-430 rpm the speed increase slightly while the speed will increase about 10rpm as the compression force. Meanwhile, the open circuit voltage and the short circuit current will be increased as speed increases as shown in figure 8. The maximum open circuit voltage of 82V and the maximum short circuit current of 0.49A were obtained from the compression force of 460N and 445N, respectively. The result implies that a RPG can produce the electricity when the compression force press on the folded plate.
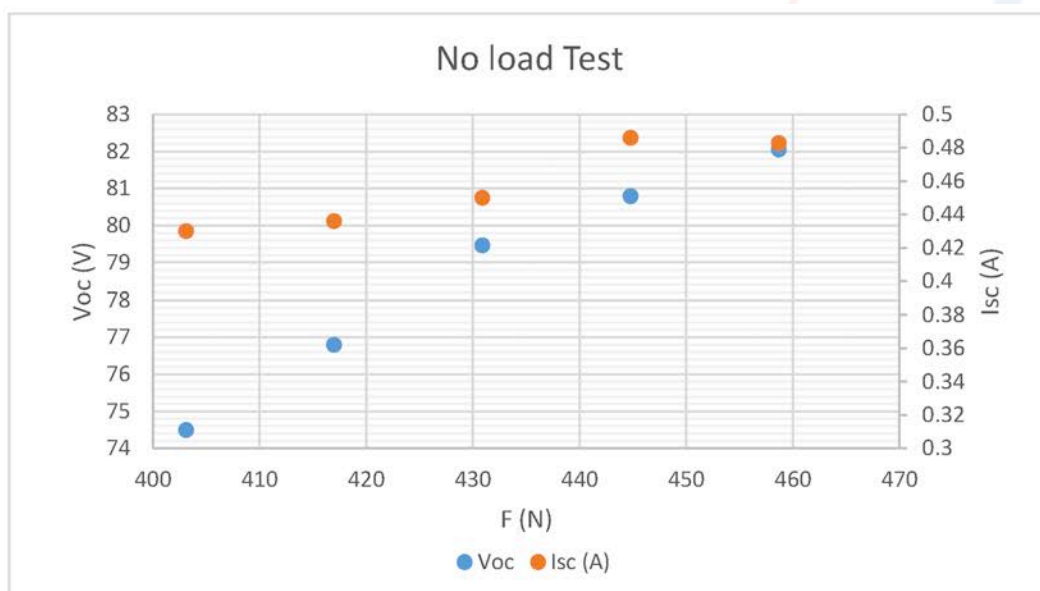
Figure 8. The open circuit voltage and short circuit current of a RPG versus different force with no load

5.2 Load Test

In this experiment, the motorcycle is fixed at 170 kilograms. The speed of the motorcycle is 10km/hr. It was found that if the resistance load is lower, the speed of the generator will be also lower obtained as shown in figure 9.
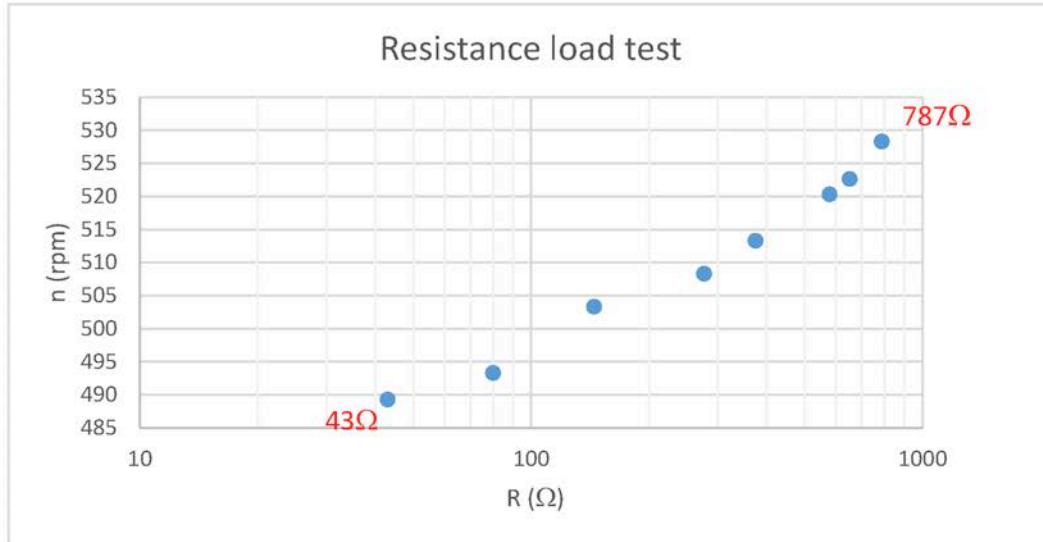
Figure 9. The speed of a RPG versus resistance load (from 43 to 787 ohms)

Figure 10 shows the measured voltage and power of a RPG versus current with resistance load. The results show that the maximum voltage of the RPG is about 83V at no load. The maximum current (short circuit current) of the RPG is about 0.49A. The maximum power of the RPG is about 10.98W at 43 ohms.
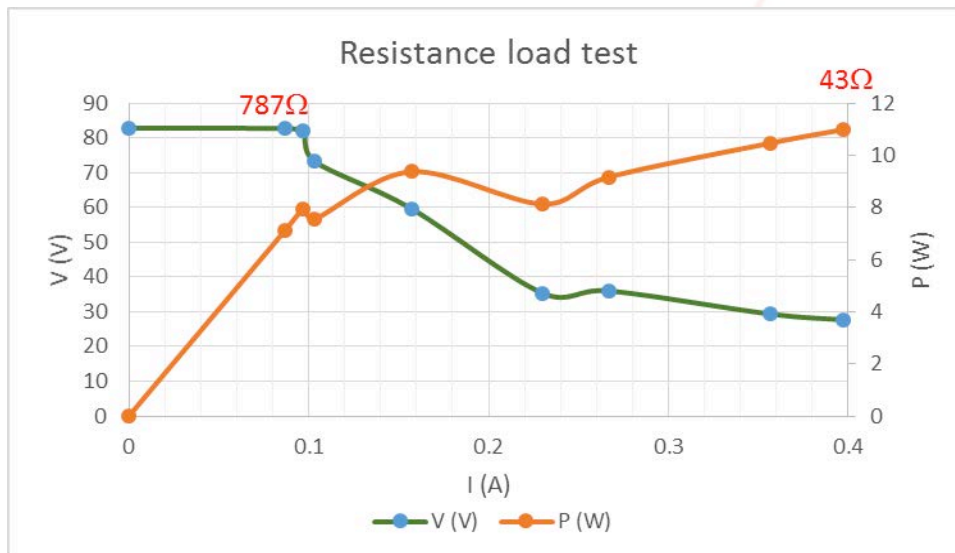
Figure 10. The voltage and power of a RPG versus current with resistance load (from 43 to 787 ohms)

6. Conclusion

This paper presents the prototype of Road Power Generator to convert the compression force from the traffic into the electricity. YAMAHA Fino is used as a test motorcycle which have weight about 96 kilograms. The speed of the motorcycle is 10 km/hr. The weight of the driver is varied from 45 – 75 kilograms. The RPG test is divided into two tests including no-load test and resistance load test. For no-load test, it was found that the speed of generator and the induced voltage from the generator will increase when the weight increases. For load test, the motorcycle with a weight of 170kilograms is riding pass along the RPG which connects the resistance load varying from 43 to 787ohms. The results showed that the RPG produces the maximum power of 10.98W at load 43ohms while the speed, the induced voltage, and the current are 489.33 RPM, 27.67V, and 0.397mA, respectively. In addition, the RPG produces a maximum voltage of 82V at load more than 579ohms and speed 522-535RPM.

7. Acknowledgment

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Suitable Alternative Energy in Bang Phra District Chonburi Thailand

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Abstract
The objective of this article is to study about the potential of wind and solar energy at the beach of the public park, Bang Phra District, Si Racha Amphur, Chonburi province, Thailand. The record data set of hybrid energy was installed for collecting the data at the beach of the public park. The record data set of hybrid energy consists of an anemometer, a wind turbine 200W 12V, a solar cell 120W 12V (Model: SP120E), a hybrid charger controller (Model: WWS02A-12-R-L-E), and a battery 12V 120Ah. The recorded data can be downloaded and displayed via WinPowerNet, which is a program from the record data set. The results show the recorded data from October 9, 2012 to November 7, 2012. It can be found that the wind velocity is fluctuated at all time. The maximum wind velocity was 8m/s and the average wind velocity was 0.94m/s. The wind turbine produced the maximum voltage at 13.55V. The solar cell can produce the maximum voltage and current at 16.7V and 9.8A, respectively. Obviously, the wind turbine can produce the electric power about 1 hour/day while the solar cell can produce the electric power about 10 hours/day. It implies that, in this area, the solar cell is suitable for producing the electric power more than the wind turbine.

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1. Introduction

The energy problem is one of the major problems that affects to all countries in the world. While the energy consumption is increasing [1], the resources are decreased and some are extinct.
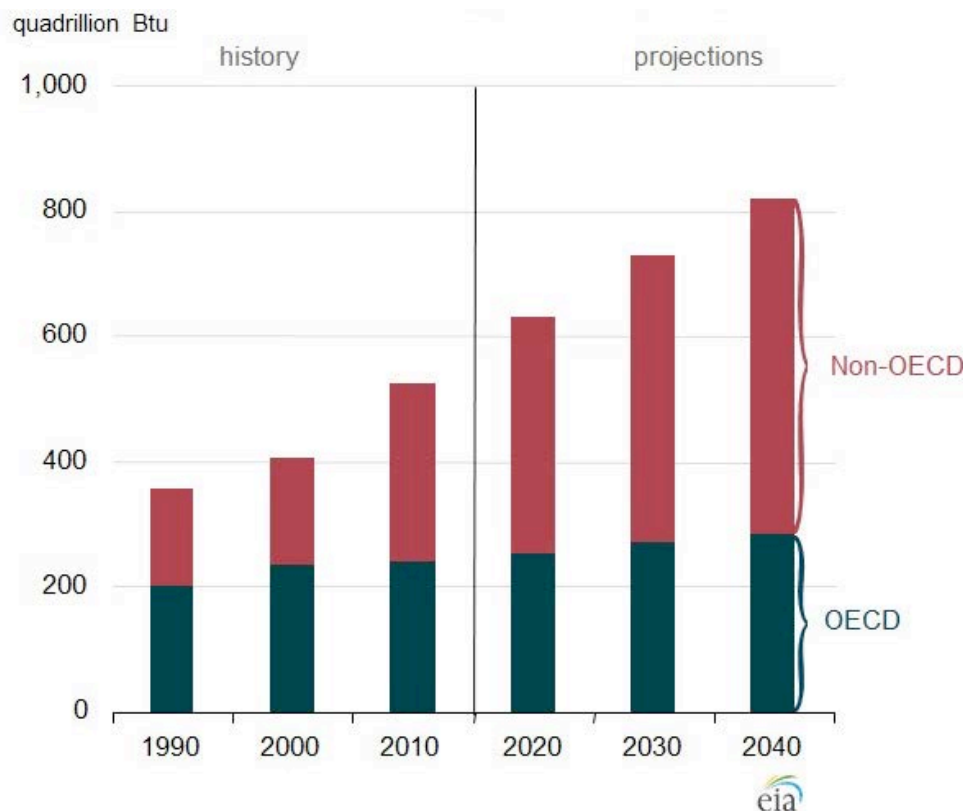
Figure 1. World total energy consumption, 1990 – 2040. [1]

From the figure 1, the *IEO2013* Reference case, world energy consumption increases from 524 quadrillion Btu in 2010 to 630 quadrillion Btu in 2020 and 820 quadrillion Btu in 2040, a 30-year increase of 56 percent. More than 85 percent of the increase in global energy demand from 2010 to 2040 occurs among the developing nations outside the Organization for Economic Cooperation and Development (non-OECD), driven by strong economic growth and expanding populations. In contrast, OECD member countries are, for the most part, already more mature energy consumers, with slower anticipated economic growth and little or no anticipated population growth. [1]

Electricity consumption grows faster than their use of other delivered energy sources in the Reference case, as has been true for the past several decades. Net electricity generation worldwide rises by 2.2 percent per year on average from 2010 to 2040. Renewable generation (including hydropower) is the interesting option to reduce the power using and pollution, so it is the world's fastest-growing source of electric power in the *IEO2013* Reference case, rising by an average of 2.8 percent per year. Government policies and incentives throughout the world support the rapid construction of renewable generation facilities as shown in figure 2. [1]
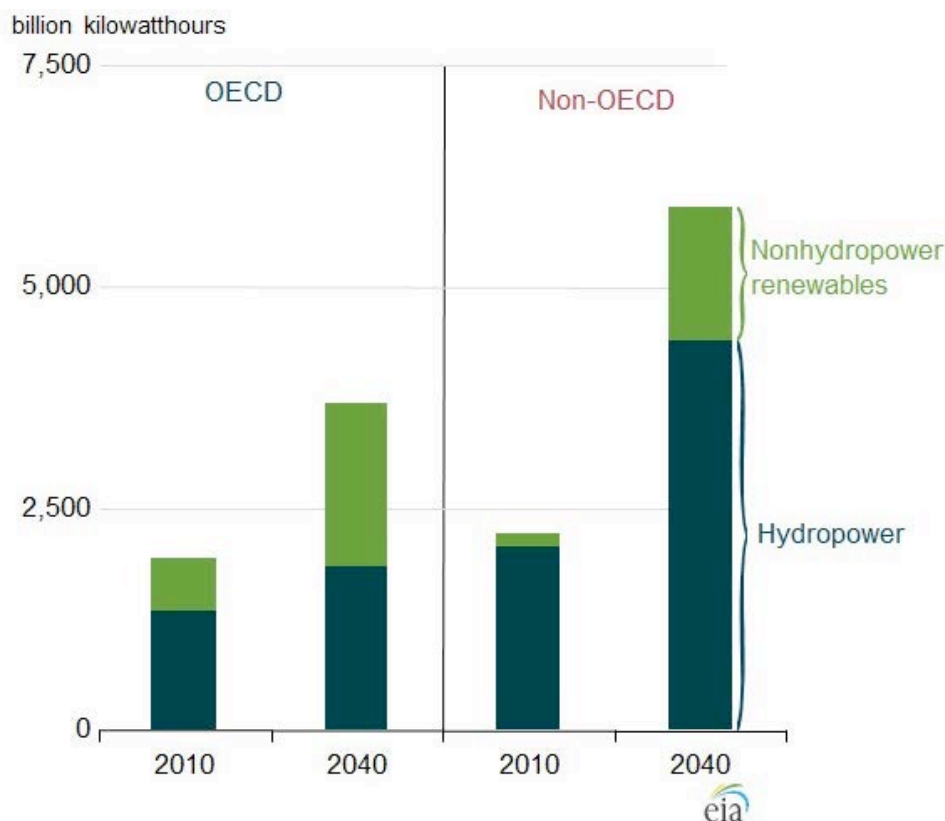
Figure 2. World electricity generation from renewable sources, 2010 – 2040. [1]

In Thailand, the renewable energy are used only 18.3 percent, while the crude oil has reached 81.7 percent [2]. There are many types of renewable energy, such as hydro power, solar, wind, etc. Each type is suitable for the different geography. So, the Bang Phra Municipality has an idea to initiate the renewable energy project to response the government's policy in dealing with the situation sustainable energy. The objective of this project is to study about the potential of wind and solar energy at the Bang Phra District to be a guide or tool for selecting the appropriate renewable energy that most effective in the Bang Phra Municipality.

2. Renewable Energy

2.1 Wind Energy

Surface wind is the wind blowing near the Earth's surface about 1 km above the ground. It is measured by an anemometer (speed) or wind vane (wind direction) at a standard height of 10 m above ground in an area. The changing of wind speed depends on the altitude and terrain as well as the wind direction as shown in figure 3. Performance of the wind turbine is based on these two variables. At the equal wind speed but the different wind direction, while the wind moving towards the axis of the wind turbines will largely affect to the torque of the wind turbine. The result is a different net force output from wind turbines. Thus, it can be concluded that the factors that determine the use of wind power is the speed and direction of the wind.
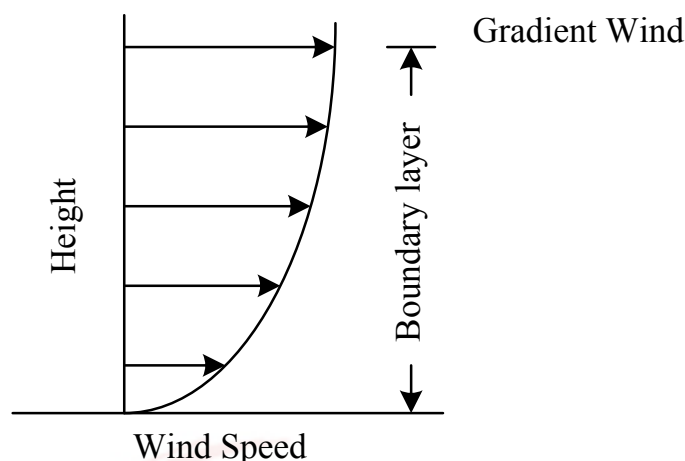
Figure 3. Characteristics of wind speed under the atmosphere.

Energy from wind turbines depends on wind speed as shown in figure 4. At very low wind speeds, there is insufficient torque exerted by the wind on the turbine blades to make them rotate. However, as the speed increases, the wind turbine will begin to rotate and generate electrical power. The speed at which the turbine first starts to rotate and generate power is called "the cut-in wind speed (3 - 4 m/s)". As the wind speed rises, the level of electrical output power rises rapidly as shown. However, at wind speed 12 - 17 m/s, the power output reaches the limit that the electrical generator is capable of. The wind speed at which it is reached is called "the rated/nominal wind speed". At higher wind speeds, the design of the turbine is arranged to limit the power to this maximum level and there is no further rise in the output power. In the range that wind speed climbs to the rated wind speed, the wind turbine operates with the maximum rotor efficiency as shown. Moreover, as the speed increases above the rate output wind speed, the forces on the turbine structure continue to rise and, at some point, there is a risk of damage to the rotor. As a result, a braking system is employed to bring the rotor to a standstill. This is called the cut-out speed and is usually around 25 m/s. [3]

Figure 4. Wind turbine power output variation with steady wind speed. [3]

The general principle of using wind energy is that while the wind blows against the blades of wind turbines, the wind power will be converting from kinetic energy to mechanical energy by the rotation of the blades. Force from the rotation of the blades will be passed to the spindle made of gears attached to the spindle rotation as well. Mechanical energy from the rotation of the gear can be applied to various practices, such as in the case of using wind turbines to generate electricity. It is connected to a generator. With this principle, the generator can produce the electricity. In the case of using windmills to pump water or rice mill, the mechanical energy of rotation of the gears can be taken for applications directly.

2.2 Solar Energy

A photovoltaic system (informally, PV system) is an arrangement of components designed to supply usable electric power for a variety of purposes, using the Sun (or, less commonly, other light sources) as the power source [4]. Todays, solar cell is

more commonly used because it easy to installation and maintenance. Moreover, the lifespan is too long (about 20 years). The PV system can be divided into 2 types, such as off-grid and on-grid.

A solar cell is a solid state electrical device that converts the energy of light directly into electricity by the photovoltaic effect. It is made of the semiconductor, such as silicon, and through a process to make a thin-film. While the light is striking on the cell the photons in sunlight hit the solar panel and are absorbed by semiconducting materials. Then, if the absorbed energy has greater than the band gap in order to excite an electron from the valence band into the conduction band, the electron will be free and allowing them to flow through the material to produce electricity.

There are number of different types of solar cells. It can be classified according to the material used to produce 2 types:

1) Solar cells made from silicon, this type is most commonly used because the silicon is abundant elements in the world such as, in the sand, in the quartz. Solar cells made from silicon can be classified according to the crystal structure into 3 types.

1.1) Single crystalline silicon is the base material of the electronic industry. It consists of silicon in which the crystal lattice of the entire solid is continuous, unbroken (with no grain boundaries) to its edges. It can be prepared intrinsic, i.e. made of exceedingly pure silicon alone, or doped, containing very small quantities of other elements added to change in a controlled manner its semiconducting properties. Most silicon monocrystals are grown by the Czochralski process, in the shape of cylinders up to 2 m long and 45 cm in diameter (figure on the right), which, cut in thin slices, give the wafers onto which the microcircuits will be fabricated. The example of single crystalline silicon can be shown in the figure 5.

1.2) Polycrystalline silicon is developed to solve the problem of the production cost of single crystalline silicon. Polycrystalline silicon is composed of a number of smaller crystals or crystallites. It can be recognized by a visible grain, a "metal flake effect". The process to produce the polycrystalline silicon is short and simple than the single crystal. So, the production cost is cheaper and slightly lower efficiency than the single crystal. The example of polycrystalline silicon can be shown in the figure 6.

1.3) Amorphous silicon is the non-crystalline allotropic form of silicon. It can be deposited in thin films at low temperatures onto a variety of substrates. It offers some unique capabilities for a variety of electronics. The production method is use a siren gas (SiH_4) through the vacuum tube, which is placed on the plate and silicon is excited to dissociate from gas. Silicon is separated from the gas to be captured into each other on the plate. Silicon is formed by deposition and accumulation on the plate to be a silicon film while the boron gas (B_2H_6) is diffused into the plate for coating to be the p-type and phosphate compound gas is diffused to form n-type. The example of polycrystalline silicon can be shown in the figure 7.

Figure 5. Single crystalline silicon [5]
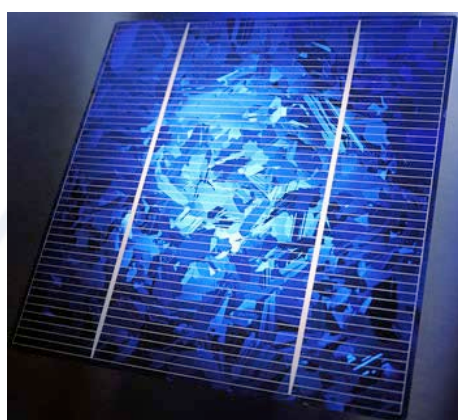
Figure 6. Polycrystalline silicon [6]
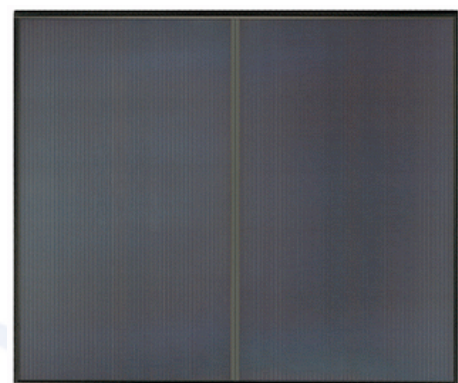
Figure 7. Amorphous silicon [7]

2) Solar cells made from compound such as Gallium Arsenide (GaAs), Cadmium Telluride (CdTe), Copper Indium Gallium Selenide (CIS), etc. It has both single and poly crystal. The most of this type has a high efficiency. The disadvantage is expensive. In addition, some of these types of solar cells made from substances that pollute and usually have a lifespan problem.

3. Methodology

3.1 Location

The most areas of Bang Phra District are the residence areas that are not suitable for installing the wind turbine. However, the west area of Bang Phra District has the Public Park which is the coast. Then, we decide to install the wind turbine and solar cell at the Bang Phra Public Park as shown in figure 8.

Figure 8. Satellite picture of recording data location

3.2 Equipment
- Wind turbine 200W 12V
- Solar cell 120 W Model: SP120E
- Hybrid controller Model: WWS02A-12-R-L-E
- Battery Deep Cycle 12 V 120 Ah
- Outdoor Cabinet (IP45)
- Anemometer

All equipment's are installed at the edge of Bang Phra Public Park. The wind turbine 200 W 12 V and solar cell 120 W 12 V are generates the electricity for charging into the battery 12 V. The hybrid controller has a function to control the battery charging and display the data on the screen. Battery is used to storage the electrical energy. It can be charged and discharged depends on the load. If the electrical energy is generated more than load, the rest energy is kept into the battery. On the other hand, if the electrical energy is generated less than load, the energy that storage in battery is taken to use for load. The system diagram can be shown in the figure 9 and the set of equipment's for recording wind and solar data is shown in the figure 10.
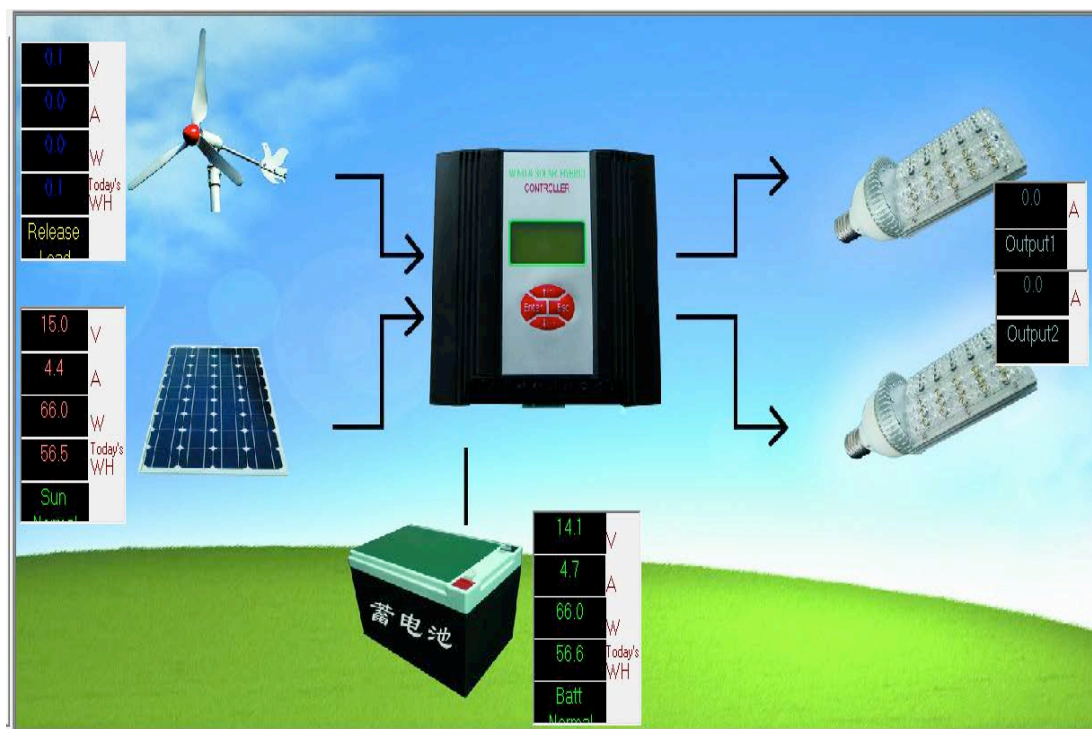
Figure 9. System diagram

a) Complete installation   b) Equipment within the cabinet
Figure 10. Set of recording data for wind and solar energy

3.3 WinPowerNet

All data will be recorded to the SD card which can be downloaded or opened with WinPowerNet program. It can show the data into 3 types such as trend chart, table, and simulation graph. The details of each type can be shown bellows.

1) Trend chart
The values of voltage of battery, produced voltage from solar cell, produced voltage from wind turbine are shown. Moreover, the graph of electrical power varies with time and radar graph between voltage and current are shown in figure 11.
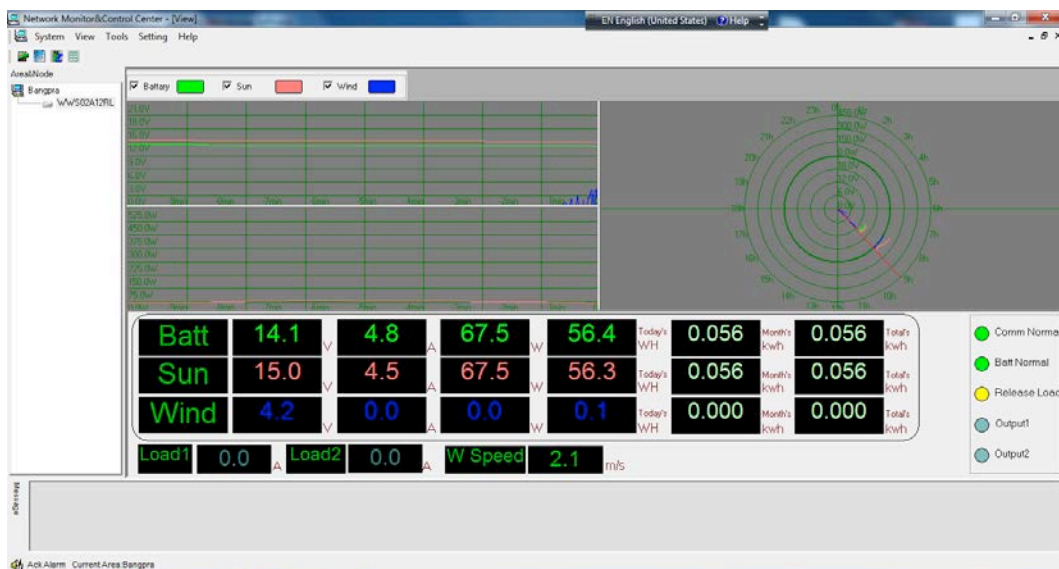
Figure 11. Example of the trend chart

2) Table
The real time data in 20 seconds will be shown in the table. The example of table can be shown in figure 12.

Figure 12. Example of the table data

3) Simulation graph

The data of battery, wind turbine, and solar cell will be shown in real time. The example of the simulation graph can be shown in figure 13.
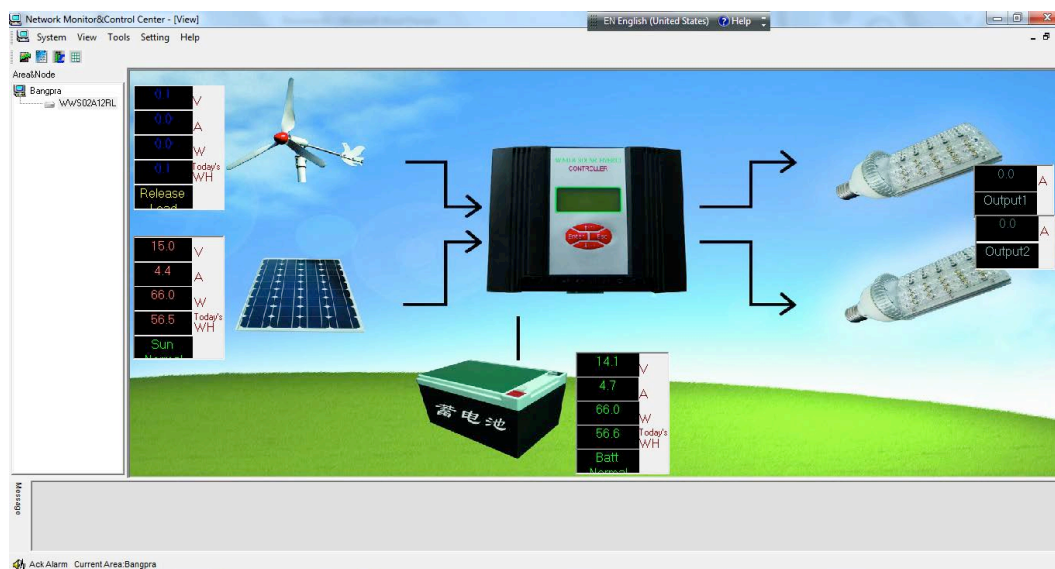
Figure 13. Example of the simulation graph

4. Results

The results can be divided into 2 parts: wind energy data and solar energy data.

4.1 Wind Energy Data

The data were recorded at every 1 minute. The example of daily wind speed can be shown in figure 14.
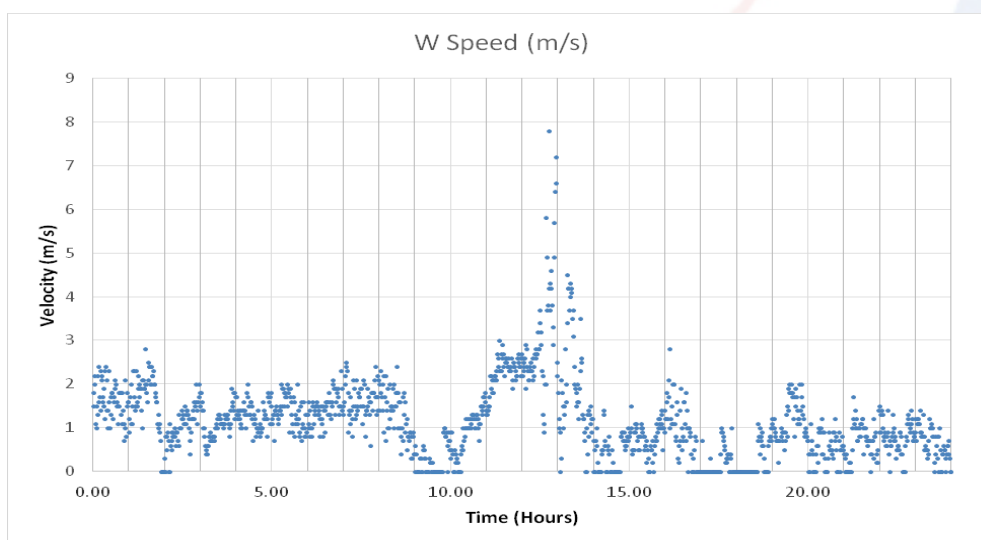
Figure 14. Daily wind speed on October 10, 2012

From the figure 14, it was found that the wind speed is fluctuated and the maximum wind speed is 8 m/s at 13.00 o'clock on October 10, 2012. The 30 days record data can be shown in the figure 15 – 18.
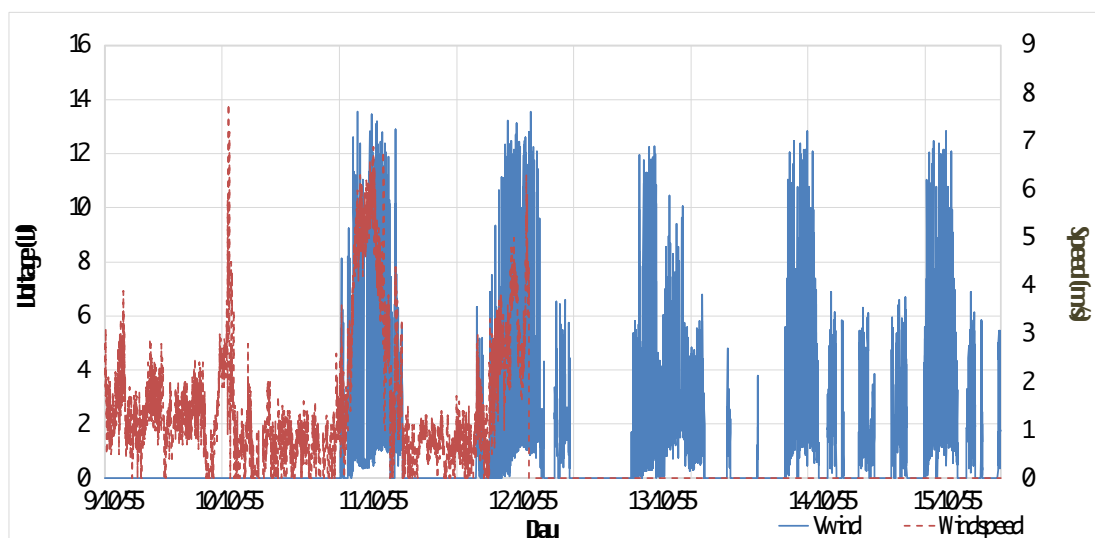
Figure 15. Wind speed and produced voltage on October 9 - 15, 2012
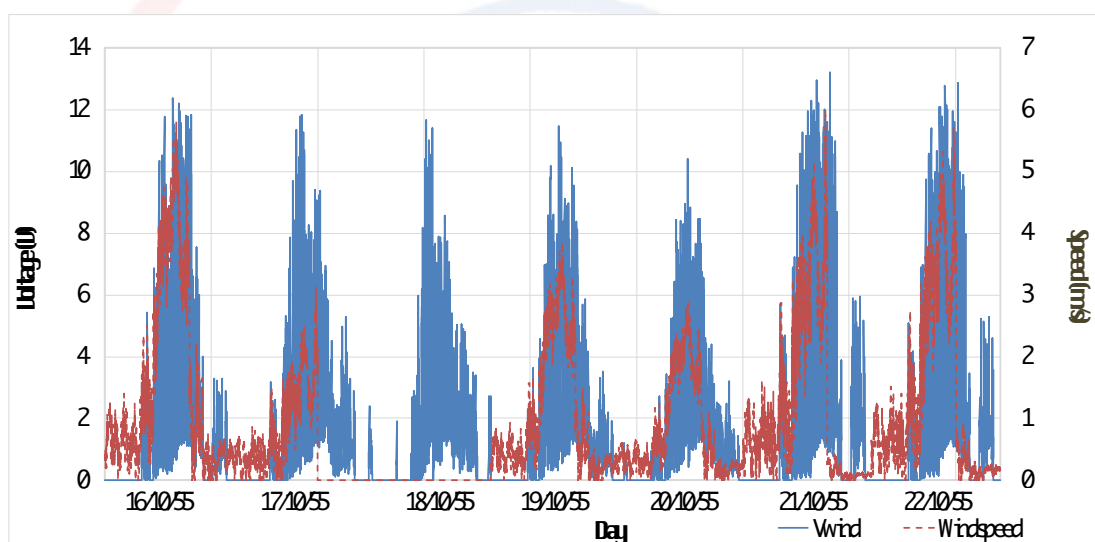
Figure 16. Wind speed and produced voltage on October 16 - 22, 2012
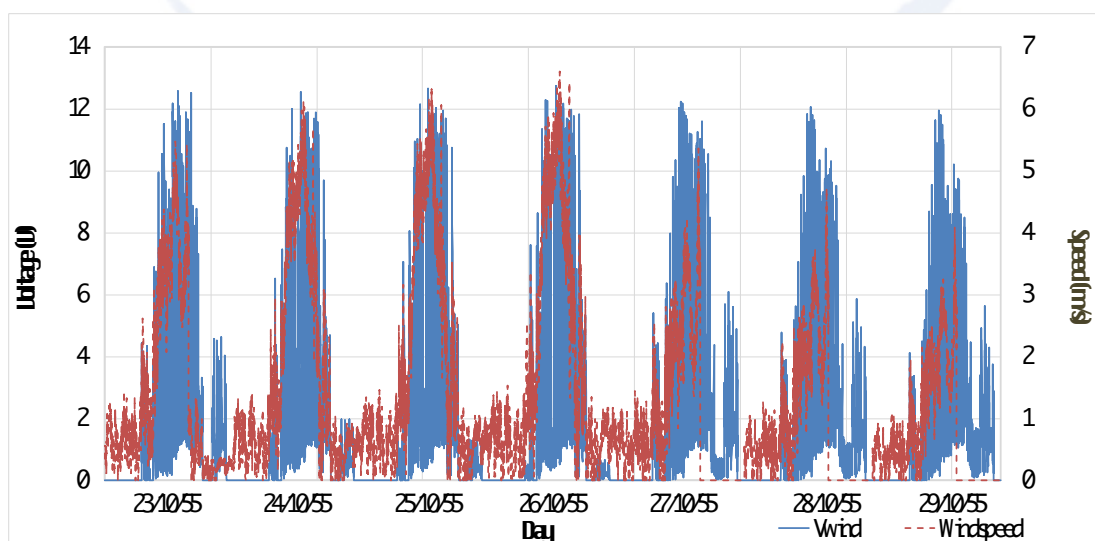
Figure 17. Wind speed and produced voltage on October 23 - 29, 2012
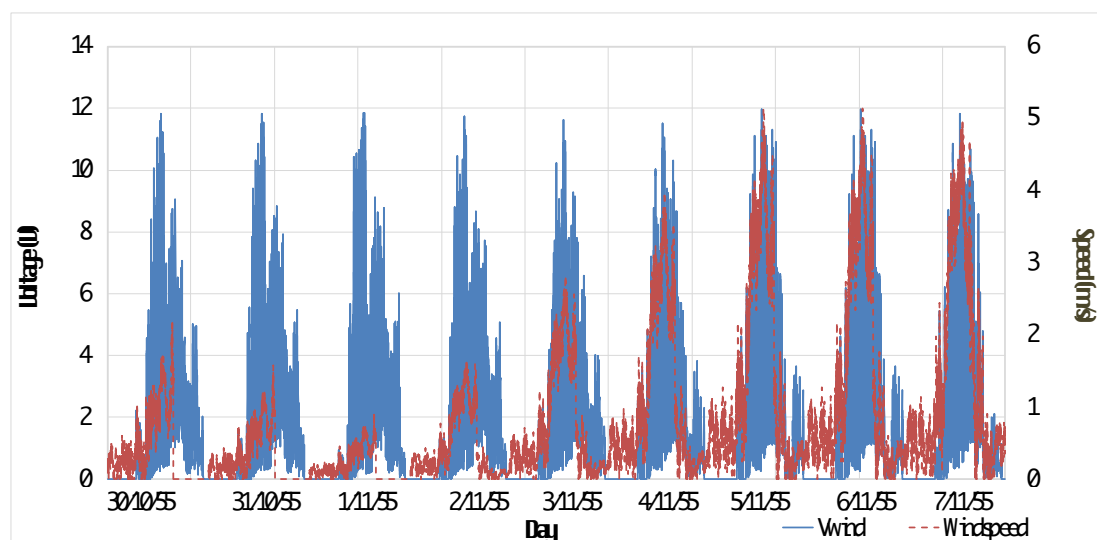
Figure 18. Wind speed and produced voltage on October 30 – November 7, 2012

From the figure 15 – 18, it was shown that the maximum produced voltage from wind turbine is 13.55 V at 5.4 m/s wind speed. The maximum voltage was happened on October 11, 2012 at 10.41 o'clock. Moreover, the average wind speed on 30 days is 0.94 m/s and the average produced voltage is 1.46 V.

4.2 Solar Energy Data

The example of daily produced voltage from solar cell can be shown in figure 19.
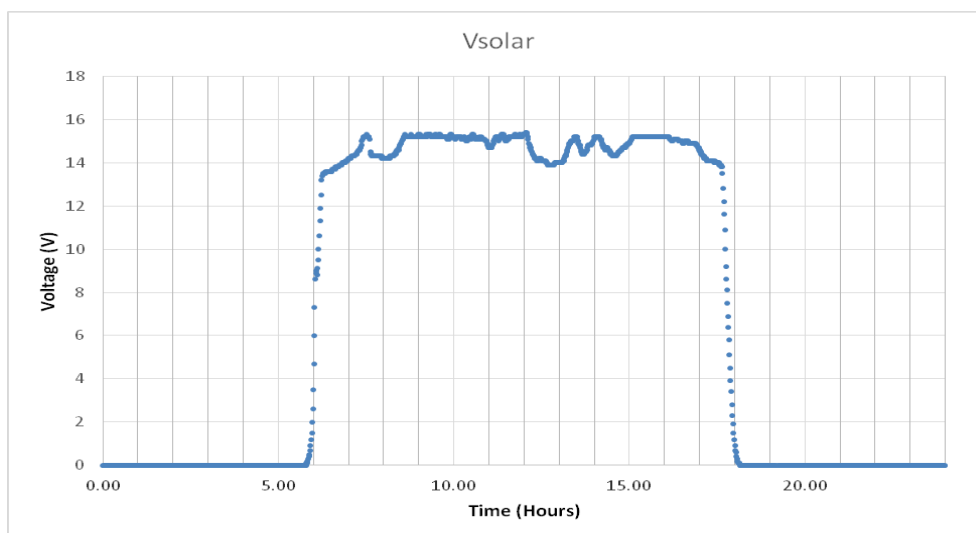
Figure 19. Daily produced voltage on October 10, 2012

From the figure 19, it was found that the produced voltage is quite constant from 6.00 – 18.30 o'clock. The average voltage is 15 V and the maximum voltage is 16 V. The 30 days record data can be shown in the figure 20 – 23.
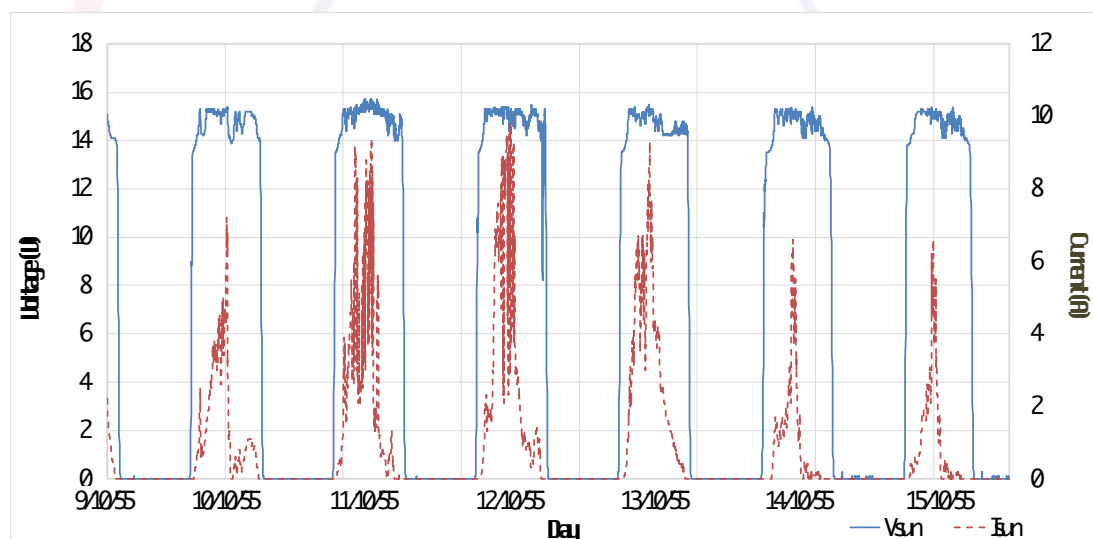
Figure 20. Produced voltage and current on October 9 - 15, 2012
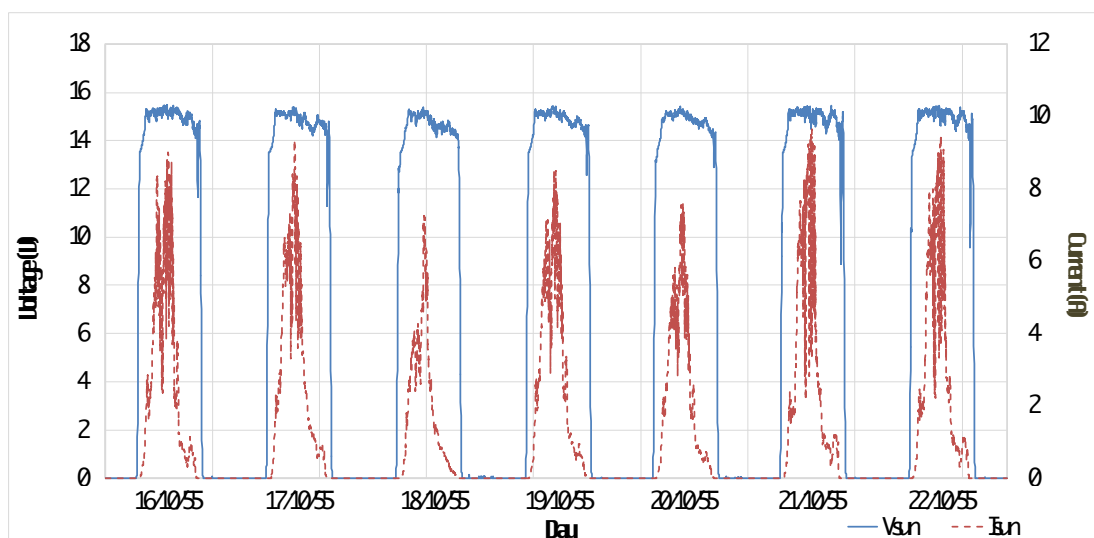
Figure 21. Produced voltage and current on October 16 - 22, 2012
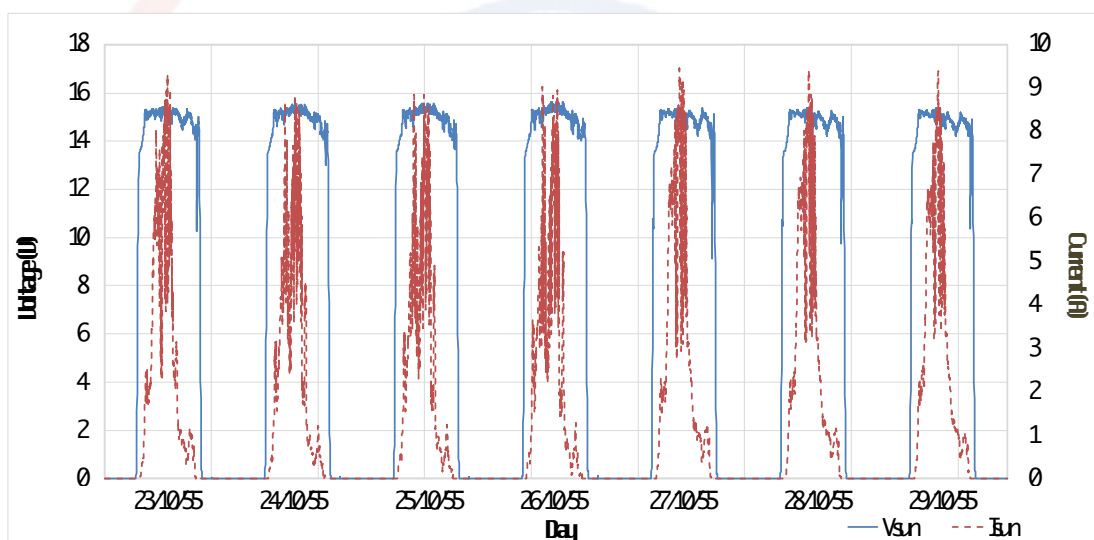
Figure 22. Produced voltage and current on October 23 - 29, 2012
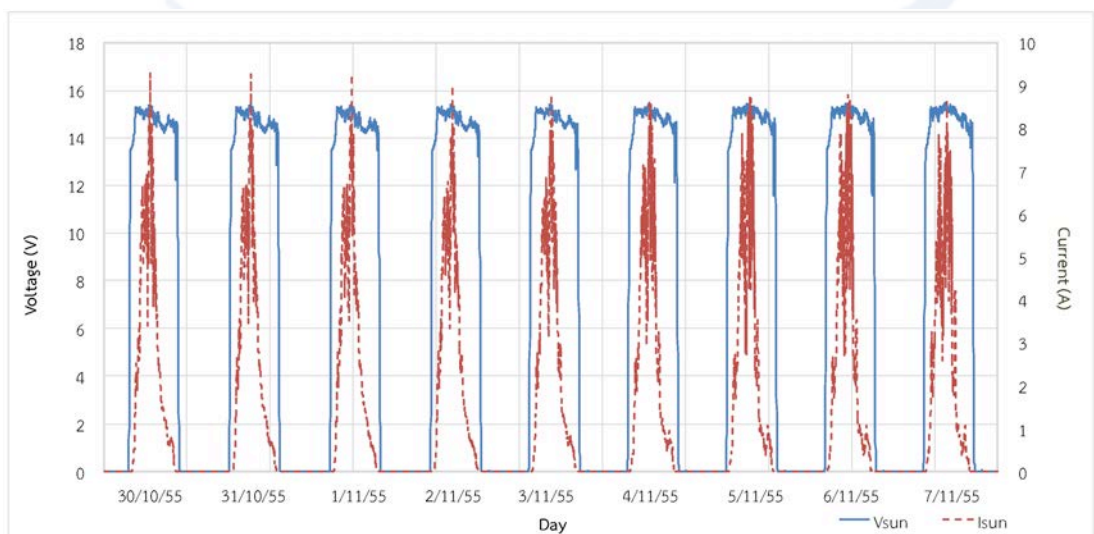
Figure 23. Produced voltage and current on October 30 – November 7, 2012

From the figure 20 – 23, it was shown that the sun rises on the 6.30 o'clock and fall on the 18.30 o'clock. However, the solar cell can be produced the energy only 10 hours per day. The current and power can be produced more than 3 A and 40 W in 9.30 – 12.15 o'clock. The maximum produced voltage is 15.7 V on October 11, 2012 at 11.24 o'clock.

5. Conclusion

This article presents the potential of wind and solar energy at the beach of the public park, Bang Phra District, Si Racha Amphur, Chonburi province, Thailand. The data such as wind velocity, produced voltage from wind turbine, and the electrical parameters from solar cells are recorded from October 9, 2012 to November 7, 2012.

From the record data, we found that the wind velocity is fluctuated at all time. The average wind velocity was 0.94 m/s which were the low rate and the average voltage produced from wind turbine was 1.46 V. Moreover, the maximum voltage was 13.55 V at 5.4 m/s wind speed on October 11, 2012.

Considering the data from solar cells, we note that the sun is rise and down on 6.30 and 18.30 o'clock respectively. However, the solar cell can produce the electrical energy only 10 hours per day. Especially on 9.30 – 12.15 o'clock, the solar cell can produce the current and electrical power much more than 3 A and 40 W. The maximum current was 9.8 A on October 12, 2012 at 11.43 o'clock.

The wind velocity is measured at the 10 m height from the ground. It is low rate (0.94 m/s) and not sufficient to produce the energy (3-4 m/s). Then, if we still need to install the wind turbine, it should be installed at the higher than 10 m. It implies that, in this area, the solar cell is suitable for producing the electric power more than the wind turbine. However, the only 30 days record data were not sufficient to decide for choosing the suitable renewable energy. It should be recorded more than 1 year.

References

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[6] http://www.m0ukd.com/Solar_Panels/

[7] http://phys.org/news88965013.html

Model of Sustainable Housing Management

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Abstract

Individuals in the community awareness about the environment and conservation is very important now. Communities exposed to pollution, and environmental destruction are difficult to avoid. The concept of sustainable settlements is one of the solutions to overcome these problems. Various findings and innovations such as the concept of water resources planning, the concept of waste management, environmental planning and sustainable concepts has been implemented. But the new finding sand innovations are not implemented integrally in a residential area so that its function is not optimal to apply in a community of sustainable settlements. This research aimed to develop a model of environmental management of sustainable housing. The concept of sustainability does not only apply to estate planning, but also in the management process. The hypothesis of this research is that the application of the model would not be optimal if the management does not understand the character and its social system. So the roles and responsibilities of the people involved in them can be well planned. In this research, required the implementation of co-operation with housing managers, housing residents, local governments and national public housing companies. Research methodology begins with a survey, analysis and resulted in the finding. The finding of this research is applied to the study area to test models of housing management.

Keywords : social system, management, sustainable housing

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Introduction

Individual awareness in society about the environment and its sustainability is very important today where pollution and environmental destruction is difficult to avoid (Hawley, 1950). Root causes of the environmental damages are the fault of human behavior perspective about themselves, nature and the relationship between human and nature (Keraf, 2002). This finding highlights the importance of sustainable development in the settlement sector, mining and energy, transportation and the environment (Kirmanto, 2002). Sustainable housing development is defined as a sustained effort to improve social conditions, economic and quality of the environment in which to live and work everyone.

Awareness of the population and the Indonesian government to implement the concept of sustainable housing as a solution to address the environmental damage that occurred and preserving the environment is a good first step. Various programs and activities are being implemented for moving step towards a sustainable housing. Various findings and new innovations such as: the concept of water resource planning (Kayo, 2001; Syarif, 2003), the concept of waste (Wibowo, 2002), the concept of sustainable environmental planning (Gunawan, 2007; Astuti, 2005) has been implemented. However, the findings and new innovations are not implemented in an integrated manner within a residential area so that their role is not optimal can be applied in a sustainable residential community. That's why this research is needed so that the management model of sustainable housing environment, all aspects and related components can be implemented in an integrated manner.

Sustainable Housing

Sustainable housings have different interpretations from various viewpoints. But basically contains 15 principles declared by the United Nations Conference on the Human Environment, namely: planning human settlements that avoid the destruction of the environment and contain the maximum benefit socially, economically and environmentally. (Larasati et al, 2006) describes the application of a sustainable housing to the conditions in Indonesia as follows:

Table 1. Implementation of sustainable housing in Indonesia

Aspect of sustainability	Criteria for implementation in Indonesia
Energy	Reducing the demand for energy Promoting the use of sustainable energy resources
Materials	More efficient use of material Reducing waste
Water	Reducing water usage Preventing land drying up Protecting water quality
Indoor environment	Disseminate, and implement the standards of Healthy House
Surrounding environment	Increased housing infrastructure Stimulate community activities for environmental preservation

Economy	Community empowerment in the system of financing.
Socio Culture	Reducing the gap between social classes Consider ways of living communities of Indonesia.

Source : (Larasati et al, 2006)

Some of the strategy planning of the sustainable housing can be seen on the principles (Grant, 1996) are: manage and maintain the environment in order to function properly, minimizing the influence of buildings on the surrounding environment, protect natural resources and land resources for further generations, reducing the waste generated by residential buildings, increase community involvement in promoting environmental preservation and promotion the importance of healthy social environment.

According to (Badan Standarisasi Nasional, 2005), environmental management system is part of the organization's management system used to develop and implement environmental policy and manage its environmental aspects. The research was conducted with the prediction that the implemented of sustainable housings will be successful if the needs of occupants are effectively accommodated and the occupants are deeply involved in the management of their settlement environment (Larasati et al, 2006). To recognize the characteristics and patterns of residents living in the neighborhoods, the research is conducted in the social system of residential community.

Social system of residential community is a complex system of interdependence between the parts, components, and processes surrounding the rules of relationship between the residential community. Residential community is a set of people who lived in a residential location with a variety of status and role in an organization of society. By understanding the social system within a residential community, the role and involvement of each member of the community in achieving a sustainable housing can be planned. This approach is used in planning for sustainable communities (Roseland, 1998).

Sustainable community

Some experts say that a sustainable society is a society that is learning the system and working at a faster rate than the rate of problem that will destroy it. In other words, the community can anticipate the problems that will arise to destroy it.
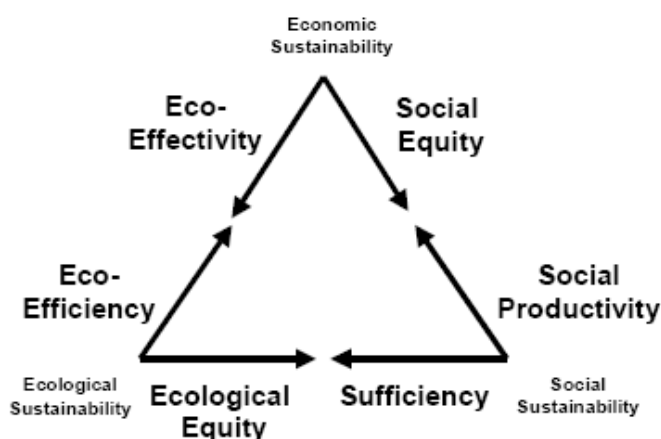
Figure 1. Sustainable community (Bieker, 2000)

The ideal form of sustainable community when economic, social and ecological support each other (Figure 1). The concept of a sustainable community if (1). Meet the ecological sustainability of natural resource use in the form of an efficient, effective and equitable., (2). Meet the social sustainability of human productive and sufficient (3). Meet the financial sustainability of the ecological efficiency and social equity

Research methodology

The development of housing is always confronted with the problem between the housing demand and the quantity of supply housing are falling further behind. This problem mainly occurs in low income community. Residential community who live in Perumnas housing represent the image of the low income community. Although some studies mention that the housing development by Perumnas is still not on targeted (Tjahyono, 2004). Stages of research conducted with the hypothesis that the success of a residential management model can be achieved when community members and components involved in these residential communities have the same goals and the roles and responsibilities of each one correctly. To ensure a success, there are four activities need to be done: planning, implementation, examination and action. The research carried out in two years. The first year is planning and implementation of the concept of sustainable housing. The components of the concept tested in the context of existing housing (in this case is Perumnas). Then in the second stage of examination and then do the action.

Research conducted is a descriptive study. The data was collected by survey method in three housing developed by Perumnas in the city of Medan such as : Perumnas Helvetia , Perumnas Martubung and Perumnas Simalingkar. The spread of the questionnaire carried out at random sample to get a picture of the characteristics of Perumnas community occupants. The number of respondents from the three community occupants is 388 respondents. Structurally there are three stages research conducted in this study: first, get an insight of the socio economic conditions of the Perumnas occupants in general, the second is to know the characteristics and potential of community groups and third, is to develop a sustainable housing components that can be applied in the management of sustainable housing.

Variables

To get an idea of the community characteristics of the Perumnas occupants, the tabulations related questionnaire about the background of the occupants. Socio-economic condition of residents can be grouped into two portion: 1) Profile of residents described by age, sex, marital status and number of home contents and 2) The condition of social fragmentation is described by income, occupation and education the head of household (van Kempen, 2000). Follow (Morrison, 2003), the characteristics of the occupants will affect the social dynamics that will occur in the neighborhood. There are three aspects that affect the social dynamics namely: 1). Type of home ownership status, 2). Social identities in residential areas and 3). Balance between incoming residents moved into the area and residents who came out of the residential area.

Management modeling method

The preparation of the model is doing by sustainability methods (Figure 2). The meaning of sustainable that each phase of the action has taken repeatedly and continuously. This activity needs to be done to maintain environmental sustainability housing management conditions. Schematically action began when researchers intervene a residential neighborhood. Interventions made by observation and interview. Then the next step is to evaluate the physical and non-physical condition. The results of the evaluation such as the identification problem issues in the environment. Then the concept of problem solving will be applied as an environmental improvement.
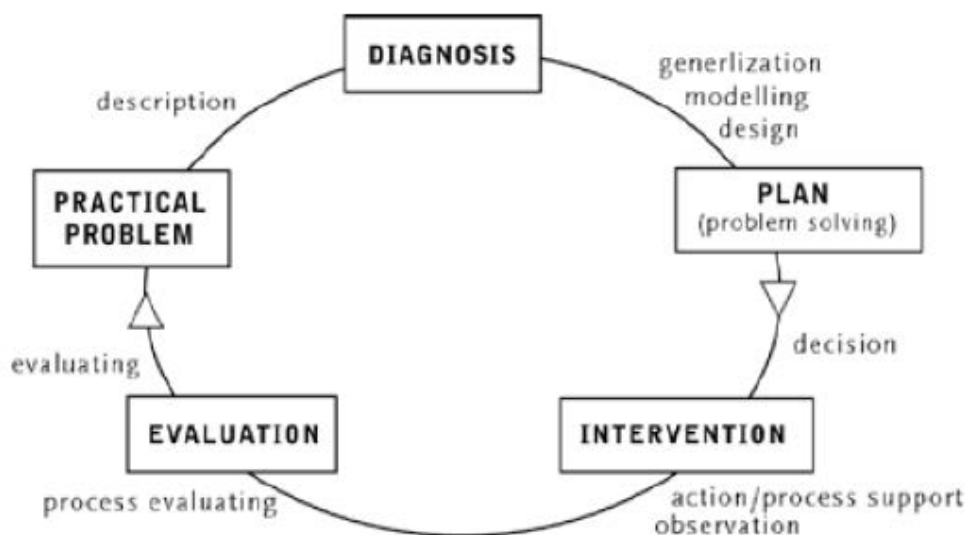
Figure 2. Management modeling method (Larasati et al, 2006)

Results and discussion

The method of analysis is carried out by using the triangulation method that is a way to check and crosscheck the information received to see equality, harmony and also differences. Further triangulation results are arranged in a descriptive summary to see equality, harmony and distinction. After the analysis description is structured, it is

then carried out to make conclusions and recommendations strategy for community empowerment

Community profile describes the community with young families and middle-age group is in productive age. This community is still possible to evolve by added family members and the improvement of economic conditions. In the human life cycle stages, this community is still allows more and the improved quality of life. This condition causes the community is dynamic and changing rapidly (Kartasasmita, 1997). This condition describes the characteristic of modern society community. This community requires: the ability and the right of people to develop choices, recognition as individuals than as members of society, and social structure is open and voluntary.

Social fragmentation in these communities illustrates the low to moderate income groups with diverse composition. This community represents a heterogeneous group of people from the type of work, education and income. This condition indicates the community social capital can be used optimally. Community social capital is (Witrianto, 2007) the potential of groups and patterns of relationships among individuals within a group and between groups with the chamber's attention on social networks, norms, values and beliefs within the group. High Social Capital will tend to be more efficiently and effectively carry out various policies for the welfare and advance the group. A group of people who have high social capital will open up the possibility of completing the complexity of the problem more easily.

Social dynamics in these communities illustrate the mobility rate is high enough. It can be seen from the majority of residents had inhabited the area for 1-5 years although the age of housing is already more than 10 years. Although the mobility of residents is quite high but the majority of residents are homeowners. This condition describes the transfer of home ownership is common. This condition describes a dynamic community and the mobility of residents who moved in and out of this community is quite high. Perumnas as a public housing provided by government for low-moderate income communities often become a temporary home in accordance with the family's ability at a certain life cycle stages. This is also confirmed by (Winstanley, 2002) which conducted an evaluation of public housing in Venezuela. It was found that the respondents choose public housing because the price is cheaper than the other and because of the concept design "Core House" allows the development of the house when necessary according to the stage of the life cycle.

Model of sustainable housing management.

Sustainable housing management model can be applied to existing residential areas and areas of inhabited housing to be built because this model is applied continuously and sustainably. In the area of housing to be built, it becomes easy to take more fundamental requirements of their application for a simple Healthy House can be applied when designing and building the residential area. But in the context of residential areas that are already occupied, the sustainable housing management model is implemented by making changes and behavioral adaptations by the occupants. Sustainable housing management arrangements applied to the physical components of residential and non-physical component.

Figure 3. Model of Sustainable housing management. (Aulia, 2010)
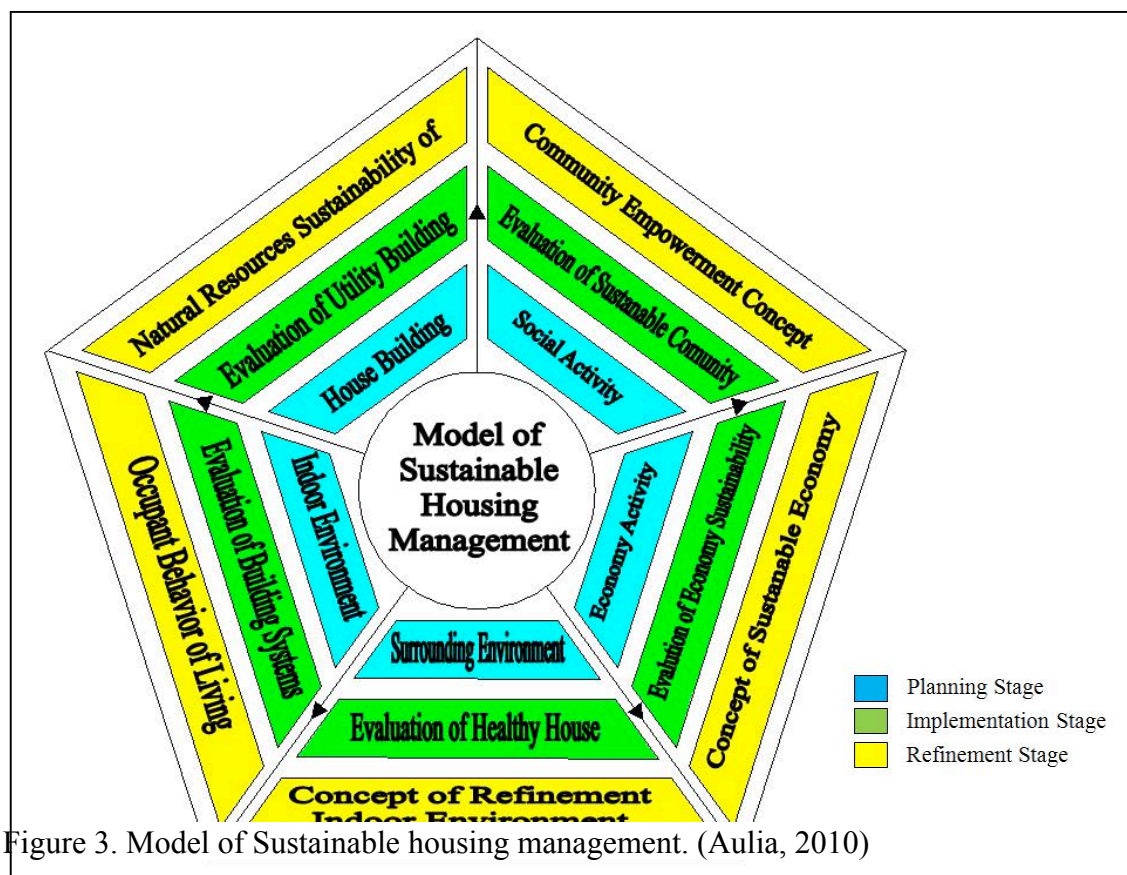
Sustainable housing management model (Figure 3) more easily applied to small-scale residential communities such as in the neighbourhood. However, if this model is successfully applied to small residential communities, it will directly affect the quality of a larger scale residential neighborhood. It is expected that all the layers in residential communities is involved to achieve sustainable housing.

The first step of implementing the model of sustainable housing management is classifying the physical and non-physical components in a residential area into five components, namely:

1. Component of house building consists of three sub-components, namely: energy consumption, utilization of building materials and water conservation.
2. Component of Indoor Environment consists of two sub-components: implementation requires standards / mental health needs and the implementation standards of comfort.
3. Component of Surrounding Environmental consists of two sub-components, namely: sanitation and waste management.
4. Component of Social Activity consists of two sub-components, namely: mutual cooperation and social interaction.
5. Component of Economic activity consists of three sub-components: income, expenditure and economic sustainability

The second step is applied the sustainable housing management model to the planning of new housing areas or tested in a residential area is already occupied.

1. Testing the occupant to the component of house building such as the pattern of energy consumption, the water consumption patterns and occupant activity doing water conservation.

2. Testing the physical condition of house building, whether it meets the standards of Healthy Homes. If did not follow the standard, needs to be repaired.
3. Testing the operational system of the building. The test is doing to see if waste treatment systems and sanitation systems already meet sustainable housing concepts. When did not fit the concept then we have to do community empowerment in the implementation of waste management and sustainable sanitation systems.
4. Testing the sustainability of the community in social activity. The test is taking to see if social interaction and cooperation worked well in the community. When did not fit the idea then we have to do simulation the activities to make it right.
5. Testing the economic sustainability of the community. The test is taking to see if the community has sufficient income patterns, and the sustainability of economic production can occur in this community.

The third step is improving the management of housing. Improvements made on each of the sustainable housing management components.
1. Implementing the concept of sustainable energy savings and water conservation.
2. Implementing the concept of Healthy Home such as improvement the cross ventilation systems, lighting and humidity inside residential buildings.
3. Implementing the repaired process of waste management and sustainable sanitation system such as repairs and changes in living patterns of occupant behavior.
4. Implementing community empowerment such as repaired social interaction and organized activities along with the pattern of cooperation.
5. Implementing sustainable economy such as repairs and changes in occupant behavior patterns in economic management that maintained its sustainability.

Conclusions

In applying the concept of the management model, it will be more easily applied when the social characteristics of the community is more homogeneous and stable because it requires a consistent sustainability in its implementation. There are high social dynamics in occupants community of Perumnas presented by the results of the study. However, the social capitals of communities presented by the level of social interaction and a fairly close relationship between residents presented potential for implementating the models of sustainable housing management.

Planning a sustainable housing will not produce an optimal implementation when the components involved such as residents, managers, developers and the government does not run a proper role. It requires the participation of government (such as Lurah, Kepling, chairman of RW, chairman of RT) in a pioneering application of models of sustainable housing management. The government act is necessary as a facilitator in the implementation of this model.
Perumnas is an occupants community model that can be used as a case study for implementation of sustainable housing management because Perumnas is a form of urban fabric in the reality of Indonesian settlement. Perumnas occupants community model is largely the model of olow – moderate income communities in Indonesia.

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Inclusive Design Applied in Open Public Spaces for the Promotion of Cultural Exchanges

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Abstract

Open public spaces, such as parks, squares and malls, plus their respective street furniture are germane for sustainable living as they facilitate social interactions; provide recreational moments that are symbolic in the sense of gathering people and help to develop local cultural identities are important as well. However during the design of such spaces, particularly in developing countries such as México, there are other aspects to consider that are often overlooked, aspects such as accessibility, inclusive and environmental impact.

As designers of products, images and urban spaces, we have the responsibility of consider all the members of a community regardless of age, sex, culture or abilities. That is, to develop a truly inclusive design that considers the community's diverse needs (such as physical, ergonomic and of interaction) within its social, cultural and historical context, this should be analysed to provide them of meaning and purpose.
There is a lack of understanding on how different population sectors interact in such spaces, accordingly to the physical abilities (such as the case of the elderly population).

It is because of this that it becomes important to design street furniture that answers the need of a wide range of public as well as being adequate to the image of the local context. The aim of this paper, as result of an ongoing research Project; is to reflect upon the generalities of inclusive design that should be observed, particularly with the elderly population in mind, using the case study of the Constitution Passage, located in Toluca city, Mexico.

Introduction

Victor Papanek posed that a priority of design should be, in order to be meaningful to meet the needs of those less fortunate sectors population in terms of physical or mental abilities, whether disabled or sick birth or elderly people who see their physical and mental capacities decreased significantly.

When talking about universal design, it is needed to discuss two complementary but different point of view. On the one hand we talk about designing the world around us-in this case-public spaces such manner anyone regardless of age or physical abilities can access and interact in that space. The other approach is to design products with no boundaries: the disabled, pregnant women, children, seniors; so that they are most comfortable, functional and aesthetic potential that rather than become a stigmatizing mark, become a real space to inhabit in their daily activities.

Although in recent years there has been an increase in awareness of this topic in terms of generating some concessions as ramps and hearing support, in reality and particularly in Toluca, Mexico is that it is an aspect that has been rather neglected, either through ignorance, lack of adequate knowledge on the subject or simply because it is not considered a priority. However this is only avoiding the reality. Mexico is a country with a growing population in the not so distant future will seem as old and is going to find with the harsh reality that in this country (and this city) is still designing for an idealized world where we all have perfect athletic, sensory and mental physical conditions perfect.

Additionally it is necessary to consider that every person is one accident to become disables, either temporarily or permanently. While the topic has been mentioned in the media, be through interviews with experts in gerontodesign or through commercials to raise awareness about the needs of people with disabilities, this has no take-off as the lack of awareness at times betray a lack of empathy for the other persons –they are dehumanized and seen as a being outside most people's reality- which would only be acquired when these disabilities happen.

Coming back to what Papanek in his seminal book "Designing for the real world" observed, it is necessary that designers become aware of this situation and use their abilities to modify and manipulate the world around us with more emphatic, holistic vision. While it may not be possible to raise awareness in every single person, it is possible to design the world in such way that improves the quality of life of the population to contribute to all the people to enjoy their city. To this end it is necessary to draw on aspects of urban image, inclusion, identity and cultural exchanges was created.

What are the open spaces?

Cities are complex systems, that includes individual activities and within public spaces, economic, administrative, recreational, cultural activities unfold. In that regard, public spaces function as hubs for the inhabitants of the city to carry out cultural exchanges.
Designers, urban planners and architects have a responsibility to treat all members of a community in a universal way regardless of their physical characteristics. Often

open public spaces and the urban furniture included in them tend to serve several purposes, be it by design or by customs. Thus, and coupled with the requirements by the weather, tend to be designed in an utilitarian, functional way, regardless of the physical and mental attributes of the citizens that attend to the place. They are designed in a very general, broad way.

Culture can be defined as a set of ways in which members of a society act, think and interact within a social contract (sometimes bypassing it). Open public spaces and the urban furniture included in them often act as a way to allow such interaction. The better known or designed is the space, the better is the participation of the people in such exchanges. However designers tend to overlook this and coupled with the tendency to form an idealized image of the human body, which in reality has diverse 'presentations' that means that a more universal design in required when it comes to open public spaces if a cultural exchange is to be carried out as expected. In Mexico, the National Human Rights Commission (CNDH for its acronym in Spanish) observes that there is a law of equality, which can be summarized as "no gender boundaries," denoting the inclusion of all citizens in the enjoyment of public spaces, regardless of age, sex or physical and mental abilities and this forms a universal right.

While there are numerous ways to specify the kinds of culture, several experts have classified according to two distinctive features: the definition and development of the same; in this regard discuss two classifications of culture that are taken up in the sense of promoting cultural exchanges in public spaces.

a.   Structural Culture: culture is understood as a set of symbols and
b.   Culture Symbolic thereof is formed from arbitrary granted significance, communicated and shared by members of a social group.

People without boundaries

For those elderly citizens enjoying retirement, spending their time is leisure activities should be a given; be tasting food, reading a book (eyesight allowing), enjoying nature or resting. This leisure time is a necessity for them. As such, leisure activities have to be considered while designing open public spaces. In some cases, even allow for supporting the treatment and rehabilitation of special conditions, physical disabilities, which is known as recreational therapy (Tapia, 2006). Well-being and healthy life are related with emotional welfare, and as such it is necessary to promote healthy emotions and harmony within the city (Tapia, 2006), creating an identity between people and space.

Conflict theory and the relationship with cultural exchanges

There are several elements that influence cultural exchanges and thus, impact on the identity of the space. From the analysis of these elements, identity is reconstructed, making designs that mean, take ownership and care of the space (residents); in turn, this will help to work with the community, responding to the needs, desires and expectations towards harmony, comfort, accommodation and proposed working together, reducing the potential for conflict. At times, design can help to reduce or increase conflict.

Johan Galtung, founder of the conflict theory (2003), considers that there are three levels of conflict:

a)   Direct Conflict, which is visible and concrete behaviours and responds to violence.

b)   The Structural Conflict, (the worst of the three), which focuses on the set of structures that do not allow the satisfaction of needs.

c)   The Cultural Conflict, which creates a legitimizing framework of violence and is based on attitudes.

The proposal is to design adequate public space to transform violence potential into peaceful potential in order to increase wellness and healthy living. This is related to emotional well-being, the ability to control emotions, to feel comfortable in harmony, which at times and with the way cities are designed, can be difficult. In order to develop better public spaces with this aim in mind it is necessary to listen to the needs of users. With adequate street furniture it is possible to change attitudes of the users in order to promote make cultural exchanges in healthy living manner, providing the ability to interact well with people and the environment, thus achieving satisfactory relationships (see F):
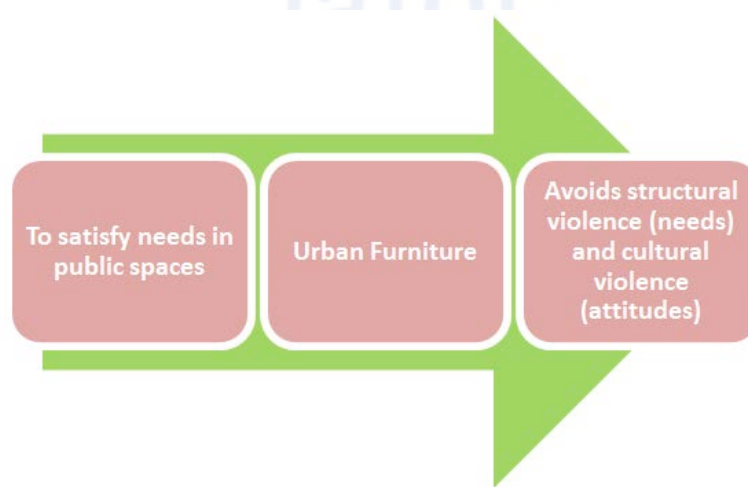
Figure 1. Conflict theory applied to inclusive design. (Galtung by Utrilla, 2014).

It is considered that those members of society that have access to appropriate social welfare can effectively integrate into their social environment. This is characterized by good relationships with others, a culture of solidarity and successful adaptations to the environment. The individual and collective behaviour will tend to take care of public spaces because they provide a cosy atmosphere (Tapia, 2006).

The proposal: Inclusive Design

The Inclusive Design definition used in this paper is a proposal that aims to respond in the first instance to the primary users, ie, residents of the nearby community open public space in question as it is part of everyday life, when used for outdoor activities. There is a methodological process created to implement this proposal, through the use of inclusive design applied in open spaces as well as urban furniture. Usually, when it comes to design, the final user is not involved in design decisions. However for public spaces, there is potential to create meaningful places; a mirror of their needs, desires and aspirations is dependant of creating a more inclusive, co-design system where the final user opinions and needs is necessary.

The proposal presented in this paper is to respond to this need through inclusive design. This must be a result of a closer participation both its relationship to public open space in order to increase the sense of the quality of personal relationships for the primary users. It is also necessary to study the particular dynamics of the space be it for cultural, artistic, everyday business or personal activities. The proposal is to show how the design may have a meaningful role of public spaces, enabling the participation of broad sections of users, generating solutions that narrow cultural exchanges including the participation of all potential users, and resume their views on the proposed design.

This proposal is based on four principles:

1. **Urban image.** Meet the evolution in terms of aesthetics and context of public spaces as well as the natural components (trees, bushes, etc).

2. **Inclusion.** Consider the feelings and opinions of residents who use the particular open public space, as well as detect the key informants to identify the real needs. Summarize their needs, desires and expectations in a design brief, without gender boundaries (elderly people, children, pregnant women, disabled).

3. **Identity.** Answer the needs of the community, ownership and management of green spaces while considering the cultural and historical identity of the space.

4. **To promote cultural exchanges.** Through the design, develop the open public space to promote cultural exchanges that increase the living standard, communication with others, recreation, pride in material culture and security.

In this regard it is necessary to emphasize the fact that everybody, regardless of their physical and mental abilities, age or sex should be able to use and enjoy the space and its included furniture. Design needs to put this into practice. The right to equality is a verb, not a noun.
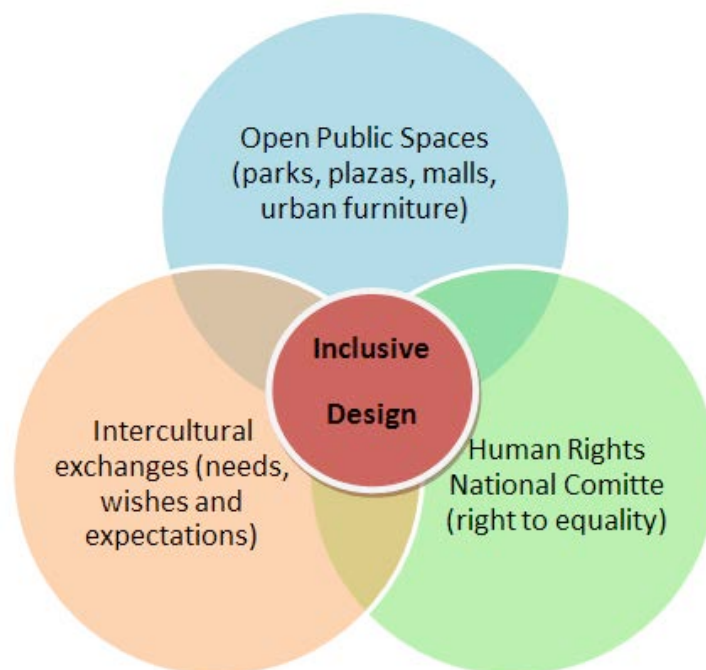
Figure 2: The proposal of inclusive design and rationale.

Inclusive Design applied in open public spaces to promote cultural exchanges

On the design of public open space, many elements are involved; therefore becomes a complex issue. The adequate universal design of public furniture is needed to create cultural exchanges, since they are some of the basic elements of the open space. The characteristics of the design will have to show a strong recognition of the local identity as well as awareness of the kind of regular users, spatial, cultural elements, in order to reassess their meaning and functionality.

The physical appearance of public open play an important role as a framework for different activities and therefore each significant element help to create patterns, behaviours, performances and expectations for each user, being often the scenario of leisure and various commercial and administrative business activities in a daily basis.

Public open spaces, such as parks, plazas, passage in addition to their respective street furniture are relevant for sustainable living, as they facilitate social interactions; provide moments of recreation, they are symbolic in the sense of bringing people together and enable the development of local cultural identities. However, during the design of these spaces, especially in developing countries like Mexico, there are other aspects to keep in mind that often gets overlooked: aspects such as accessibility, inclusive design and environmental impact.

As product designers, images and urban spaces have a responsibility to treat all members of a community, regardless of age, gender, culture or capabilities. That is, to develop a truly inclusive design which takes into accounts the diverse needs of the community (e.g., physical, ergonomic and interaction) within its social, cultural and historical context to provide meaning and purpose.

There is a lack of understanding on how different sectors of the population interact in such spaces, according to the physical abilities (such as the case of elderly people, pregnant women, children, etc.). That is why it is important to design street furniture to the human scale in the diversity of users that should go to them, and because they are not taken into account all these wide range of groups, no longer a scenario where some social groups do not go for not responding to their anthropometric, physical, or comfort.

This work is the result of a research project in progress; the intention is to reflect and bring about the generalities of inclusive design, particularly the elderly population. The application of the study is performed in Constitution, which is located in the historic centre of the city of Toluca, State of Mexico.

What is meant by cultural exchanges?

People employ space as a way to meet individual needs and vital relationships with others; design should be used to facilitate mobility and access to public spaces in everyday life. In indoors spaces, such as households, where personal, individual and personal exchanges of individuals that live there take place in somewhat of a 'forced' basis, to some degree make changes to housing for its inhabitants to have some independence develop, prevent assistance, are designed from a style and on behalf of those who inhabit it needs.

On the other hand, in public spaces, interaction between people is optional as it depends on the spatial distribution of spaces and urban furniture. Another fact is the identity of the place. It the location lacks identity, then nothing of transcendence for the users will happen.

For designers it is necessary to find the right contextual conditions for people (regardless of physical or mental conditions) in order to improve the experience and facilitate cultural exchanges. It is necessary to ensure the inclusion of people by providing good, inclusive design. This inclusive design aims not only meet the particular needs of the disabled, but also improve the experience and facilitate cultural exchanges.

The quality of life spread depends largely on the environment in which daily life, the conditions in which the basic needs of life are met, belong to a group develops. Public spaces are a resource available for people to enjoy and generate an identity; their layout must facilitate cultural exchanges, understanding those values, beliefs and behaviours that take place on them.

Case study: Constitution Passage in Toluca, State of Mexico

The case study being carried out in the current research project is in the Constitution Passage in Toluca, State of Mexico. In Toluca's downtown walking is the best way to go, mainly due the excessive traffic. There are several routes to transit streets and cultural and tourist attractions available. Constitucion Passage (or 'Los Portales' as it is known by the local population), could be considered portals the first major civil works for the city of Toluca, with the first arches on it being built in 1832 and subsequently adding other sections to form a set of 118 arches. Over each arch comes

a balcony. The height is 11 meters on average. This gallery of arches, the largest in Mexico, has always harboured antique shops and restaurants with the typical flavour of the city (for a while was also host to the first departmental shop of the city. Cultural exchanges in this space, immersed in the historical centre, suffer from a complex and changing system requirements, but lacks identity; due undergoing several design changes in the past century.

To the authorities of the Directorate General of Public Works (2011), Passage Constitution is considered space where people walk towards other destinations so that the design responds to a fast and fluid movement to prevent chaos. But as shown in Figure 3, the Constitution Passage, when undergoing its latest redevelopment, had no street furniture, the space shown desert, killing any potential interest in one of the most historical sites of the city (one of the few standing to this day), while it could very well be a space that calls for social and cultural exchanges.

Figure 3. Constitution Passage. The lack of street furniture denotes distress and lack of cultural exchanges.

Part of the actions taken in the place, reconstruction and renovation of public spaces, arises from the dynamics and activity that aimed to modernize, the first action that took place was in the year 2009. Upon completion of the renovation, urban benches arranged transversely with respect to the Constitution Passage as seen in figures 4. It has to be noted that the local government changes every three years, each one with its own vision on how the city should look, which ends in constant changes affecting the identity and functionality of the place.

Figure 4. Modified arrangement.

In February 2014, Toluca became the safest city in the world, while it watched deploy hundreds of members of the secret services of the United States, the Mexican Army, the General Staff, Canadian guards and state security, distributed throughout the capital in parks, buildings and squares of the city. This as part of the preparations for the holding of the Summit of the Leaders of North America, with the assistance of US President Barack Obama, Canadian Prime Minister Stephen Harper and Mexican President Enrique Peña Nieto. The result of this was a new wave of redevelopment, most noticeable transformation in terms of its urban furniture. The arrangement of the urban seats moved parallel to buildings Constitution Passage (the current state) as shown in photo 3.

Figure 5. The current design and place of the urban furniture in Constitucion Passage, while allows for fluid pedestrian traffic, it doesn't allow cultural exchanges

Regarding facilitating cultural exchanges, the current design of the seats becomes uncomfortable and inappropriate: it does not provide the opportunity to talk with other users and as shown in figure 6, it lacks adequate ergonomics, making them uncomfortable not suitable for the elderly.

Figure 6. The current urban furniture does not meet the needs of elderly people.

The objective in the project being carried out in Constitucion Passage by designing an urban bench is to design urban furniture that meet the physical needs of the users and aiming to implement an appropriate design that promotes cultural exchanges, helping to avoid conflicts and provide people, particularly the elderly, with a place to rest and socialize. But this requires a deep observation and analysis, as Johan Galtung says in his theory of Conflict: "Failure to observe this all involves a limited perception of the conflict and can lead to management Bad of it ... if there are contradictions, there is the risk of intensifying the hatred and violence ... to transcend conflict, first: fundamentals thereof: Dialogue "(2006).Dialogue with the users help to understand their needs and through inclusive design, conflicts of public space are transcended.

Conclusions

It is possible to use Inclusive Design as guide to develop open public spaces, increasing the possibilities of participation of all kinds of users, developing solutions that improve cultural exchanges. As well it can help to ensure the needs of all members of a community and allow for better quality of life between the people and their city.

One of the key points to attend is the design of urban furniture, so it can attend issues such as maximum capacity, physical abilities of the local people as well as the local context. Also, a good design can help to improve social relationships and in a best case scenario, help to increase a wellness environment that reduces potential sources of conflict as well as ensure the right to equality, including people of different abilities, without border gender (elderly, pregnant women, children, etc.).

Co-design, is the best way forward to create open public spaces, taking in account the opinion, participation and feelings of the users and the local councils, developing a more humane, holistic proposal of open public spaces. That incorporates artistic, cultural, social, economic and political aspects.

Designers need to develop the abilities and knowledge to:

•   Promote the culture of care and respect for human rights of people regardless of gender, age, sex, disability.
•   Create opportunities for inclusion aimed at people with disabilities.

•   Promote educational, employment, social and cultural opportunities that encourage participation and full inclusion of people with disabilities.
•   Encourage the development of skills and competencies of people with disabilities in the process of social inclusion and integral development

Finally, more research needs to be carried out, in particular, applying these concepts into more practical cases to develop a body of research robust enough to create a more flexible, universal theoretical framework that can be transferred to other cities and countries.

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Examination of Power Consumption Behaviors of Electronic Office Equipment for Commercial Buildings

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Abstract
In this paper, the power consumption behaviors of electronic office equipment are investigated. In order to study the load forecast, transformer load management and feeder load management problems in detail, the power consumption characteristics of electronic office equipment and user behaviors should both be taken into account. By using the proposed procedure, the power consumption behaviors of classical electronic office equipment can be simplified into several mathematical models. According to power consumption behaviors of electronic office equipment and daily life schedules of users, the daily load demands curves of electronic office equipment can be restructured. Furthermore, the daily load demands curves can be effectively used to evaluate the power consumptions of electronic office equipment for commercial buildings. The outcomes are of value to power companies to plan the power dispatch of the entire power system, and to promote the sustainable development policies.

Keywords: Commercial buildings, daily load demand curves, electronic office equipment, power consumption behaviors, power dispatch.

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1. Introduction

The efficient use of energy resources has become an essential element for rapid progress of industry and commerce. Most energy resources used by people are derived from nature. For a long time, the harmony between human and nature has been maintained. The human population has increased markedly since the industrial revolution. The demands of energy resources become more and more obvious. However, the use of natural resources has a significant effect on the environment.

Taiwan is a mountainous island situated in a subtropical zone. It depends on imports for approximately 97.9% of primary energy (Chan, Yang, Hsu, Chien, & Hong, 2007). Nowadays, the applications of solar power, wind power, biomass power, geothermal power, small hydro power, tidal power and other renewable energy generation are continually promoted in Taiwan. On the other hand, the problems caused by the use of energy resources can be divided into three parts: (1) energy production, (2) energy transmission, and (3) energy consumption. As well, the power consumption behaviors of office equipment are all taken into consideration in the proposed assessment system.

In 2001, the electricity consumption in residential sector was about 26% of the total electricity energy used in Sao Paulo State, Brazil (Mariotoni & Santos, 2006). In 2004, the residential electricity consumption was about 29.24% of total electricity consumption in the EU-15 (Atanasiu & Bertoldi, 2008). In addition, the residential energy consumption in the UK has consumed 28% of the total energy use, and the residential energy consumption in the USA was 22% of the total energy demand (Perez-Lombard, Ortiz, & Pout, 2008). In 2006, the residential and commercial energy consumptions in Malaysia were 13.6% of total energy use (Al-Mofleh, Taib, Mujeebu, & Salah, 2009). In Taiwan, the residential sector consumed 44.4 billion kWh in 2011, which equivalent to 18.33% of the total energy consumed ("Energy Statistical Annual Reports," 2012). Residential electricity consumption in Taiwan is shown in Fig. 1.
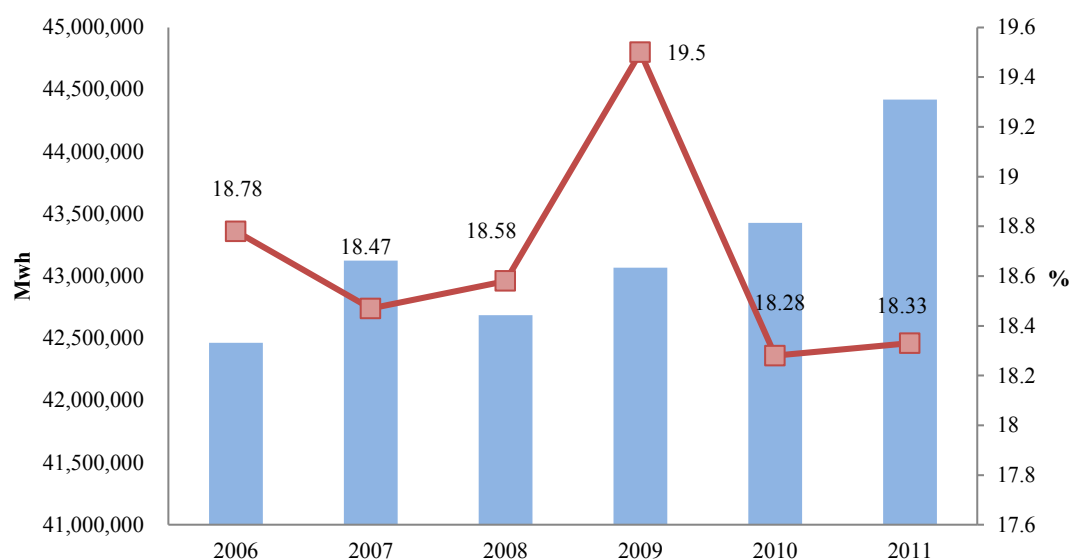
Fig. 1. Residential electricity consumption in Taiwan

To improve the energy efficiency of power systems, an effective method for evaluating energy losses is imperative (Chen & Yang, 2010). The existing energy loss estimation methods can be used to assess energy losses in large systems in a precise way, but they are not suitable for estimating the annual energy losses in branch circuits or feeders of households or buildings (Mikic, 2007).

In commercial buildings, a large number of office equipment often are connected with branch circuits. Because the power consumption behaviors of the electrical office equipment may change time to time, they may have a considerably effect on the accuracy of energy loss evaluations for low-voltage power distribution systems. In low-voltage distribution systems, especially in branch circuits or feeders, the system topologies and power consumption behaviors of each load should therefore be reflected. Unfortunately, the existing probabilistic energy loss estimation methods cannot take into account the real characteristics of the small load variance in low voltage distribution systems.

In order to overcome the problems mentioned above, an effective assessment system is proposed to evaluate power consumption behaviors of electrical office equipment. After performing the proposed assessment system, a set of daily load demand curves for each kind of office equipment can be obtained. Therefore, the energy consumptions in low voltage distribution systems can be evaluated in detail.

2. Framework for assessment system of power consumption behaviors of office equipment

Because of a large number of office equipment that must be served, it is not possible to simultaneously monitor the usage of all office equipment. For the same kind of office equipment with different rated capacities, their power consumption behaviors can be considered alike. To evaluate the electrical power use for each end user, the power consumption patterns for typical office equipment should be dominated.

In this paper, many sets of daily load demand curves are used to represent the power consumption behaviors for all kinds of office equipment. To consider time-to-time, day-to-day, and season-to-season changes in the electrical load patterns of office equipment, sixteen daily load demand curves are used to represent the active and reactive consumption behaviors for each kind of typical office equipment. In other words, the electrical load patterns of office equipment are different from weekday to holiday and from season to season. During the same season and for the same kind of office equipment, the daily load demand curves used for weekday and holiday are different. The schematic diagram of the proposed assessment system for the power consumption behaviors of office equipment is shown in Fig. 2.
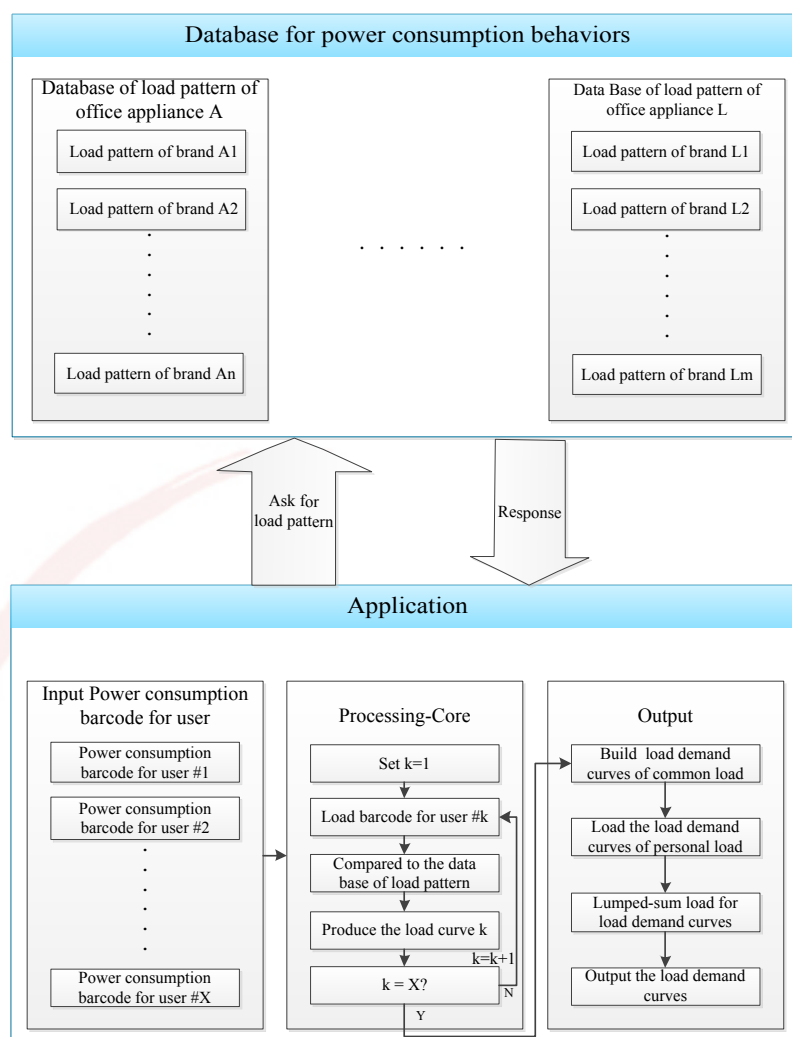
Fig. 2. Scheme of assessment system for power consumption behaviors of office equipment

The solution process of the proposed assessment system is described below, step by step.

Step 1. Measure the power consumption behaviors of all kinds of electrical office equipment by using a power quality analyzer.

Step 2. Disassemble the load patterns of each kind of electrical office equipment, and then building the database for typical office equipment.

Step 3. Recode the user behaviors for different seasons and times, and then representing the energy usage patterns of end users by the barcodes of user behaviors.

Step 4. Scan the power consumption barcodes for end users, and then combining the barcodes of user behaviors and database of typical office equipment.

Step 5. Build a set of typical daily load demand curves for energy usage patterns.

2.1 Database for power consumption behaviors of various office equipment

According to the power consumption characteristics of office equipment, the load patterns of office equipment can be divided into several categories. In other words, the load pattern of an office equipment is composed of a small number of power consumption scenarios. In general, the power consumption characteristics of office equipment can be distinguished into 4 scenarios: (1) shutdown mode, (2) low load demand mode, (3) middle load demand mode and (4) high load demand. In this paper, Fluke 43B power quality analyzer, shown in Fig. 3, is used to monitor the power consumption behavior of each office equipment.

Fig. 3. Measurement circuit by Fluke 43B

As shown in Fig. 4, the real power consumption of the computer is shown by the black solid line. According to the power consumption characteristics of office equipment, the load pattern of the computer can be divided into 4 scenarios: (1) shutdown mode (colorless), (2) low load demand mode (pink), (3) middle load demand mode (green), and (4) high load demand mode (purple). Because of the space limitation, only the power consumption behaviors of typical office equipment are shown in Table 1.
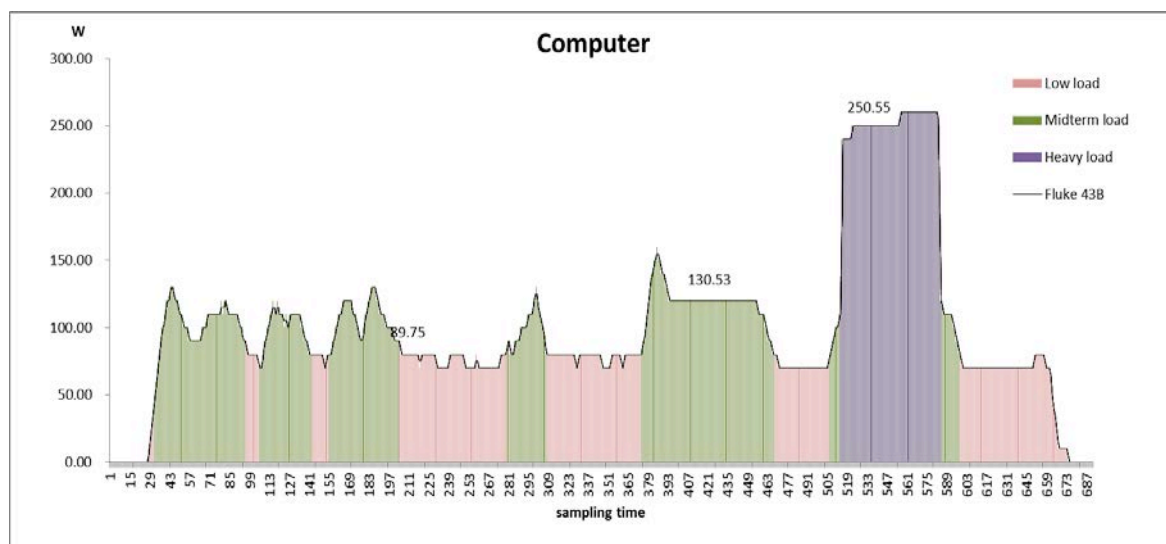
Fig. 4. Real power consumption curve of computer measured by Fluke 43B.

Table 1 Power consumption behaviors for typical office equipment.

Item	Power Consumption Behavior		
	Low load demand	Middle load demand	High load demand
Intel Computer	P=89.75W Q=21.35Var	P=130.53W Q=30.43Var	P=250.55W Q=57.48Var
3M table lamp	- -	- -	P=19.87W Q=19.87Var
Delonghi coffee machine	- -	- -	P=396W Q=21.62Var
Tatung refrigerator	- -	- -	P=97.67W Q=130.31Var
Hp printer	- -	- -	P=235.38W Q=104.32Var
TOA fluorescent (*24)	- -	- -	P=960W Q=168Var

2.2 Barcode for user behavior

The barcodes of user behaviors are used to represent the energy usage patterns of end users. As can be seen from Fig. 5 and Fig. 6, the load types of office equipment can be divided into 2 groups: (1) personal load and (2) common load. The computers and table lamps belong to the first group, the personal load. The refrigerator and coffee machine are included in the second group, the common load. As a result, the power consumption barcodes can be divided into 2 user behavior pattern barcodes: (1) personal load barcode and (2) common load barcode.
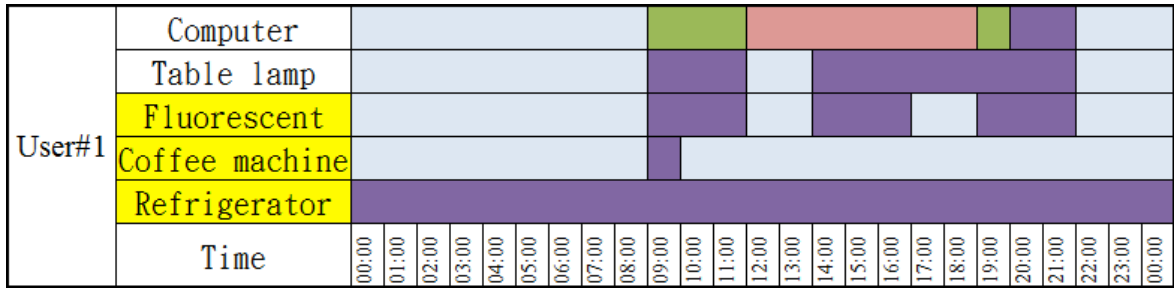
Fig. 5. Power consumption barcode for user #1
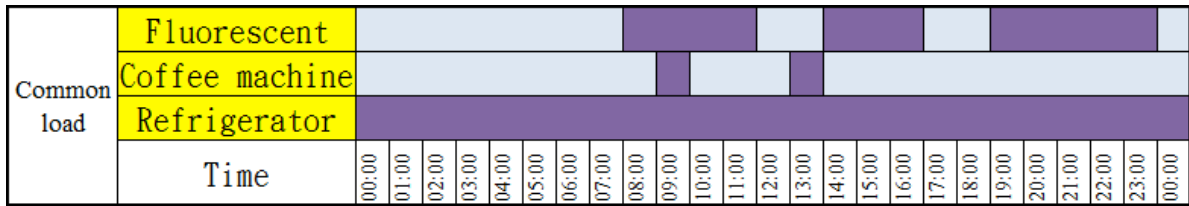
Fig. 6. Power consumption barcode for common load

2.3 Daily load demand curve for lumped-sum load

With application programs, the barcode for common loads can be built by reading the user behavior barcodes. After performing the decomposition and rebuilding process, the daily load demand curves of the common load can be obtained. The power consumption pattern of the personal loads and common loads can be shown in Table 2. Then, the daily load demand curves of the lumped-sum load, shown in Fig. 7, can be obtained by combining the effects of personal loads and common loads. The time interval of 15 min is adopted because most power companies have selected the same value. In other words, there are 96 time intervals in each daily load demand curve.

Table 2 Power consumption pattern of personal loads and common load.

		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
Personal loads of user#1	Computer	0	0	0	0	0	0	0	0	0	89.8	89.8	89	80	90	118.5	118.4	90	80	92	250.6	250.6	250.5	0	0	0
	Table lamp	0	0	0	0	0	0	0	0	0	19.9	19.9	19.9	0	0	19.9	19.9	0	0	0	19.9	19.9	19.9	0	0	0
Common loads	Fluorescent	0	0	0	0	0	0	0	0	0	960	960	960	0	0	960	960	960	0	0	960	960	960	0	0	0
	Refrigerator	88	90	90	91	90	91	90	89	88	90	120	90	91	90	122	90	80	90	91	90	90	90	92	91	89
	Coffee machine	0	0	0	0	0	0	0	0	0	396	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The daily load of active power(W)		88	90	90	91	90	91	90	89	88	1555.6	1189.6	1158.9	171	180	1220.4	1188.3	1130	170	183	1320.4	1320.4	1320.4	92	91	89
Time		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00

		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
Personal loads of user#1	Computer	0	0	0	0	0	0	0	0	0	21.4	22	23	20	21	30	31	20	20	21	57.4	56	58	0	0	0
	Table lamp	0	0	0	0	0	0	0	0	0	19.9	19.9	19.9	0	0	19.9	19.9	0	0	0	19.9	19.9	19.9	0	0	0
Common loads	Fluorescent	0	0	0	0	0	0	0	0	0	168	168	168	0	0	168	168	168	0	0	168	168	168	0	0	0
	Refrigerator	130	129	130	129	130	130	130	130	130	130	190	130	130	120	130	130	129	131	130	128	130	130	129	130	130
	Coffee machine	0	0	0	0	0	0	0	0	0	21.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
The daily load of reactive power(Var)		130	129	130	129	130	130	130	130	130	360.8	399.9	340.9	150	141	347.9	348.9	317	151	151	373.3	373.9	375.9	129	130	130
Time		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
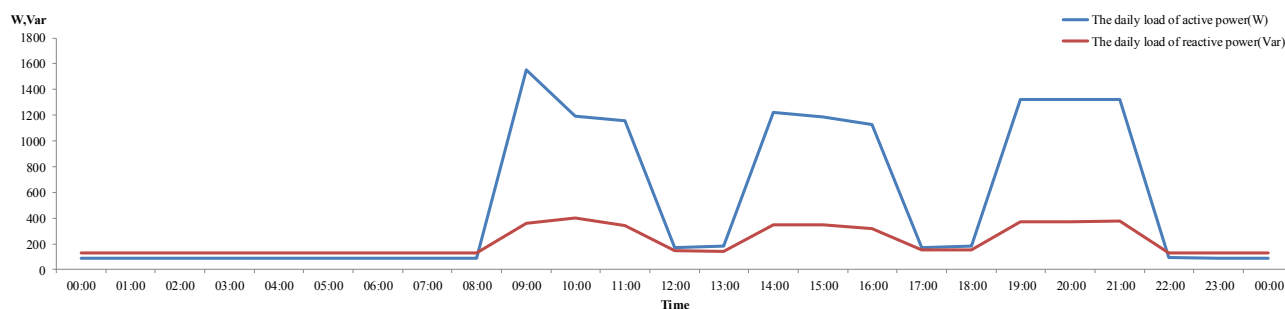
Fig. 7. Daily load curve for a lumped-sum load

3. Assessment system of power consumption behaviors of office equipment

In this paper, the proposed assessment system of power consumption patterns of electrical office equipment was developed in MATLAB R2010a software package. The graphical user interface (GUI) of the proposed system is shown in Fig. 8. The program execution is described as follows: (1) **Read user barcode:** The user barcode can be obtained by Excel files. (2) **Load Setting:** The brands of electrical office equipment can be selected by the drop-down menu. (3) **Output Daily Load Curve:** The daily load curves for end users can be output, as shown in Fig. 9.
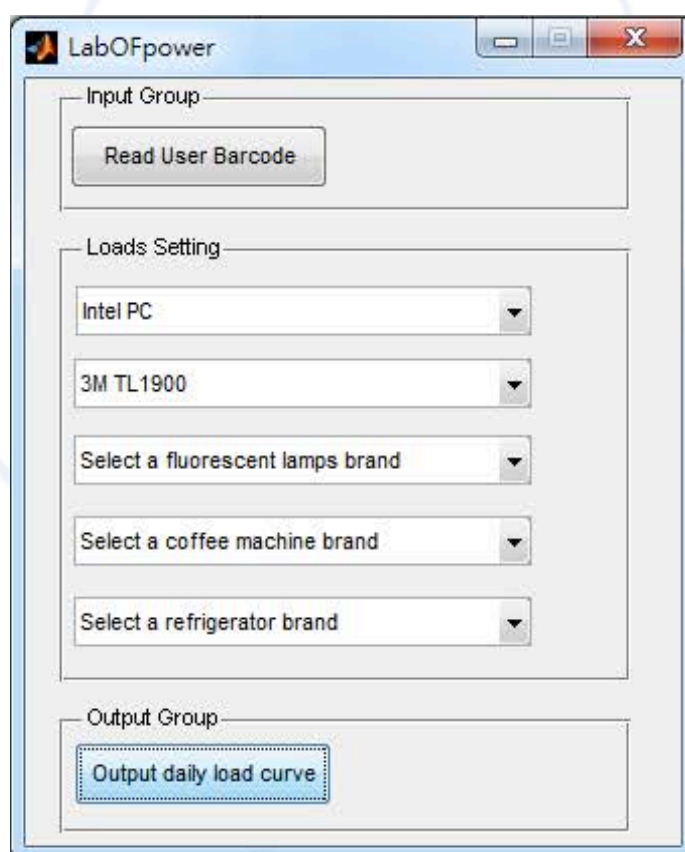
Fig. 8. GUI for the propsoed system.
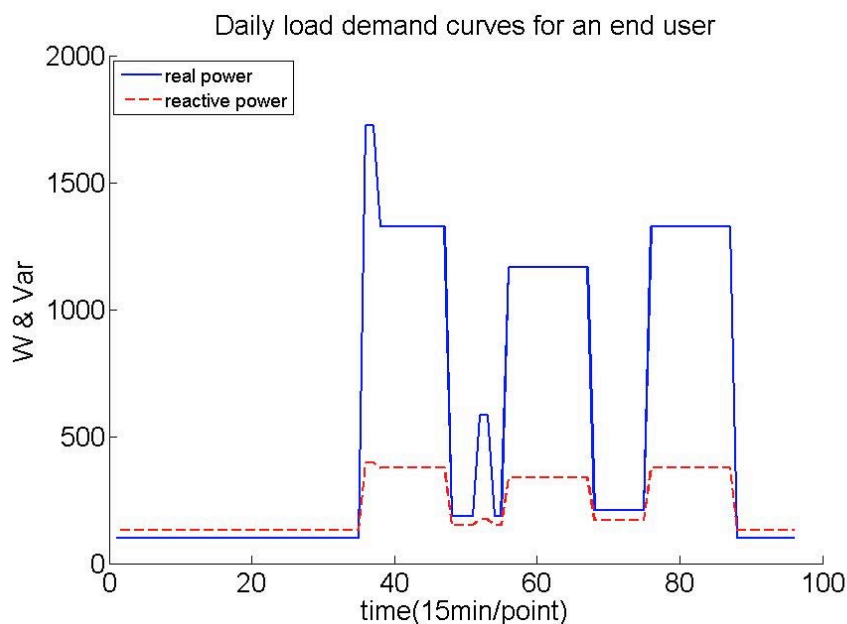
Fig. 9. Daily load demand curves for an end user.

4. Case study

The energy usage patterns of six end users in Yuan Ze University are adopted as a sample case to examine the use of user behavior barcodes. The user behavior barcodes of six end users are shown in Fig. 10. After performing the assessment system for power consumption behaviors of office equipment, the daily load demand curves of the personal loads can be obtained as shown in Fig. 11-16. After performing the decomposition and rebuilding process, the daily load demand curves of the common load can be obtained as shown in Fig. 17.

To avoid double counting of the effects of personal loads and common loads, the personal loads and common loads shall be considered separately. By combining the effects of personal loads and common loads, the daily load demand curves of the lumped-sum load can be obtained as shown in Fig. 18.

5. Conclusion

In this paper, the proposed assessment system was used to produce the daily load demand curves for the power consumption behaviors of electrical office equipment. In order to produce the daily load demand curves, the power consumption characteristics of office equipment and user behaviors are both taken into account in detail.

To reduce carbon dioxide emissions and to protect our earth, the efficiency of energy usage should be improved by coordinating the load demands and power generations. The outcomes are of value to distribution engineers to perform power dispatch, as well as to promote the sustainable development policies in Taiwan.

Fig. 10. User behavior barcodes for user #1 to user #6.
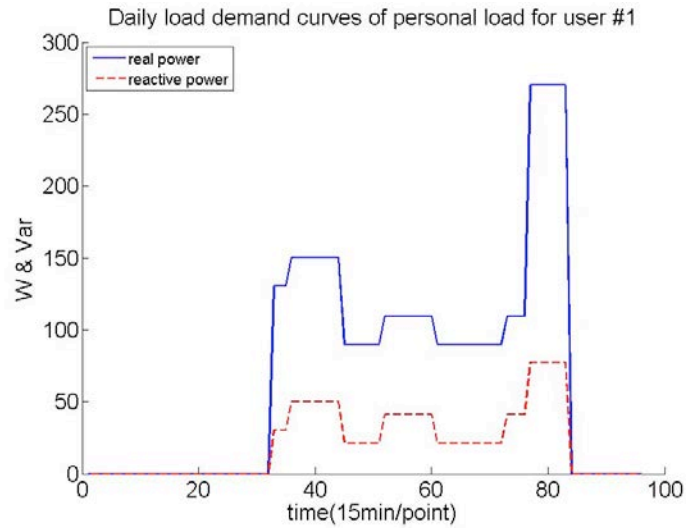
Fig. 11. Daily load demand curves of personal load for user #1.
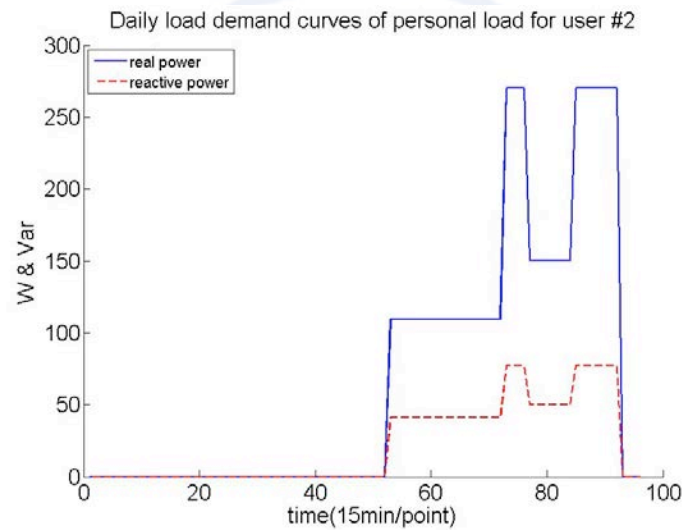
Fig. 12. Daily load demand curves of personal load for user #2.
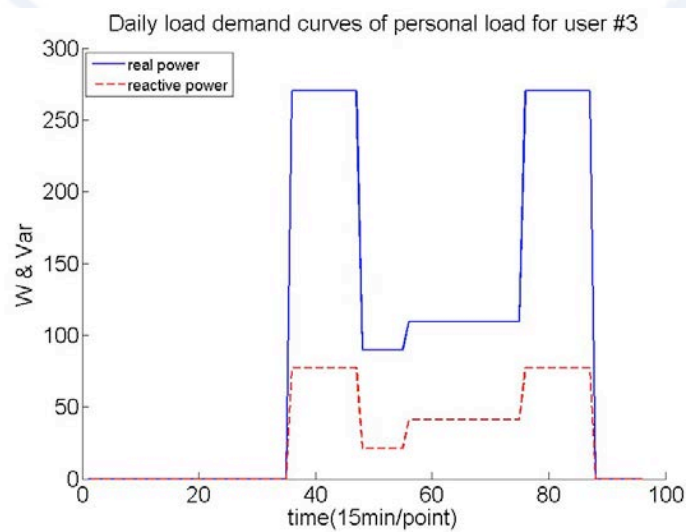
Fig. 13.   Daily load demand curves of personal load for user #3.
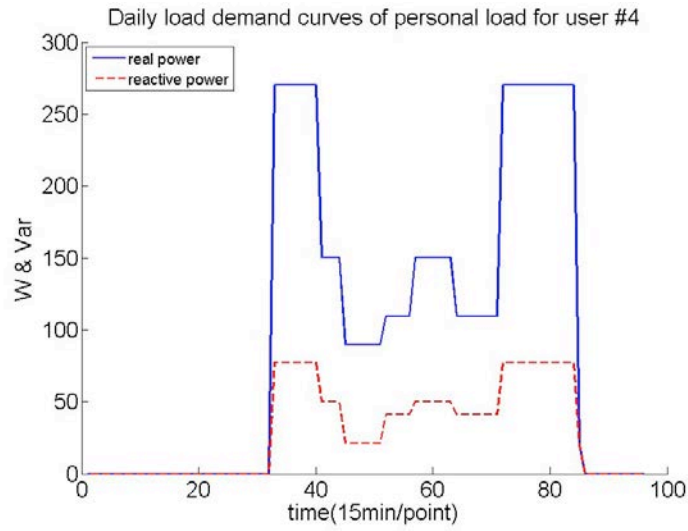
Fig. 14. Daily load demand curves of personal load for user #4.
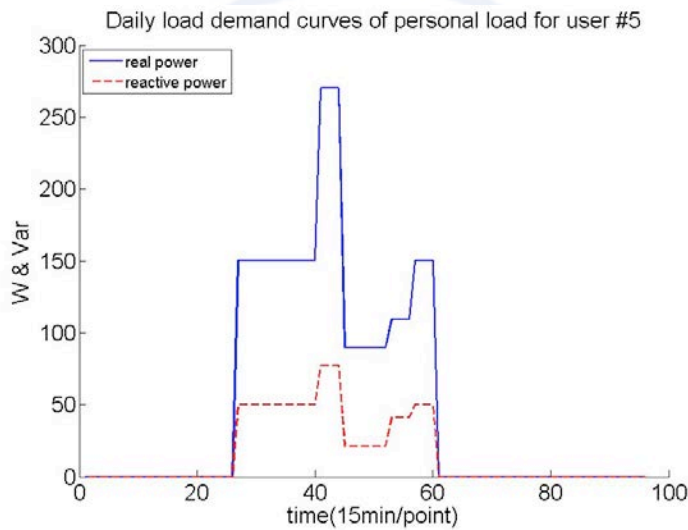
Fig. 15. Daily load demand curves of personal load for user #5.
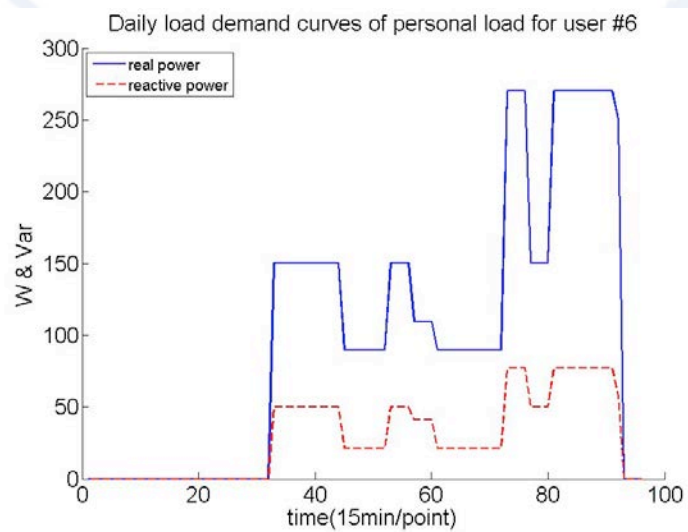
Fig. 16. Daily load demand curves of personal load for user #6.
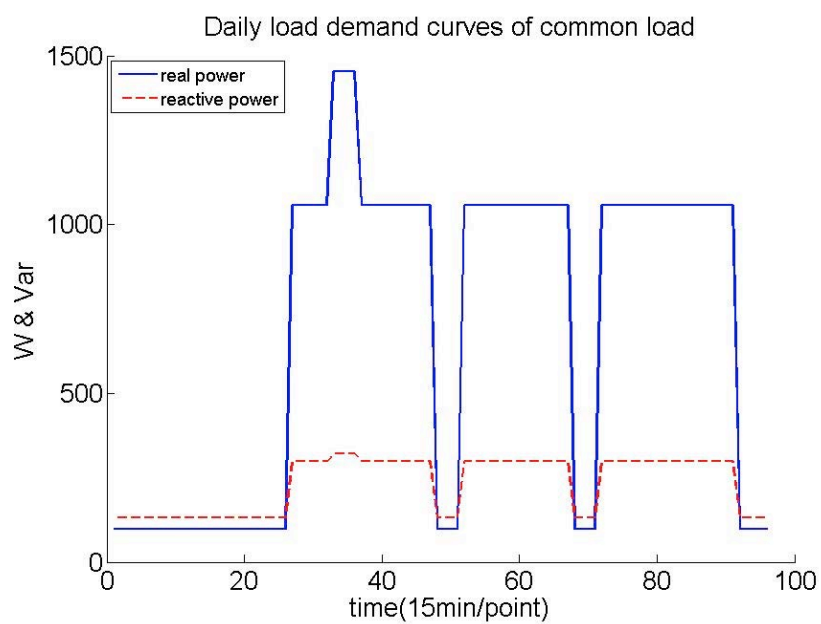
Fig. 17. Daily load demand curves of common load.
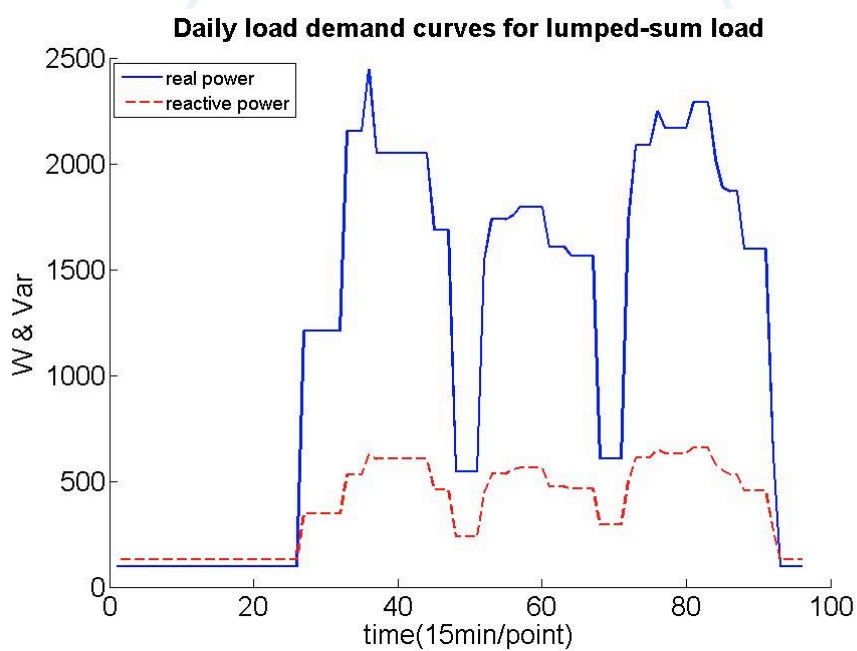
Fig. 18. Daily load demand curves for lumped-sum load

6. Acknowledge

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Thermal Reliability of Nano Cu-Paraffin Wax Phase Change Material as Thermal Energy Storage

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Abstract

Phase change materials (PCMs) as thermal energy storage medium are proven to be effective enhance the performance of solar thermal system. The degradation of the thermal properties due to thermal cycles is changeable and accordingly the performance of the solar thermal cycle may decline. In this study, the thermal reliability of paraffin wax and copper nanoparticles mixtures was investigated. The mixtures were subjected to 400 phase change cycles and the thermal properties were measured. Four samples have been prepared; two samples (Sample 1 & 2) were new one whereas two more samples (Sample 3 & 4) were gone through 400 phase change cycles. Sample 1 and 3 were pure paraffin wax, while sample 2 and 4 are mixture of paraffin wax with 1% of nano Cu powder. The added nano Cu powder were 20 nm sizes. 400 phase change cycles indicated the phase change cycle for 1 year 35 days as 1 cycle equivalent to 1 day. The comparison of samples with and without 400 phase change cycles showed slight changes in thermal conductivity, specific heat, melting point and solidification point. FT-IR and Thermogravimetric Analysis showed that after 400 phase change cycles there is no weight loss observed. After 400 phase change cycles, the paraffin wax and nano Cu paraffin wax was still reliable to use without any weight loss, without chemical reaction and thermophysical properties were improved.

Keywords: Copper Nanoparticles, Phase Change Cycles, PCM, Thermal Cycling, TES, Thermal Reliability

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INTRODUCTION

Organic PCMs such as paraffin wax, bee wax and fatty acids are widely used as thermal energy storage because of non-corrosive, no super cooling, chemical and thermal cycle stability compared to inorganics PCMs and eutectics. Inorganic PCMs have higher latent heat and thermal conductivity compared to organic PCMs but the super cooling and phase segregation help to decrease the latent heat value during the phase change [1]. Researcher [2] suggested chemical and metallic to be added to inorganic PCM to prevent the phase segregation and super cooling. However, these methods faced some challenges as metallic will eventually increase the weight penalty. Thus, the chemical used can modify the nature properties of inorganic PCMs.

Nanofillers such as nanoparticles, nanowire, nanographite and carbon nanotubes were introduced to improve the thermophysical properties, mechanical properties and flame retardation behaviour of organic PCMs instead of using metal particles, graphite, fiber and inorganic filler [3-6]. The mixtures of nanofillers into PCMs are called nanocomposites. Thus, the suspension of nano-meter sized particles dispersed in a solvent or liquid is termed as "nanofluids" whereas in the solid phase is also terms as "nanocomposites" [7]. Various nanofluids and nanocomposites have been reported mainly for enhancement in the thermal conductivity of the storage medium. The thermal conductivity of paraffin wax was enhanced by 35% and 40% when mixed with multi-walled carbon nanotubes (MWNT) by 1% and 2% respectively [8]. The researcher [9] doped 1% of carbon nanotubes (CNT) into acid based phase change material, the thermal conductivity enhanced by 30%. Another type of nanotubes that is halloysite nanotube reported enhancement of 59% of thermal conductivity when graphite and halloysite are added to paraffin wax with 60:35:5 percentages [10].

For further investigation of thermal properties, thermal cycling needs to be considered to test the thermal degradation and chemical reaction effect on the PCMs properties. Researcher [11] revealed that paraffin and form stable paraffin/PP blended composite have the same Fourier transform infrared spectra peak before and after 3000 thermal cycles. Researcher [12- 13] concluded that fatty acid esters have no effect on the thermal degradation and chemical reaction after 1000 thermal cycles for their application. Inorganic PCM such as sodium hydroxide, di-sodium borate, barium hydroxide and ferric nitrate are found to be not suitable for higher thermal cycling (1000 cycles) as high deviation from the quote and experimental properties measured compared to organic PCM [14]. Researchers [15-17] investigated the thermal stability of nanofillers added to PCMs but no investigation on thermal cycling was reported. It is found that organic PCMs have stable thermal cycling compared to inorganic PCMs.

In this investigation, copper nanoparticles (nano Cu) are dispersed into paraffin wax instead of using CNT to form polymer nanocomposite or nano phase change material. 20nm copper nanoparticles are chosen as it has a high thermal conductivity compared to aluminium and iron nanoparticles. This is the smallest copper nanoparticles were supplied by Dong Yang (HK) Int'l Group Limited. Small size of metal nanoparticles is an alternative choice compared to CNT as carbon nanotubes have been widely applied and used in many applications.

EXPERIMENT

In this section, experimental equipment's used to analyse the thermophysical properties and thermal cycling were explained. The procedures of preparing the samples also explained.

Experimental Instruments

a) Differential Scanning Calorimetry (DSC)

Melting temperature, solidification temperature, latent heat and specific heat of the samples were analysed by Pelkin Elmer DSC 1 device with accuracy of $\pm 0.1^oC$. 5 mg of the sample is tested at heating rate of $10^oC/min$ from 30^oC until 120^oC.

b) Thermogravimetric Analysis (TGA)

Boiling temperature, degradation point and weight loss percentage were observed by Pelkin Elmer TGA Q50 device with accuracy of $\pm 0.1^oC$. 10 mg of sample is tested at heating rate of 10^oC from 30^oC until 650^oC.

c) Fourier Transform Infrared Spectrometer (FT-IR)

An analytical technique to analyse chemical bonding, molecular structure and degradation effect of the sample. Infrared will be transmitted through the samples, the absorption and emission of wave length from the sample were observed. FT-IR Perkin Elmer device covered wavelength range 660 Cm^{-1} to 4000 Cm^{-1}.

Synthesis Procedures

Figure 1a and **Figure 2a** show the samples without mixing with Cu nanoparticles while **Figure 1b** and **Figure 2b** show the samples mixing with Cu nanoparticles (Nano Cu). Furthermore, the comparisons of samples without thermal cycles (Sample 1 and Sample 2) and with thermal cycles (Sample 3 and Sample 4) have been tested and elaborated in this paper. 20 nm copper powders were purchased from Dong Yang (HK) Int'l Group Limited. The 20nm copper nanoparticles were mixed with heated paraffin wax and undergone ultra-sonication for 1 hour to minimize agglomeration of Cu nanoparticles and obtain uniform dispersion of Cu nanoparticles in the wax. The samples are left for 4 hours to stabilize and solidified completely as shown in **Figure 2b.** Based on 1 hour ultrasonication, FESEM test observed reduction in particles agglomeration as suspension of Cu nanoparticles percentages increased. **Figure 2a** showed the Sample 1 prepared for paraffin wax without going through ultrasonication.

a) Sample 1 (S1)   b) Sample 2 (S2)
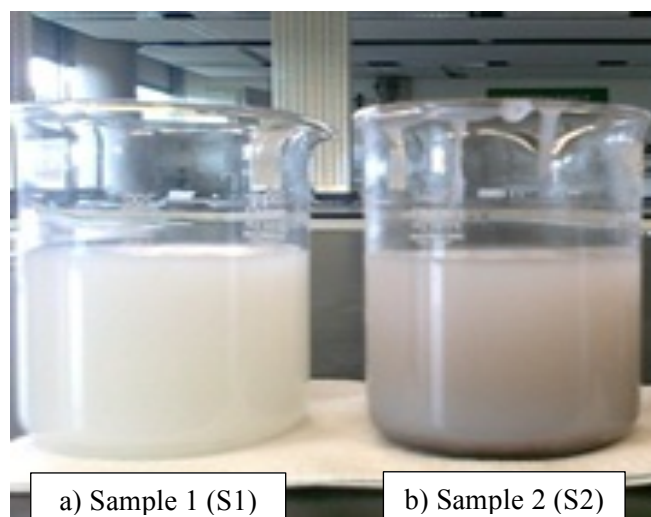
Figure 1: a) Sample 1(Paraffin wax) b) Sample 2 (Paraffin Wax with 1% Cu Nanoparticles)

After the synthesis of paraffin wax with Cu nanoparticles, the colour of white paraffin wax change to brown colour. Sample 3 was heat up until 70°C and cool down for 400 phase change cycles with stirring whereas Sample 4 is taken from the real experimental model for solar water heating that have been gone through 400 phase change cycles [18]. Sample 3 had changed to greenish colour whereas the sample 4 had changed to yellowish colour.

Figure 2: a) Sample 4 (Paraffin Wax 400 Cycles) b) Sample 3 (Paraffin Wax + 1% Cu Nanoparticles 400 Cycles)

RESULTS & DISCUSSIONS

TGA and FT-IR device were used to analyse the degradation of paraffin wax. Firstly, TGA analysis found that all the samples will start to vaporize at 200°C till 309°C. Only differences found for the boiling point after Cu nanoparticles were mixed. All

the samples showed the same curve trend. No significant different of weight loss for with and without 400 phase change cycles on TGA analysis. Thermogravimetric analysis (TGA) on all the samples was carried out with heating rate of 10^oC/min up to 650^oC. The results showed degradation trend of the paraffin wax with and without 400 phase change cycles were the same, as shown in **Figure 3.** However, small differences were observed in the starting and ending of degradation temperature. Degradation started at 205^oC, 206^oC and completely vaporized at 295^oC, $301\ ^0C$ for Sample 1 and Sample 3 respectively. A slight changes on the starting and ending of degradation temperature occurred after Cu nanoparticles was mixed. Degradation started at 208^oC, 211^oC and completely vaporized at 305^oC, 309^oC for Sample 2 and Sample 4 respectively. Starting from 300^oC, the weight percentage of all the samples were almost zero and left with oxidized Cu nanoparticles residues. Sample 3 and sample 4 showed the end of degradation temperature have shifted to more than 300^oC after phase change cycles applied. Phase change cycles and nano Cu added helped to increase degradation time with increase end of degradation temperature.
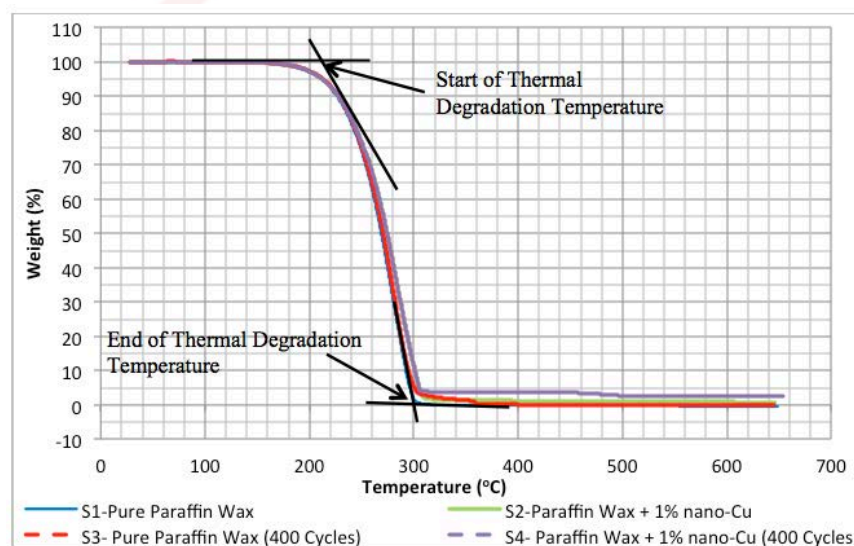
Figure 3: Weight Loss Comparison for PCM nanocomposite

Secondly, the result on the FT-IR analysis showed that the paraffin wax has no significant changes of wavelength peaks of the paraffin wax before and after the 400 phase change cycles for sample 1 and sample 3. Paraffin wax composed of $-CH_2$ and CH_3 bonding and it molecular formula is $C_{28}H_{58}$ [19, 20]. Two sharp strong peaks at the 2848 - 2958cm^{-1} shows that CH_2 and CH_3 molecules asymmetric and symmetric stretching vibration occur, two weak sharp peaks at 1462 - 1472cm^{-1} shows the CH_3 molecules deformed with in-plane and out of plane bending mode occur. Two weak peaks at 718 – 887 cm^{-1} for all the samples showed that paraffin wax molecules are on the vibration rocking mode as depicted in **Figure 4**.
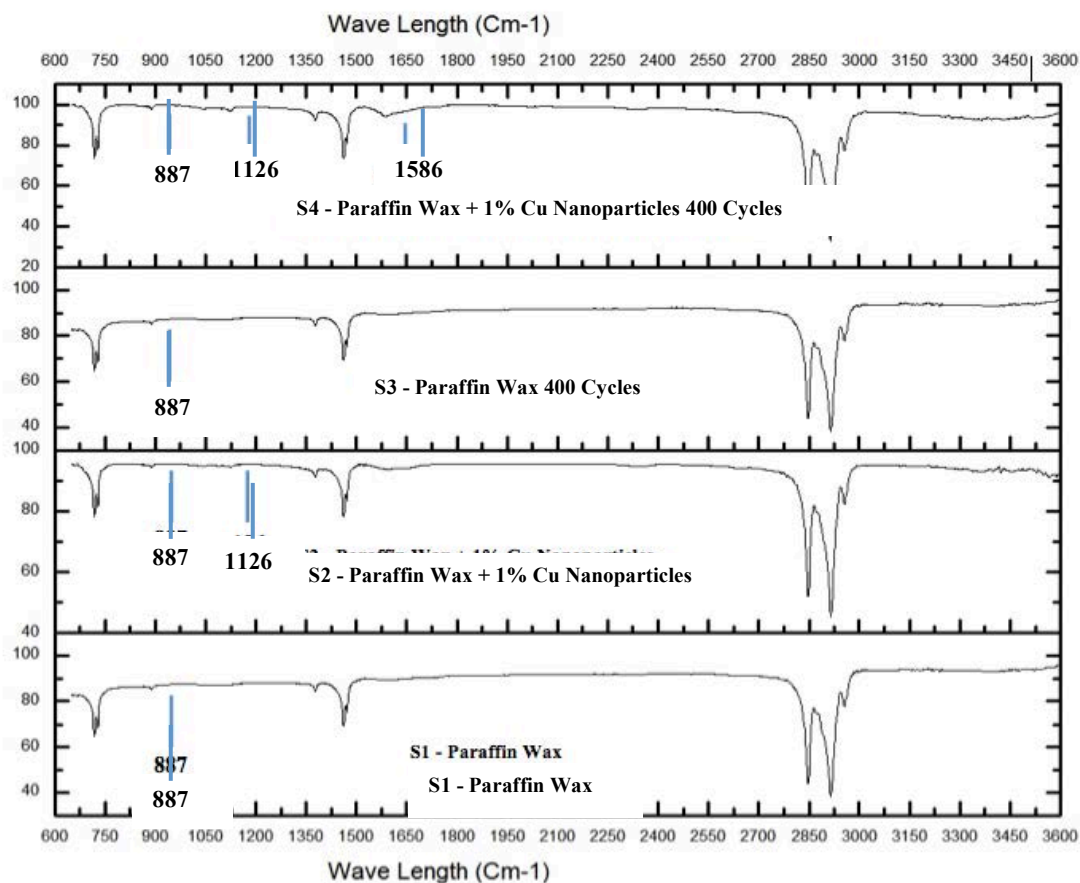
Figure 4: FT-IR Analysis on the Paraffin Wax

However, Sample 2 and Sample 4 showed small peaks appeared at 1126 cm^{-1} and 1586 cm^{-1} to prove that bonding between copper nanoparticles and carbon of paraffin wax exist. In the same time, the physical bonding of copper nanoparticles with paraffin wax exist does not disturb the chemical structure interaction for chemical stability since the FTIR absorption spectra are the same for Sample 2 and Sample 4. All sharp strong and weak the peak showed the same curve at the same wavelength for Sample 1 to Sample 4. The FTIR results shows that there is no thermal degradation effect happened for all the samples after 400 phase change cycles since the FTIR absorption spectra did not change for all the samples.

In this study, thermal properties and thermal cycling of paraffin wax was investigated. Sample 2 and Sample 3 that gone through 400 phase change cycles showed changes in the thermophysical properties. Sample 3 showed the great changes in the thermophysical properties because stronger bonding between Cu nanoparticles with paraffin wax are expected after 400 phase change cycles of heat treatment. However, only small percentages of Cu nanoparticles homogeneously mix with paraffin wax after 400 phase change cycles. Assistance of more ultrasonication hours needed as 1 hour of ultrasonication performed is not enough to reduce the agglomeration of Cu nanoparticles.

CONCLUSIONS

Phase change cycle act as heat treatment process to help to improve the thermophysical properties of mixture. After 400 phase change cycles occur, the more bonding interaction observed between Cu nanoparticles and paraffin wax results a new small peak appeared at 1586 cm^{-1} for the Samples 3 in FT-IR analysis. While a new small peak of 1126 cm^{-1} in Sample 2 and 3 showed a bonding interaction between paraffin wax with Cu nanoparticles when 1% of Cu nanoparticles added. Although the thermophysical properties of mixtures improved but the mixtures still does not homogeneously mix.

Thermogravimetric and FT-IR analysis results no thermal degradation and no chemical reaction occur after 400 phase change cycles performed as long as the temperature not exceeding 200°C. Latent heat and thermal conductivity showed improvement with phase change cycles for Sample 4 compared to Sample 2. Latent heat was enhanced by 6.91% and thermal conductivity was enhanced by 1.74% when compared to Sample 2.

However, more ultrasonication hours need to perform for the mixture to reduce all the agglomeration and settlement of Cu nanoparticles. Porosity of mixture reduced as Cu nanoparticles try to replace void exist to create a strong bonding mixture. Hence the mixture will become more compact, incongruent melt and solidify reduced and increased in thermal conductivity as well as thermophysical properties. This observation increased more research to be done on paraffin wax and Cu nanoparticles enhanced paraffin wax. Paraffin wax and nanoparticles-enhanced paraffin wax showed there is a wide opportunities to be used as thermal storage medium.

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An Economize Luxmeter for Data Logger

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Abstract

This research was aimed to develop an economize luxmeter for data logger. This luxmeter was designed in 2 types for measuring both of high illuminance and low illuminance. Both luxmeters were used the visible light detection photodiode as photometric sensor. Its spectral sensitivity was similar to the human eye. The photodiode was converted light into an electrical current. The load resistance was connected in parallel with the photodiode in order to convert the current into a voltage. The body of luxmeter was constructed using PVC tubes. The four layers of an aperture, i.e., a diffuser, a translucent blue plastic, a translucent green plastic, and the photodiode were assembled in the PVC tube. The acrylic plastic diffuser was spread and diminished the light flux. This light flux was filtered with the translucent blue plastic and the translucent green plastic. The results revealed that the developed luxmeters could be used for data logger, the intensity of the illuminance agreed with that of commercially standard luxmeter with the correlation of about 0.98 and error less than 6.7%. The high and low illuminance luxmeters could be measured of a maximum illuminance at about 60 klx and 10 klx, respectively. A sensitivity of the developed luxmeters was obtained closely to the commercially standard luxmeter at 0.2 µV/lx of the high illuminance luxmeter, and at 0.8 µV/lx of the low illuminance luxmeter. In addition, the cost of developed luxmeter was approximately 100 times cheaper than that of the commercially standard luxmeter.

Keywords: Photometric sensor, illuminance sensor, luxmeter

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Introduction

The accumulation data of physical quantities are needed in research in science and technology. The measuring systems are importance to support the obtained data. There are two kinds of physical quantities measuring systems, i.e., measuring system and measuring plus controlling system. The first system can be divided into two types, i.e., measuring plus indicating system, and measuring plus recording system. Each system has its advantages and limitations. The measuring plus recording system is important for research and development. It can measure and record the acquired physical quantities automatically, which makes it easy to use this measuring system. It also reduces time and labor to record the physical data. However, the price of this measuring system is relatively high. Thus, it makes a limitation on the research and development of the developing country.

The measuring plus recording system of physical quantities contains two parts, i.e., a sensor, and a data logger. The data logger is a physical quantities recording device. Its can be enumerated to two types, i.e., stand-alone data logger, and computer-base data logging system. The first type, the acquired data will be stored in the memory by its self- controller. The second type is incorporated with the data acquisition device (DAQ), computer, and software. Therefore, the data is saved into the hard drive of computer.

The physical quantities are measured in several forms such as temperature, humidity, heat transfer, light, radiation, voltage, current, power and energy. The amount of light is necessary to measure and control its level that will suitable for various activities in building. Thailand is located in the tropics where most parts of the country receive the highest global illuminance in the summer month especially in April, with a monthly average of hourly values of about 80-100 klx, whereas 44.1% of the total area of the country receive the yearly average of hourly illuminance in the range of 75-80 klx. The areas, which receive the highest global illuminance, are in the middle part of the central region of the country and the lower part of the south (Janjai, 2004). Therefore, there is a need to study the day lighting in order to find the way to reduce the usage of fossil energy.

The maximum demand in Thailand was approximately 26,121 MW in 2012, which it was increased 368% from 1990, while the rest of power generation was approximately 6,169 MW (EGAT, 2013). Thailand has a 15 years renewable energy development plan (2008-2022) to increase the usage of renewable energy up to 20.3% of the total energy usage in 2022 (DEDE, 2008). Thailand has enacted an act for promotion of energy conservation since 1992 (Ministry of Energy, 1992). The royal decree on designated building and a set of ministerial regulations was enacted in 1995 (B.E. 2538) (Ministry of Energy, 1995a; Ministry of Energy, 1995c). The law mandates issuance of ministerial regulations for energy conservation in large commercial buildings. Thailand's building energy code was gazetted and implemented on new and existing large buildings (Ministry of Energy, 1995b). The code comprises mainly of performance-based requirements on building envelope system, lighting system and air-conditioning system. The earlier study found that the electricity consumption of a commercial building in Thailand concerning air-conditioning and electric lighting was typically accounted for 50-60% and 20-30%, respectively (Chirarattananon, 2005).

According to the aforementioned electricity consumption, if buildings reduce the lighting energy consumption, it will result in an increase energy efficiency of the building. Thus, there are many researchers doing research on the lighting and the day lighting, which is necessary for energy conservation. There is a need to study the luxmeter as a necessary sensor for the energy conservation, but it has to be imported from abroad and it is very expensive (1,200 to 1,600 USD). A preliminary study on the luxmeter from technical data of imported luxmeter is obtained from the luxmeter that developed from a photodiode. The photodiode has the wavelength response of 350 to 820 nm, which covers wavelengths of human eyes and it is also available in Thailand. Thus, the objective of this research was aimed to develop an economize luxmeter for data logger, which was expected to acquire the illuminance level with an efficiency equivalent to those of imported sensors.

Materials and Methods

The modification of a luxmeter

A luxmeter is a photometric sensor or illuminance sensor, which is used with a data logger for measuring an intensity of the light. Two types of luxmeters were designed for measuring of the high illuminance and the low illuminance. The commercially available of high illuminance luxmeter could be used to measure a maximum illuminance at approximately 150 klx with 280 Ω of internal resistance. The commercially available of low illuminance luxmeter could be used to measure a maximum illuminance at approximately 30 klx with 1.2 kΩ of internal resistance. Both luxmeters gave a maximum voltage output at approximately 30 mV with a spectral response in CIE photopic curve. The visible light detection photodiode was used as photometric sensor, where the spectral sensitivity was similar to the human eyes, as shown in Fig. 1.
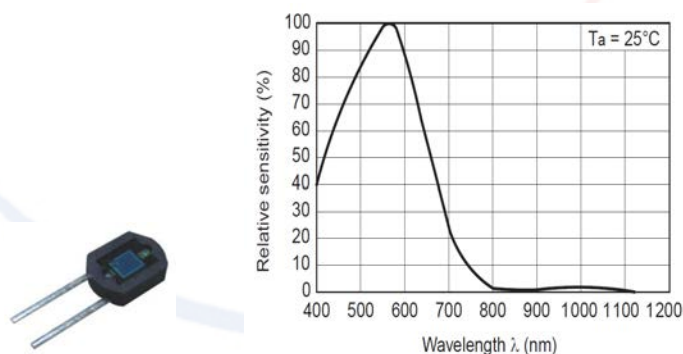
Figure 1. Showing the BS520E0F photodiode and its spectral sensitivity (Sharp, 2007, p.p. 1-4).

The photodiode was fabricated from semi-conductor, and it must have a significant field of junction ($\vec{E}$) in order to efficiently separate the created photo carriers. The diode must be polarized in reverse (François, 2007, p.103), as shown in Fig. 2.
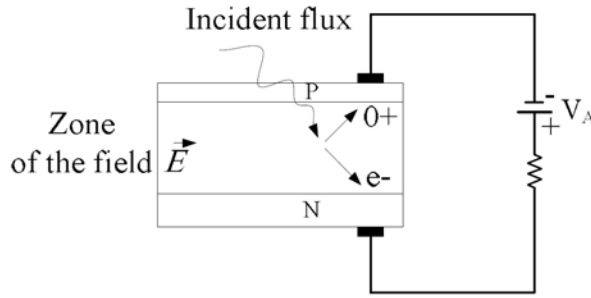
Figure 2. Showing the schematic diagram of a photodiode (François, 2007, p.103).

The photodiode could be represented by a current source in parallel with an ideal diode as shown in Fig. 3. The current source represented for the current that generated by the incident light flux, while the diode represented for the p-n junction. The values of a junction capacitance (C_j) and a shunt resistance (R_{sh}) were in parallel with the other components. The shunt resistance was used to determine the noise current in the photodiode with no bias (photovoltaic mode). A series resistance (R_s) was connected in series with all components in this model in order to represent the resistance of the contacts and the resistance of the undepleted silicon (OSI optoelectronics, n.d., p.3).
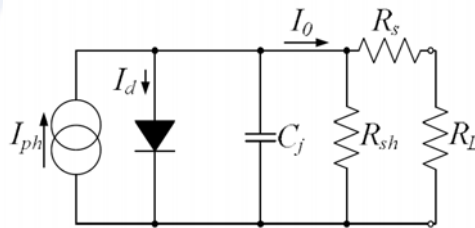
Figure 3. Showing a equivalent circuit for the silicon photodiode (OSI optoelectronics, n.d., p.3).

The photodiodes could be used as photoconductors with a reverse bias or as photovoltaic sources without bias as shown in Fig. 4. This study was used the photodiode in photovoltaic mode.
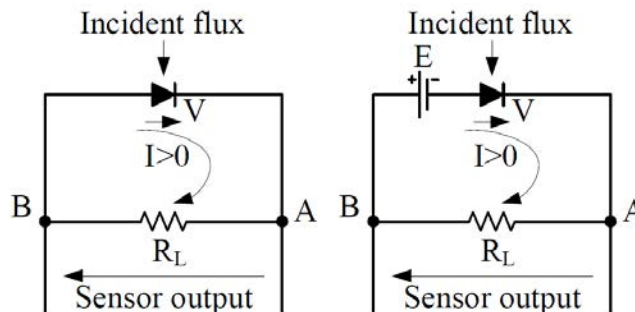
Figure 4. Showing the photovoltaic and photoconductor modes (François, 2007, p.105).

A circuit of developed luxmeter is summarized in Fig. 5. The load resistance was connected in parallel with the photodiode in order to convert the current to the voltage signal.
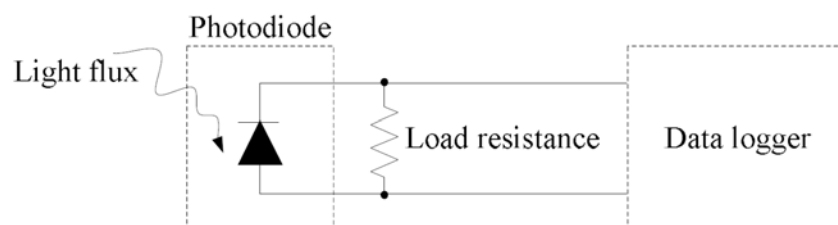
Figure 5. Showing a circuit of a developed luxmeter.

A structure of the developed luxmeter was modified from EKO (2009) as shown in Fig. 6. The four layers of an aperture, i.e., a diffuser, a translucent blue plastic, a translucent green plastic, and the photodiode, were assembled in a PVC tube. The acrylic plastic diffuser was spread and diminished the light flux. This light flux was filtered with the translucent blue plastic and the translucent green plastic. The load resistance was connected in parallel with the photodiode in order to convert the current into a voltage.
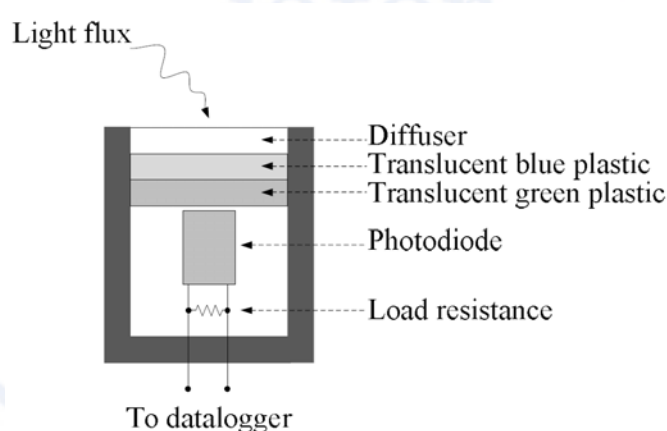
Figure 6. A structure of the developed luxmeter (EKO, 2009).

Experimental setup

Experiments were set up to acquired sensitivity and an accuracy of the developed luxmeter. The luxmeters were connected to a data logger. The records of required data of the light flux were obtained from daylight between October and November 2013. The test place was located at Mueang district, Chachoengsao, Thailand at latitude 13.4°N and longitude 101.4°E.

Experimental setup to acquire the sensitivity of developed luxmeters

The experiment was set up in order to measure the light flux in the building on the East façade, and to find a sensitivity of developed luxmeters. The sensitivity of luxmeter was the multiplying value in the unit of µV/lx. This was used to convert the sensor output voltage into the illuminance level, which was adapted from EKO (2012, p.2) and could be obtained by the following equation.

$$E = \frac{V}{K}$$

(Equation.1)

Where, E is an illuminance level, V is an output voltage from luxmeter, and K is a sensitivity of luxmeter.

The output voltage was obtained from luxmeter. All six luxmeters, i.e., commercially high illuminance luxmeter, two of developed high illuminance luxmeters, commercially low illuminance luxmeter, and two of developed low illuminance luxmeters, were connected to a data logger. All measured data were acquired by the ZR-RX45 data logger of Omron Corporation, and recorded onto its internal memory at 2-minute interval.

Experimental setup to acquire the accuracy of developed luxmeters

The daylight measurement system was installed at Mueang district, Chachoengsao province, Thailand, in order to find the accuracy of developed luxmeters. A building model was constructed from gray PVC sheet, where its foreshorten from 3 rooms building. The dimension of each room was 3 m width, 6 m in length, and 3 m height. The size of window was 2.8 m x 1.8 m. EKO of Japan supplied the commercially available standard luxmeters. The high illuminance luxmeters were installed above this model in order to measure an exterior illuminance. The low illuminance luxmeters were placed about 0.75 m above the floor at middle of each room in order to measure an interior illuminance as shown in Fig. 7.

Figure 7. Showing a photograph of the daylight measurement system.

All measured data were acquired by the ZR-RX45 data logger of Omron Corporation, and recorded onto its internal memory at 2-minute interval. The illuminance level from each luxmeters were plotted and compared to consider the trend of the curve. Both data sets were plotted with a trend line. An equation of the trend line and the coefficient of determination (R-square) were used to consider the accuracy of the developed luxmeter. Other statistics values of developed luxmeters could be analyzed with Microsoft Excel, i.e., percentage error, correlation, and standard error. However, the developed luxmeters could be tested and certified by the Institute of Metrology, but this services were not available in Thailand at this moment.

RESULTS

The sensitivity of developed luxmeters

The commercially available high and low illuminance luxmeters had the sensitivity of 0.186 µV/lx and 0.820 µV/lx, respectively. The value of the sensitivity of the developed luxmeter was calculated using two equations, i.e., calculated an intensity of the illuminance of the commercially available standard luxmeter from the recorded voltage by equation 1, and subsequently divided the voltage of developed luxmeter by the value of the illuminance, which was obtained from the first equation. Results showed that the sensitivity of developed high and low illuminance luxmeters were closed to the values of the commercially available luxmeters as shown in Table 1.

Table 1. Showing values of the sensitivity of luxmeters.

Luxmeter	L_ch	L_dh1	L_dh2	L_cl	L_dl1	L_dl2
Sensitivity (µV/lx)	0.186	0.195	0.213	0.820	0.877	0.829

Where

    L_ch is the commercially available high illuminance luxmeter,
    L_dh1 is the first developed high illuminance luxmeter,
    L_dh2 is the second developed high illuminance luxmeter,
    L_cl is the commercially available low illuminance luxmeter,
    L_dl1 is the first developed low illuminance luxmeter, and
    L_dl2 is the second developed low illuminance luxmeter.

The accuracy of developed luxmeters

The experiment was set up to measure the exterior and the interior illuminance during the period of October to November 2013, where the test building model façade facing north and east. The results indicated that the maximum values of the high illuminance and low illuminance luxmeters were approximately 60 klx and 10 klx, respectively. The values of the illuminance were calculated for the sensitivity and summarized as shown in Table 1.
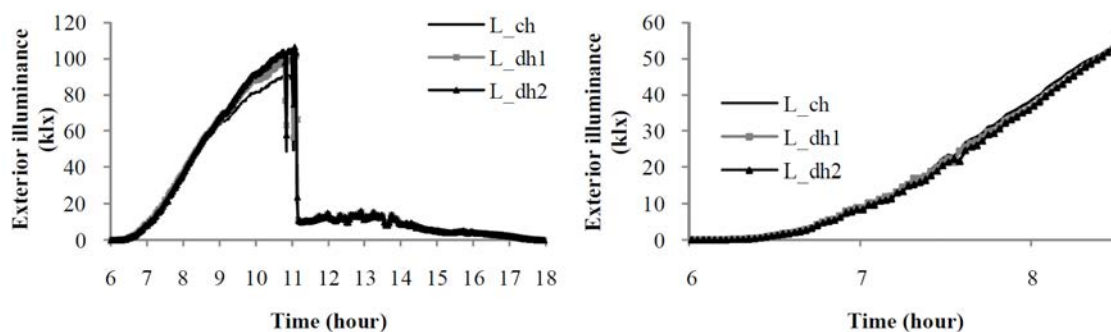
a. Showing the maximum values of measured exterior illuminance.
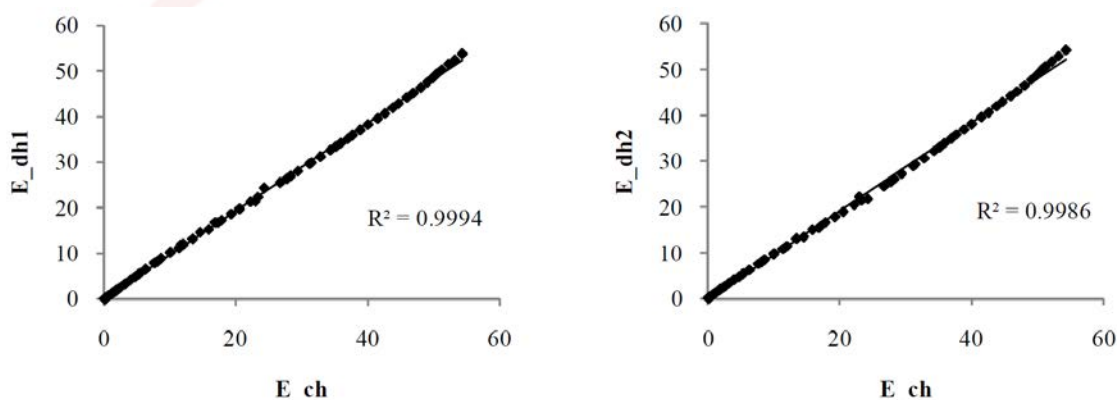
b. Showing the relationship of the coefficient of determination of high illuminance luxmeter.

Figure 8. Showing results of measured illuminance on 27th November 2013.

Where

E_ch is the measured illuminance of the commercially available high illuminance luxmeter,
E_dh1 is the measured illuminance of the first developed high illuminance luxmeter, and
E_dh2 is the measured illuminance of the second developed high illuminance luxmeter.

Results from Fig. 8a were obtained from the experiment conducted on 27th November 2013, while the building façade was facing east. The variations of the exterior illuminance, which were obtained from the developed high illuminance luxmeters agreed with the commercially available standard luxmeter until it reached 60 klx with the coefficient of determination over 0.99 as shown in Fig. 8b. The variations of the interior illuminance were indicated a high error value. Results from Fig. 9a were obtained from the experiment conducted on 10th October 2013, while the building façade was facing east. The variations of the interior illuminance obtained from the developed low illuminance luxmeters agreed with the commercially available

standard luxmeter until it reached 10 klx where the coefficient of determination was over 0.99, as shown in Fig. 9b.
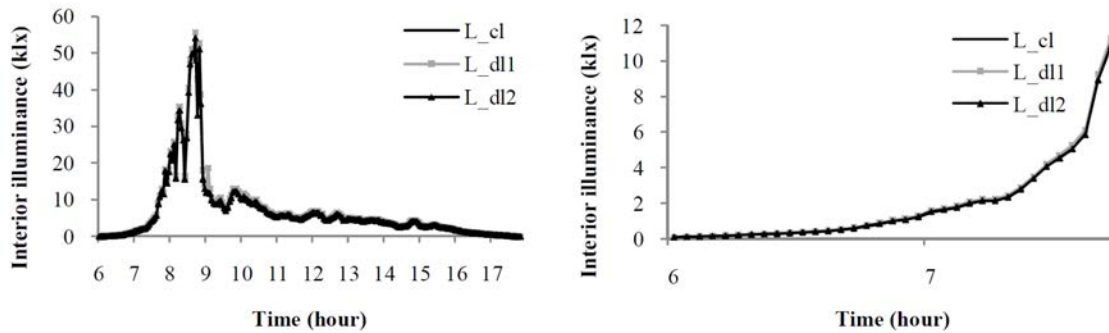
a. Showing the relationship of the maximum values of measured interior illuminance.
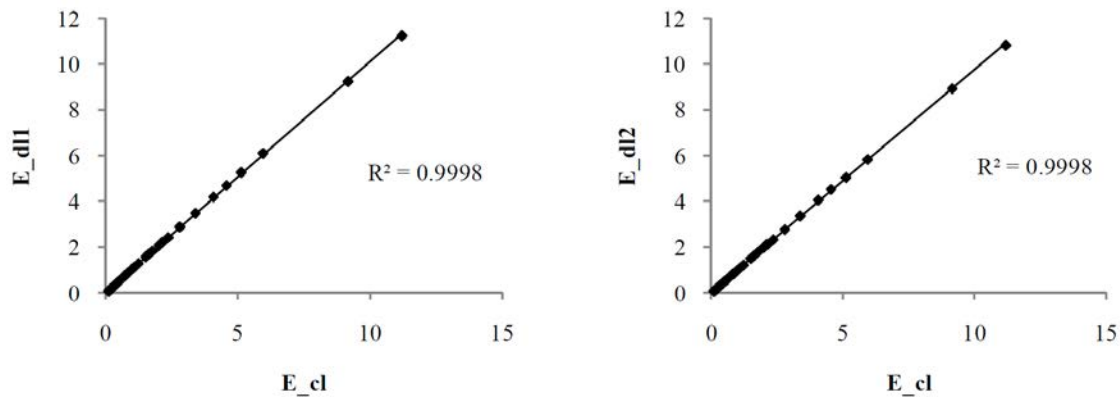
b. Showing the coefficient of determination of low illuminance luxmeter.
Figure 9. Showing results of measured illuminance on 10th October 2013.

Where

> E_cl is the measured illuminance of the commercially available low illuminance luxmeter,
> E_dl1 is the measured illuminance of the first developed low illuminance luxmeter, and
> E_dl2 is the measured illuminance of the second developed low illuminance luxmeter.

It was found that the maximum illuminance of the developed luxmeter was 60 klx for the high illuminance luxmeter and 10 klx for the low illuminance luxmeter. The values were highly accurate and agreed with the commercially available luxmeters. The experiment was conducted on 16th November 2013, while the building façade was facing north. The variations of the exterior illuminance obtained from the high illuminance luxmeter. Values of the exterior illuminance reached the peak at 13 klx during the midday when they were measured with high illuminance luxmeter. The variation of the interior daylight illuminance on the work plane at the middle of room from the window, where it reached the maximum value at daylight of 1800 lx during

midday, when it was measured with low illuminance luxmeter. This result was similar to the values of the illuminance and the accuracy of the developed luxmeters, as shown in Fig. 10.
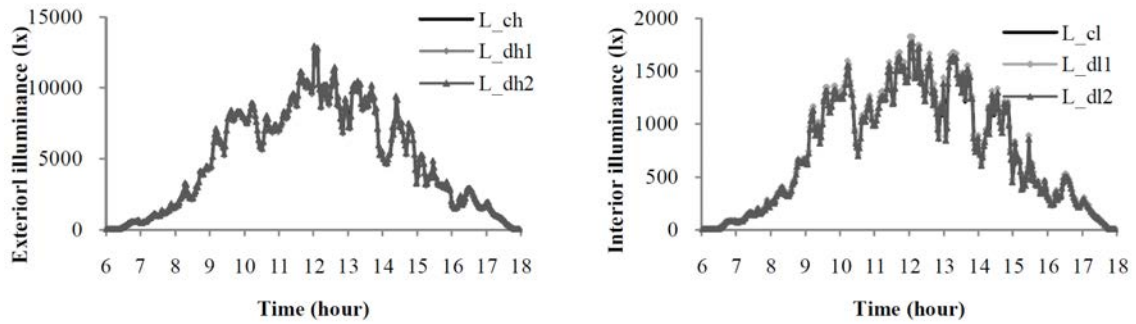
Figure 10. Showing results of measured exterior and interior illuminance
on 16th November 2013.

It was found that the developed luxmeter yielded an accurate result. The experiment was set up to measure the exterior and the interior illuminance during October to November 2013, while the building façade was facing north and east. The data logger recorded the 3,267 data points of the observation. The results revealed that the measured illuminance of the developed luxmeters agreed with commercially available standard luxmeter with the correlation was over 0.98, as shown in Fig. 11. The average error of the developed high illuminance luxmeter was 6.49 % of L_dh1 and 6.62 % of L_dh2, when compared with the commercially available standard luxmeter. The average error of the developed low illuminance luxmeter was 4.31% for L_dl1 and 2.35 % for L_dl2, when compared with the commercially available standard luxmeter, as shown in the Table 2.
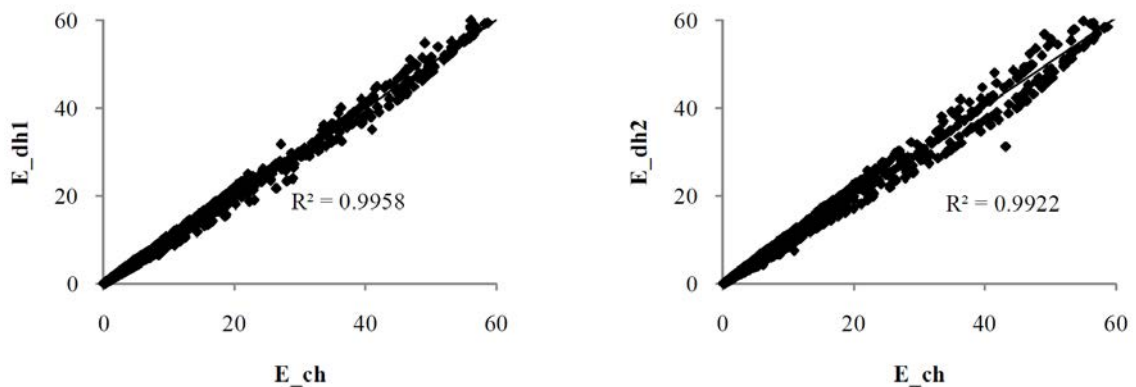
a. The coefficient of determination of high illuminance luxmeter.
Figure 11. Showing the coefficient of determination.
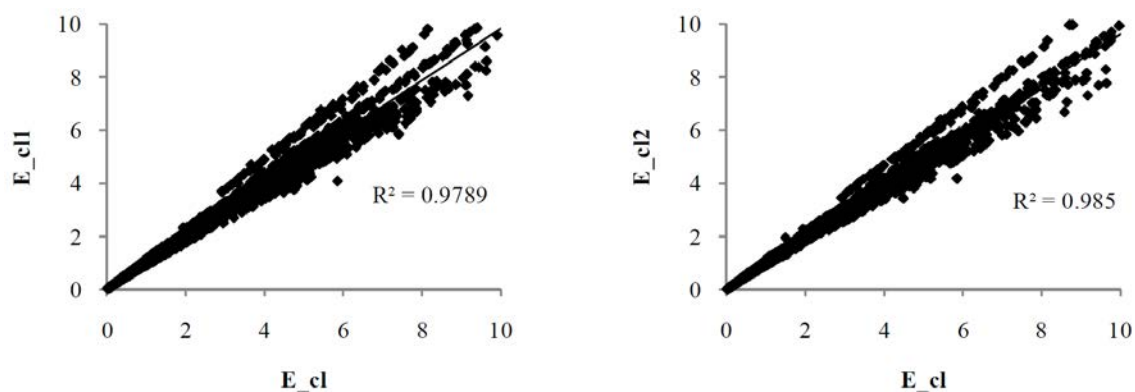
b. The coefficient of determination of low illuminance luxmeter.
Figure 11. (cont.) Showing the coefficient of determination.

Table 2. The statistics of developed luxmeters.

Statistics	L_dh1	L_dh2	L_dl1	L_dl2
Percentage error	6.49	6.62	4.31	2.35
Correlation	0.9979	0.9961	0.9894	0.9925
R square	0.9958	0.9922	0.9789	0.9850
Standard error	648	881	310	261
Observations	3267	3267	3267	3267

Discussions and Conclusions

Two types of luxmeter were developed according to the model that created from my own idea, i.e., the high illuminance and low illuminance. The basic ideas were based on a simple design with a reasonable cost of material in order to produce a low cost luxmeter. It was built from an easy to find material, i.e., photodiode, PVC tube, translucent blue plastic, translucent green plastic, acrylic plastic, and resistors. Our results showed that luxmeter could work appropriately with data logger. The luxmeter was used to measure the light and convert into voltage, and then an input of the data logger was setting-up according to the voltage type. The sensitivity of the developed luxmeter was used to convert the voltage into the illuminance level. The finding demonstrated that the developed high and low illuminance luxmeter could be used to measure a maximum illuminance, which yielded 60 klx and 10 klx, respectively. The measurement and calculation indicated that it had the coefficient of determination about 0.98 and error less than 6.7%, when compared to the commercially available standard luxmeter. Furthermore, the developed luxmeter could be used to measure the other measuring range of illuminance level, but the sensitivity yielded a new value. This observation was from the acceptable range of sensitivity in the calibration certificate of the commercially available standard luxmeter. It was found that one luxmeter had a sensitivity of 0.820 µV/lx, where the acceptable range of 0.700-1.200 µV/lx. However, the price of the developed luxmeter was cheaper than that of the commercially available standard luxmeter approximately 100 times. This study can help us to save the budget for other research, which is involved daylight or lighting application in Thailand. Moreover, this knowledge can be adapted for an assembly of the digital luxmeter. Further studies should be considered to adapt this knowledge for

the development of LED lighting system cooperated with day lighting for energy efficient in building, in the future.

Acknowledgement

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UHI and Temporal Study of Urban Growth: A Study of the Klang Valley Area

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Abstract

The growth in urbanization has received much attention since the late 19th century. One physical aspect that needs to be understood regarding urban climate problem is the urban heat island phenomenon. The steady economic growth and rapid urbanization has created increased concrete landscapes that can elevate the level of discomfort within the population due to this phenomenon. The problem is worsening in the Klang Valley area particularly, which is plagued by the extensive economic activities as well as the heat generated from factories, transport and air conditioners. This study examines the expansion of temporal urban growth by using Landsat images during different time periods according to the images' availability which were used under unsupervised classification. Meteorological data were also used to monitor historical temperatures. This finding indicates that the UHI intensity from the slope difference of urban and rural is 0.4º Celsius per decade. Datasets from remote sensing imageries found that the average rate of urbanization spread is 42.5 km^2 per year. This study shows that the use of remote sensing is beneficial for multidisciplinary study. The mitigation of UHI can be proposed by considering steps such as planting trees and choosing ground paving material which are important measures in urban planning and decision making for future environment.

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1.0 Introduction

The growth of urbanization has become a great concern particularly to environmentalist. The rapid activities of green cover transformation on impervious surfaces have raised conflicts in relation to human actions alongside the awareness on environment. The process of urbanization can basically be triggered off by three factors: Natural population increase, rural–urban migration, and annexation (Brockerhoff, 2000). Urbanization has altered the energy balance of outgoing and incoming radiation. With the increase of urbanization, the excess heat from buildings, transportation, industrial and residential areas is trapped and consequently accelerates temperatures to higher degrees in the urbanized area.

In the local scenario, UHI was not received well, as concurrently supported by several local studies (Ahmad Fuad Embi & Norlida Mohd Dom, n.y.; Shaharuddin Ahmad, Noorazuan Md. Hashim, & Yaakob Mohd Jani, 2009). In fact, urban heat island, thunderstorm and poor air quality are environmental problems that are closely related. These environmental problems need great attention from many people, namely the policy makers and public.

As the weather of the study area becomes hot and humid over the years, people had to try to adapt with the increasingly warmer environment. In several occasions when there is no rain for several consecutive weeks, cloud seeding procedure was employed by the government. This indicates that urbanization clearly poses a negative correlation to vegetated indicators such as NDVI and green land, as done by several studies (Chen, Ni, Li, & Ren, 2009; Zeng, Qiu, Gu, He, & Wang, 2009). However, in order to pursue the aspiration to build a well developed city, urbanization cannot be avoided. Therefore, integrated approach to sustain the city should be adopted both at policy and implementation level.

2.0 Literature Review

UHI occurs in the densely populated urban areas at the condition where the energy balance is modified and inadvertently affects the local climate. UHI is caused by a reduction of the latent heat flux and increase of sensible heat flux in urban areas as vegetated and evaporating soil surfaces are replaced by impervious low albedo paving and building materials (Imhoff, Zhang, Wolfe, & Bounoua, 2010).

Many observational studies estimated an increase in UHI intensity by comparing ground based observed air temperature in urban and rural weather station (Oke, 1973). These researchers have conducted in situ measurements, set up weather stations and remote sensing techniques in order to mitigate UHI. However, these techniques have produced both drawbacks and advantages. For instance, although in situ measurement yielded very good information as it was done on site, it requires more budget and manpower. Therefore, remote sensing can be considered as cheaper and good temporal resolution. However it has poor spatial resolution as the wide pixel size, for example ASTER and Landsat TM are 60 and 90 meter respectively. In addition, the weather station can provide a historical perspective on temporal variability of the temperature pattern.

The urban growth analysis is best analysed using remote sensing. Availability of historical images and straightforward classification of land cover types are among its advantages. The rate of urbanization can directly be derived from visual interpretation and pixel calculation. A local study, Asmala Ahmad & Noorazuan Hashim (n.y.) shows that according to analysed images, urban growth has swelled up to 25 percent in only a decade (1989 to 1999).

In earlier UHI works, Colacino & Lavagnini (1982) found differences in warming rates between urban and rural areas in Rome, which occurs at a different intensity depending on the season. A number of researchers conducted long term investigations to identify the temporal variability of the temperature (Garcia-Cueto & Martinez, 2009; Nonomura, Kitahara, & Masuda, 2009; Stone, 2009). It was observed that different cities show different rate of mean minimum and mean maximum temperature. According to the observation done by (Garcia-Cueto & Martinez, 2009), the trend of mean minimum temperature in the urban area is 0.66/decade, with a negative trend in mean maximum temperature which is suspected due to the thermal inertia of urban materials. In addition, Nonomura et al. (2009) found that the temperature pattern increase is different in several cities in Japan, whereas the increase of temperature in Takamatsu is higher, at 0.7º Celsius per decade compared to the temperature increase at Senyu, which is 0.3º Celsius per decade. The difference is suspected to be due to the loss of vegetated areas for urbanization.

3.0 Study area

The Klang Valley is comprised of Kuala Lumpur and part of the state of Selangor, whereby Kuala Lumpur is the federal territory and Selangor is one of the richest states of Malaysia within rapidly developed cities and suburban areas. Fig. 1 shows the area of interest, Klang Valley region in Peninsular Malaysia.

As the study area is located near the equator, it experiences tropical monsoon and is hot and humid throughout the year. According to the dataset on Petaling Jaya produced by Meteorological Department of Malaysia (MET), the mean temperature is 27.3º Celsius and the relative humidity is 76.7%. This area receives six (6) hours of sunshine each day throughout the year (Meteorology Department, 2012). However, Malaysia at large, experiences two (2) main monsoonal seasons and two (2) transition seasons.
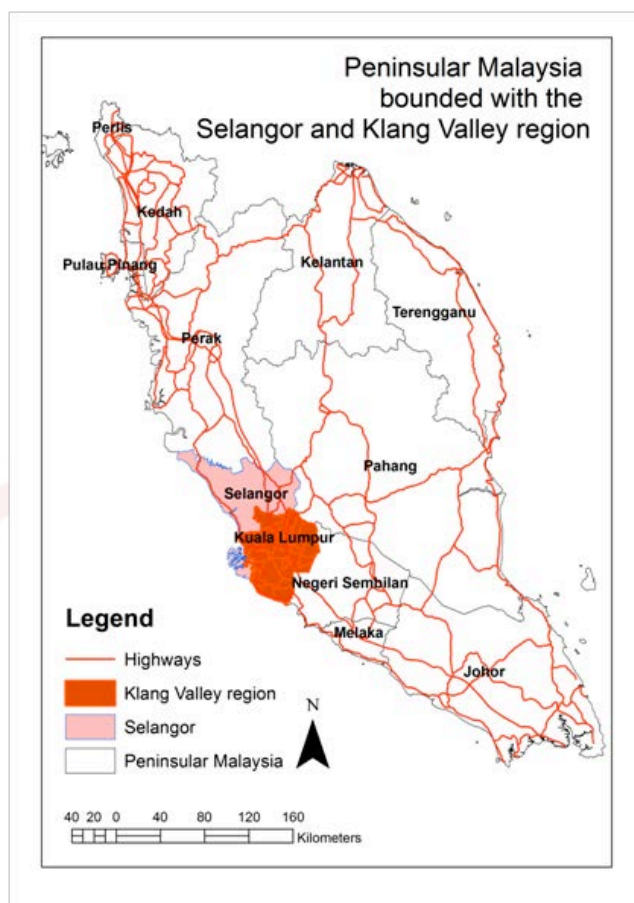
Figure 1: Images since 1989 to 2009

The main monsoonal season is the north-eastern monsoon that sets in from November to March bringing episodes of heavy rain that mostly affects the states in these areas of Peninsular Malaysia, where monthly rainfall exceeds 200 mm. During this season, steady easterly or north-easterly winds of 10 to 20 knots prevail (Meteorology Department, 2012). The south western monsoon season sets in through June to September and this season usually would bring drier periods. The prevailing wind flow during this period is generally south-westerly and light, below 15 knots (Meteorology Department, 2012). The transition between two of these seasons happen from April to May and October to November, when the wind is generally light. Dataset of the urbanized meteorological station in Petaling Jaya for example, shows that the mean monthly temperature is between 26 to 28°C and relative humidity is 74 to 80% throughout the year.

4.0 Method

The study area, Klang Valley was extracted from the raw image. Available Landsat imageries from NASA webpage were downloaded, of which only those with less and no cloudy images was considered in this study. Necessary pre-processing imagery including the radiometric and geometric correction was done. The unsupervised image classification was performed. Here, it was found that the heterogeneity of urban landscape can impact the same land cover with different spectral characteristics. Therefore, the analysis of the images by identifying fifty land cover classes was done

and later classified according to the analyst's experience in the study area. The images were categorized into six classes, including: (1) urban areas; (2) green; (3) forest; (4) water bodies; (5) bare land; and (6) clouds.

The time series of meteorological dataset of mean minimum and mean maximum temperatures were collected from the archives of Meteorology Department beginning from 1989 to 2008. Two meteorological weather stations were used for this study: urban (Petaling Jaya and Subang) and rural (Ulu Langat and KLIA Sepang). Temperature is used as a dependent variable and time as an independent variable. These datasets were analysed using the linear regression method.

5.0 Results

This section discusses the classifications of land cover in the study area for every image. To begin with, the analysis of the urban growth rate was described by demonstrating the calculation of the urban area coverage using image calculation. Secondly, the explanation of weather station datasets is carried out.

Further analysis moves into to the classification of land cover using five available remote sensing images (Fig. 2). The duration of time for available images was through two decades; since 1989 to 2009. It is found that the most cloudless map was captured on 2nd February 2006. The cloudiest one was taken on 12th January 2009.

Accuracy assessment was carried out for these images and it is found that the overall accuracy and overall Kappa coefficient respectively are seen in the following images: 7th Feb 1989's image (93.33%, 0.9204), 12th Dec 1999's image (96.4%, 0.9580), 31st May 2001's image (95.4%, 0.8299), 2nd Mar 2006's image (95%, 0.82) and 21st Jan 2009's image (97%). This analysis shows that a reliable accuracy in classification was achieved for the land cover classification. The land cover types were divided into five (5) categories of classification; urban areas, green areas, forest areas, water bodies and bare land.

The image of 7th February 1989 shows that urban areas were mainly located in the Kuala Lumpur area (4 percent), with a linear extension directed to the Straits of Malacca into the Klang area. Majority of green areas were seen in this image compared to other land cover types. Small amount of built up area (purple) was identified; wider built up area was found in Petaling Jaya and other built up area covered areas just next to the highways.

After a decade (12th Dec 1999), the built up areas have grown to the south west of Klang Valley and it is clear that the green and forest areas were reduced. The bare land was growing as well. However, more bare land expanded at the south east of the study area, where a large new government district (Putrajaya) was being developed.
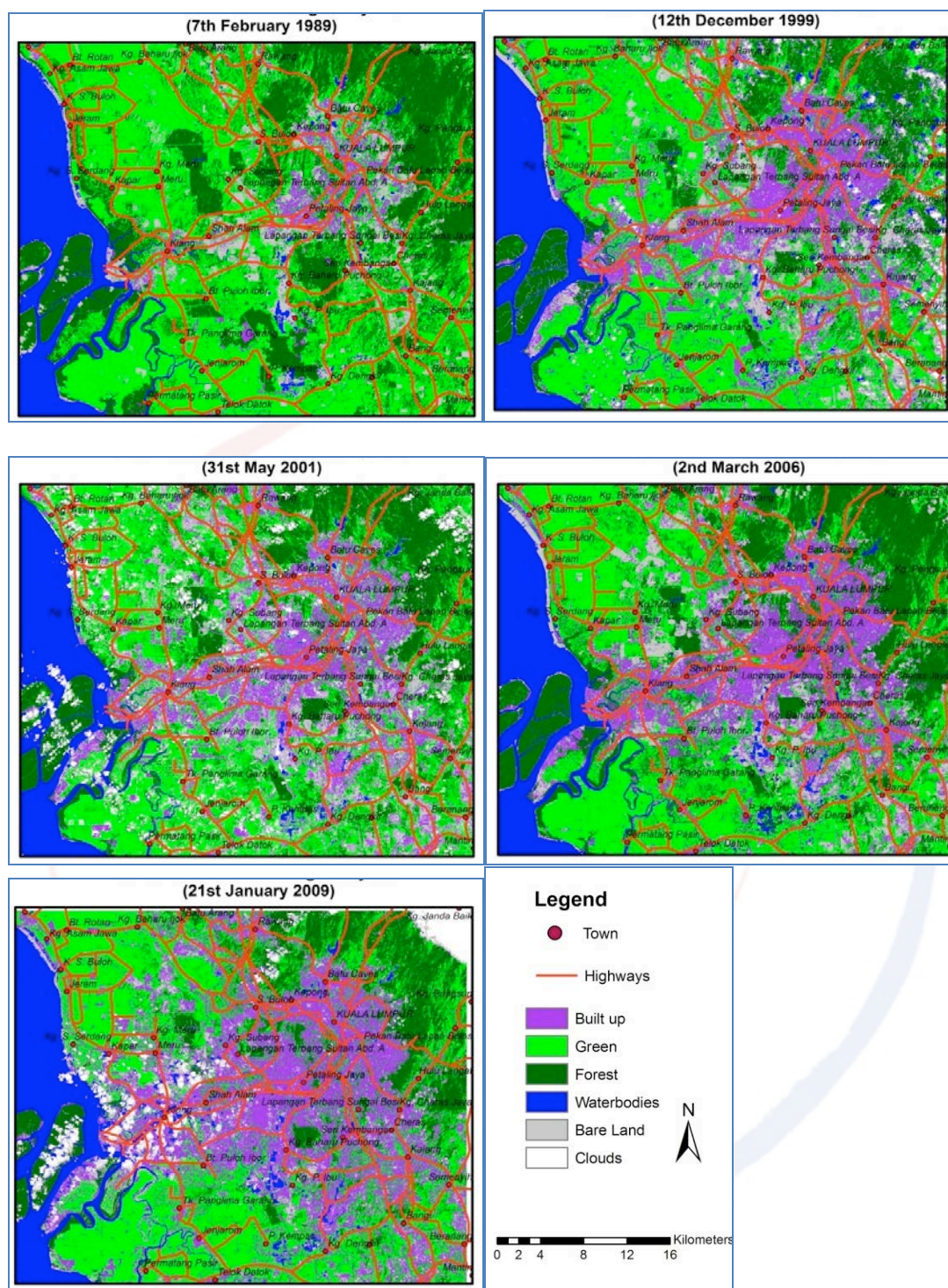
Figure 2: Images since 1989 to 2009

In 31st May 2001, no distinct pattern was found as compared to the previous image, except that the built up area kept increasing since the difference in time between these images was less than 2 years. The green areas were still found throughout the south and northwest areas, where most of the activities are agriculture with cultivation. In rural districts, small towns such as Teluk Panglima Garang and Banang are slowly developing.

On the 2nd Mar 2006 image, the spread of built up area are clearly visible and green area has become lesser. The urban expansion has extensively moved to the southeast area. It can also be seen that the cultivated area at the northwest of the image and a small portion of urban area has emerged whereby these areas were observed to be previously (2001 image) bare lands.

The last image (21st Jan 2009), shows that the built up area has clearly spread to the three corridors: Kuala Lumpur to Klang (south west), Kuala Lumpur to Rawang (north) and Kuala Lumpur to Seremban (south east). However, a good sign is observed here whereby the forest areas within these zones were well maintained even though the forest fringe has become much closer to the urbanized areas. Although the previous image (2001 image) has shown that in the southeast, there was a combination of bare land and urban, this image now shows that it has been fully converted to an urban area.

Analysis that was done of these images lead us to conclude that urbanization seems to have extended from northeast to the southwest, right up to the coastal area from 1989 to 1999. Over a decade, the urban expansion was focused on the southwest, northwest and southeast areas (according to 7th Feb 1999 and 31st May 2001 images). Nine years later, the urban areas were found to be denser in both directions (21st Jan 2009).
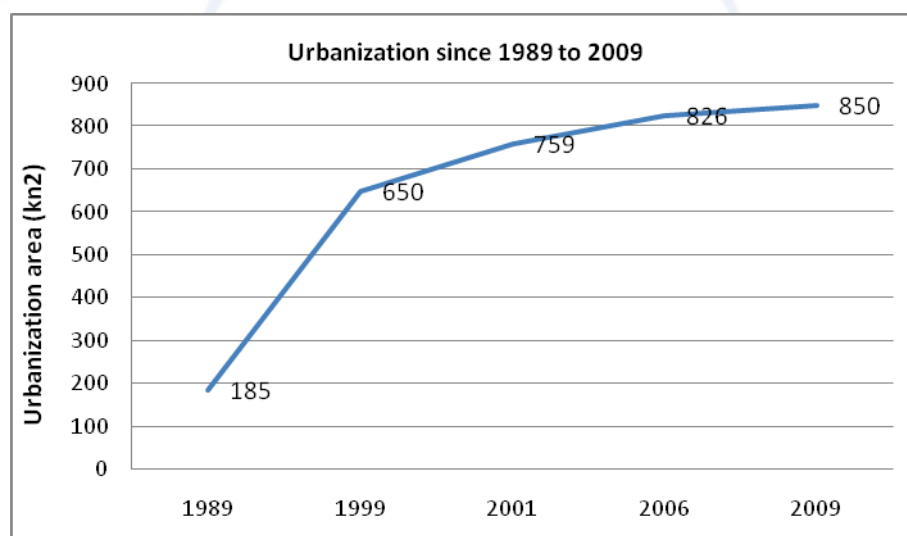
Fig. 3: Urbanization (km^2) versus year of the images were taken

Fig. 3 shows the urbanization expansion with the year the images were taken. Two phases was shown in the graph: the first phase is between 1989 to 1999 images and the second phase between 1999 to 2009 images, both through a span of 10 years. A graph of the urban growth in the first phase shows a sharp increasing linear line, at 270 km^2 per year. On the other hand, a slower rate of urban growth was found at 61 km^2 per year. This trend indicated that a more rapid urban growth took place in the first phase even though both phases occurred in 10 years. In addition, it was calculated that more than fourfold of urban growth rate was detected in the first phase compared to the second phase.

Fig. 4 and Fig. 5 present the datasets of the urban and rural areas for mean monthly temperature. In general, both datasets indicated an increasing trend in temperature during daytime, but with different intensity. The analyses were based on Petaling Jaya's weather station to represent the urban area and the Ulu Langat's weather station to represent the rural area. Thus, monthly mean temperatures of rural area from Ulu Langat weather station were also referred to. The mean monthly temperatures of Petaling Jaya, which were recorded since 1989, were in fact available from 1975; however, in order to compare them alongside with the datasets from Ulu Langat, only the datasets from 1989 onwards were used from Petaling Jaya..
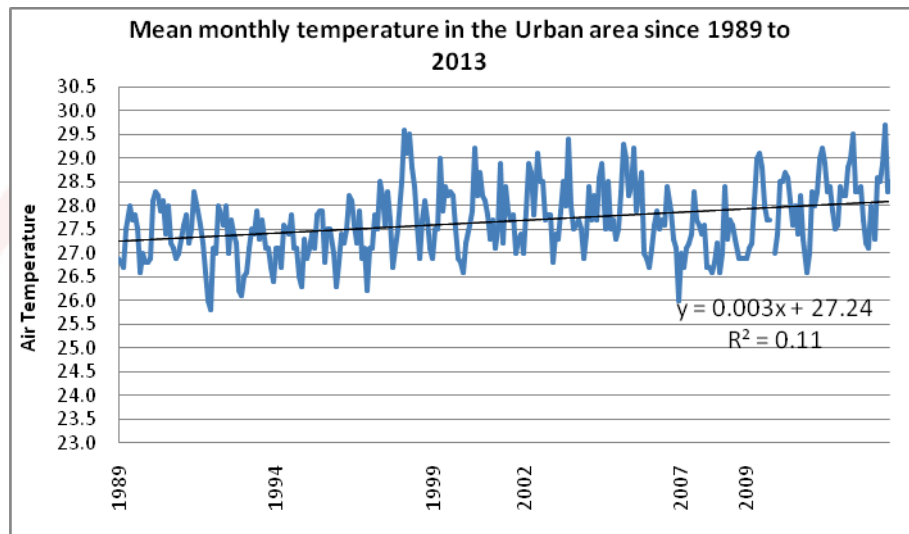
Figure 4: Warming Rate (Slope) in urban area from 1989 to 2013
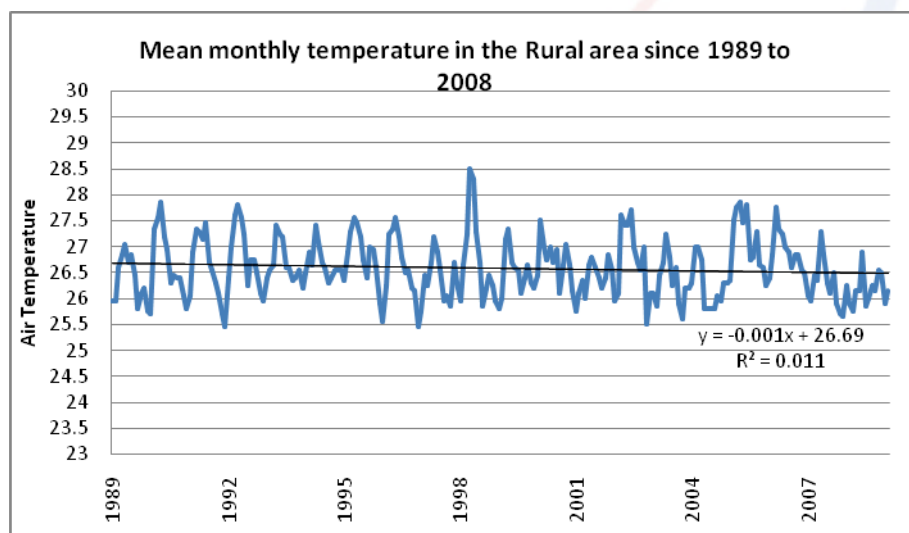
Figure 5: Warming Rate (Slope) in rural area from 1989 to 2008

In general, the slope shows a positive trend of warming in Petaling Jaya's and a negative trend of the same in the rural area. At the urban weather station, the monthly

trend was found to be 0.3 °C/decade. On the other hand, a negative warming rate was found within the rural area (Fig. 5), indicating the existence of cooling island in this vicinity. The monthly trend in the rural area was found to be -0.1 °C/decade.

The slope difference between the urban and the rural areas reveals UHI for the years studied. This trend is evident in the UHI reading of 0.4°C/decade, which indicates that the urban area's temperature has been growing faster than the warming rate of the rural area. Both datasets, the urban growth and warming rate analyses suggests that urbanization process has led to a warmer climate in the urban area compared to the rural area.

6.0 Discussions and Conclusions

Prior studies have noted that urbanization is one of the factors that leads to the increasing temperatures in a local area (Sajjad, Shirazi, Khan, & Raza, 2009; Yang, Lau, & Qian, 2010; Zhang, Shou, & Dickerson, 2009). The finding of this study shows that the urbanization rate over two decades was 42.5 km^2 per year (at least 7 times since 1989 to 2009). In relation to this finding, Atturo & Fiumi (2005) also pointed out that the high thermal levels recorded near roads are due to factors of wider surfaces, dark colour of materials and presence of high percentages of bitumen in asphalts that are exposed to the sun's radiation. (Rose & Devadas, 2009) discussed that increasing urbanization with artificial features such as roads and buildings is a significant factor in the increase of heat pockets. A more drastic urban growths is shown in the county of Fuqing, China whereby in only 5 years since 1991, the land growth increased up to 39 times in 1996 (Xu, Wang, & Xiao, 2000).

This study also shows that temperature pattern is increasing over the years, as found in the increasing of urban temperature rate of 0.4° Celsius/decade. However, another study found that in Puerto Rico, the UHI is 0.6° Celsius. Garcia-Cueto and Martinez (2009) took 50 years of measurements, beginning from 1950 to 2000 and found that the warming rate trend there was found at 0.66° Celsius/decade. In addition, in the tropical area of San Juan, it was found that the surface temperature in urban areas have increased compared to the vegetated area, at a rate of 0.6° Celsius per decade (González, Luvall, Rickman, Comarazamy, & Picón, 2006). In the subtropical area in Hong Kong, with population density of over 3000km^2 and 100km^2, the warming rates are about 0.1° Celsius/decade and 0.03-0.05° Celsius/decade, respectively (Fung, 2010). These studies show that the warming rate is unique to the structure and local conditions of the study area.

The result from this study shows that remote sensing tool is very useful in urban planning and sustainability, especially to understand urbanization in a bigger picture. The use of new sources of spatial data has potentially improved the analysis and is thus seen as an added value in the fields of urban geography and urban planning. The limitation in using remote sensing is the cost which is too expensive to stakeholders (Taubenböck & Esch, 2011). Fortunately, remote sensing data is cheaper compared to the airborne and in situ measurement data. The integration datasets from different sources, for example meteorological data, can provide good opportunities to obtain for multidiscipline results.

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Environmental Sustainability Drivers: A Study on Malaysian Palm Oil Industry

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Abstract
Industrial practitioners and policy makers in the Malaysian palm oil industry are now focusing on understanding the factors that influence sustainability of palm oil supply chain network involving the fundamental principle of triple bottom line of social, environmental, and economic performance impacts of supply chain network design. In order to achieve sustainable products, an interpretive structural modelling approach method was used to better understand the drivers related to environmental sustainability reporting in the supply chain network related to the Malaysian palm oil industry. This paper has identified nine (9) environmental sustainability drivers and the relationships between them. The findings from the environmental sustainability reporting drivers of this study can be furthered use to explore the potential impacts of supply chain network design on sustainability using the Malaysian palm oil industry as a reference. The novelty of this research is that it identifies the significance of environmental sustainability reporting based on the analyzed drivers and provides evaluation of environmental sustainability criteria's. This paper has provided a structural model of environmental sustainability and its associated method was developed by using the interpretive structural modelling model to determine the potential drivers in environmental sustainability reporting.

Keywords: life cycle assessment, sustainability analysis, sustainability reporting, triple bottom line

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1   Introduction

With the rapidly growing world population, the demand for palm oil is increasing. Among the 17 world major oils and fats, palm oil has made impressive and sustained growth in the global market. In 2008, palm oil accounted for 54% of the world's production of oils and fats; it is projected that palm oil will become the leading oil in the world around year 2016 [14]. Malaysia is the world's second largest producer and exporter of palm oil after Indonesia; in 2007 it produced about 15.8 million tons of palm oil. In year 2020, production is forecast to increase to 18.5 million tons. Key challenges to the palm oil industry include misconceptions on palm oil sustainability and awareness of its potential in the global vegetable oil market, consumer demands for certification of products and processes and the competitiveness on the triple bottom line performances as uncertainties to the supply network.

Sustainability of palm oil is important if this versatile crop is to become the leading vegetable oil in the world. This multipurpose vegetable oil needs to be cultivated to ensure sustainable development from the environmental, social and economic aspects. With the world's population expected to increase to 8 billion in 2028, palm oil has the potential to be the source of fats and vegetable oil to feed the people around the globe [2, 3]. As high demand of cheap and quality vegetable oil is needed to feed the world's growing population, building a tool to improve the performance of sustainability of the palm oil supply chain network involving real-time data is necessary in order to achieve sustainable production. In this context, all parties involved with palm oil like plantation owners, financial institutions and banks, manufacturers of palm oil products and governments play an active role to realise this win-win situation for all. Hence, the time has come for all parties to co-operate and realise a sustainable production and development of palm oil. Ideas and efforts will become futile if all parties do not take an active and responsible role towards this aim as sustainable development of palm oil requires collaboration and initiative among the stakeholders.

Sustainability is also particularly important when it comes to the production of food, especially commodities that are widely used by the global food industry. The need to produce palm oil sustainably has led to the establishment of the Round Table on Sustainable Palm Oil [16]. This roundtable is a platform to reach mutual understanding at the international level among various palm oil stakeholders namely; oil palm growers, palm oil processors/traders, consumer goods manufacturers, retailers, investment organizations, social or development Non-Governmental Organizations and environmental or nature conservation Non-Governmental Organizations. This understanding would be translated into common actions towards achieving sustainability of palm oil production and used in its entire supply chain. The Round Table on Sustainable Palm Oil has progressed towards formulating a set of principles and criteria for sustainable production, but has yet to implement a scheme to enable sustainably produced palm oil to be certified with full traceability. It is not easy to implement such an ambitious scheme, since maintaining the chain of custody for traceability purposes will be difficult and expensive. The importance of studying these environmental, social and economic issues, such as land conversions, productivity and environmental problems were also addressed by Sustainable Agriculture Initiative Platform and Sustainable Food Lab in Short Guide to Sustainable Agriculture documents [17, 18]. This is particularly important with the

increased awareness of the environmental, social and economic issues as one of the key factors which influence consumer's perception towards sustainability in markets such as Europe.

1.1 Sustainability SWOT Analysis of the Malaysia Palm Oil Industry

SWOT analysis is an important support tool for decision-making, and is commonly used as a means to systematically analyse an organisation internal and external environments [7, 10]. By identifying its strengths, weaknesses, opportunities, and threats, the organisation can build strategies upon its strengths, eliminate its weaknesses, and exploit its opportunities or use them to counter the threats. Strengths, weaknesses, opportunities and threats of the Malaysian palm oil industry in its present state from the SWOT analysis are presented in Figure 1.

The preliminary study of SWOT analysis was done to build understanding of the supply network in the Malaysia palm oil industry sector by carrying out semi-structured interviews. The objective was to review the literatures from academic and industrial viewpoints on the development of palm oil industry in Malaysia and categorise the findings into strengths, weaknesses, opportunities and threats and as well as in the form of semi-structured interviews. From the inputs of these interviews, data and information related to the palm oil industry corresponding to the research topic in Malaysia can be used for a better understanding of the supply network sustainability issues.

Strengths	Weaknesses
-The Malaysian palm oil industry is considered the second largest in the world after Indonesia. -The Malaysian palm oil industry is greatly supported by its local government. -Palm oil itself is a resource that is used for the production of diverse products (part of agricultural diversifications). -Geographical diversifications.	-Poor performance of plantation segments. -Changes in the weather patterns worldwide can affect Malaysia's palm oil plantation and production.
Opportunities	Threats
-The support of the country's government and agencies to the industry in research findings. -Increasing demand of biofuels derived from palm oil and biomass from plantations which can be used as alternatives to fossil fuels such as diesel. [Palm oil gives high yields at low prices and is likely to be important in biofuel demand].	-Shortage of labour is one of the main threats of the palm oil industry in Malaysia. -The palm oil industry in Malaysia faces other other significantly growing competition with other foreign producers. -The country is also experiencing lower land meeting availability for future expansion for palm oil plantation.

Figure 1: SWOT Analysis for Malaysia palm oil industry [11,12,13]

1.2 ISO Standards

A range of standards have been developed in the last two decades to enable sustainable development [4]. ISO 14000 standards create a systematic approach for reducing the impact on the environment due to the activities of an organization [5]. ISO 14000 standards include the ISO 14020 series for environmental labelling, ISO 14040 for Life Cycle Assessment, ISO 14064 for Green House Gases, as a few given examples. ISO 19011 provides guidelines for auditing quality and environmental management systems [6]. Figure 2 showed the examples of identified environmental

sustainability drivers of life cycle stages which can be used for the proposed environmental sustainability reporting of the palm oil industry.

	Raw Material	Product Manufacturing	Transportation	Product Use	Product After Use
Environmental Sustainability Drivers					
1)Environmental Management	•	•	•		
2)Life Cycle Assessment	•	•	•	•	•
3)Green Labelling		•			
4)GHG Emissions		•	•		•
5)Climate Change	•				•
6)Energy Efficiency	•	•	•		
7)Renewable Resources	•				•
8)Water, Soil & Air Quality	•	•	•	•	•
9)Waste Management	•	•			•

Figure 2: Examples of identified environmental sustainability drivers of life cycle stages

(i)   Environmental Management
A number of palm oil mills and palm oil refineries in Malaysia have achieved certification to this ISO standard of environmental management. The standard requires organizations to assess their environmental impacts and develop an environmental policy to address them. The two specific requirements of relevance are:
- the policy includes a commitment to comply with relevant environmental legislation and regulations; and
- the policy includes a commitment to prevention of pollution.

Environmental management is an auditable standard that provides a framework for organizations to implement their environmental policies and can be verified by third party certification.

(ii)   Life Cycle Assessment
In the ISO 14000 family of standards, the ISO 14040 standard provides the framework and guidance for conducting life cycle assessment (LCA). This is the "cradle-to-grave" approach for assessing the environmental profile and performance of a product from sourcing of raw materials to its final disposal after the useful life of the product. Application of this methodology to the palm oil industry would provide an assessment of the potential environmental impacts of all inputs and outputs throughout the production chain from the planting of the palm oil seed to the consumption of the final processed product.

(iii)   Green Labelling
Green labelling refers to a scheme which awards green label to environmental friendly products. These are products that have less environmental impacts. The purpose of

labelling these products is to help consumers to identify and purchase those products that are environmentally friendly. Strong demand from the consumers for environmental labelling products will encourage more manufacturers to adopt environmental friendly policies.

(iv)   Greenhouse Gas Emissions

Carbon conservation aspects need to be addressed and greenhouse gas balance and land use competition should also be included in the design of sustainable industrial systems for the palm oil industry. Additional principles should be developed for palm oil sustainability, to cover aspects related to carbon balance and preservation of carbon stocks. As reducing greenhouse gas emissions is a prominent goal for sustainable development policies, certain levels of greenhouse gas reductions based on a life cycle assessment should be developed.

(v)   Climate Change

Forest conversion by plantation companies contributes to climate change. Emission of carbon dioxide known as the greenhouse gas is a cause of global warming and climatic change. The rainforests which are cleared to make place for palm oil plantations are storing huge amounts of carbon. Massive amounts of carbon are released straight into the atmosphere but the land's ability to take up carbon dioxide is also diminished with these land conversions.

(vi)   Energy Efficiency

Increasing energy efficiency will help to reduce the impact of energy consumption on climate change by replacing non-renewable energy with alternative renewable and low impact energy sources.

(vii)   Renewable Resources

The efficient use of renewable resources should be targeted since the use of non-renewable resources, such as fossil fuel, is not sustainable in the long term. Greenhouse gases and polluting gaseous emissions must be minimised.

(viii)   Water, Soil and Air Quality

During planting, several measures must be taken to prevent soil degradation and conserve soil fertility in order to minimise soil erosion and fertilizer loss. The soil is highly susceptible to erosion during the land preparation stage preceding planting palm oil trees are unique in a way that they have higher leaf area index that allows them to have better photosynthetic efficiency to produce more oxygen to the air and absorb more carbon dioxide from the atmosphere. Water quality around palm oil plantations and processing mills must be carefully handled to avoid from the impacts of using banned herbicides and pesticides for the use to control weeds and pests. Oily sludge of palm oil mill effluent from palm oil processing mills must be treated before being discharged into water systems to avoid water supply contamination.

(ix)   Waste Management

All waste must be handled, stored and disposed off correctly to avoid pollution to minimize the amount of waste produced, thus reducing environmental cost and ensuring that legislative requirements are met.

2   Materials and Methods

Interpretive structural modelling was first proposed by Warfield [22]. Interpretive structural modelling referred henceforth as ISM, is aid for modelling relational structure among the number of parameters. While dealing with large number of attributes, it gets complicated to relate them with reference to the final goal. Interpretive structural modelling can help in interpreting the decision maker's judgment about relation among the parameters. It extracts a structured model out of pool of parameters to simplify decision making process.

The major steps involved in using interpretive structural modelling are as follows:

(i)   Identification of parameters
          The relevant parameters to be considered in final analysis are listed in Figure 2.

(ii)   Structural self interaction matrix
          Depending on the situation and parameters, a contextual relation is chosen and compared with every other parameter to decide presence and direction of chosen relationship. This generates self interaction matrix.

(iii)   Reachability matrix
          From the self interaction matrix, the relational indicators are converted in to binary digits 0 and 1 to get a square matrix, called reachability matrix. Simple transitivity check is done as, if parameter A relates to B and B relates C then A relates to C. This helps in extracting a consistent model from the set of parameters. Summations of row indicate driving power of the parameters and summations of column indicate dependence. Higher dependence rank and lower driver rank indicates dependent parameters, whereas lower dependence rank and higher driver rank indicate independent parameters. Lower dependence and driver rank indicate autonomous parameter, whereas higher dependence and driver rank indicate linked parameters.

(iv)   Level partition
          From reachability matrix, for each parameter, reachability set and antecedent sets are derived. Reachability set contains parameter itself and other parameters to which it may reach. Antecedent set contains parameter itself and other parameters which may reach to it. Depending on intersection of these sets, the parameters are partitioned in hierarchical levels.

(v)   Construction of interpretive structural modelling
          From the partitioned set of parameters and reachability matrix, structured model is derived, indicating parameters in each level and arrows indicating direction of relationship present. Such a graphic representation of model is called diagraph.

The various steps involved in interpretive structural modelling methodology are shown in the flowchart in Figure 3 modified from Kannan et. al [8].
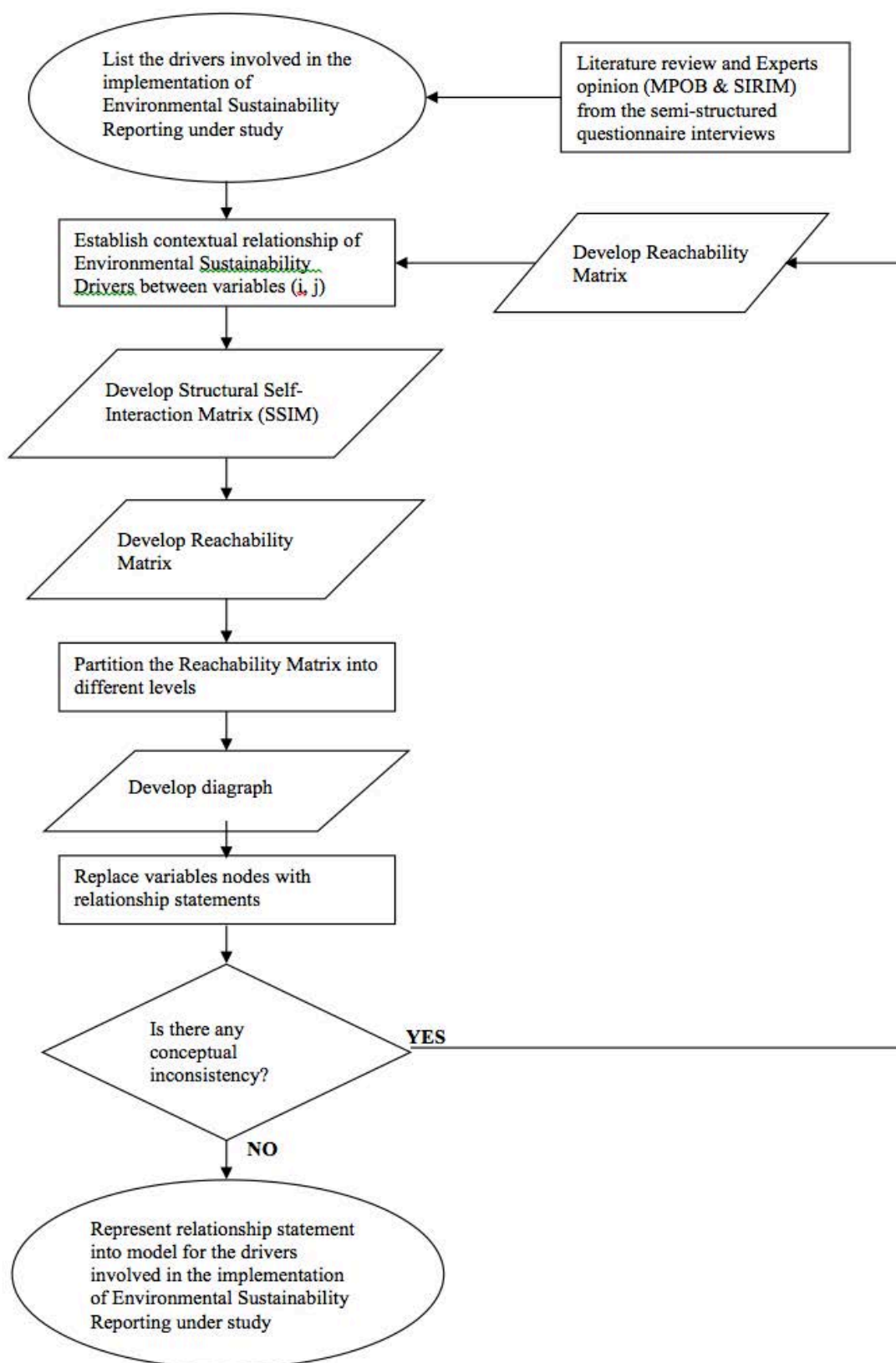
Figure 3: Flowchart of interpretive structural modelling methodology

3   Results and Discussion

3.1 Structural self-interaction matrix

The first step is to analyze the contextual relationship of type "leads to". That is one Environmental Sustainability leads to another. Based on this contextual relationship, a structural self-interaction matrix is developed. In this research, 3 experts, from the research based industries were consulted in identifying the nature of contextual relationship among the environmental sustainability drivers.

Following, four symbols are used to denote the direction of relationship between the Environmental Sustainability Drivers (i and j):

• **V**: Environmental Sustainability Drivers of i will help to achieve Environmental Sustainability Drivers of j

Environmental Sustainability Drivers of i	will help to achieve	Environmental Sustainability Drivers of j
Water, Soil and Air Quality		Climate Change
Renewable Resources		Green Labelling Life Cycle Assessment
Energy Efficiency		GHG Emissions Life Cycle Assessment Environmental Management

Water, soil and air quality (without pollution) determine agricultural sustainability [1, 19] and environmental quality [20] and have impacts on environmental pollution, degradation and depletion of natural and non-renewable resources [21]. Applying renewable resources will minimise pollution and by using green labelling and life cycle assessment will help to provide qualitative and quantitative information regarding consumption of material. Energy use is a major source of emissions, thus achieving energy efficiency is important to control greenhouse gas emissions, assessing life cycle and managing the environment.

• **A**: Environmental Sustainability Drivers of j will be achieved by Environmental Sustainability Drivers of i

Environmental Sustainability Drivers of j	will be achieved	Environmental Sustainability Drivers of i
Renewable Resources		Climate Change
Climate Change		Life Cycle Assessment Environmental Management
Green Labelling		Environmental Management

Concerns about degradation of natural resources and climate change have triggered the need for preventive measures of environmental protection. Promotion of renewable resources and green labelling will be achieved by implementing life cycle assessment and environmental management systems. These will help to reduce the greenhouse effect.

- **X**: Environmental Sustainability Drivers of i and j will help to achieve each other

Environmental Sustainability Drivers of i	will help to achieve each other	Environmental Sustainability Drivers of j
Waste Management		Water, Soil and Air Quality Renewable Resources Energy Efficiency Green Labelling Life Cycle Assessment Environmental Management
Water, Soil and Air Quality		Renewable Resources GHG Emissions Life Cycle Assessment Environmental Management
Renewable Resources		Energy Efficiency Environmental Management
Energy Efficiency		Climate Change
Climate Change		GHG Emissions
GHG Emissions		Green Labeling Life Cycle Assessment Environmental Management
Green Labelling		Life Cycle Assessment
Life Cycle Assessment		Environmental Management

The development of an Environmental Management System (EMS) includes rational land use planning, water management, energy management (promotion of renewable energy sources, promotion of clean and energy efficient technologies), waste management (minimization, recovery, reuse, recycle, etc.) and life cycle assessment.

- **O**: Environmental Sustainability Drivers of i and j are unrelated

Environmental Sustainability Drivers of i	unrelated to	Environmental Sustainability Drivers of j
Waste Management		Climate Change GHG Emissions
Water, Soil and Air Quality		Energy Efficiency Green Labelling
Renewable Resources		GHG Emissions
Energy Efficiency		Green Labelling
Climate Change		Green Labelling

Waste management is regarded to re-use, recycle, repair, life extension, incineration (with or without energy recovery), landfill and composting and is unrelated to climate change and GHG emissions. Water, soil and air quality are referred to unpolluted and emissions which can lead to erosion, climate change and ozone depletion. They are not related to energy efficiency and green labelling. Renewable resources are non-depletable resources which can be used in a cleaner and more efficient technologies

manner and non-related to GHG emissions. Energy efficiency and climate change are not related to green labelling.

Based on expert's responses, the structural self-interaction matrix is constructed as shown in Table 1.

Table 1: Structural self-interaction matrix for Environmental Sustainability

Environmental Sustainability	9	8	7	6	5	4	3	2	1
1.Environmental Management	X	X	X	V	A	X	A	X	-
2.Life Cycle Assessment	X	X	V	V	A	X	X	-	
3.Green Labeling	X	O	V	O	O	X	-		
4.GHG Emissions	O	X	O	V	X	-			
5.Climate Change	O	V	A	X	-				
6.Energy Efficiency	X	O	X	-					
7.Renewable Resources	X	X	-						
8.Water, Soil and Air Quality	X	-							
9.Waste Management	-								

3.2 Reachability matrix

The structural self-interaction matrix for environmental sustainability is transformed into a binary matrix, called the initial reachability matrix by substituting V, A, X, O by 1 and 0 as per the case. The rules for the substitution of 1s and 0s are as follows:

• If the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
• If the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
• If the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1.
• If the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

Then its transitivity is checked (which means if Environmental Sustainability of i leads to Environmental Sustainability of j and Environmental Sustainability of j leads to Environmental Sustainability of i, then Environmental Sustainability of i should lead to Environmental Sustainability of j) and the final reachability matrix as shown in Table 2 is obtained. In this table, the driving power and dependence of each Environmental Sustainability's are also shown. The driving power of a particular Environmental Sustainability is the total number of Environmental Sustainability (including itself) which it may help to achieve. The dependence is the total number of Environmental Sustainability which may help achieving it.

Table 2: Final reachability matrix

Environmental Sustainability Drivers	1	2	3	4	5	6	7	8	9	Driving Power
1.Environmental Management	1	1	0	1	0	1	1	1	1	7
2.Life Cycle Assessment	1	1	1	1	0	1	1	1	1	8
3.Green Labelling	1	1	1	1	0	0	1	0	1	6
4.GHG Emissions	1	1	1	1	1	1	0	1	0	7
5.Climate Change	1	1	0	1	1	1	0	1	0	6
6.Energy Efficiency	0	0	0	0	1	1	1	0	1	4
7.Renewable Resources	1	0	0	0	1	1	1	1	1	6
8.Water, Soil and Air Quality	1	1	0	1	0	0	1	1	1	6
9.Waste Management	1	1	1	0	0	1	1	1	1	7
Dependence Power	8	7	4	6	4	7	7	7	7	

3.3 Level partitions

From the final reachability matrix, the reachability set and antecedent set for each ES is found. The reachability set includes Environmental Sustainability itself and others which it may help to achieve, similarly the antecedent set consists of Environmental Sustainability itself and the other Environmental Sustainability's which help in achieving it. Then, the intersection of these sets is derived for all Environmental Sustainability's. The Environmental Sustainability for which the reachability and intersection sets are same is the top-level Environmental Sustainability in the interpretive structural modelling hierarchy.

Table 3: Iteration i

Environmental Sustainability Drivers	Reachability Set	Antecedent Set	Intersection Set	Level
1.Environmental Management	1,2,4,6,7,8,9	1,2,3,4,5,7,8,9	1,2,4,7,8,9	**I**
2.Life Cycle Assessment	1,2,3,4,6,7,8,9	1,2,3,4,5,8,9	1,2,3,4,8,9	
3.Green Labeling	1,2,3,4,7,9	2,3,4,9	2,3,4,9	
4.GHG Emissions	1,2,3,4,5,6,8	1,2,3,4,5,8	2,3,4,5,8	
5.Climate Change	1,2,4,5,6,8	4,5,6,7	4,5,6	
6.Energy Efficiency	5,6,7,9	1,2,4,5,6,7,9	5,6,7,9	
7.Renewable Resources	5,6,7,8,9	1,2,3,6,7,8,9	6,7,8,9	
8.Water, Soil and Air Quality	1,2,4,7,8,9	1,2,4,5,7,8,9	1,2,4,7,8,9	**I**
9.Waste Management	1,2,3,6,7,8,9	1,2,3,6,7,8,9	1,2,3,6,7,8,9	

The top-level Environmental Sustainability in the hierarchy would not help achieve any other Environmental Sustainability above its own level. Once the top-level ES is identified, it is separated out from the other Environmental Sustainability's (Table 3). Then, the same process is repeated to find out the Environmental Sustainability's in

the next level. This process is continued until the level of each Environmental Sustainability is found. Results for the iteration process are summarized in Table 4. The resulting levels help in building the digraph and the final model.

Table 4: Iteration ii-v

Iteration	ES's	Reachability Set	Antecedent Set	Intersection Set	Level
ii	2	2,3,4,6,7,9	2,3,4,5,9	2,3,4,9	**II**
ii	3	2,3,4,7,9	2,3,4,9	2,3,4,9	**II**
iii	7	5,6,7,9	6,7,9	6,7,9	**III**
iii	9	6,7,9	6,7,9	6,7,9	**III**
iv	4	4,5,6	4,5	4,5	**IV**
iv	5	4,5,6	4,5,6	4,5	**IV**
v	6	6	6	6	**V**

3.4 Building the ISM model

From the final reachability matrix (Table 2), the structural model is generated. If there is a relationship between the Environmental Sustainability's i and j, this is shown by an arrow which points from i to j. This graph is called a directed graph, or digraph. After removing the transitivity's the digraph is finally converted into the interpretive structural modelling-based model (Figure 4).
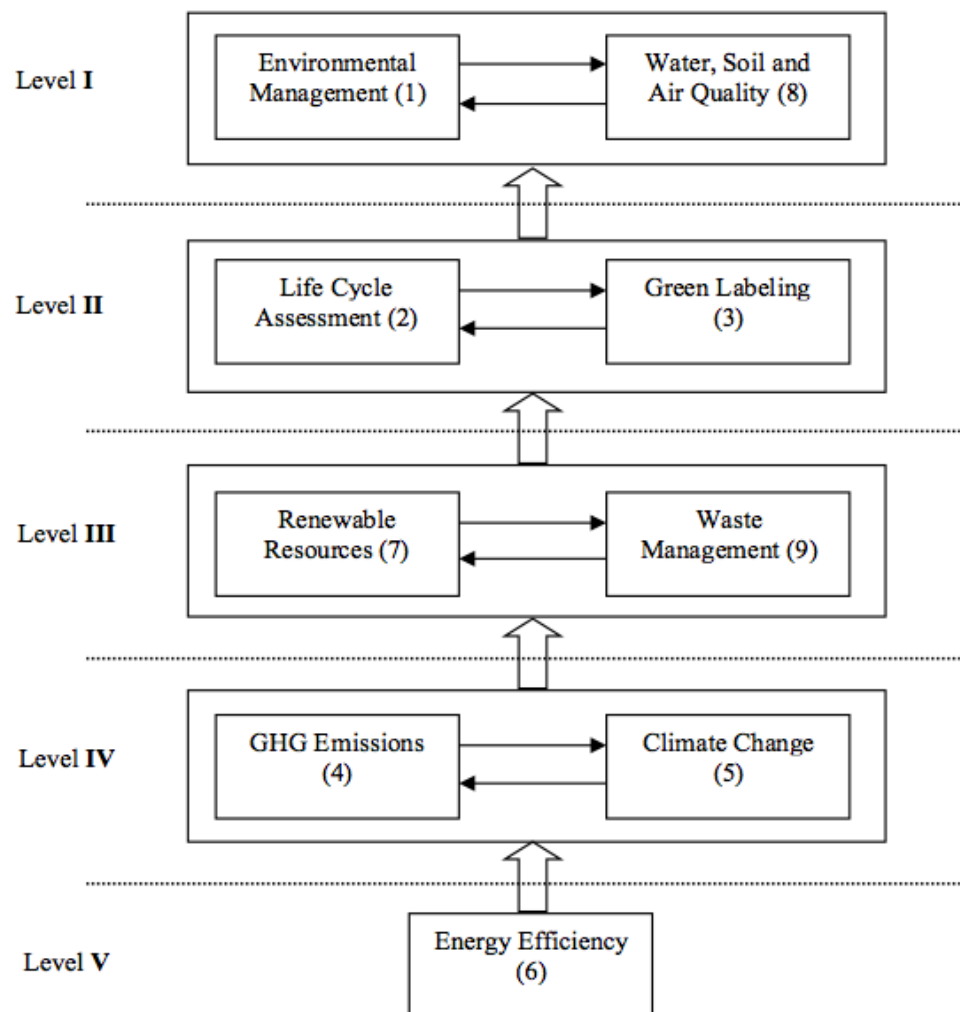
Figure 4: Structural model of Environmental Sustainability Drivers

Several interesting findings for the implementation of environmental sustainability arise from the application of interpretive structural modelling approach. The findings offered new considerations regarding the successful implementation of sustainability reporting. In this analysis, the dependence power and driver power of the variables are analyzed. On the basis of the above study, the drivers were classified into four sectors. The four sectors are autonomous, dependent, linkage, and driver/independent (refer to Figure 5). In the final reachability matrix, shown in Table 3, the driving power and dependence of each of the drivers are calculated. The drivers that have weak driver power and weak dependence will fall in Sector I and are called autonomous drivers. Drivers that have weak driver power, but strong dependence power will fall in Sector II and are called dependent drivers. Drivers that have both strong driver power and dependence power will fall in Sector III and are called linkage drivers. These drivers are unstable due to the fact that any action on these drivers will affect the others, and may also have a feedback effects on themselves. Drivers that have strong driver power but weak dependence power will fall in Sector IV and are called independent drivers [9].
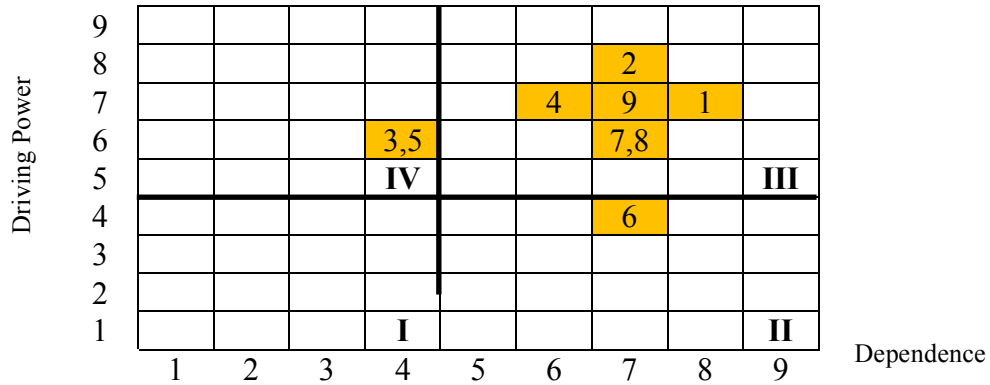
Figure 5: Driving power and dependence diagram

Sector **I**:   Autonomous Driver
Sector **II**:   Dependent Driver
Sector **III**:   Linkage Driver
Sector **IV**:   Independent Driver

3.5 Predicting the palm oil products life cycle to improve sustainability reporting
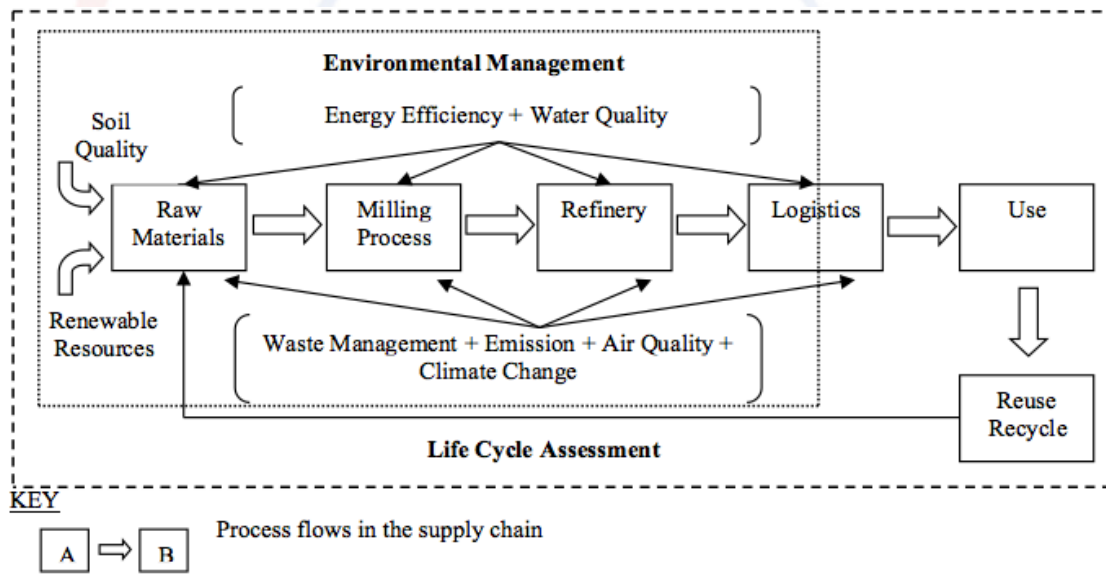
Figure 6: Environmental sustainability reporting drivers in the Malaysian palm oil industry

The drivers involved in the environmental sustainability reporting for Malaysian palm oil industry case study pose considerable challenges. Decision makers must be aware of the relative importance of the various drivers and the techniques for implementing them. Highlighting the 9 types of drivers, an interpretive structural modelling-based model was developed and the interactions between these drivers were analyzed. From Figure 4, it is evident that energy efficiency is the significant driver to reduce and eliminate product environmental impact, which is in tern critical to achieving the sustainability certification between suppliers in the supply chain network. Life cycle assessment, green labelling, renewable resources, waste management, GHG emissions and climate change are placed at an intermediate level of the interpretive structural

modelling-based model. Environmental management and water, soil and air quality are at the top level of the interpretive structural modelling-based model hierarchy.

From the driving power and dependence diagram shown in Figure 5, it is evident that there is no driver that has weak dependence and weak driving power, so there are no drivers that map to Sector I. Next, the energy efficiency driver is found to have weak driving power and strong dependence power so it maps to Sector II. In this case, implementation of environmental management, life cycle analysis, GHG emissions, renewable resources, water, soil and air quality and waste management are found to have strong driving power and strong dependence power so they map to Sector III. These drivers are unstable due to the fact that any change occurring to them will affect other drivers and may be affected through a feedback mechanism [15]. Lastly, the green labelling and climate change drivers possess strong driving power and weak dependence power so they map to Sector IV. The above model is based on the interpretive structural modelling methodology, which has its own limitations. For example there will be subjective bias of the person who is judging the drivers, as the relations among the drivers always depends on that person's knowledge and familiarity with the industry.

Issues of product sustainability are being undertaken in supply chain network by using simulation analysis and subsequently to ascertain a novel approach to outline a guideline of their product life cycle. It is intended that the standard of environmental sustainability reporting can utilize these drivers (shown in Figure 6) as part of a useful guideline to aid decision making. The novelty of this research is that it identifies the significance of environmental sustainability reporting based on the analyzed drivers and provides evaluation of environmental sustainability criteria's. This paper has provided a structural model of environmental sustainability and its associated method was developed by using the interpretive structural modelling model to determine the potential drivers in environmental sustainability reporting. The developed model can be used in the design life cycle of a product whether it is viable to be reused, remanufactured or recycled and subsequently to improve its sustainability. Indicators and units examples of the environmental sustainability indicators and units of life cycle stages related to the Malaysian palm oil industry were shown in Table 5.

Table 5: Examples of environmental sustainability drivers' indicators and units of life cycle stages of the Malaysian palm oil industry

Environmental Sustainability Drivers	Indicators	Units
1) Environmental Management	Compliancy to the Environmental Management Standards	Number or %
2) Life Cycle Assessment	A specific entire product life cycle from the environmental point of view	Number or %
3) Green Labelling	Labels on products indicating carbon footprints, water and energy use, resource consumption and health impacts	Number or %
4) GHG Emissions	Emissions in total	CO_2 equivalent
5) Climate Change	Contribution to global warming	kg/yr or t/yr CO_2 equivalent
6) Energy Efficiency	Energy used in total	TJ/yr
7) Renewable Resources	Rate of renewable resources (relative to total world/regional reserves)	%
8) Water, Soil and Air Quality		
For water	Amount of water used	m^3/yr
For soil	Amount of soil used	ha/yr
For air	Amount of air pollutions	kg/yr or t/yr
9) Waste Management	Amount of solid waste (hazardous or non-hazardous)	kg/yr or t/yr

4 Conclusion

In order to achieve sustainable products, an interpretive structural modelling approach was conducted to better understand the drivers related to environmental sustainability reporting in the supply network chain related to the Malaysian palm oil industry. This paper has identified nine (9) environmental sustainability drivers and the relationships between them. The findings from the environmental sustainability reporting drivers of this study can be furthered use to explore the potential impacts of supply chain network design on sustainability using the Malaysian palm oil industry as a reference.

The decision makers related to the Malaysian palm oil industry will be directly benefited from the outcome of this research, as this would help them in prioritizing decision-making efforts on various issues. The strongest driver in the decision-making process of this industry is energy efficiency. By increasing energy efficiency will help to reduce the impact of energy consumption on climate change. This is perhaps the reason why issue relating to energy efficiency is in the level of the strongest driver. This issue has triggered the next level of issues, which includes greenhouse gas emissions and climate change. As climate change is primarily affected by the greenhouse gas emissions, replacing non-renewable energy with alternative renewable and low impact energy sources can help to increase energy efficiency. The next level of issues as shown in the interpretive structural modelling-based model in Figure 4 covers the issues related to renewable resources and waste management. This level of issues is primarily at the cradle-to-grave life cycle, where efficient use of renewable resources and successful implementation of waste management will ensure long term sustainability achievement. In the next level of issues, life cycle assessment and green labelling are applicable to provide an assessment of the potential environmental impacts of all inputs and outputs throughout the production chain and to produce environmental friendly products. The final issues are the environmental management and water, soil and air quality which are important to access environmental impacts and to prevent contamination.

As for further research, simulation analysis can be carried out to determine the influence effect of these drivers had on the performance of the network. From the performance analysis, focus can be better made on the sensitivity of triple bottom line to factors of uncertainties of the supply chain network in order to understand the potential risks of sustainability in palm oil supply chain network and could be diagnosed for better sustainability development indicators.

Acknowledgement

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Finding Balanced Synergies- Putting Resilient Sustainability into Business and Technical Strategy

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Abstract

Whilst some pioneer businesses have integrated sustainability into their fundamental strategic decisions this can be a difficult task. Our recent review indicates a blend of both sustainability and resilience is needed, to ensure the reliable synergy of reduced impacts and improved performance which make up sustainable business. This is supported by recent evidence that organisations which do implement such Resilient Sustainability flourish compared to their peers, by benefiting from better risk awareness and avoidance, reduced costs, maintained access to investment, flexible solutions and improved ability to exploit opportunities. However not much detailed help is available for less well-resourced firms on how to implement such an integration and access those benefits.

The paper reports on the development and testing of a new generic flexible approach to decision-support which aims to integrate sustainability and resilience into strategic processes. It is based on techniques from complex systems engineering and influenced by best business practice such as Porter and Kramer's Creating Shared Value. This allows decision-makers and their teams to approach commercial and technology strategy formation in a new structured way, to identify gaps in their knowledge and create more resilient options which better balance people, planet and profit.

The research uses case studies to test the approach, within Ford Motor Company and other organisational strategy contexts. The paper summarises the findings to date, including user feedback and evidence for how the approach can deliver increased capability for managing risks and uncertainties and thus improve an organisation's strategic performance.

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1.0 Introduction

Sustainability is increasingly a strategic issue for companies (Haanaes et al., 2012) and those which are more sustainable perform better than competitors (Eccles et al., 2012). They also need resilient strategies to maintain this performance in turbulent business conditions (Hamel and Välikangas, 2003, Bhamra et al., 2011, Taleb, 2008). Blending both qualities when making decisions is difficult yet guidance for how to do this- or even half of the task- has been almost non-existent (Bocken et al., 2013, Winnard et al., 2014). Even where executives acknowledge the strategic importance of sustainability issues for their organisations, many are not yet addressing these (Kiron et al., 2013).

Companies also cannot afford to develop every feasible single technology, business model or product option and must choose between alternatives, often at an early stage of their strategy. Therefore a new approach is needed to make the integration of sustainability and resilience into these choices more consistent and easier (Winnard et al., 2014).

1.1 Developing the new decision-support process

The first step was to define sustainability and resilience. It is possible to define sustainability for businesses, based on reducing their negative and improving their positive social, environmental and economic impacts and prioritising those actions which restore various forms of capital (*ibid.*). Definitions for strategic business resilience vary; possibly because it appears to consist of three main elements. Combining these gives a definition covering the capacity to continue functioning when suffering a disruption of some kind; further capacity to recover from disruption, and *adaptive capacity* for developing new abilities and resources, preferably in anticipation of problems (*ibid.*). The synergy between resilience and sustainability is not much explored but is best expressed by Walker *et al.* (2002) who suggests resilience should be developed in order to deliver sustainability reliably.

1.2 How this new approach benefits companies

The new blended approach was named SuReSDS™ (for Sustainable Resilient Strategic Decision-Support). In every-day business terms its purpose is to facilitate companies in managing forms of strategic and other risk better, which arise as a result of unknowns. This can be shown in the form of a "Rumsfeld" grid as in Figure 1 describing different kinds of uncertainty and risk, named for Rumsfeld's famous speech (Pullum, 2003, Steyn, 2003).
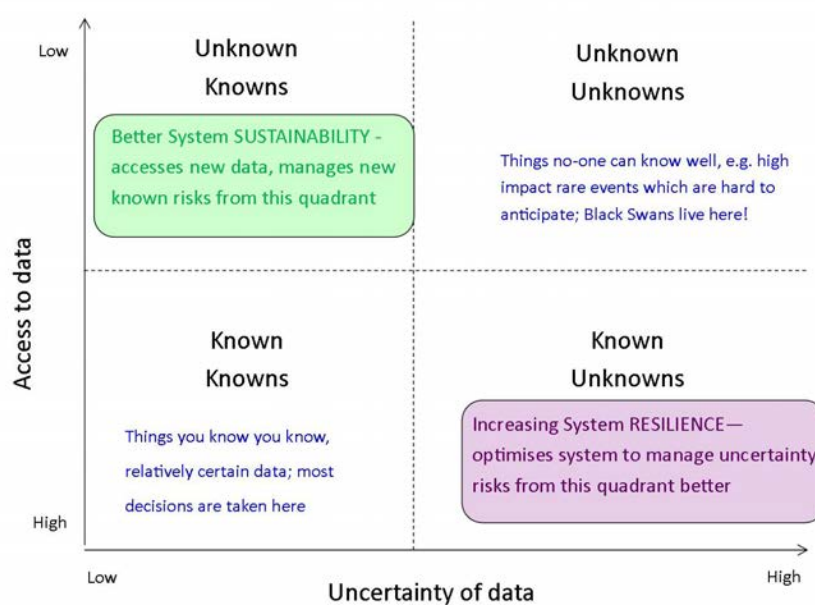
Fig. 1- Effects of SuReSDS™ on risk from unknowns

"Unknown Knowns" represents data which may be available to other organisations but not your own, for example if you are not using sustainability expertise to inform corporate strategy. "Known Unknowns" indicates chaotic random elements of the business context about which there is some information, but low certainty; for example the size and timing of commodity price fluctuations. By expanding the organisation's capability to manage these two areas, its resilience to disruptions is improved; its sustainability risks are reduced, opportunities exploited better, and surprises have less of an impact on business performance. Although little or no data exists about events in the "Unknown Unknowns" area, the capability to handle these is also improved. The organisation becomes more capable in the other areas; therefore it becomes more resilient to the effects of some types of uncertainty and risk which also occur in this fourth category whether or not they can be anticipated.

1.3 SuReSDS process flow

Developed during research hosted by a manufacturing company (Ford Motor Company Ltd), the approach blends the sustainable business ethos of Creating Shared Value (Porter and Kramer, 2011) with strategy creation and comparison techniques from Transition Engineering (Krumdieck, 2013). In addition system-functionality techniques adopted from Robustness Design engineering (FMC, 2011) look rigorously at how each choice improves both sustainability and resilience. The ultimate aim is to identify the most appropriate strategy option(s) for users to adopt across a range of possible future conditions, by considering a broad range of sustainability performance criteria, alongside effects of the strategies on resilience related to risks and opportunities. The main stages are shown in Figure 2.
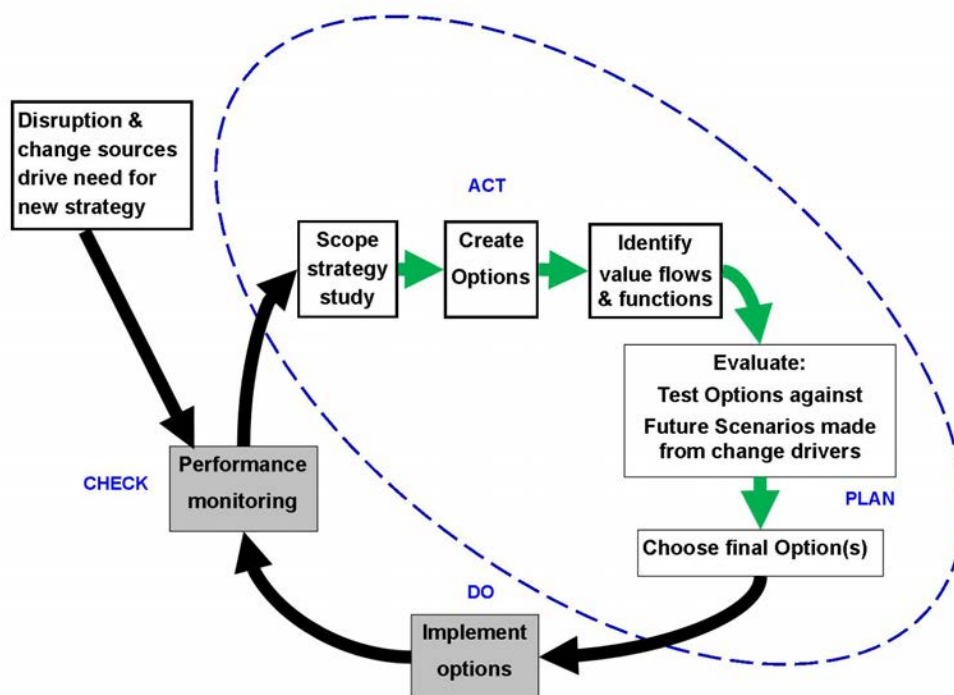
Fig. 2– SuReSDS™ process (inside dotted line) inserted into a typical Deming-style strategic decision-cycle (adapted from Arveson, 1998)

The process flow for the new approach was developed using a pilot case study, into a more detailed set of steps which could be communicated to company staff. These are shown in overview in Figure 3. The intervention point for this project, at which the new process could effectively be inserted within company activities, was identified using semi-structured interviews and meeting observations. This point was the use of strategic studies, in which teams of engineers, specialists and managers prepare information and recommendations for decision-makers at higher levels. This information is used in iterative, multi-level and multi-function decision-making loops to alter or create strategies at Ford, which may concern technologies, products and services or even business models.

2.0 Testing the new process

Next a process instruction manual and some simple training examples were created. Further case studies inside Ford were used to test its validity in real situations and to investigate whether it could provide the desired beneficial effects for its users. As many of Ford's strategic decisions are on future products which are commercially sensitive, and this limits the ability to publish the research results, further organisations were approached for case studies. These consisted of a nearby (non-automotive) Small to Medium-sized Enterprise (SME) manufacturer, and a non-educational department of the University.

Managers and their teams were chosen for participation in the research who said their teams already encountered issues associated with environmental or social impacts of their organisation's activity or products, and who therefore had an interest in

integrating these issues within their work. Interviews recorded their existing approaches to strategic studies and strategic decision-making, before training the teams in the new process using a facilitated workshop.
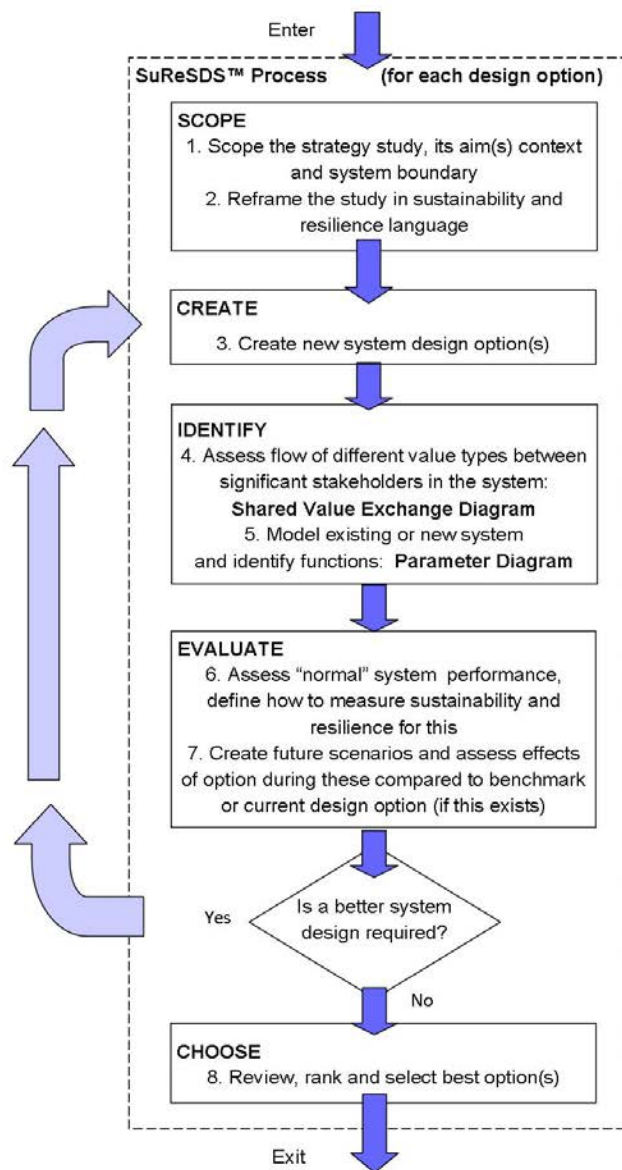
Fig. 3– The 8 steps of the SuReSDS™ process flow

The teams then applied the SuReSDS™ approach to a real-world strategic study they were working on, facilitated and observed by the researcher. After either a complete pass of the process steps, or as many as could be accommodated in the available time, feedback was sought using a short questionnaire and further interviews.

3.0 Case study results

The case study samples which have been completed and analysed so far have ranged from early product-service concepts, through business plans and technology roadmaps, to capital-asset planning strategy processes. The original pilot case study at

Ford provided confirmation that the approach was logically valid within quantitative studies, by reproducing results from a previous study, before exploring which extra insights might be gained from using SuReSDS™. As a result of the aforementioned confidentiality concerns, this paper illustrates the results primarily using an early case sample where SuReSDS™ was used at the SME.

3.1 Butyl Products Ltd case study

Butyl Products Ltd is a medium-sized UK manufacturer serving several sectors. Amongst these they make aid and development equipment for charities, governments and other organisations, focussing on kits for water-related needs such as sanitation and hygiene. The study concerned the business case for, and design of, a new product, which the company wished to offer in response to an unmet hygiene need for end-users identified by customers at a recent sector workshop. This case sample was also a pilot study in that this was the first time the approach was utilised by ordinary business people outside the research project.

There were two elements to the case study design:
•   Checking that SuReSDS™ would reproduce similar results during its process, to an original qualitative analysis; to show whether as an analysis approach it is logically valid.
•   Testing whether SuReSDS™ produced extra information and insights. This investigated whether it enabled users to integrate resilient sustainability into their strategic choices as intended, and whether it produced extra benefits to justify the effort required to use it.

3.1.1 Methodology for applying SuReSDS™

The new approach was applied to existing strategic information from a current product and business-model study, by the researcher and a specialist from the SME together. An initial analysis was produced, and the results compared to the existing study. The analysis was then extended using SuReSDS™ to look at product function, sustainability, and resilience to issues in the field. This analysis was conceptual (for a new product-service idea) and therefore qualitative rather than quantitative. The specialist was interviewed afterwards to see how useful the experience of using SuReSDS™ had been. They were asked whether it had made the decision process easier and whether it had influenced the choice of strategy, or improved business performance.

3.1.2 Scope phase

The case is explained here in terms of the process steps of the new approach. The first phase is intended to clearly define the purpose of the strategic study, and to set the boundaries of the business model, product or service, or technology to which it is being applied (that is, the *system* which the strategic decision is seeking to change). It seeks to reframe the study in terms of sustainability and/or resilience issues or opportunities, to check that use of SuReSDS™ is appropriate and necessary.

The design problem to which the process was applied at Butyl Products Ltd relates to menstrual hygiene in aid camps and development projects all over the world. Butyl's

clients had identified a "wicked problem" in that young women in developing nations can experience problems managing their menses discreetly, frequently staying away from school and other public activities for up to a third of each month. This means they fall behind and often drop out of general education and development projects. This matters because it undermines the social and economic development these projects are meant to support; both generally and for individual females.

Hygiene kits for aid and development treat menstrual hygiene as less important than survival and tend to contain either nothing, simple cloths, or at best Western-style adhesive disposable paper pads. These lead to several issues:

- A complete absence of menstrual hygiene supplies does nothing to alleviate the related issues for women and girls receiving kits.
- Cloths are washable so re-useable and cheap but do not work very well as they are not secure and do not stop leaks. Kits may also lack instructions and cloths may not be laundered or can end up being used for other things.
- Stick-on disposable pads attach to underwear during use and function well; except for cultures which do not wear underpants. Here even if underwear is also supplied, this and the pads are rarely used.
- Even where they are used, the disposable pads create hygiene and waste problems when disposed of after use, and users must be resupplied with new pads at further cost and logistical difficulty. When the camp closes or development project finishes, there may not be a further supply of items and project benefits may be lost.
- Finally there is a common set of issues; lack of hygiene education and lack of suitable materials, or unhygienic use arising from any of these kit options means women and girls using various unsuitable materials and methods to manage their menses. The resulting poor hygiene is thought by Non-Governmental Organisations (NGOs) to account for a significant proportion of female infections and diseases in some countries.

The company's clients at the sector workshop identified from this that they needed:

- A new design of menstrual hygiene kit which works in all cultures but also functions well generally
- To be combined with hygiene education
- And which is also low-cost enough to be used everywhere, to avoid complexity and related costs in NGO distribution and supply chains.

The NGOs and other sector organisations would supply the education side but needed their suppliers to come up with solutions for the physical items. From this Butyl had identified a potential solution but wanted to check if their intuition that it was the best suitable design solution was correct. They also needed to investigate the business case to see if the required investment in prototypes and business development was justified.

Working with the relevant specialist at Butyl, the case study was identified as seeking to primarily solve a cultural resilience design issue. This was that the best available solution for menstrual hygiene kits, stick-on pads, does not work in some cultures and so this undermines the function of the kit and other aid or development project effectiveness. The design is of a Product-Service System (PSS) in that the pads are providing the service of discreet menstrual hygiene management. This service can be

thought of as the "function" of the PSS, which currently has social (cultural and also various hygiene) issues. The wish of the client NGOs was that these issues should be solved whilst improving (or at least not worsening) the environmental (mainly disposal) and economic (user purchase and/or donor cost) impacts of the system. Therefore the study was confirmed as containing both resilience and sustainability concerns, and so being suitable for applying SuReSDS™.

3.1.3 Create Options phase

If the organisation does not already have strategy or system design options in mind, at this stage some initial options should be created using the simple results from the scope phase. To assess any such option it is necessary to find something to compare it with; either the existing situation without the new design/strategy if it is new, or some existing variant if it is an improvement. The results of other phases of the analysis process can also trigger ideas for more changes leading to further improved function or reduced negative impacts, creating new versions of existing options. In this way SuReSDS™ has been designed from the start as an iterative process.

In this case study the company had identified a solution using a combination of design elements from existing products. They had one design concept which they could supply to customers, and so in order to analyse its benefits it was decided to compare it with the best available external option. The new design was a washable re-useable set of fabric pads combined with an elastic belt, storage bags and laundry soap. The pads were absorbent but shaped and had a waterproof layer (taking the best elements of the paper pads to provide a good basic functionality), and the elastic belt had loops and clips to secure the pads without underwear (borrowing from another older type of paper pad). The use of tough, stain-proof but soft and absorbent fabrics plus storage bags and soap allowed clean and soiled pads to be kept separate, and soiled ones washed for reuse, many times.

Other existing hygiene products such as tampons, washable internal cups or clip-on washable pads, were considered but rejected due to one or more of the following issues:
- Products which are inserted are not acceptable within all cultures
- Inserted products also pose a larger hygiene risk whether or not they can be washed and reused
- Clip-on pads even if washable still need underwear to work

Additionally, some suppliers reviewed or approached to explore sourcing parts of the new design were either uninterested, too small or deemed unreliable commercially.

This left one design and the need to set up a new supply chain to deliver it. The best existing design to which it could be compared was the adhesive disposable paper pads. These have absorbent paper layers with a waterproof backing, adhesive, and packaging. Although the study was conceptual there was sufficient information now available to progress with an analysis. One intention of SuReSDS™ is to allow this type of qualitative analysis which can highlight where further quantitative information is needed.

3.1.4 Identify Stakeholders and Value Flows phase

To compare the different PSSs meaningfully a common basis was needed- a Unit of Analysis similar to that used in Life Cycle Analysis (Baumann and Tillman, 2004). This unit was identified as supplies for one woman for one year- also implying that one new re-useable kit must last for at least this long. The paper pads would have to include 13 sets of 12 to 20 pads for one year. In order to analyse the effectiveness of the new option against this requirement and the external best-existing system, it was next necessary to identify which people and entities (stakeholders) are significantly affected positively and negatively by the system (in this case the menstrual pads PSS) and its functions or malfunctions.

This phase applies Creating Shared Value principles (CSV, Porter and Kramer, 2011). This seeks solutions to social and environmental problems or opportunities to exploit in these areas, to gain competitive advantage by producing more sustainable strategies, products and services. This analysis was developed as a map of stakeholders to identify the flows of different types of value (including social and environmental, positive and negative) between them. The different stakeholders are viewed as belonging primarily to one of the Triple Bottom Line (TBL) categories (Elkington, 2004) of society, economy or environment; according to the main impact the system has on them. E.g., consumers are part of the economy but they hand over their economic capital (money) in order to receive a social service or product and therefore would be placed in the "society" group. The environment (local and/or global) does not in itself own money, but resources are extracted from it, and waste and pollution returned to it, as a result of the lifecycle of economic goods and services. Organisations may represent it as proxies, by passing laws, exacting fines and sanctions or applying societal pressure.

Due to the need to consider the lifecycle impacts of the PSS designs, it was decided that only direct and significant effects of the system could be included on the value flow diagram to avoid overcomplicating it. Effects on areas of the environment such as air pollution do feed back into negative health impacts on all of society; these have to be borne in mind when considering the analysis but are indirect. Both options were analysed, then compared using the value flow map shown in Figure 4. The two designs are shown photographically in Figure 5.

By considering the flows of value the system causes or enables, it is possible to come up with system designs which reduce negative impacts and improve positive ones. Effectively these are looking for more sustainable solutions by better balancing the TBL outcomes or looking for innovative synergies which benefit all areas where possible. In Figure 4 the arrows show flows of value between the stakeholders most significantly affected. The symbols show the estimated relative effect of the new design compared to the old. A + or ++ indicates a smaller or larger increase in the *magnitude* of a flow, and so on, whilst the symbols are colour coded to indicate whether this is considered a good or bad thing from the viewpoint of sustainability. +/- indicates an unclear outcome needing more work to quantify.
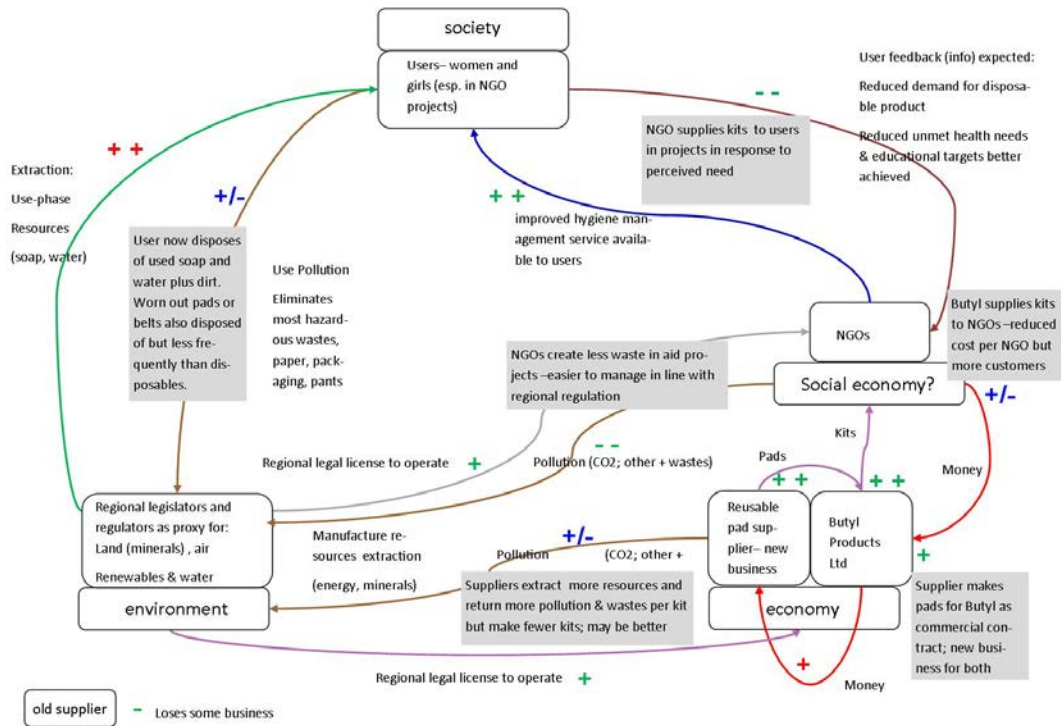
Fig. 4- Value flow map for menstrual hygiene kit comparison

Fig. 5- existing design (left, disposable sticky pads) and new design (right, washable fabric pads and belt)

It was later found that this judgement on the changes may vary according to whose viewpoint is adopted- the NGO, the supplier or the user may have a different view of economic impacts in particular, for example. One party may view them as a burdensome cost and another see them as valuable income. The assessment of social and environmental impacts so far has not been as likely to change with changing

viewpoints. The diagram in Figure 3 is drawn from the viewpoint of Butyl Products, as the organisation conducting the analysis.

In this exercise a number of advantages were confirmed for the new design in reducing the major social and some environmental issues. However it also highlighted trade-offs in impacts. The new kit is likely to be more resource-intensive per pad, using fabric, and uses soap and water to clean them; but it also uses far fewer pads in a year and very few are disposed of to the local environment or waste system. When the pads are used in aid camps they would need to be provided in tandem with washing facilities and water. Their appropriateness and associated water impact in development projects is more difficult to assess and will depend on water scarcity and other projects occurring in parallel. This is more a matter for the NGOs to consider but indicates that choices made using SuReSDS™ can be context-dependent. More quantitative information on the lifecycle impacts from each design and the changes in specific impact types, possibly in location-specific analyses would be needed to assess whether the new design represents a general improvement in environmental terms.

Other outcomes were that it is not clear whether NGOs such as charities sit in the "society" or "economy" group of stakeholders. In this case study the differing assessment of strategy effects on certain value flows was not an issue so long as the organisations (in this case both the client NGO and supplier Butyl) seek to balance the benefits and downsides to themselves and other stakeholders; and provided that all the significant stakeholders are included in the analysis. After all, Shared Value proposes exactly this balancing act for companies to become more sustainable (Porter and Kramer, 2011).

3.1.5 Evaluate Options Against Scenarios phase

The PSS function could now be considered in more detail to assess how its resilience can be improved. This phase uses a simplified Parameter Diagram borrowed from Taguchi's robustness engineering (Karna and Sahai, 2012, FMC, 2011). Using the value flow diagram as the context for the PSS, different elements of its functional design, its input and outputs were identified. This also allowed consideration of feedback effects between different aspects of the system, and which parts of the system design were truly able to be altered by the organisation (Butyl).

It was now possible to define both resilience and sustainability more specifically using the Parameter Diagram. Sustainability is effectively measured within it by the ratio between all of the beneficial impacts of the outputs of the system's function (the *desirable outputs* in Figure 5) and all of their negative impacts (*undesirable outputs*). This could be expressed using a mix of all the TBL types of value or checked by selecting only items which the strategies affect differently. All of the value flows from the previous phase appear in the diagram as one or other type of output. As before, no definite measurements for these value flows existed and only the likely effect of different strategies on these value flows could be considered.

Similarly resilience is the ability of the system to maintain this level of sustainability when disturbed by one of its inputs. This might be a *signal* (something the system is designed to respond to) or a *noise* (something it should ignore). The simplest form of resilience measure is therefore how much the output performance changes in *response*

to an input changing- another ratio representing short term or innate resilience. Over the longer term the system may also *recover* and *adapt* which allows for other measures of resilience.

In this case the resilience of interest was the immediate ability of different cultures to use the hygiene kit pads. The populated Parameter Diagram is shown in Figure 5. As before the new and existing designs were compared, and the flows marked with +/- symbols using the same logic.
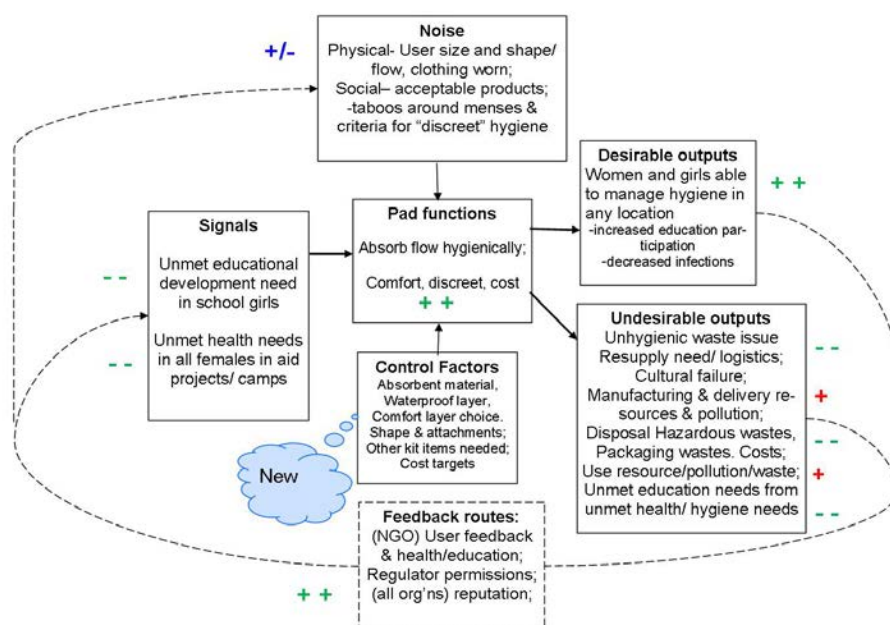
Fig. 6- System Parameter Diagram analysing function of new menstrual hygiene kit

By looking at how local culture might affect users of the pad, the resilience of the new design could be checked against these. This was effectively forming very simple scenarios of future use in the field. The main signals were the presence or not of underwear, and the new design was confirmed to work better than the old one. However other noise factors were also identified such as the size and shape of users or the intensity of flow they must manage, and these led to some improvements in the physical design and therefore function of the new PSS. The possible need for an ethical supply chain was also highlighted as a potential demand of customer NGOs. This last is probably not a concern for the users but does concern Butyl as the supplier. Figure 6 is also drawn from their perspective.

Once the strategic alternatives have been analysed, users should check that their strategies do improve the performance of the product, service or business model as needed. If not, the SuReSDS process prompts them to return to the hunt for better options. The exception is if the existing strategy is already the best available one.

3.1.6 Choose Option phase

Butyl Products Ltd did not have many strategic options to select between- their decision was whether to develop their design and enter a new part of their market, or

not. Therefore a full comparison grid was not created. When comparing multiple strategies companies would normally use a comparison matrix adapted from Transition Engineering (Krumdieck, 2013, pp 722-728) or a version of their normal format for strategic comparisons, to select their best option.

The specialist at Butyl reported that they individually found the new approach enabled a methodical approach to a complex set of issues. It gave them confidence that they had found the best PSS design, and provided missing information to help them make a strong business case. The staff at the SME generally felt that the exercise was worth the effort and used the extra information to help specify product criteria (e.g. target costs and technical performance) develop prototypes, identify suitable suppliers and approach potential customers.

4.0 Discussion of results

SuReSDS™ reproduced a description of social and environmental issues surrounding the current product, and modelled conceptually how a new product-service system (PSS) might address these. It also allowed a more detailed exploration of how the compared designs affect different stakeholders, and where the new version could improve both sustainability and resilience of the PSS. Additionally some possible negative impacts and context-specific aspects were discovered that required more investigation, to quantify any trade-offs. This allowed the advantages and disadvantages of the new design to be included in a business case and a strategy decision. Finally this study produced clear real-world impacts, assisting in the development of a new more resilient and socially sustainable product.

In terms of Figure 1 the case study succeeded in integrating sustainability and resilience thinking into organisational strategy to manage risks from both negative impacts and uncertainties. This allowed Butyl to make a strong case to customers, resulting in expressions of customer interest; which demonstrates some immediate benefits to the company.

4.1 Other case study results

Two subsequent studies at Ford looked at innovative product designs using trained participants facilitated by the researcher. These showed that the approach is transferrable by training, whilst users again reported that they were better able to tackle sustainability and resilience-related strategy tasks using SuReSDS™. The information derived was used directly within their real-world projects and highlighted a number of extra opportunities and risks which they were then able to exploit or ameliorate. Further case study samples are planned at Ford, University of Surrey and the SME with trained participants, facilitated and observed by the researcher.

5.0 Conclusions

SuReSDS™ appears to deliver the intended immediate benefits to decision-makers. It has affected some of the choices made in this and other case studies, by identifying new opportunities or risks and providing a methodical comparison of strategic options. If these results are supported by the other case studies the implication is that the approach is suitable for use in both large and small suppliers of PSSs, and possibly

other types of organisation. One limitation however is that companies may need to import or develop sustainability and resilience expertise to be able to continue to use the approach.

Resilient Sustainability as deliverable by SuReSDS™ should therefore provide a competitive advantage to its users by allowing them to integrate sustainability into their strategy more easily and reliably than before. It allows them to look for better synergies between their economic gain and the social and environmental value they deliver to stakeholders. However SuReSDS™ has been designed for organisations which were not previously able to do this; different industries may be better or worse equipped than automotive giants and small manufacturers. It also assumes that the organisations using it wish to integrate sustainability into their decisions; any tool can of course be subverted by a different purpose than that intended. The suitability of SuReSDS™ for other sectors and more firms is one future area for research, together with exploring larger sample sizes.

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Decolorization of Methyl Orange Dye by Laccase Immobilized on Histidine Modified Chitosan

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Abstract

A large number and quantity of synthetic dyes are being increasingly used in the textile, paper, pharmaceutical, cosmetics and food industries. Discharge of dye effluents into the natural streams is toxic to the aquatic lives. Hence, removal of these dyes from industry effluent is a critical issue. Enzymatic oxidation of the dye using oxido-reductases such as laccases has received great attention in recent years due to the efficient decolorization of the effluent. Immobilization of these enzymes is potentially more cost effective as it would allow their reused and may improve enzyme stability.

In the present study amino acid modified chitosan beads for immobilization of laccase from *Trametes versicolor* were prepared by activation of a chitosan backbone with epichlorohydrin followed by histidine coupling. The beads were characterized by scanning electron microscopy and fourier transform infrared spectroscopy. Laccase was immobilized onto histidine modified chitosan beads by glutaraldehyde crosslinking method and its activities were assayed. Immobilization yield and enzyme activity per gram carrier were recorded 59% and 2.84 U/ g carriers, respectively. Compared with free laccase, immobilized laccase was less sensitive to changes in pH and temperature, thereby exhibiting higher stability and reusability. The immobilized laccase was applied to decolorization of methyl orange dye. The maximal decolorization efficiency of %90 was achieved at optimized conditions (pH 5.0, 30 °C) in 24 hours. These results demonstrated that the features of this immobilized enzyme are very attractive for their application on the decolorization of dyes in textile industry.

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1. Introduction

In recent years, there have been increasing environmental and toxicological interests about wastewater from textile industries due to their widespread occurrence and relative frequency in the aquatic environment. The use of oxidative enzymes such as laccase for the treatment of wastewater from textile industries has received great attention because of the efficient and low-cost degradation of the pollutants [1-3]

Effluents produced by textile industries are often strongly colored and their disposal into receiving waters causes environmental damage, including significant impacts on the photosynthetic activity of aquatic plants due to reduced light penetration. High concentrations of such dyes can cause water borne diseases and increase the biological oxygen demand (BOD) of receiving waters [2]. Wastewaters from textile dying process are usually treated by physical- or chemical-processes, which include physical–chemical flocculation combined with flotation, electro-flotation flocculation with $Fe(II)/Ca(OH)_2$, membrane-filtration, electrokinetic coagulation, electrochemical destruction, irradiation, precipitation or ozonation, [2,3]. However, these technologies are usually inefficient in the removal of colour, costly and difficult to adapt to a wide range of dye wastewaters. Alternatively, dye decolorization using microbial enzymes, such as free and immobilize laccases, has received great attention in recent years due to its efficient application [3].

Immobilization can be defined as the fixation of the biocatalysts (e.g. enzymes, microorganisms and organelles) to insoluble solid supports. The most important advantage of immobilization is that it makes continuous bioreactor operations possible and this is especially useful in the production of fine chemicals and bio-treatment of industrial and agricultural wastes [4].

Immobilized enzyme has many operational advantages over free enzyme such as reusability, enhanced stability, continuous operational mode, rapid termination of reaction, easy separation of biocatalyst from product and reduced cost of operation. Enzymes may be immobilized by a variety of methods, which may be broadly classified as physical, where weak interactions between support and enzyme exist, and chemical, where covalent bonds are formed with the enzyme [1-7]. To the physical methods belong: (i) containment of an enzyme within a membrane reactor, (ii) adsorption (physical, ionic) on a water-insoluble matrix, (iii) inclusion (or gel entrapment), (iv) microencapsulation with a solid membrane, (v) microencapsulation with a liquid membrane. The chemical immobilization methods include: (i) covalent attachment to a water-insoluble matrix, (ii) crosslinking with use of a multifunctional, low molecular weight reagent, and (iii) co-crosslinking with other neutral substances.

Laccase (benzenediol:oxygen oxidoreductase, (EC 1.10.3.2) is a multi-copper oxidase produced by many plants and numerous fungi and it is able to oxidize a wide range of xenobiotic compounds such as synthetic dyes, chlorinated phenolics, and polycyclic aromatic hydrocarbons. The rather relaxed substrate specificity of laccase in conjunction with appreciable stability properties has suggested its potential use in biotechnology and its effectiveness in regiospecific biotransformations, biosensor constructs as well as in biobleaching, in particular, in wastewater treatment [8–12],

has been extensively reported. Laccases could immobilize on different carrier for mentioned purposes.

Enzymes have been successfully immobilized on many different types of organic or inorganic (natural or synthetic) carriers, such as modified chitosan, cellulose, alginate, controlled porosity glass, activated carbon, acrylic beads, magnetic-chitin particles, clay, silica nanoparticles, bentonite, perlite, amberlite. In fact, immobilization can protect enzyme from denaturation by organic co-solvents, thereby extending its half-life, and allows the reuse of the enzyme in several reaction cycles [12-15]. An additional advantage due to immobilization is the ease of separation of reaction products from the heterogeneous catalyst.

Chitosan is a cationic biopolymer obtained from alkaline N-deacetylation of chitin, the second most abundant biopolymer in nature and supporting material of crustaceans, insects, etc. Chitosan is well established as an excellent natural carrier because its amine (–NH$_2$) and hydroxyl (–OH) groups may serve as coordination sites to form complexes with various enzymes. Chitosan is soluble in most dilute mineral acids. Consequently, its chemical stability needs to be reinforced through treatments using crosslinking agents for application in acidic media. Thus, some chemical and physical modifications of chitosan have been prepared as carriers for enzymes [14-17].

In our study, modified chitosan beads were prepared as a carrier for immobilization. *Trametes versicolor* laccase was immmobilized on modified chitosan beads and some characterization of immobilized laccase were investigated. In addition, the decolorization efficiency of the immobilized enzyme was studied in the presence of methyl orange in a batch system.

2. Experimental

2.1. Materials

Fungal laccase from *Trametes versicolor* was supplied by Fluka (Buchs, Switzerland) (EC 1.10.3.2) and stored at -18°C. ABTS(2,2_-azino-bis-(3-ethylbenzthiazoline-6-sulfonic acid), dopamine chitosan, glutaraldehyde (%25), sodium triphosphate pentabasic (TPP), comassie Brilliant Blue G-250, nano clay were obtained from Sigma Chemical Co. (St. Louis, MO, USA). Acetic acid (%100) and all other chemicals were obtained from Merck AG (Darmstadt, Germany).

2.2. Methods

Laccase immobilization on modified chitosan beads and characterization
Chitosan was obtained using a method adapted from Zeng and Ruckenstein [17]. Chitosan was dissolved in acetic acid (2% v/v) solution producing 2.5% (w/v) solution. The viscous solution was left overnight before adding drop wise into a sodium triphosphate (TPP) (pH was adjusted to 8.2 by 0.1 N HCl) solution. Beads were stirred 4 hours for hardening and then the beads were filtered and washed with distilled water. The crosslinking of chitosan by epichlorohydrin was carried out as described by Bueno et al. [18]. After this procedure, the beads were washed with ultrapure water until reaching neutral pH, indicating that excess of epichlorohydrin

was removed. The linkage of histidine was performed using similar procedure that described previously [18]. After this time, beads were washed until excess of non-immobilized histidine was washed out. Laccase (1mg/ml) was immobilized onto histidine modified chitosan beads (0.05 g) by glutaraldehyde crosslinking method at 25°C and its activities were assayed. The beads were washed with 0.1 mM acetate buffer and were stored in acetate buffer at 4°C until use.

The activity of free and immobilized laccase was determined spectrophotometrically at 420 nm with 1 mM ABTS as substrate in 0.1 M acetat buffer (pH 5.0) at 30 ºC [19]. The oxidation of substrate to $ABTS^+$ was measured for 3 min using a UV–vis spectrophotometer (Perkin Elmer), with the molar extinction coefficient of 36 x10^3 M$^-$^{1} cm^{-1}. One unit (U) of laccase activity was defined as the amount of enzyme needed to oxidize 1 μmol of ABTS per minute. The activity recovery of the immobilized enzyme is calculated from the following formula:

R(%): (Ai/Af) x100

where R is the activity recovery of the immobilized laccase (%), Ai is the activity of laccase immobilized on modified chitosan beads (U), and Af is the activity of the same amount of free laccase in solution as that adsorbed on particles (U).

Fourier transform infrared (FTIR) analysis was accomplished on a Perkin Elmer spectrum BX scanning from 4000 cm^{-1} to 400 cm^{-1} at room temperature. The surface morphology of the beads was examined under scanning electron microscopy (SEM) (XL30-SFEG, FEI/Philips).

The effect of pH on activities of immobilized laccase were determined by using 1 mM ABTS substrate prepared in buffer at pH 3.0-8.0. The effect of pH on activities of free and immobilized laccase were determined by using 1 mM ABTS substrate prepared in 0.1 M acetate (pH 3.0-5.0), 0.1 M potassium phosphate (pH 6.0-7.0) and 0.1 M tris-HCl buffer (pH 8.0) at 30 ºC. The residual activity was estimated at the end of the incubation period for all the different pH ranges.

The thermal stability studies on the free and immobilized laccase were conducted by treating laccase in acetat buffer solution (pH 5.0) for variable incubation time at 60 °C. The residual activity was measured.

Storage stability of immobilized laccase was investigated by measuring their activities after being stored at 4 °C for 10 weeks period and the remaining activity measurement was performed once a week.

Decolorization Studies

Effect of pH on methyl orange was studied over a pH range of 4.0-6.0. pH adjusted by the addition of dilute aqueous solutions of HCl or NaOH (0.1 M) by using a Hanna P211 pH-meter with a combined pH electrod. In each set of the experiment, 3.0 mg of the immobilized laccase was added into 10 ml reaction medium with 20 ppm dye, with incubation time lasting for 12 h. Assay of decolorization of methyl orange dye was performed at 30 °C. The percentage of dye decolorization was determined at

different incubation times, by measuring the decrease of the color at the wavelength of the maximum absorbance of methyl orange (470 nm). The percent of decolorization was calculated as follows:

Decolorization (%) = [(A$_i$ − A$_0$)/Ai] × 100

where A$_i$ and A$_0$ are initial and final absorbance, respectively.

3. Result and Discussion

In the present study, the laccase from *Trametes versicolor* was immobilized on histidine modified chitosan beads. The SEM images of natural chitosan and histidine modified chitosan are shown in Fig. 1a and b respectively. It was found that the surface of the modified chitosan was noted to have much asperity and to be more regular and smooth.

The IR spectrum of chitosan exhibits an adsorption band from 3600 to 3200 cm^{-1} due to O–H and N–H stretching vibration; at around 2850 cm^{-1} assigned to –CH stretching vibrations in –CH and –CH2. The pick at around 1600 cm-1 is due to amino group bending vibrations in –NH2. 1150 cm^{-1} is due to C–O–C in the pyranose ring. In the spectrum of ECH-CB, the definition of a peak near 1030 cm^{-1} is attributed to the stretch of C–O bond, formed in the crosslinking process, which tends to form crosslinks. In the spectrum for HIS-ECH-CB, the linkage of histidine to ECH-CB system is supported by the increase in intensity at 1342 cm^{-1}, attributed to N–H vibration and 1627 cm^{-1}, attributed to N=C bonds.
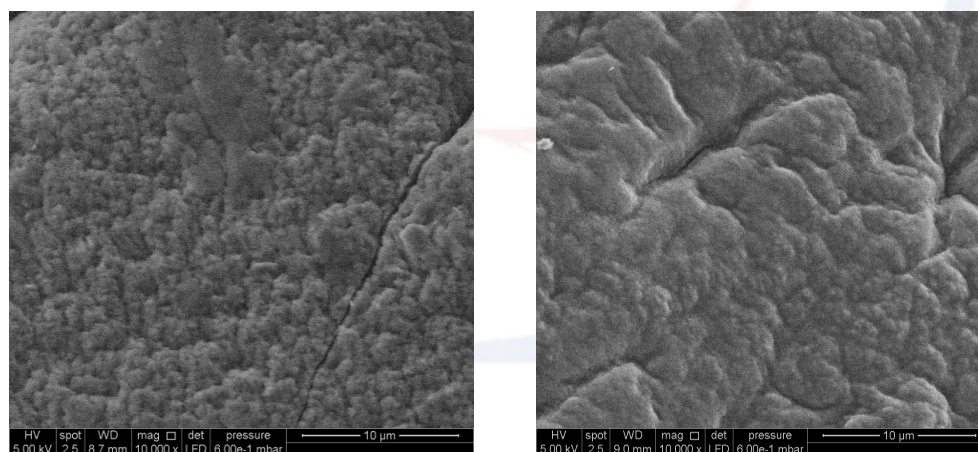
(a)	(b)

Figure 1. SEM images of natural chitosan (a) and modified chitosan (b)

Immobilization yield and enzyme activity per gram carrier were recorded 59% and 2.84 U/ g carriers, respectively. Optimum pH of free and immobilized enzyme was found as pH 4.0 and 5.0 respectively. Similar results for laccase found by Çorman et. Al [9]. In general, the immobilized enzymes have either a broader or the same pH

range of high activity than free enzymes [20]. Subtle changes in the activity/pH profiles have been reported on the immobilization of enzymes to charged supports.

The thermal stability of free and immobilized laccase was examined in the temperature range 20-70 ^{o}C. Immobilized laccase showed better thermal stability than free enzyme at high temperatures. These results agreed with those of Kunamneni et al. [21] and Kandelbauer et al. [22], who reported that the immobilization process induces 10–15% enhancement within the tested temperature range.

The free and immobilized laccase was stored in sodium phosphate buffer solution (pH 5.0) at +4 ^{o}C for 10 weeks. C.The free enzyme lost all its activity within a 6-week, whereas the immobilized laccase lost only 45 % of its initial activity over the same period. Similar findings were observed by Huang et al. (2006).

Decolorization Studies

The decolorization ability of immobilized laccase was tested for it stability to decolorize methyl orange dye. Assays of decolorization of 20 ppm methyl orange dyes (Fig.2) were performed at 30 ℃ with immobilized laccase (50 mg) in different pH (3.0-6.0) with stirring (100 rpm). The percentage of dye decolorization was determined at different incubation times, by measuring the decrease of the color at the wavelength of the maximum absorbance of methyl orange (420 nm). Fig. 2 illustrates the effect of dye solution pH on decolorization yield. Immobilized enzyme showed maximum decolorization at pH 5.0. At acidic conditions (pH <4) a little decolorization was observed for methyl orange dye. Similar results were observed in other studies [21-24] with dyes or similar substrates. These results suggest that acidic pH values may influence the stability of the enzyme causing denaturation. According to Tavares et al. [25] laccase loses stability at pH of 3.0 whilst for pH of 5.0 no loss of enzyme activity is observed.

The amount of enzyme also plays an important role in enzymatic dye decolorization. The effect of immobilized enzyme amount on dye decolorization was studied to determine the minimum amount of immobilized enzyme required for maximum decolorization. The decolorization increased with increase in immobilized enzyme amount from 10 to 100 mg beads. A similar observation has been reported in other studies [22-25].

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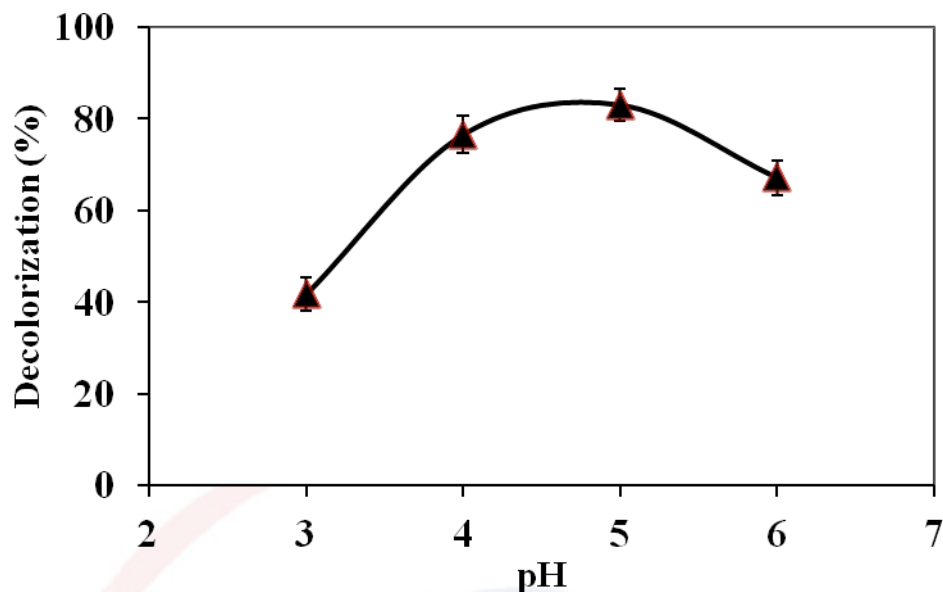
Figure 2. The effect on dye decolorization of pH at 30 °C.
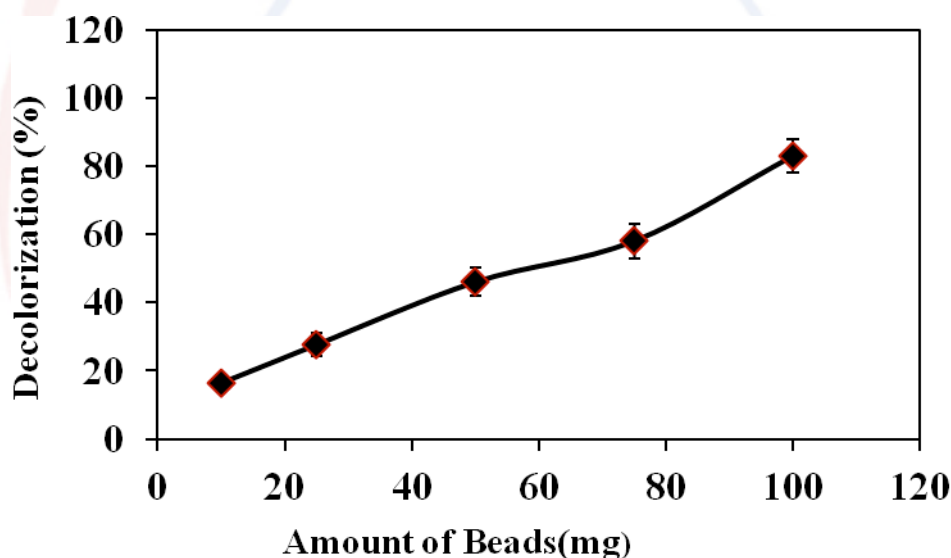
Figure 3: The effect on dye decolorization of amount immobilized enzyme pH 5.0, at 30 °C, incubation time 1 hour.

The effect of dye concentration on decolorization was tested with different initial dye concentration from 5 to 40 mg/L with constant amount of immobilized enzyme (50 mg) at 30∘C. The results revealed that the decolorization was decreased with increasing dye concentration for methyl orange. However, during further incubation of up to 24 h 90–100% decolorization was observed. Our observation is similar with other previous reports [24-26].
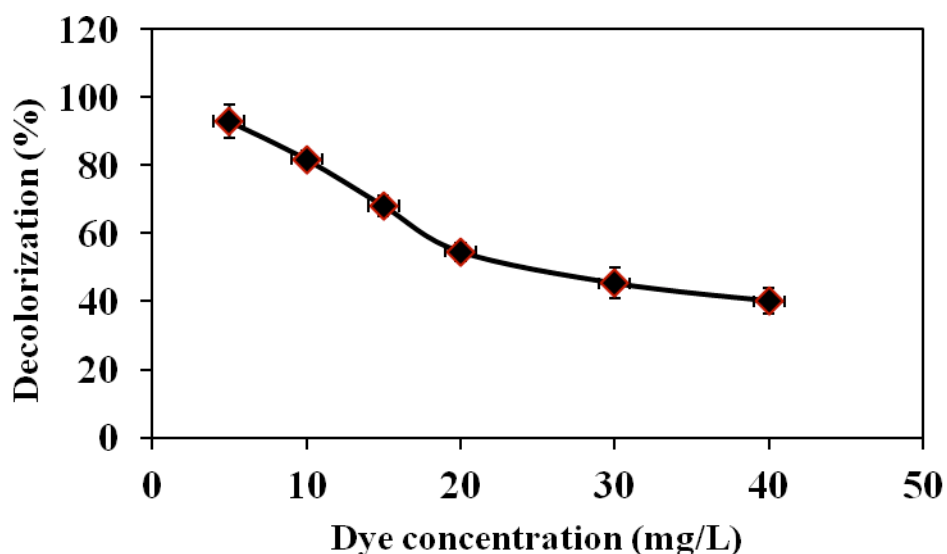
Figure 4: The effect on dye decolorization of dye concentration (50 mg beads, 90 min, pH 5.0.
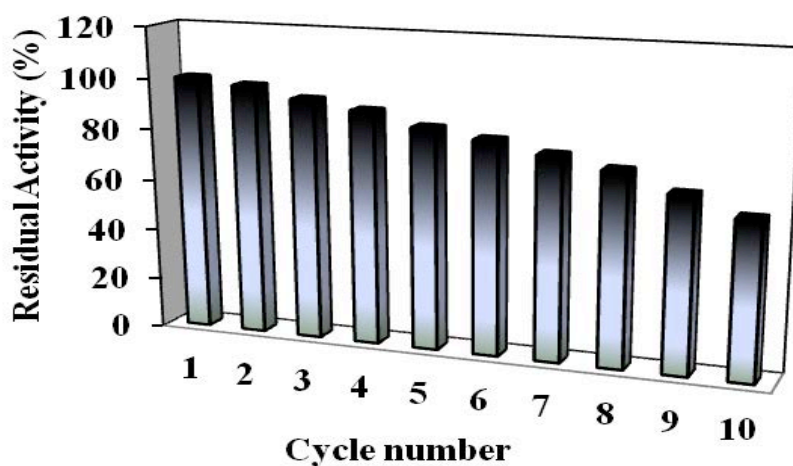
Figure 5. Effect of the reuse number on activities of immobilized laccase on histidine modified beads. Reaction condition: pH 5.0 at 30°C, 1mM ABTS, incubation time 4 h.

During the study of reusability, laccase immobilized on chitosan derivative retained 60% of initial activity after 10 cycles (Figure 5). The immobilized enzyme showed 90% decolorization during 4 h incubation (Figure 6) thus, immobilized laccase could be applied to the wastewater to decrease the environmental contamination caused from the industry effluent.
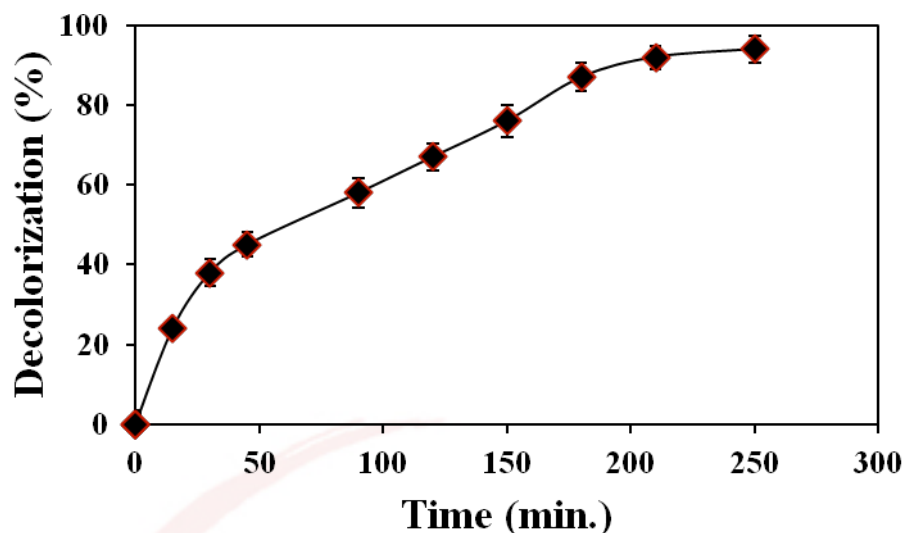
Figure 6: The effect on dye decolorization of time (20 ppm, 10 ml methyl orange, 50 mg immobilize laccase, pH 5.0, °C 30).

4. Conclusion

We have shown that *Trametes versicolor* laccase immobilized on his-modified chitosan. The immobilized enzyme exhibited a higher stability at different pH (3.0-8.0) and temperature (20-70) than that of the free one. The immobilized enzyme retained 60 % of its initial activity after ten cycles. These important properties of immobilized laccases could provide potential advantages for various biotechnological and industrial applications. It was also shown that laccase immobilized on histidine modified beads demonstrated high decolorization of methyl orange by enzymatic degradation.

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Municipal Solid Waste Management Policies and Practices in the Philippines

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Abstract

Municipal solid waste is growing at a fast rate and its management remains a key challenge especially in developing countries and the Republic of the Philippines remains no exception. To address the growing solid waste problem the government enacted the Philippines Republic Act 9003 in the year 2000, which provides a systematic and comprehensive ecological solid waste management program for all sectors of society to adopt and implement, to ensure the protection of public health and environment. However, even after more than a decade, most of the local governments in the Philippines are not able to fully implement the act and solid waste management is still a major problem for the local government. This study reviews the present solid waste management policies and practices in Quezon City of Metro Manila and tries to identify and assess the factors influencing households' solid waste generation and management practices. It also addresses the issues faced by the local government in implementing the policies, initiatives taken by the government to promote proper solid waste management system and problems faced by the households in current solid waste management practices. This study concludes that a sound solid waste management system is possible only with an appropriate policy, effectiveness of local government in implementing the policy into practice, innovative awareness and educational campaigns and participation by all stakeholders of the solid waste management system.

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1. Introduction

The Philippines is a fast developing country with equally increasing rate of population growth and urbanization impacting significantly on its waste generation (Atienza, 2011; Guzman & Reyes, 2003). The population of the Philippines is 92.34 million with an annual growth rate of 1.9% (NSO, 2012) and 45.3% people lives in urban areas (NSO, 2013). The average waste generation in the Philippines is 0.3 kg per person per day in rural areas and 0.7 kg per person per day in urban areas (Atienza, 2011). The average waste generation in Quezon City (QC) has increased from 0.66 kg per person per day in 2003 to 0.74 kg per person per day in 2013 (EPWMD, 2003; EPWMD, 2013). The Philippines government enacted Republic Act (RA) 9003, or the Ecological Solid Waste Management Act in 2000 which is considered to be a broad-based and comprehensive approach to Solid Waste Management (SWM) by promoting 3 Rs: reduce, reuse, and recycle. Households (HHs) are regarded as the foundation for such management progression. The QC government has also enacted various city ordinances pursuant to RA 9003 and those relevant for this study is presented in the table below:

Table 1: Salient features of RA 9003 and relevant city ordinances pursuant to the act

S.N.	RA 9003		City Ordinance	
	Section	Provision	Number	Provision
1.	10	Local government units (LGUs) are primarily responsible to implement and enforce the provisions of act	SP-982, S-2000	To create Environmental Protection and Waste Management Department mainly to: Implement an efficient garbage collection and disposal system; Monitor and enforce of all environmental laws and city ordinances
			SP-1323, S-2003	To adopt guidelines and procedures for a unified approach on SWM
2.	10	Collection of segregated solid waste shall be conducted at barangay (lowest administrative unit) level specifically for biodegradable, compostable and reusable wastes.	SP-1323, S-2003 Article II (Rule 6)	The QC Government through EPWMD shall be primarily responsible in collecting solid waste, door to door, on the specified collection day without fail. For areas where the garbage collection truck has no access, pushcarts/garbage buggies shall be used for the door-to-door collection of solid wastes.
	17 (c)	Barangay should ensure 100% collection efficiency		

3.	21	Mandatory segregation of solid waste at source	SP-1707, S-2006	Segregation of solid waste at source.
4.	20	Waste diversion through composting, re-use and recycling activities	SP-2122, S-2011 Section 4 (B)(d)	Barangay SWM committee shall organize training for barangay residents on segregation, composting, recycling and livelihood opportunities from used recyclable waste
5.	32	Creation of Material Recovery Facilities (MRFs) in every, or cluster of barangays	SP-2122, S-2011 Section 4 (B) (c)	MRF includes solid waste transfer station or sorting station, drop-off center, composting facility, and recycling facility. Barangay SWM committee shall establish MRF within the barangay or use MRF's of a nearby cluster of barangays
6.	55	Mandated continued efforts to develop public awareness about SWM by National Solid Waste Management Commission in coordination with other concerned actors	SP-1323, S-2003 Section 8	Conduct of public information, education and communication (IEC) campaigns
7.	48 (3)	Open burning of solid waste	SP-2122, S-2011	Prohibition on open burning of garbage, trash or any other refuse material

Source: Republic of the Philippines, 2000 and EPWMD

This study is conducted to analyze HHs' current waste management practices and their compliance and awareness towards waste management policies as indicated by the above law.

2. Methods

This study was conducted in barangay Pansol of Quezon City in Metro Manila, the Philippines. Based on key informant interview, barangay Pansol was selected for its low compliance to RA 9003. A total of 114 household respondents were selected randomly and interviewed using open-ended questionnaire. Interview was also conducted with concerned officials in Metro Manila Development Authority, Quezon City and barangay Pansol including various other stakeholders like non-governmental organizations (NGOs), junkshop owners and street sweepers. As for the analysis, Excel and SPSS Statistics 22 software was used to run t-test, calculate mean, frequencies and for simple cross-tabulation.

3. Results and Discussions

3.1 Current SWM Services Provided in Barangay Pansol

Figure 1: Current SWM services provided in barangay Pansol
Source: Field Survey, 2014

- City government provides waste collection facility for 3 days a week, which HHs uses as per their convenience.
- Street sweeping service is available only on main roads that cover only 75% of the HHs.
- MRF is used only by barangay staffs and they bring their recyclables for which they receive points that can be traded for daily necessary items like sanitary goods from the MRF office.

3.2 Socio-economic Characteristics

Table 2: Socio-economic characteristics of the HHs

Characteristics	Total
Sample size	114 (100)
Male headed HH	63 (55.26)
Number of employed household head (HHH)	68 (59.65)
HHs living in owned house	95 (83.33)
Characteristics	**Mean±Standard Deviation**
Average age of HHH	46.23±11.7564
Average formal education attainment of HHH (in years)	10.68±2.275
Average HH size	5.46±2.066
Average annual income of HH (in Philippine Peso)	193540.35±126831.508
Average waste generated by HH per week (in kg)	18.35±10.65678

| Average waste disposal by HH per week (times) | 2.93±1.83630 |

Note: Figures in parenthesis indicate percentage
Source: Field Survey, 2014

- Average HH size in barangay Pansol is larger than Quezon City's average of 4.3
- Annual HH income is less than national average of 235,000 Philippine Peso
- Average waste generated per capita per day is 0.48 kg, less than Quezon City's average of 0.74 kg/capita/day.

3.3 Awareness and Initiatives of RA 9003
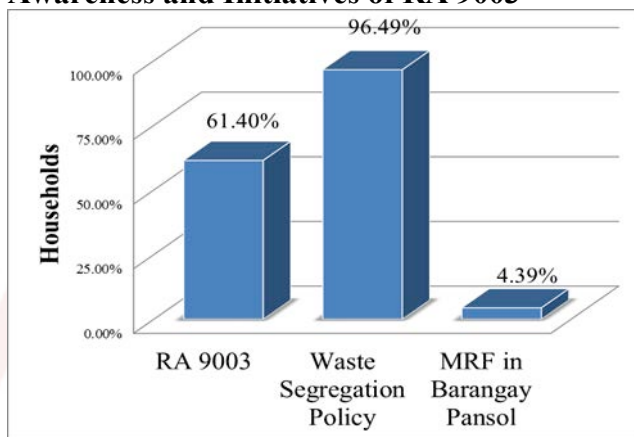
Figure 2: Awareness about RA 9003
Source: Field Survey, 2014

- Respondents who are aware about RA 9003 are not aware of all the provisions of the act and most of them could relate only to waste segregation policy.
- Not all respondents who are aware of waste segregation policy know it as part of RA 9003.
- Though 4.39% of respondents are aware about MRF in their barangay, they are not using the facility since they prefer selling recyclables to formal/informal sectors over MRF to get cash in return.
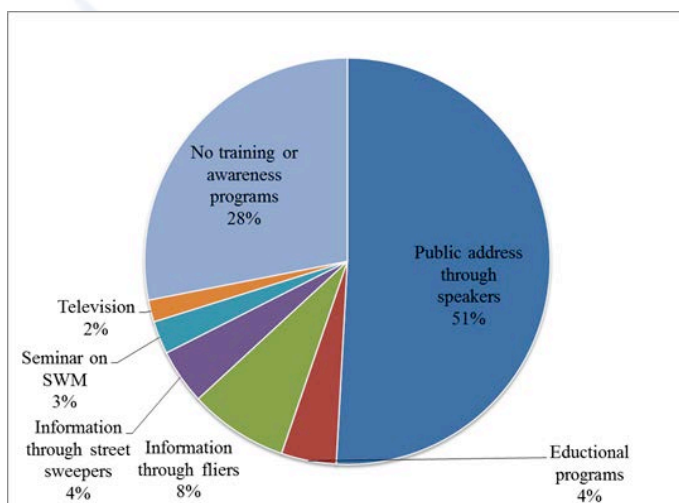
Figure 3: Training and awareness programs
Source: Field Survey, 2014

- The main source of information for the respondents is through public address that is announced occasionally by barangay chairman from speakers installed at strategic places within the barangay.

3.4 SWM and Waste Disposal Practices in Barangay Pansol
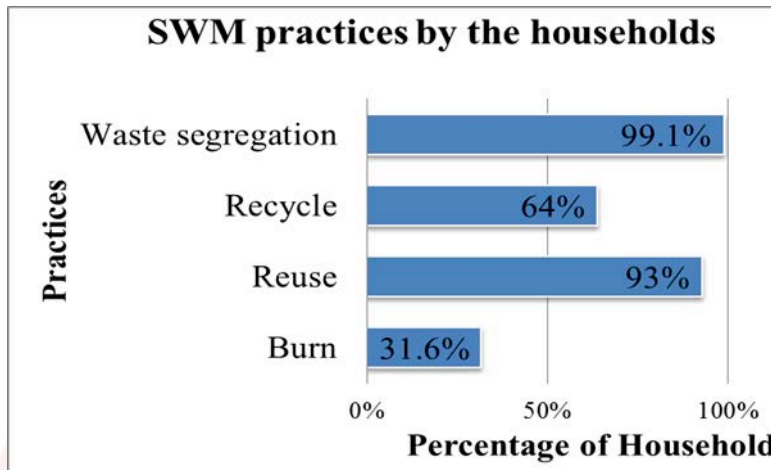
Figure 4: SWM practices by the households in barangay Pansol
Source: Field Survey, 2014

- Most of the respondents started recycling wastes only after they have started practicing waste segregation.
- Recyclables are also given to street sweepers and/or neighborhood children for free (to help them make some money) in addition to selling to formal/informal sectors.
- HHs reuse plastic bags, rice sacks, bottles, cartons, etc.
- Some HHs burn wastes like paper, cardboards and even plastics to complement the fuel for cooking and some burn yard wastes to get rid of it easily.
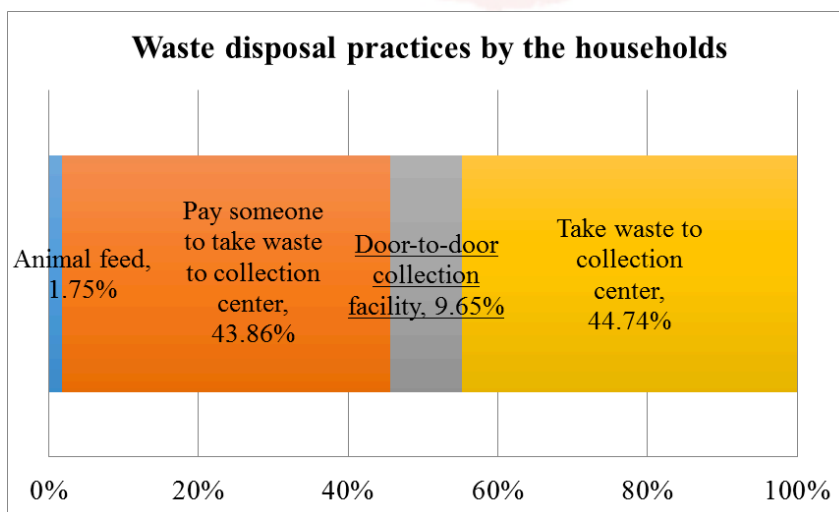
Figure 5: Waste disposal practices by the households in barangay Pansol
Source: Field Survey, 2014

- Some HHs use biodegradable wastes for animal feeding (pig, poultry, cats or dogs).
- Those HHs who do not have government`s door-to-door collection facility because of narrow roads for garbage trucks to enter, either pays someone to take their waste to collection center or does it by self.

3.5 Relationship between SWM Policy Awareness and HH Characteristics with SWM Practices

Table 3: Relationship between awareness about policy with SWM practices

Awareness		SWM Practices (n=114)					
		Recycle		Reuse		Burn	
		Yes	No	Yes	No	Yes	No
RA 9003	Yes	43 (37.7)	27 (23.7)	65 (57)	5 (4.4)	22 (19.3)	48 (42.1)
	No	30 (26.3)	14 (12.3)	41 (36)	3 (2.6)	14 (12.3)	30 (26.3)
Waste Segregation Policy	Yes	70 (61.4)	40 (35.1)	102 (89.5)	8 (7)	34 (29.8)	76 (66.7)
	No	3 (2.6)	1 (0.9)	4 (3.5)	0 (0)	2 (1.8)	2 (1.8)
MRF in Barangay	Yes	3 (2.6)	2 (1.8)	5 (4.4)	0 (0)	1 (0.9)	4 (3.5)
	No	70 (61.4)	39 (34.2)	101 (88.6)	8 (7)	35 (30.7)	74 (64.9)

Note: Figure in parenthesis indicate percentage
Source: Field Survey, 2014

Table 4: Relationship between HH characteristics with SWM practices

Socio-economic Characteristics		SWM Practices (n=114)					
		Recycle		Reuse		Burn	
		Yes	No	Yes	No	Yes	No
HH size	Average	6	5	6	3	5	5
	p-value	**0.06***		**0.00*****		0.82	
Annual Income of HH (Philippines Peso)	Average	193414	193766	194760	177375	153633	211959
	p-value	0.99		0.71		**0.02****	
HH Waste Generation (Kg/week)	Average	19.75	15.85	18.88	11.38	16.14	19.37
	p-value	**0.06***		**0.06***		0.13	

Note: *** at 1%, ** at 5% and * at 10% level of significance
Source: Field Survey, 2014

- Though HHs are aware about RA 9003 and waste segregation policy, many are not recycling and even burning waste.
- The average HH size and average waste generation is significantly higher for HHs who recycle and reuse waste compared to those who do not.
- The average income of HHs who burn waste is significantly different from those who do not.

4. Conclusion and Recommendations

- According to SP-1323, S-2003 Article II (Rule 6), door-to-door waste collection facility should be provided for each HHs but only few HHs have such facility.
- Very few HHs are aware about MRF in barangay. Moreover, only barangay staff are using the facility.
- Low income HHs and those who generate less waste are found to be least compliant in waste management practices like recycling, reusing and burning. These HHs should be focused to improve current SWM practices.
- The local government should effectively implement its city ordinances to improve current SWM system like door-to-door waste collection, MRF and awareness programs. Additionally, HHs should also be encouraged to use MRF by providing incentives.

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Proposal of Appropriate Geothermal Energy in Consideration of Appropriate Technology

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Abstract

To propose the appropriate geothermal energy system, we understand an appropriate geothermal energy promotion characteristics. The geothermal resource is finite, and the secondary product such as electricity or thermal energy is renewable one. So far, in Indonesia, the government has a plan to construct 9500 MW scale of geothermal plant. If the plant owner would like to operate this system sustainably, an awareness survey on the plant construction and/or operation among the end-users should be conducted in the early stage. The questionnaire is carried out for the purpose of understanding their consciousness. That is, we investigated the relationship between household monthly income and willingness to pay (WTP) for blackout. As results of our questionnaire, it was shown that many Indonesians do not prefer to disturb their own relaxation times. On the other hand, they understand a crisis of global warming, too. This means that they are likely to have a good image about geothermal plant. Because in our questionnaire, almost respondents have the Eco friendliness about that. Concretely, we obtained the following suggestions: they have a willingness to pay of 795.2 [IDR/kWh] to avoid a blackout, which has a correlation with monthly household income. That is, based on our results, we would be able to associate the area, in which the residents have high household income and high educational background, with the appropriate promotion area. Also, it may not be suitable to generate the eco-friendly electricity through geothermal plant since the operation is less stable than that of conventional plant.

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1. Introduction

In recent years, Indonesia has achieved average annual economic growth of around 6% supported by healthy domestic demand. That's why there are many times blackout in Indonesia. In order to sustain this growth, a sustainable is indispensable (Marubeni Corporation, 2012). On the other hand, annual CO_2 emission from 2005 to 2030 will increase due to fossil fuel electric power generation from the amount of 110 to 810 Mt-CO_2e/year, which corresponds with the increase from 124 to 970 TWh (Mitsubishi Corporation, 2011). They have established the requirement of reduction of CO_2 emissions by 26% from 2005 levels, by the year 2020 (Mitsubishi Corporation, 2011). Therefore the country's government has formulated a large-scale power generation plan known as the Crash Program, and the second Crash Program, announced in January 2010, stated that around 10,000 MW of new power supply is to be developed by 2014. The second Crash Program puts the emphasis on developing renewable energy, such as geothermal power generation because the CO_2 emission of geothermal power plant is about one-fiftyth as much as of oil thermal power plant (Mitsubishi Corporation, 2011). The goal is for geothermal power generation to produce by 9500 MW (Marubeni Corporation, 2012).

However, there are some problems about resident's concern which company and/or government failed to promote because of end users opinion. For instance, in Bali, they failed to promote it because people who live in there wanted to protect forest reserve and mountain as a holy place for them (The Japan Economic Research Institute, 2012). They failed to construct geothermal power plant in Indonesia because local people want to protect forest reserve area (The Japan Economic Research Institute, 2012) and in California because local people want to keep their area as a resort place (The Japan Economic Research Institute, 2012).Thus, we must understand the end users to propose the geothermal system which is acceptable for end users.

In this study, as a fast step of designing the appropriate geothermal energy, we understand the opinion of attitude toward global warming, geothermal power plant, electricity preference and willingness to pay (WTP) to avoid blackout. Though them, we find out the appropriate geothermal energy promotion characteristics.

2. Research overview

2.1. Research design

Figure 1 shows the research design. In this study, we designed the three steps: understand end users opinion, design appropriate system and checking for appropriate. In In this study, as a first step of this, we must do questionnaire to understand the end users opinion because there is no data about this. There are some researches about attitude survey toward electricity in Japan (Kubota H and Baba K, 2011) and electricity preference in America (Brian R, Mario FT, Alan L and Matthew R, 2001). However, there is difference by countries about electricity preference (Accenture Corporation, 2011). Thus we did preliminary research to gather end user's opinion. Through preliminary research and main research, we determine the appropriate system promotion area. Based on end users opinion, we will design

appropriate system for promotion area. Then we will do interview for end users and decision makers whether it is acceptable or not.
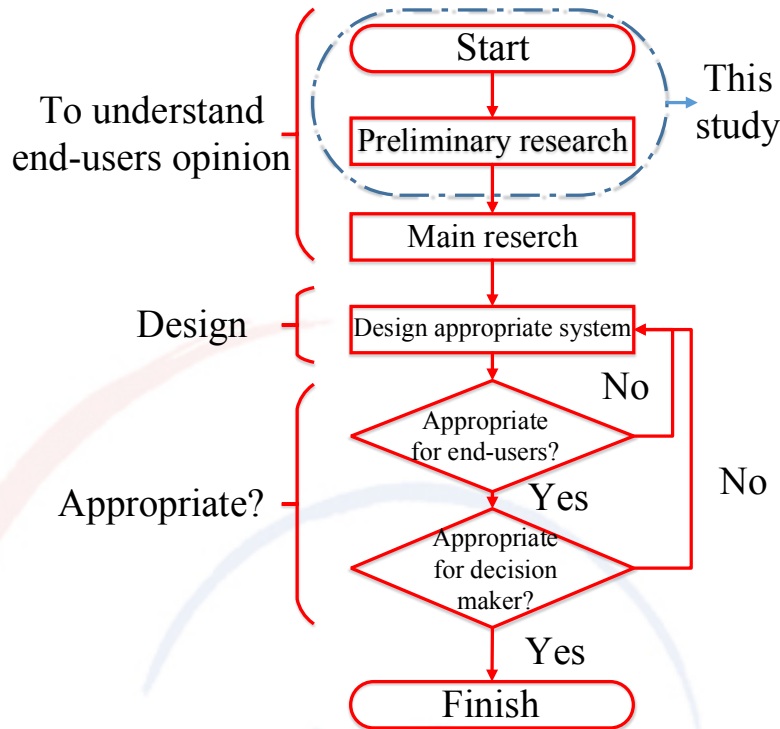
Figure1. Research design

2.2. Survey overview

In this paper, a questionnaire survey was done to understand Indonesian's opinion for determing which location is the most suitable for the geothermal energy. Table1 shows the survey overview. We supposed the household case because we wanted to know the general Indonesian's opinion. Also, we distributed it for all Indonesian because purpose of this questionnaire is to determine the promotion area of geothermal energy.

Table1. Survey overview

Term	2 May, 2014-11 May, 2014
Respondent	50
Distribution method	Website
Area	All Indonesia
Contents	1. Respondent's profile 2. Attitude survey toward blackout 3. Attitude survey toward global warming 4. Attitude survey toward geothermal and thermal power plant 5. Willingness to pay to avoid a blackout 6. Electricity preference

2.2.1. Respondent's profile

Respondent's profile is shown in Figure 2. We asked respondents respondents about age, educational background and monthly household income because it tends to bias

age by using internet survey (Koguma S and Nagumo T, 2011) and there is a relationship between monthly household income and educational background (Asano E et al, 2012). The ratio of less than 29 years is 82%. However, according to the previous research, a ratio of less than 34 years is 62% (The World Bank). That's why there are more young respondents than general. Next, about monthly income, a ratio of more than 9.1 million IDR is the most of all. However, according to the previous research, about 50% of Indonesian is less than 4.8 million IDR and middle class is between 4.8millionIDR and 14.5millionIDR (Cabinet Office). Thus about 74% of respondents are high income class or middle income class. Last, about educational background, about 56% respondents graduated from university or graduated school.
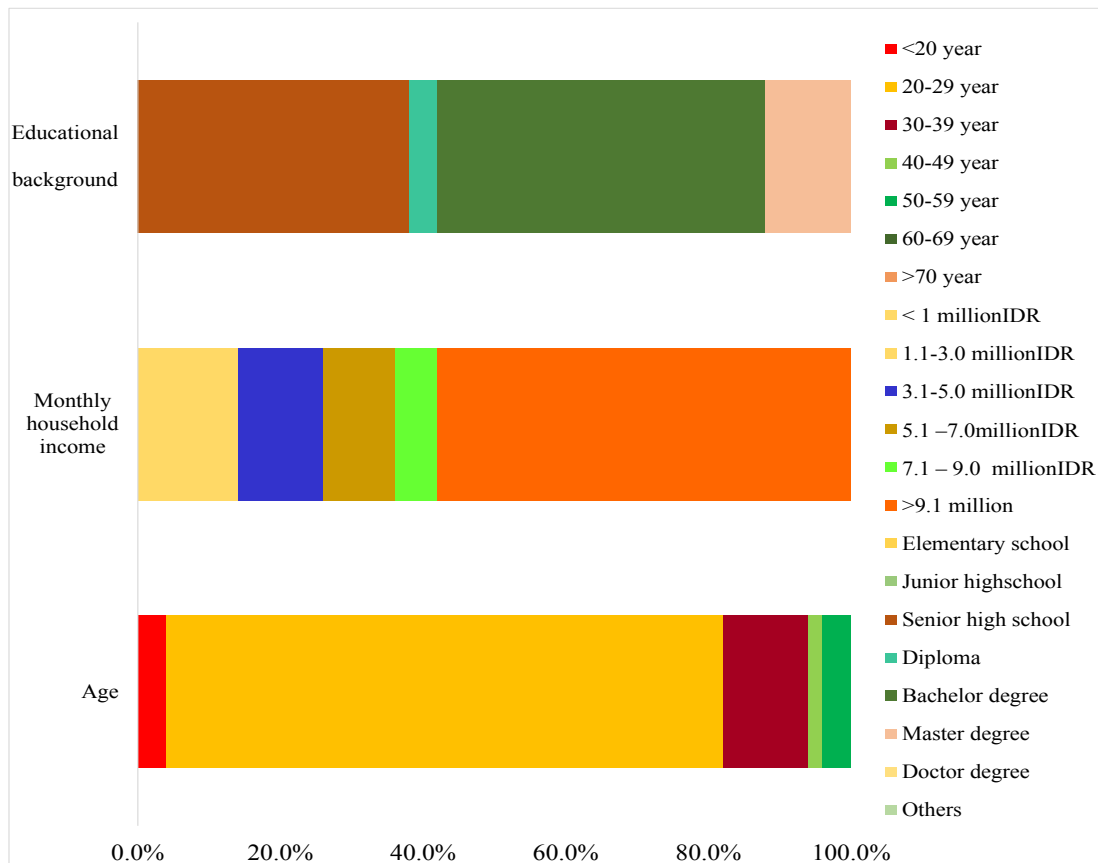
Figure2. Respondent's profile

2.2.2. Attitude survey

In this study, the question content of our questionnaire about attitude survey is as follows; (1) attitude survey toward blackout, (2) attitude survey toward global warming and (3) attitude survey toward thermal and geothermal power plant. On the content of (1), the following three items are categorized; (a) current condition of blackout (Electronic Power System, 2014) (b) the opinion about blackout and (c) home appliance (Prailandita N., et al, 2014; Electronic Power System, 2014). Second, on the items of (2), image of global warming and sense of danger toward global warming were asked. Last, on the items of (3), we asked the image of geothermal and thermal power plant.

2.2.3. Willingness to pay to avoid a blackout

We must understand blackout cost for Indonesian because it is better to understand their attitude toward blackout. There are in principle three different approaches that can be used to measure the cost of blackout to households (Carlsson and Martinsson, 2005). The first approach involves directly asking their costs for various types of blackout. The second is to study the actual behavior of households in terms of investments aiming at mitigating blackout. The third is to either directly or indirectly asking the households about their WTP to avoid blackout by stated preference approach. In this paper, we used the asking households their WTP to avoid blackout because this approach can consider all welfare effects by including nonmarket effects (ex: watching TV, cooking and so on) (Carlsson and Martinsson, 2005).

Actual query is shown in Figure 3. In previous research, there are some scenarios such as duration of blackout and starting time (Carlsson and Martinsson, 2005). However, in this study, we didn't set the starting time and duration of blackout because blackout occurs frequently and there is no data about them. Furthermore, to compare WTP for the time when blackout occurs frequently and WTP for the time when people don't want to occur, we added the question about WTP in order to avoid a blackout that occurs the time which respondents think blackout doesn't want to. To analyze the relationship among blackout time, frequency, educational background and WTP more precisely, we did the Smirnov-Grubbs test. Furthermore, to find out some relationships, we did regression analysis.

Q1. How much would your household be willing to pay IDR/kWh <u>in order to avoid a blackout</u> that occurs the time which you think blackout occurs frequently? You do not know in advance that the blackout will occur. The average generating cost is 792.0[IDR/kWh]. (Note: I assume that you don't pay additional fee for avoid a blackout.)

Q2. How much would your household be willing to pay IDR/kWh <u>in order to avoid a blackout</u> that occurs the time which you think blackout doesn't want to occur? The average generating cost is 792.0[IDR/kWh].You do not know in advance that the blackout will occur. (Note: I assume that you don't pay additional fee for avoid a blackout.)

Figure 3. WTP questions

2.2.2. Conjoint analysis

In this study, we executed a questionnaire on consumer's electricity preference to understand what kinds of attribution Indonesian focus on. The conjoint analysis is a research technique by which the trade-off relationship between providers would be identified. Also, through the analysis, we can estimate the WTP of attribution. There are three kinds of conjoint analysis methodology; full profile rating conjoint analysis, pairwise rating conjoint analysis and choice based conjoint analysis (Washida T et al., 2001). the items are similar to an actual purchase behavior in each consumer and neglected on the selection bias. Table 2 shows the attribution data of preference survey of electricity. Based on the previous survey, we adopted energy resource, cost, environment, stability and safety as an attribution (Hiwatani R et al, 2008).

Table2. Attribution data of preference survey of electricity

Attribute	Level			
Resource	More than NG	Same as NG	More than NG	
Cost	Decrease 270000[IDR/year] per person	Constant	Increase 270000[IDR/year] per person	
Environment	<1/10 times of the NG	1/2 times of the NG	Same with NG	More than NG
Stability	No effect	Effect		
Safety	No effect	There is no hazard if you shelter.	There is a possibility to get health damage, but no one will die.	There is a possibility to die.

3. Result and discussion

3.1. Attitude survey

3.1.1. Blackout

As a result of questionnaire, blackout frequency and duration time of blackout are about 22 [times/year] and 108[min/blackout], respectively. To understand the Indonesian's opinion toward blackout, we asked questions as follows:
Case1: When do you think blackout occurs frequency?
Case2: When do you think blackout doesn't want to be occurred?

The result is shown in Figure 4. Consequently, In Case1, about 66.0% of respondents answer that blackout is occurred frequency between 18:01 to 24:00. Also, we asked about most troubled if blackout occurs. Most answers consist of disturbing household activity, watching television, using PC, taking shower and reading books. Also, Figure 5 shows the home appliances ownership. As this shows, own of electronic fan, air conditioner, television and laptop are more than the others. As a result of these, we found out that Indonesian hesitate to occur blackout on evening (18:01-24:00) because they dislike to disturb their own relaxing time.
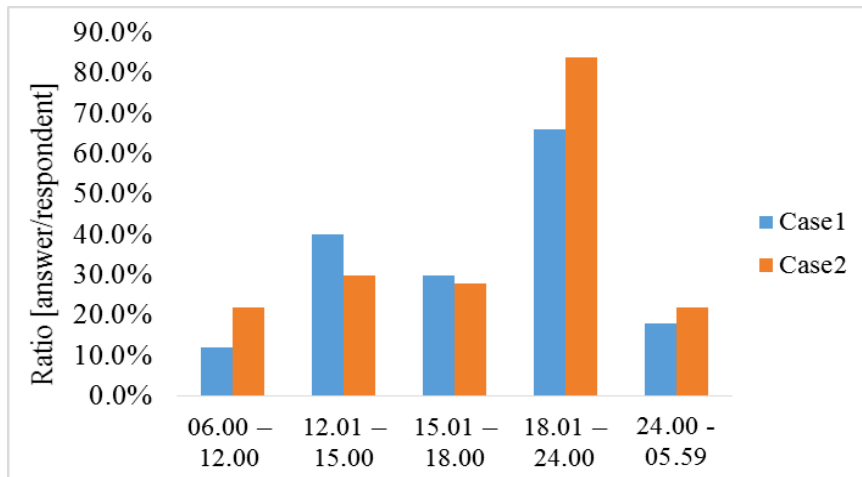
Figure 4. Comparison actual blackout time with hesitation time
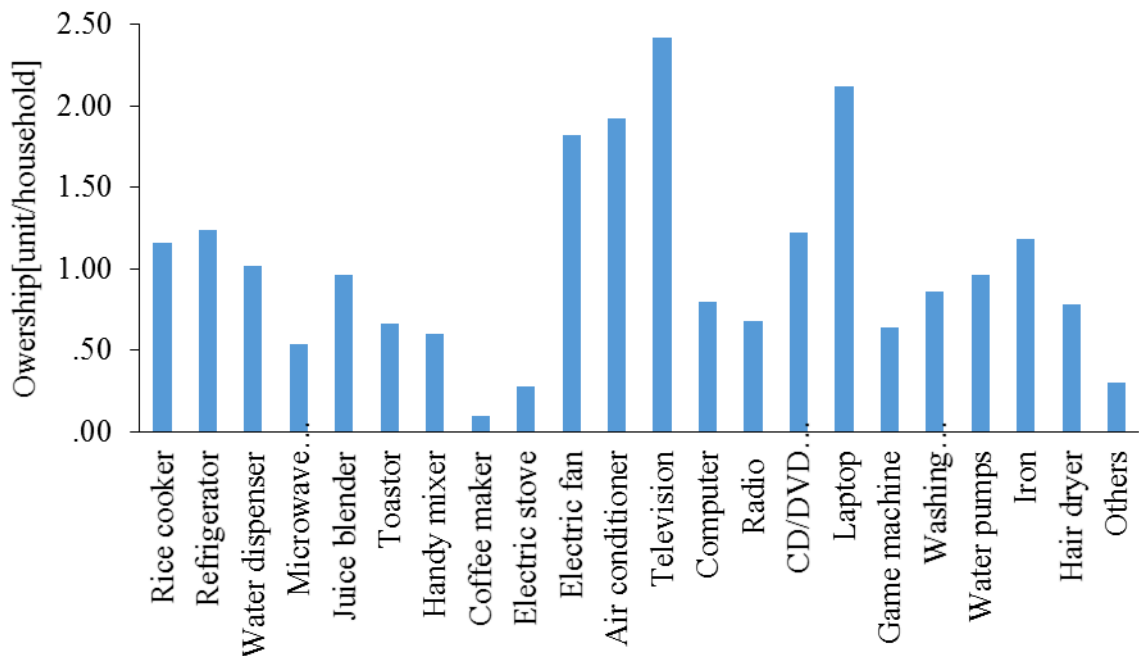
Figure 5. Home appliances ownership

3.1.2. Global warming and power plant

We asked respondents about crisis for global warming and image of global warming to understand the opinion of them because there is a relationship between crisis for global warming and household income (Asano E et al, 2012). Figure 6 shows the result of crisis for global warming. About 92% respondents answer has a crisis of global warming.
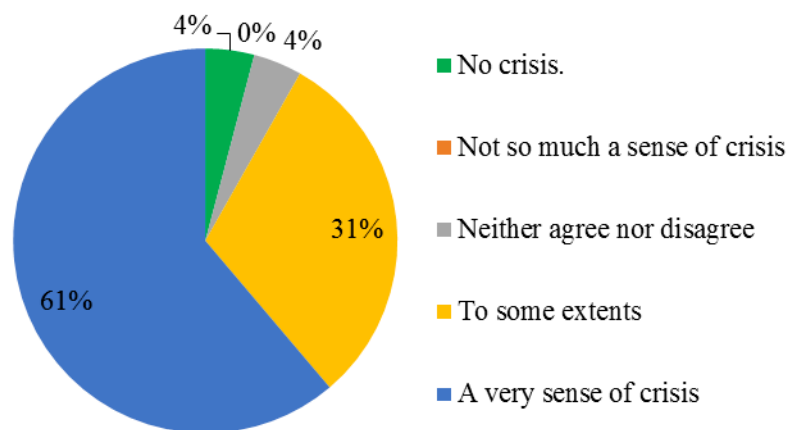
Figure 6. Crisis for global warming

Furthermore, to understand the image difference between geothermal power plant and thermal power plant, we asked the image of them. The result is shown in Figure7 (a) and Figure7 (b). According to them, almost the image of geothermal power plant and thermal power plant are ecofriendly and non ecofriendly, respectively. Based on my survey of global warming, the image of geothermal power plant is better than of conventional ones.

(a)

(b)
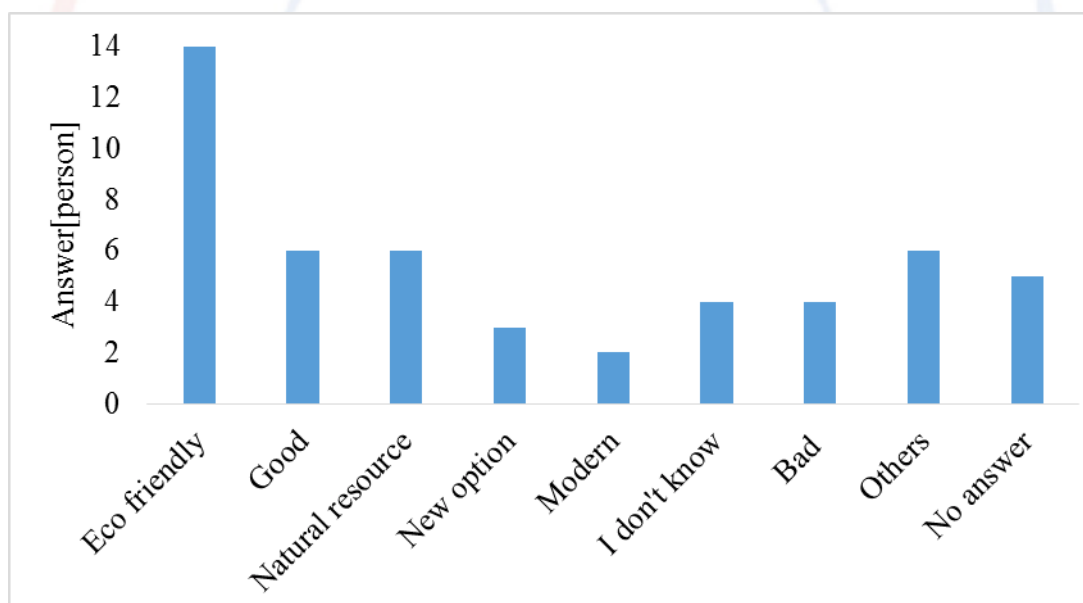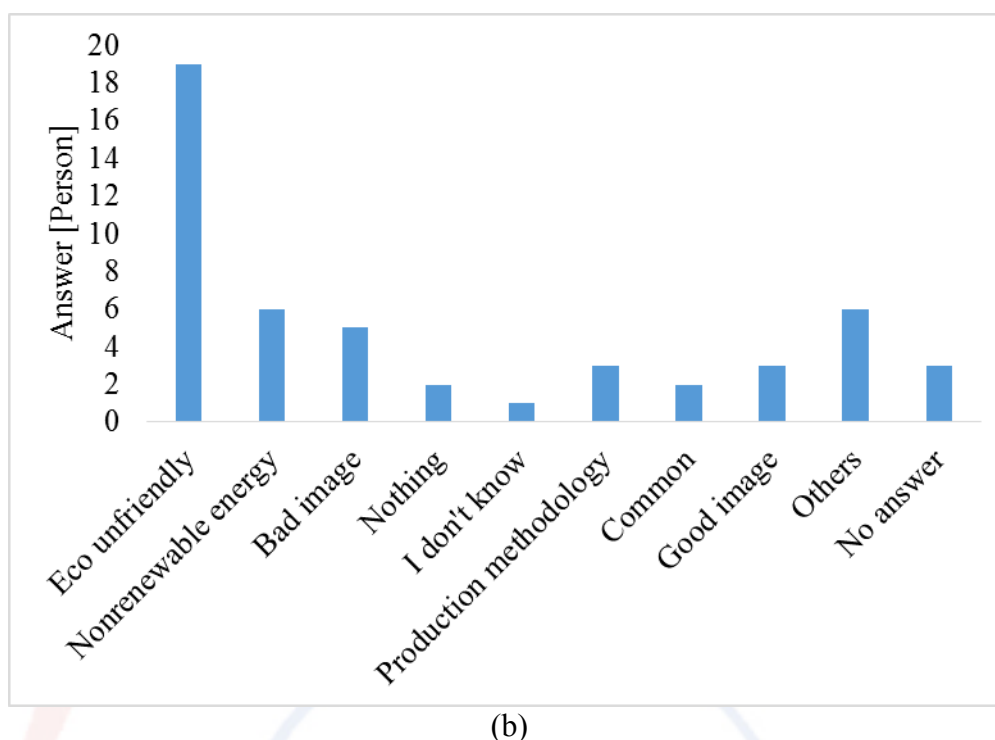
Figure 7 Image of (a) geothermal power plant and (b) thermal power plant

3.2. Willingness to pay to avoid a blackout

In this questionnaire about WTP, 5 respondents of total respondents (10%) didn't answer them and 9 answers were excluded because of Smirnov-Grubbs test. Table3 shows the result of WTP to avoid a blackout. Compared the actual blackout occurring time with which people don't want, the blackout which doesn't want to occur has about 38.8[IDR/kWh] higher than actual. Both of WTP has higher than electricity price because current electricity price is 792.0[IDR/kWh].

Table3. WTP results

Question	Actual	Don't want to occur
Min	0.0	0.0
Percentage of zero	6.0%	4.0%
Max	1500.0	1500
Average	795.2	834.0
Variance	125796.0	167087.5
Standard deviation	354.7	408.8

To find out the relationship among blackout frequency, blackout time and WTP, we did regression analysis because according to the previous research, it has a correlation between blackout duration time and WTP (Electronic Power System Council of Japan, 2014). Figure 8 (a) and 8 (b) shows the relationship between WTP and (a)

blackout duration time, (b) blackout frequency. Correlation coefficient of blackout duration time and frequency are 0.23 and 0.002, respectively. According to the previous research, if it is more than 0.3, they have a correlation (Mizumoto A, 2011). Thus, there is no correlation among duration time, frequency and WTP.

(a)

(b)
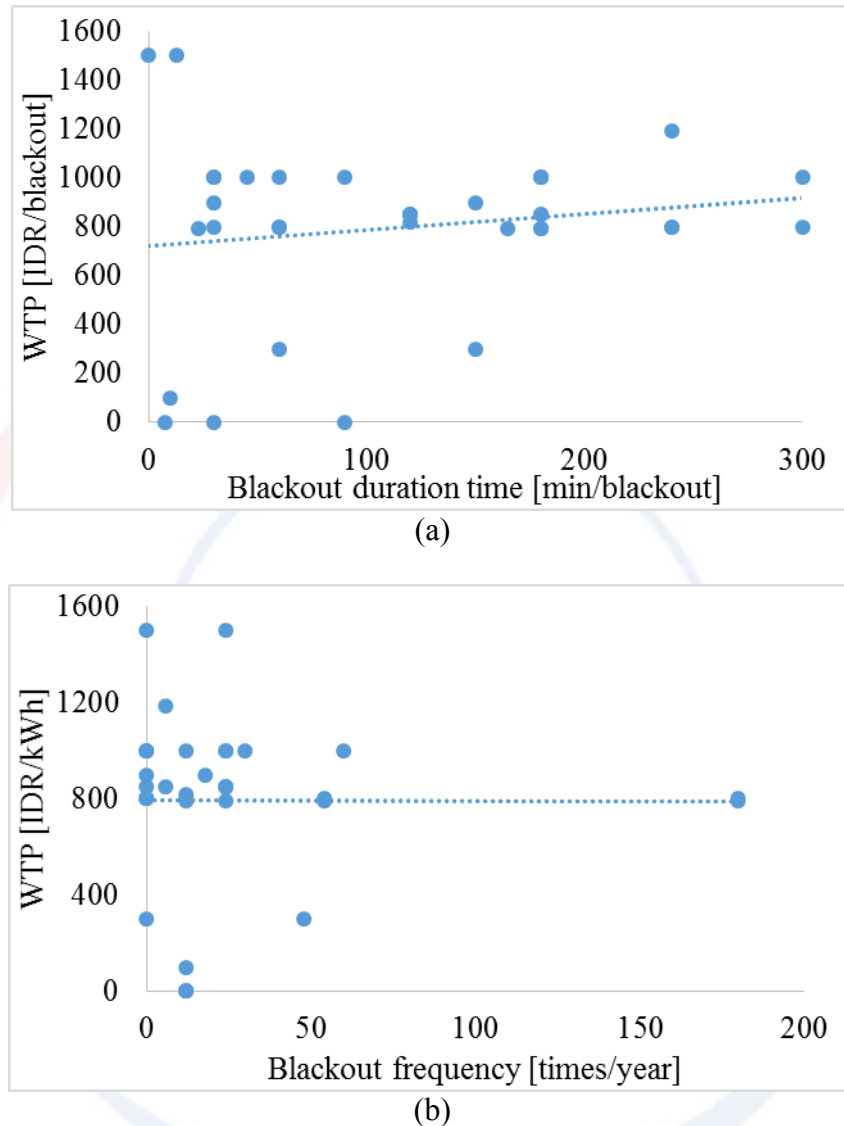
Figure 8. The relationship between WTP and (a) blackout duration time (b) blackout frequency

Furthermore, to understand the relationship between monthly household income and WTP, we also did regression analysis. Figure 9 shows the relationship between WTP and monthly household income. In this study, correlation coefficient between educational background and WTP is 0.078 and monthly household income and WTP is 0.328. Regression equation is as follow:

$$y = 75.11x + 436.46 \tag{1}$$

Thus, we find out that there is a correlation between monthly household income and WTP. Based on the result, we found out that the higher people get income, the more people tend to hesitate to occur blackout because they have some home appliances

which they need for welfare (The Boston Consulting Group, 2013), and they are getting used to using electricity for their comfortable living.
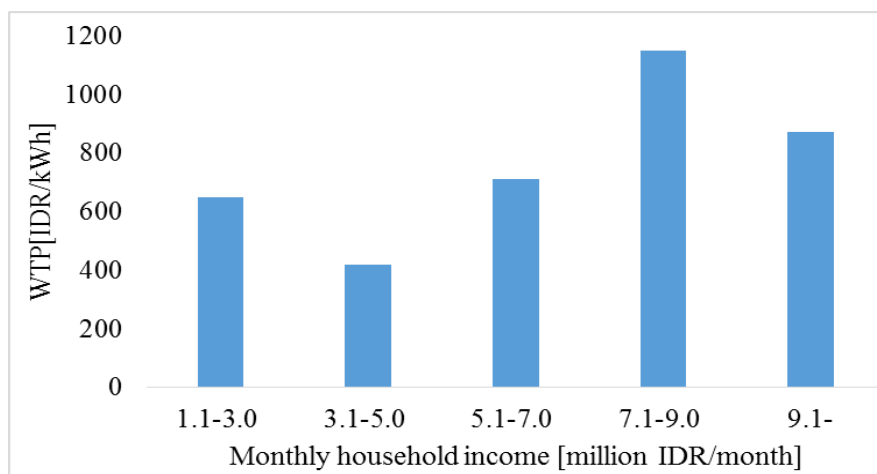
Figure 9. Relationship between WTP and monthly household income

3.3. Conjoint analysis for electricity preference

As a result of our survey, the coefficients for each element with the following statistical indexes such T-value and P value are shown in Table4. Also, Table5 shows the marginal WTP of electricity. According to the survey, the WTP would not be affected by the environment of electricity. Thus, we ignored the influence of environmental. However, as we mentioned, Indonesian has a concern about global warming. Thus, it has a possibility not to understand the relationship between global warming and CO_2 emission. Here, the WTP due to the stability effect would be effective to some extent. Table5 shows the marginal WTP for electricity. Assuming that the added value in the real transaction would be 1/3.05 times of the measured WTP (List J and Gallet CA, 2001). Based on it, marginal WTP divided 3.05 equals to measured WTP.

Table4. Results of preference intensity

	Coefficient	t value	p value	test
Cost	-0.0021	-4.952	0.000	***
Resource	0.2881	1.741	0.083	*
Environment	-0.1294	-1.240	0.216	
Stability	0.4822	2.323	0.021	**
Safety	0.5239	7.037	0.000	***

(Note: * means 1% significance, ** means 5% significance and *** means 10% significance.)

Table5. Marginal WTP

Resource [IDR/kWh]	45.0

Stability [IDR/kWh]	75.3
Safety [IDR/kWh]	81.8

Furthermore, we compared the WTP of middle and high class and of low class because it is important to consider the income based on my previous research result. The result is shown in Table6. According to it, the WTP would not be affected by the energy resource and environment in middle class and high class people. Also, it would not be affected by the environment and stability. Thus, middle and high class people dislike to occur blackout better than low class people.

Table6. Results of preference intensity about income

	Middle and high class				Low class			
	Coefficient	t value	ρ value	test	Coefficient	t value	ρ value	test
Cost	-0.002	-3.746	0.000	***	-0.003	-2.797	0.007	***
Resource	0.176	0.928	0.355		0.695	1.823	0.073	*
Environment	-0.118	-0.937	0.350		-0.231	-1.041	0.302	
Stability	0.655	2.723	0.007	***	0.079	0.172	0.864	
Safety	0.461	4.960	0.000	***	0.691	4.495	0.000	***

Table7. Marginal WTP comparison with income

	Middle and high class	Low class
Resource[IDR/kWh]		82.1
Stability[IDR/kWh]	118.5	
Safety[IDR/kWh]	83.3	81.6

4. Conclusion and future work

In this study, to understand the appropriate geothermal energy, we found out the appropriate system of promotion area. As a result of questionnaire, we found out the following contents:
(1). They hesitate to occur blackout on evening (18:01-24:00) because they dislike to disturb their own relaxing time.
(2). Indonesian has a crisis of global warming and a good image of geothermal power plant. Thus, there are many plans to promote the system.
(3). It has a correlation between household monthly income and WTP to avoid a blackout.
(4). High class people focus on stability about electricity.

Based on from (1) to (3), we set the characteristics as an appropriate geothermal energy promotion area shown in Figure10.
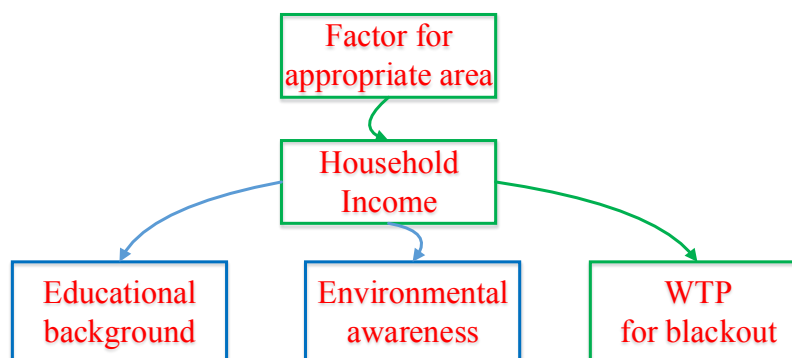
Figure10. Characteristics of appropriate geothermal energy promotion area

Furthermore, based on (4), we found out that Indonesian focus on electricity stability. However, power output which comes from geothermal energy isn't stable (Agani M et al, 2010) because it comes from natural source. Thus, in the aspects of end users opinion, it's not appropriate to promote geothermal energy only for electricity. Our future work is that we will decide some geothermal energy utilization paths based on the literature review and we will do interview for people who live in appropriate promotion area and works at decision maker company and/or government whether they are accepted or not.

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The Study of Sustainable Workplace: How Office Space Influences the Amount of Communication among Workers

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Abstract
The world economy has shifted from 'monozukuri-based' economy towards the era of knowledge economy, where organization business patterns have moved towards being more creative, innovative and more knowledge based. Communication is a vital part of sustainability strategy of an organization in order to keep abreast with business agility, as well as increasing organization's intellectual productivity. This paper aims to determine factors of office spatial design that could inspire or impede face-to-face communication by focusing on the concept of the amount of communication. The study is a cross-sectional and relationship between the two at a research institute in Japan has been explored by considering the office layout of three project groups. The finding highlighted spatial occupancy according to the amount of communication associated to its contents in regards to worker's work activities. The study concluded that there is a need to conduct further empirical studies on office space, that emphasizes on the amount of communication. In addition, the rocomendations of the study may be useful for workplace practiotioners in architecture, facilities management and design.

Keywords: Office, communication, intellectual productivity, sustainability

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1.   Introduction and Background of the Study

The world economy has shifted from 'monozukuri-based' economy towards the era the era of knowledge-based economy, which requires organization to be more creative, innovative and more knowledge based in order to keep abreast with business agility and competitiveness. 'Knowledge-based' economy is the era where organization creates wealth and business growth based on knowledge and information, henforth leads to the emerging of knowledge-based society, which is also known as knowledge worker - the term popularized by Peter Drucker in his book The Age of Discontinuity 1968. With knowledge and information have become the central resources of creativity and innovation in any organization, the intellectual productivity of its worker as well has become a concern. In Japan, the productivity of 'white collar' (refers to knowledge worker), which is also known as intellectual productivity, always becomes a subject of discussion compared to 'blue collar' since the statistics shows such number arose each year (*Statistics Bureau of Japan*, 2013). Work activities related to intellectual productivity involve three stages (Murakami, 2010) which includes – 1)information processing – activities of performing knowledge information from paperwork and routine process, 2) knowledge processing – activities of searching and processing knowledge information, and 3) knowledge creation – activities of performing value creation and innovation. This paper has given interest on the study in knowledge creation activities as the activities are parallel to the rise of knowledge-based society.

The concept of knowledge creation in organization and intellectual productivity of knowledge worker has driven researchers to explore the relationship between human within organization, including their living environment and conditions (Murakami, 2010; Takai, 2010). This has given interest to scholars, specifically from management and architectural planning studies. Office spatial settings is one of many elements that aid the cultivation of intellectual productivity when the condition is met for knowledge creation activities. However, shaping office layout for such activities must consider the link between them – communication among workers (Greene & Myerson, 2011; B. P. Haynes, 2007; Kobayashi & Yanagisawa, 2002; Kupritz & Hillsman, 2011; Midorikawa, Ikaga, Sato, & Warita, 2010).

Communication in the workplace has often been associated with how worker carries information, messages, clues, ideas, emotion and knowledge as such with organizational performance, business growth and effectiveness. This means that communication in the workplace is a snapshot showing how an organization works, how it affects the process of work being done and how to make it understood by each other. Therefore, the mutual exchange of ideas, viewpoints and beliefs that conversation entails allows for knowledge creation across organization (Krogh, Ichijo, & Nonaka, 2000; Nonaka & Takeuchi, 1995).

In productive organization, workplace communication can unleash the creative powers of individual participants and fuel knowledge creation beyond the capacities of single mind (Galvin, 1996). However, recent studies show that there is less interpersonal communication in the workplace specifically at collaborative engagement and dialogue levels due to lack of communication skills, trust in relationships among employees and quality of communication (DeKay, 2012; Weisman, 2010; Zachary, 2012). The Level of Communication Model has classified the communication levels into 5 stages, namely 1) monologue, 2) transaction, 3)

interaction, 4) collaborative engagement and 5) dialogue, whereby dialogue is the most influential level in communication behaviour (Zachary, 2012). Unfortunately, communication in the workplace has become a 'one-way conversation', and 'satisfied contact' among employees has gradually declined.

Apart from that, innovation in ICT such as computer mediated technology (CMC) in the workplace has reduced the amount of the most influential form of communication – face-to-face (F2F), even though the amount of texts, messages and virtual communication has increased as shown in Figure 1 (Dewett & Jones, 2001; Martins, Gilson, & Maynard, 2004). This phenomenon will affect organizational intellectual productivity if the organization does not focus on this matter.
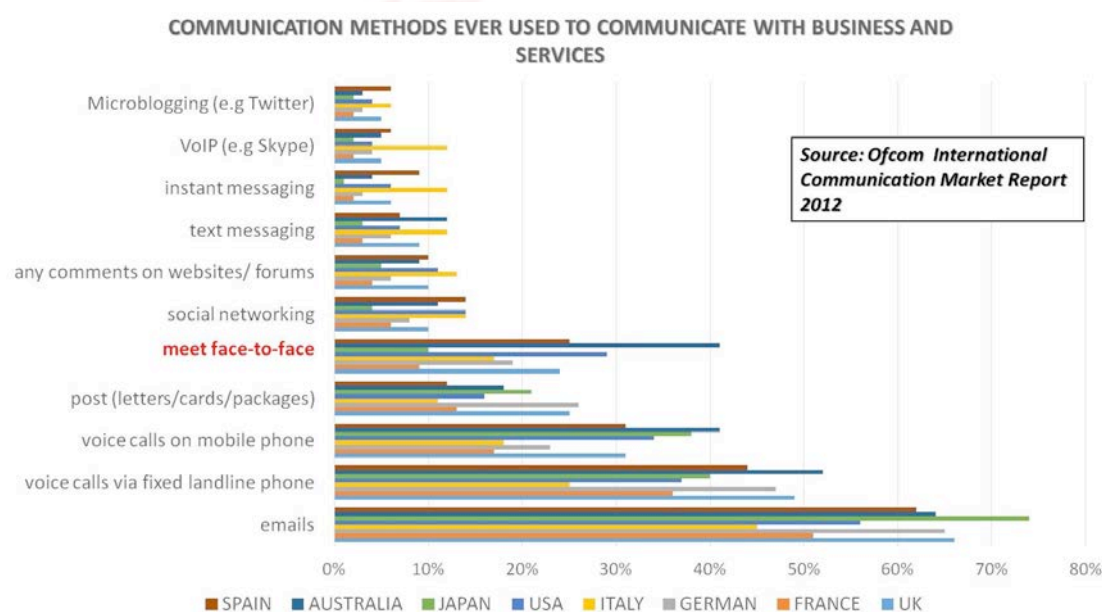
Figure 1 Communication Methods Used to Communicate with Business and Services

From the statement above, this paper aims to seek which spatial characteristics that may enhance the amount of communication among worker while performing their knowledge creation activities. The study is performed using the empirical evidence as it is quite limited in the field (Kishida, Uchida, Matsumoto, & Naka, 2008). Although there are few studies concentrating on its effect by workplace physical settings, the study on the amount of communication among worker that is affected by workplace spatial settings is far from reach. The study on the relationship between communication and workplace spatial settings is important because communication develops relationship quality over time, where the level of trust nurtures the willingness to collaborate in the future. From a built environment perspectives, a frequent communication is the main factor of successful organization performance, and it has also become a factor that can help to guide and recommend for a sustainable workplace design. Thus, both communication and workplace spatial settings are factors that may affect intellectual productivity (B. Haynes & Price, 2004).

2.   Defining Amount of Communication

To begin with, why does the amount of communication (henceforth stated as AOC) is important in the workplace? Wouldn't the quality of communication is more important than quantity as long as the information and objective of the conversation has been transferred? Some researches claimed that the amount of communication somehow is important in order to reduce uncertainty and ambiguity in the information transferred or shared among them (Stryker, 2004; Zimmermann, Sypher, & Haas, 1996). Hence, greater AOC encourages information exchange, reduces uncertainty and simultaneously improving information quality and communication satisfaction (Large, 2005; Mueller & Lee, 2002; Zimmermann et al., 1996), as well as improving knowledge sharing, information absorption, social network productivity and capability and knowledge-based work (Sailer, 2011; Stryker, Santoro, Farris, & Member, 2012), specifically to the non-routineness task which requires engagement of people such as collaboration working, services, innovative and creative work.

However, what constitutes the amount of communication (AOC)? Much research in the past have referred AOC as a quantity of communication occurrence (Brown & Worland, 1991; Cohen, 1997; Dewett & Jones, 2001; Martins et al., 2004; Tschan, Semmer, Nagele, & Gurtner, 2000; Wang & Ko, 2012). The term 'amount' is ambiguous but some researchers have referred the AOC as the frequency and duration of communication occurrence in a communication event (Genkai, Mizuno, Matsumoto, Naka, & Yamaguchi, 2007; Kato, 2004; Kimura, Ando, Watanabe, Kimata, & Ryoichi, 1992; Nishihama, Mizuno, Matsumoto, & Naka, 2006; Watanabe, Ando, Kimura, Kimata, & Tazawa, 1992). The discussion of AOC in workplace communication refers to the values and outcomes (Cohen, 1997; Mueller & Lee, 2002; Tschan et al., 2000) which are always measured by two dimensions – the content and social network (relationship among worker) (Large, 2005). To conclude, the definition of AOC from the perspective of workplace communication in this study can be defined as "a quantity of frequency and duration of information exchange by verbal, writing or using some other medium in communication events". Therefore, to seek what constitutes quality in the quantity of communication, this study tends to explore the communication contents, social network, tools used and body posture in communication occurs while performing job at hands. The framework of the study is shown in Figure 2.

3.   Sustainable Workplace Design and Communication

The definition of sustainability in this paper refers to how the workplace spatial settings should be able to support organization's knowledge creation activities (Häkkinen & Nuutinen, 2007) and how it should be able to foster a communicative atmosphere. Furthermore, organizational theorists such as Becker, Steele and Sundstrom have proposed several models in 1980s, which indicated that communication in activities of primary work is affected by physical structures (Hatch, 1987; Rashid & Zimring, 2005).

There are two particular models highlighted in the previous workplace literature that indicated the relation between communication and workplace spatial settings – the 'flow model' and 'serendipitous communication model' (Peponis et al., 2007; Stryker, 2004). Flow model indicates that the office spatial settings should reflect the flow of information by placing physical proximity for people who need to be adjacent to each other. Meanwhile, serendipitous model proposes that by providing informal

interaction hub such as refreshment area, lounge or leisure area, this helps people to increase their communication outside of their normal working pattern. To extend the parameter of these two models, this paper proposes to investigate the spatiality for communicative activities via the analysis of communication patterns and space occupancy.
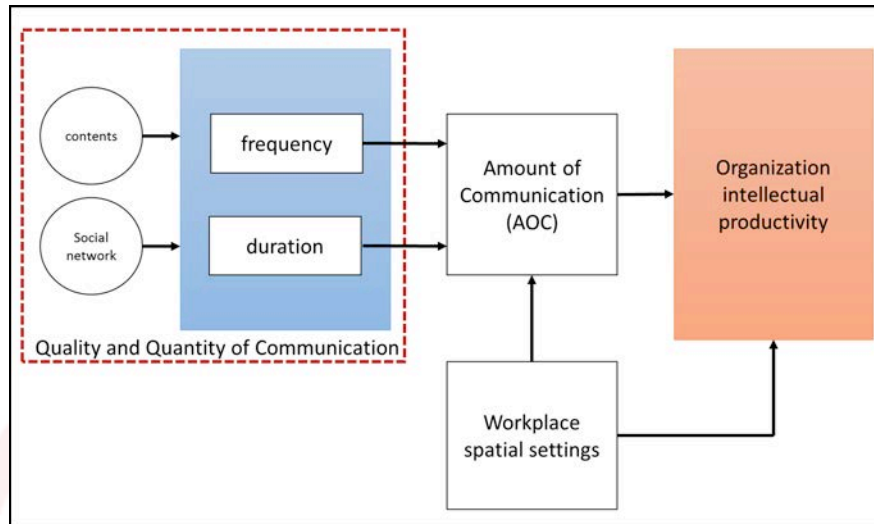
Figure 2 The Study Framework of the Amount of Communication and Workplace Spatial Settings

4. Method

The purpose of this research was to identify the space occupancy with the greater amount of communication based on two dimensions – 1) the contents and 2) communication network. The method that was carried out in this research discusses by the following topics:

- Office layout
- Data collection technique and Procedure
- Types of communication
- Measures

4.1   Office Layout

This research, which is qualitative in nature, adopted a case study approach using three project-based research groups from Japanese research institution. Research institution has been chosen due to its nature of work that falls under knowledge-based organization category as the institution relies on human capital and the use of knowledge as primary production factor. Each research group was assigned to these office spaces according to their project duration. Each research group had their own office spaces of approximately 180 m^2. Each research group designed their own office layout according to their preference, equipped with computers, furniture, telephone and standard office materials and equipment. The location of each group is shown in Figure 3, as well as the layout of each office.
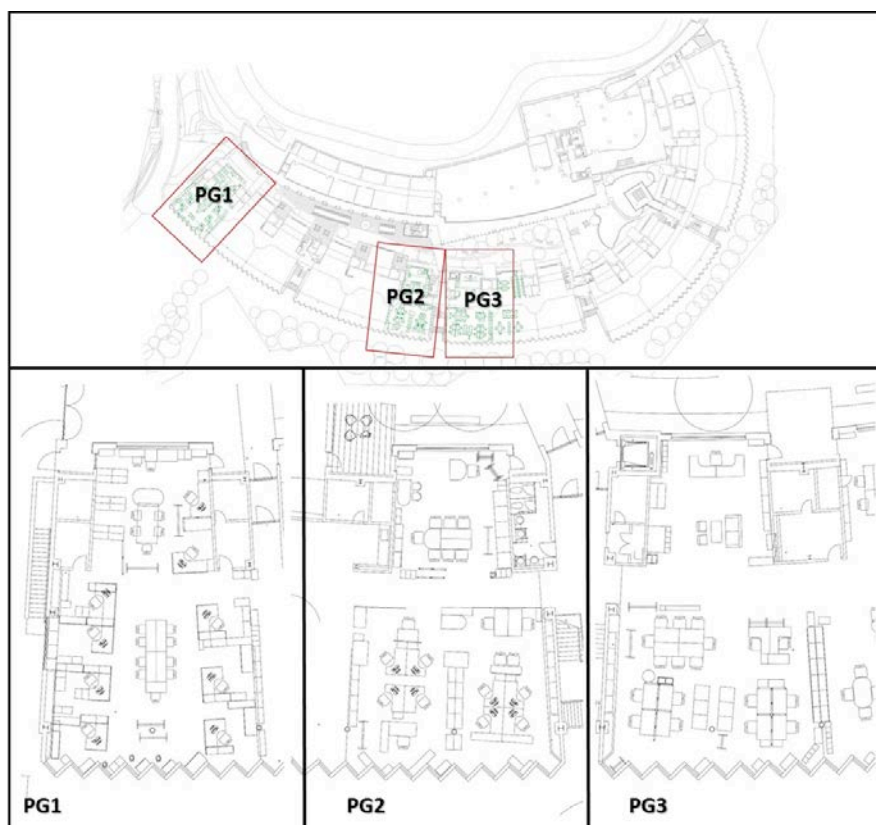
Figure 3 Office Layout of Each Project Research Group

4.2   *Data Collection Technique and Procedure*

Numerous data collection techniques were reviewed to decide the most applicable method for this research. Ethnography method was used by conducting observation and interview. First, in order to understand the nature of the work of each group, an interview was conducted. Second, the observation was applied to explore the communication behavior of each group with the following details:

1.   Semi-structured interview was conducted to obtain a rough idea regarding work activities, communication pattern and space occupancy. Each project group consists of 9 to 12 researchers assigned, and 6 participants volunteered for the interview session, where 3 of them were project leaders and the rest were researchers.

2.   Observation was conducted using overt observational research where the subjects were informed and the purpose of observation was explained. Although the behaviour of participants may alter due to the presence of the researcher, the advantage of this technique is that the data can be openly recorded. Observation was conducted for 5 days for each group during office hour starting from 930 in the morning until 1700 in the evening. A total of 112.5 hours was spent to collect the data with 600 communications recorded.

3.   The procedures during observation are – 1) all participants were given a briefing about the purpose of study and type of information that would be collected during observation, 2) an observer standing at one objective point to ensure the participants and the situation at field settings can be seen and grasp relatively, 3) participants were given a survey sheet after communication occurrence end in order to grasp the content of conversation, communication trigger, spatial occupancy, social network and duration of communication event and 4) in order to grasp people movement, presence rate of people in the

office as well as density, video recording and snapshot were taken during observation.

4.3 Types of Communication

Two types of communication – formal and informal – were of the interest in this research. Although the researchers have interest in the formal communication, but due to constrain during observation, both were recorded since it was quite impossible to record only one of them. However, it was codified and selected in the analysis. The communication observed was focused on verbal communication through face-to-face and telephone conversation.

4.4 Measures

The measures for this research include:

1. Communication contents – the higher or lower amount of communication among workers in an organization relies on the contents itself. Communication contents have a great influence in affecting the amount of communication, and measuring these variables could unveil the communication pattern practices in the organization, thus, gives a clue on what space worker may use for such purpose. The communication contents measured in this research contain five (5) attributes, and the details are shown in Table 1 adopted from a study conducted by Mizuno (Mizuno, Saji, Matsumoto, Naka, & Yamaguchi, 2006) and modified to meet with the conditions in this study.

Table 1 Variable Measured in Communication Contents during Observation

Variable	Description
1. Knowledge / information	A process involving thoughts, participations, understanding and intuition.
2. Rule of thumb / know-how	A process of developing skill, learning difficulties and challenging techniques.
3. Generating idea	A process of generating inspiration, opinion, conception, imagination and thought
4. Motivation	A process to achieve something, inspiration and encouragement.
5. Resolving problem / making decision	A process to draw a conclusion, agreement, incline towards new directions and determination.
6. Other	Greetings and instructions with very short communication exchange.

2. Communication trigger – to start a communication, it has to be triggered by something. It is either influenced by internal (coming from worker himself) or external. Communication trigger was measured using five dimensions – a) scheduled, b) ad hoc / accidental, c) being visited / being asked for, d) have a purpose to someone, and 5) other.
3. Spatial occupancy – spatial setting being occupied during communication event.
4. Social network – this dimension measures the relationship of participants with surrounding people. Relationship builds mutual trust between two people, thus, influencing the probability of having long conversation, which is a factor of duration in the AOC. Dimension under this category measures the contact across unit boundaries and within unit boundaries together with the position of communication partner.

5. Duration of communication event – duration was recorded at each communication event as it is one of the fundamental factors of AOC.

5. Findings and Discussion

In order to look into the amount of communication in this study, the following items were calculated:

① Duration rate – the proportion of durations where each worker communicated verbally on average in each communication event.

② Frequency – how frequent each worker communicated verbally on average.

5.1 The amount of communication pattern on the communication event

Table 2 shows the relationship between AOC measures upon spatial occupancy in the observation. From the analysis between the two, AOC pattern which was based on the constitution of frequency and duration of communication occurrence can be observed. Four patterns emerged from this analysis were:

① When frequency increased (↑), its duration decreased (↓).

② When frequency increased (↑), its duration also increased (↑).

③ When frequency decreased (↓), its duration increased (↑).

④ When frequency decreased (↓), its duration also decreased (↓).

Table 2 Mean of Each Project Group on Duration of Communication Occurrence and Spatial Occupancy during Communication Event

		project 1 research group	project 2 research group	project 3 research group
communication frequency		60.00 (19.59)	30.14 (19.59)	41.71 (23.47)
duration	< 1 minutes	2.17 (3.18)	6.20 (3.66)	6.20 (2.92)
	1 - 5 minutes	18.83 (4.45)	31.00 (17.17)	38.40 (11.94)
	6 - 30 minutes	5.66 (1.25)	4.20 (3.06)	9.60 (5.89)
	> 30 minutes	3.33 (1.37)	0.40 (0.49)	4.20 (3.31)
space	own workstation	20.14 (15.35)	25.33 (17.13)	16.14 (13.22)
	opponent workstation	5.57 (3.02)	9.67 (2.05)	5.29 (2.49)
	circulation area	6.00 (3.89)	3.33 (1.25)	5.57 (4.03)
	discussion area	7.00 (5.01)	13.00 (4.08)	0.86 (1.12)
	other	3.00 (2.72)	8.67 (4.19)	2.29 (2.66)
communi cation trigger	schedule	6.33 (3.09)	1.00 (1.69)	4.57 (4.20)
	adhoc / accidently	6.00 (4.08)	1.85 (0.99)	6.85 (2.94)
	being visited / being called	26.33 (16.21)	15.71 (12.45)	13.42 (11.34)
	have a purpose on someone	17.66 (6.01)	10.85 (7.80)	14.71 (10.45)
	other	3.33 (1.69)	0.29 (0.70)	2.00 (0.93)

PG1 N=3, PG2 N=7, PG3 N=7, (standard deviation in parentheses)

High mean value for communication frequency per day

Low mean value for communication frequency per day

The AOC pattern in this study was more inclined towards pattern 1, where each researcher in each project group spent 1-5 minutes to communicate within the workplace, and most communication frequently occurred at their own workstation. The average for the researchers to communicate within that range was 3 to 8 times per day. The trigger that sparked the initiation of communication showed that 'being visited / being called' as the highest mean score among others, followed by having a 'purpose on someone'. The data were observed during the preparation for periodic presentation of research output. Therefore, there was some bias on the distribution of communication contents that were exchanged in its occurrence. Hence, since accumulation and synthesizing data of research were the main activities during observation, the mentioned communication trigger was expected to be high during communication exchange.

5.2   *The communication contents and distribution of AOC on office layout*

The relationship between communication contents and distribution of AOC as per frequency and duration on each research project group is shown in Figure 4. The proportion of each distribution on communication contents is shown in Table 3. Since the layout for each research group can be categorised as small office, the spatial observed were focused at 5 specific areas – 1) own workstation, 2) opponent workstation, 3) circulation area, 4) discussion area, and 5) other (indicates space outside of office layout).

Table 3 Mean Value of Communication Occurrence at Each Space of Each Project Group

		own workstation	opponent workstation	circulation area	discussion area	other
PG1	knowledge / information	6.67 (1.25)	3.67 (0.47)	0.67 (0.47)	0.67 (1.88)	3.33 (3.30)
	rule of thumb / know-how	0.67 (0.47)	1.33 (0.47)	0.33 (0.47)	0.67 (0.47)	0
	idea	0.67 (0.94)	0.67 (0.94)	0.33 (0.47)	1.00 (0.82)	0.67 (0.94)
	chatting	3.67 (3.09)	0.33 (0.47)	0	3.33 (2.05)	0.67 (0.47)
	resolving problem / decision making	5.67 (6.02)	1.67 (0.94)	1.67 (0.94)	0.33 (0.47)	1.33 (0.47)
	other	7.67 (7.58)	2.00 (1.41)	0.33 (0.47)	1.00 (0.81)	2.67 (2.35)
PG2	knowledge / information	6.28 (6.47)	2.00 (1.92)	1.85 (1.72)	0.28 (0.70)	0.85 (1.12)
	rule of thumb / know-how	0.14 (0.34)	0	0	0	0
	idea	0.86 (1.45)	0.28 (0.70)	0.57 (1.04)	0.14 (0.35)	0.43 (0.49)
	chatting	1.00 (0.75)	0.29 (0.45)	0.71 (1.03)	0	0.57 (0.73)
	resolving problem / decision making	7.42 (5.73)	2.28 (1.16)	2.14 (1.64)	0	0.43 (0.73)
	other	0.14 (0.35)	0.28 (0.45)	0.57 (0.90)	0	0
PG3	knowledge / information	6.43 (6.43)	2.00 (1.41)	1.71 (2.25)	2.43 (1.40)	1.43 (1.29)
	rule of thumb / know-how	1.71 (2.25)	0.14 (0.35)	0.57 (1.40)	0.86 (1.36)	0.29 (0.70)
	idea	0.29 (0.45)	0.14 (0.35)	0.14 (0.35)	0.43 (0.50)	0
	chatting	1.29 (1.16)	0.43 (0.49)	1.00 (0.75)	2.14 (1.12)	0.14 (0.35)
	resolving problem / decision making	9.14 (6.6)	2.29 (1.6)	2.14 (1.64)	1.29 (1.39)	0.43 (1.04)
	other	1.00 (1.06)	0.14 (0.34)	0.42 (0.49)	0	0.14 (0.35)

PG1 N=3, PG2 N=7, PG3 N=7, (standard deviation in parentheses)

    High mean value for communication frequency per day

    Low mean value for communication frequency per day

The office layout characteristics for each office were different, where office layout PG2 adopted the island type of workstation, in which each member can see their members' faces. The communication event occurred frequently with low duration at their own workstation due to the proximity factors. Meanwhile, the other two (PG1 & PG3) adopted high partition at each workstation, thus, creating communication barrier on a certain aspect, but on the contrary, promoting concentration work. The other factor of proximity was the location of discussion / meeting area. High AOC was determined when this kind of space was allocated adjacent to workstation as it can be seen on PG1 and PG2.
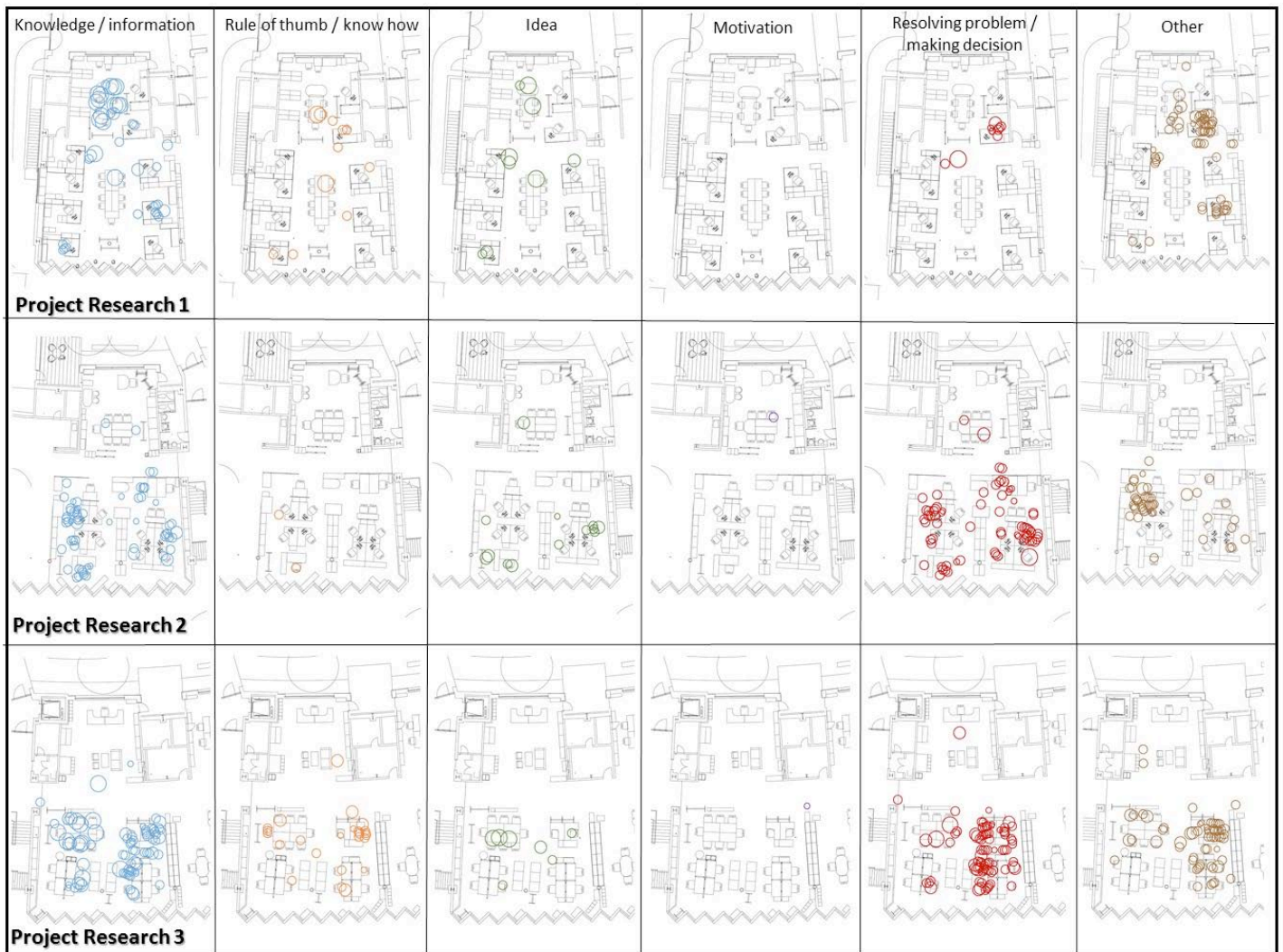
Figure 4 Distribution of AOC According to communication Contents on Office Layout

5.3 Relationship between communication network and AOC

The relationships between social network and AOC for each office are shown in Figure 5. The determination of AOC on social network was based on the communication on a single opponent instead of communication with more than one person. This analysis was done based on the assumptions that mutual trust, social relationship and familiarity factors towards opponent have the probability to enhance, thus increase the communicative environment in the workplace. The pattern emerged from this analysis is shown in Figure 5, where high AOC was determined with project member for all groups, followed by communication with superior and colleague from either different project group or other division. The duration of communication was within 1 to 5 minutes, with high frequency of communication occurrence between 9 to 17 times per individual per day.

5.4   Characteristics of office layout towards enforcing communicative workplace

The characteristics of office layout in enforcing communicative workplace in this study can be summarized as follows:

Table 4 The Findings and Discussions on AOC and Communication Contents at Each Spatial Settings

Spatial Settings	Description
Own workstations	• 2 types of workstation were identified – 1) island workstation with low partition, and 2) typical cubicle workstations with high partition. • Type 1 showed high communicative environment with short (1-5 minutes duration) communication exchanged on knowledge / information, resolving problem and making decision. • High movement was traced for type 2 workstation, and the longest (more than 30 minutes) communication exchanged was traced on knowledge and information contents from the discussion / meeting space allocated nearby (shows proximity factor). High partition / barrier creates privacy as some of the communication may need to be preserved due to secrecy, high confidential communication exchanged, as well as promoting concentration work.
Discussion / meeting area	• High AOC was traced with more than 30 minutes communication occurred regarding knowledge / information, idea, resolving problem and decision making. Communication exchanged frequently occurred with more than 2 people.
Circulation	• Support spaces including filing, storage, pantry, print and copy area were allocated under this category. Communication by accident / ad hoc frequently occurred at this area with low level of AOC.
Other	• Other spaces recorded during the observation including smoking area, admin division, library and seminar room. Within this area, moderate AOC level (5-30 minutes) and sometimes high (more than 30 minutes) were traced with resolving problem / decision making and other type of communication contents.

6.　　　Conclusion

This study has presented how the amount of communication may influence the spatial occupancy by worker by focusing on the communication contents and social network. The analysis on communication contents and social network showed that they had strong influence in shaping office spatial setting. Hence, the amount of communication based on its contents may differ for different organization due to its nature of work practiced for different profession and culture of organization. However, all consequences and consideration of this study were based on a small scale office layout, and the results may represent certain type of spatial settings.
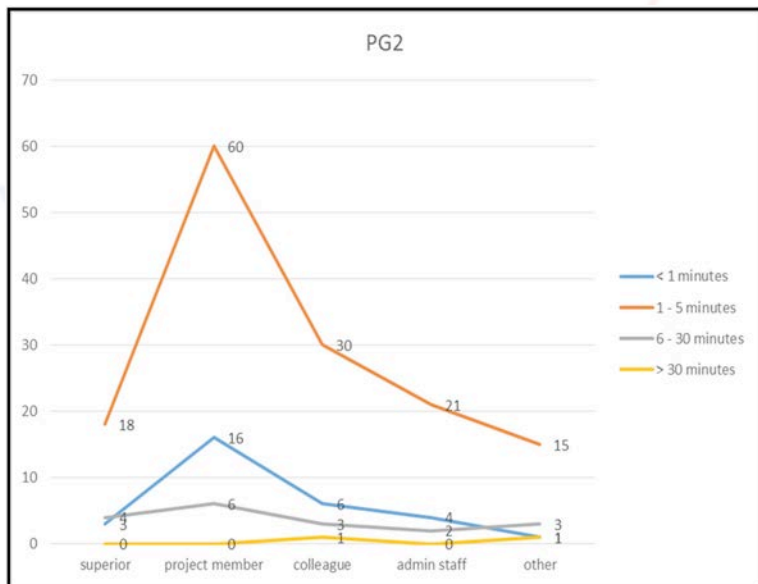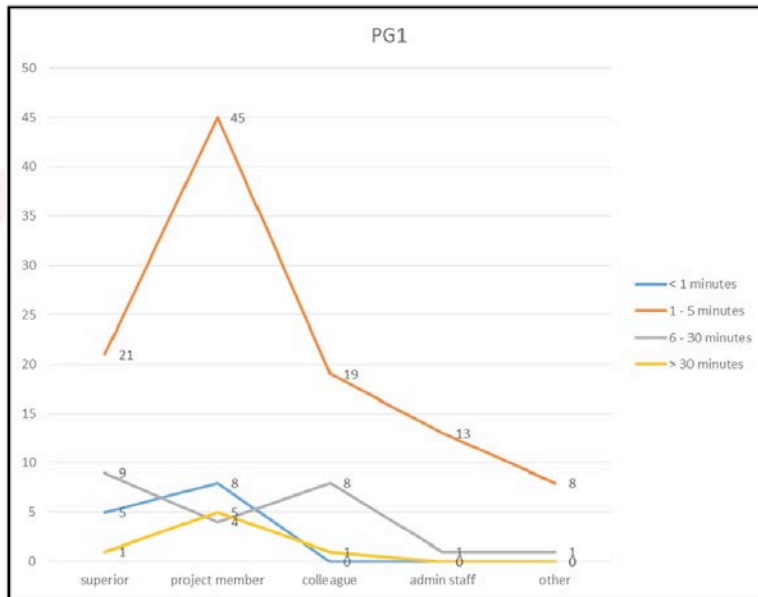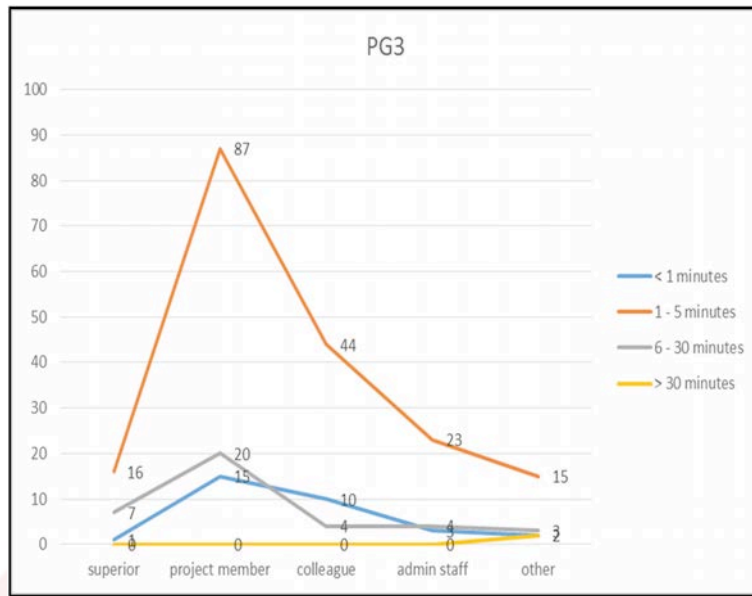
Figure 5 The AOC of Researcher with Their Social Netwotk for Each Project Group

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Socio-Cultural Sustainability within the Context of Geological Effects: The Case of Cappadocia Vernacular Architecture

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Abstract

Geology of a territory is one of the many factors such as climate, socio-cultural structure, and economy that influence the method of construction which is a part of architecture. The effects of geology on architecture differ according to regions and cultures. The geology of the region plays an active role in the diversity of the vernacular architecture of Cappadocia, the region that has an interesting architecture in the middle of Turkey. Geological factors such as variety and physical-dynamic characteristics of the rocks that belong to the region have different effects on the house types of vernacular architecture which are rock-cut, semi rock-cut and masonry.

The aim of this study is to explain how the geology of a region affects socio-cultural sustainability and vernacular architecture. Cappadocia constitutes a noteworthy sample in order to generate solutions for socio-cultural sustainability of those kind of regions by evaluating the effects of geology.

Key words: Socio-Cultural Sustainability, Geological Effects, Cappadocia, Vernacular Architecture

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1. Introduction

In the rapidly developing world, changes emerge in social structure, culture, architecture and economy in line with the development. Geology of a region has direct or indirect influence on many factors comprising a society, ranging from the architecture in the region to the social structure. Abandoning the previous data in an attempt to achieve social and cultural sustainability causes problems while producing new proposals. Especially in the areas like Cappadocia where the geology of the region has an effective role in architecture and social life, every proposal on social and cultural sustainability will remain inadequate without considering the geological and architectural data of the region.

The aim of this study is to explain how geological and architectural examinations have important contributions to the process while developing proposals in order to achieve socio-cultural sustainability in the areas like Cappadocia where geology plays an effective role in the habitat and thereby in social, economic and cultural structure of the society.

Within the scope of this study, two collective living spaces including underground settlements have been chosen from the examples of local architecture in the Cappadocia Region. These examples are Kayakapi (Stone door) and Mazi Underground City. The study is confined with these two sites. Stones constitute the building materials of rock-cut, rock-cut & masonry and masonry structures in the region. It is important to research the geological structures and features of the stones, and the influence of this geological structure on architecture and social structure, and to convey the socio-cultural prosperity shaped by this particular influence to next generations by also meeting the requirements of the century.

Detecting the requirements for the sustainability of social values by examining the architectural and social structures based on the geology of the particular areas is designated as the method of this study. It is assumed that a general proposal on socio-cultural sustainability can be produced out of the results acquired with this method for areas like Cappadocia where the geology of the region has influence on formation of the social structure.

Figure 1: Location of Cappadocia and study areas (1, 2, 3, 4)

2. Cappadocia and Sustainability

Cappadocia is located in Central Anatolia, and surrounded by Taurus Mountains in the south, Kızılırmak in the north, Kayseri in the east and Tuzgölü basin in the west (Fig.1) (Ayhan, 2004). The name Cappadocia was first used by the historian Heredotus as "Katpatuka" It means "The Land of Fine Horses" (Ayhan, 2004).

2.1. Geology of the Region

Erciyes, Hasandağ and Göllüdağ in the Cappadocia Region were active volcanoes in geologic ages eruptions of which had started in the Upper Miocene (10 million years ago) and lasted till the Pliocene (2 million years ago). Lavas extruding from the volcanoes under the Neogene lakes had formed a tuff layer, around 100 – 150 m thick and varying in rigidity, on the plateau, lakes and rivers. Besides the tuff, there are also some other geologic schist such as tuffite, volcanic mudflow, volcanic ash, clay, sandstone, marl, agglomerate and basalt (Öz, 2007). Maps displaying the types of rock peculiar to this region and the geology of the region are in Fig. 2. As it is seen in the maps, many different kinds of geologic formation and rock types exist in the region. Study areas are located in the Cappadocia Volcanic Province (CVP) as seen in Fig. 2.
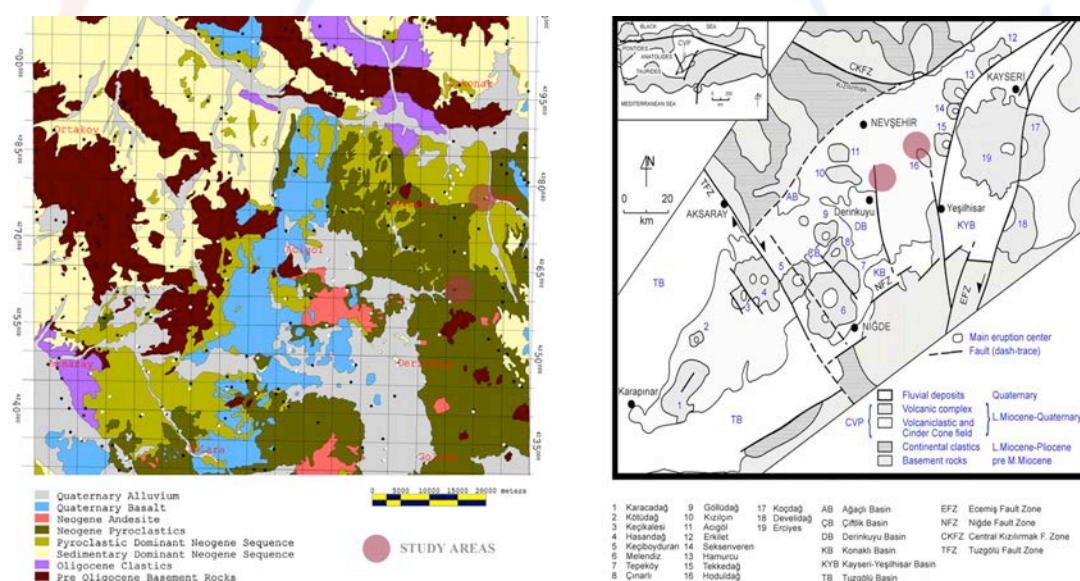
Figure 2: Rock types of the region and simplified geological map of the CVP (Ayhan, 2004 and Toprak, 1998)

2.2. Socio-Cultural Sustainability

Culture is the compilation of material, moral and intellectual features; brought in the individual and sustained by a particular society through individual and social communication and interaction (Özçetin and Dikmen, 2012). The phenomenon and process of individuals' adaptation to the environment, and their alteration of the environment based on their aims and needs is very influential in the formation of the culture. Cultural sustainability is the willingness to protect the cultural heritage and an attempt to convey the present cultural prosperity to next generations by accepting that

a society has some complicated common values, beliefs, traditions and capabilities. Social sustainability, though, means to provide efficient use of natural resources in the present day and in the future by developing and protecting a social order which will support meeting the needs of human and environmental sustainability (Sönmez, 2010). When these two definitions get combined, socio-cultural sustainability means conveying every single social, cultural value and the prosperity of the society to the next generations by protecting them considering the requirements of the day.

While sustainability was mainly divided into two groups as economic and environmental, later it was divided into sub-groups of social and cultural. Social and cultural sustainability are generally handled together but each has its own focal points: the former concentrates on social well-being, the latter on the sustainment of the culture (Chiu, 2006).

Social structure and social life are influential in the formation of the structures in the Cappadocia Region, and these structures are losing their original function and drawn into the process of destruction as the social and cultural sustainability could not be achieved. Traditional houses should be functionalized without losing their features and in accordance with the new social infrastructure and life style of the society. Protection of the structures in accordance with the present conditions without losing their features will contribute to the socio-cultural sustainability and it will help conveying the architecture, social life and culture to the next generations. Even though protection of the architecture alone is not enough for socio-cultural sustainability, wide scale sustainability can be achieved with the accumulation of new approaches upon architectural protection. In order to achieve this goal, geologic structure which allows the formation of three main types of structure in the Cappadocia Region, rock-cut, rock-cut & masonry and masonry should be investigated; and the influences of geology should be discovered and used in the context of sustainability.

3. Cappadocia Region and Architecture

As easily-excavated volcano-sedimentary rocks are extensive in the region (Ulusay et. al., 2006), rock-cut, rock-cut & masonry and masonry structures are observable in many parts of the region. Communities and states which have lived in Cappadocia and contributed to the development of the architecture for centuries are:

The Assyrian Trade Colonies and Hittites
1750 BC – Hittite Empire
1100 BC – Phrygians
950 BC – Cimmerian-Scythian Invasions and Lydians
585 BC – Persians
334 BC – Kingdom of Cappadocia
17 – 395 Roman Empire
395 – Eastern Roman (Byzantine) Empire
1072 – Settlement of Turkish Tribes
1175 – Anatolian Seljuks
1243 – Mongolians
1340 – Eretnid Dynasty
1398 – Ottoman Sovereignty

1466 – Cappadocia became an Ottoman land (Görmez, 2010)

1923 – The Republic of Turkey was founded. After the ratification of the Lausanne Treaty, within the "population exchange" Greeks living in Cappadocia were sent to Greece and the Turks from Greece were settled in Cappadocia (Güney, 2011). Changing social structure after the exchange in the 20th century caused serious social and cultural alterations.

While Cappadocia is world-famous for its scenic beauties, it also has very diverse and peculiar structures, which cannot be formed anywhere else in the world, in its traditional architecture. In the local architecture of the region, natural stones were used as building material for centuries, and masonry structures were built with those natural stones extracted from the rocks in the region. Rock-cut structures in the region are mostly observable in the underground cities.

4. Underground Cities

Underground cities are collective living spaces formed by carving in the underground in which people mostly live with their animals and spend their time during a day. According to Ayhan's thesis (2004), in Nevşehir, which constitutes a large portion of Cappadocia, there are 61 underground cities in various capacities. 18 of them can be visited, 34 of them are known but cannot be visited, and 9 of them can only be traced in some sources. Sterrett (1919) states that the volumes of places like Kaymaklı and Derinkuyu (Known as the two biggest underground cities in Cappadocia) which can accommodate 3000 people are no less than 30000 m^3; and when one person's capacity to excavate 100 m^3 in 30 days is considered, forming these cities must have taken an intense work. Underground cities are mostly located in Ürgüp formation. Among the sequences, Pyroclastic dominant Neogene sequences are the ones mostly preferred to build underground cities, and building underground cities in other units was shunned. While the unit known as "mesa" morphologically was the one mostly preferred in carving these cities, high mountain unit was the least preferred (Ayhan, 2004). Bixio and Castellani (1995) divide underground structures into 2 groups and 2 sub-groups based on the styles of carving. These are:

- Natural cavities
- Artificial cavities

-Underground structures: Towns, redoubts and tunnels.
-Cliff settlements: Cone villages, cliff wall villages, rocky churches, rocky castle villages, rocky tombs, rocky pigeon lofts (Fig. 3).
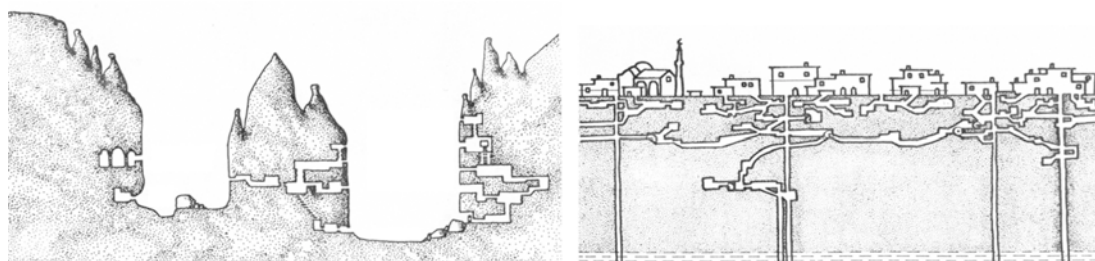
Figure 3: Schematic Section of cliff settlement and underground city (Ayhan, 2004)

While Mazi Underground City examined within the scope of this study is completely an underground structure, Kayakapi (Stonedoor) Neighborhood is in the group of cliff settlements, and there are masonry and rock-cut & masonry buildings in the neighborhood within the settlement.

Even though the exact periods when the underground cities were formed are not known, Bixio (1995) claims that as metal tools started to be used in Anatolia in the 3rd century BC and as they are required to carve rocks, the underground cities in Anatolia could not have been formed before the use of these tools. Stea and Turan (1993) state that the underground cities certainly existed in Anatolia in the 5th century AD. Although an exact date cannot be given about the formation of the underground cities, the biggest developments in these cities occurred between 6th and 16th centuries AD namely during the Christianity period. Erguvanlı and Yüzer (1977) explained the environmental and anthropological factors of living in the underground cities in 6 groups. These are:

- Daily and annual temperature changes
- Thermal insulation of the regional rock-structure
- Self-supporting structure of the rock and its eligibility for construction
- Easily-excavated soft tuff
- Advantage of security and camouflage during an enemy-attack
- Endurance and protection against the earthquake and eruption

Eligibility for agriculture on top of the underground cities can also be another factor. The issue of how frequently these cities were used is not known. Stea and Turan (1993) state that these cities might have been used for short or long terms only in cases of danger.

There are living spaces for families and storages separated from the collective space by using walls, columns or random arches. Wells are built to extract water from the depth. The oldest parts of the underground cities are the entrance floors. As the animals could not get into the lower floors, the entrance floors are generally used as barns. Some wells do not reach the entrance floor in order to prevent the enemy from poisoning the water (Ayhan, 2004). Even though it is claimed that the underground cities can be connected to each other, there is no evidence for such connection.

4.1. Mazi Underground City

Mazi Underground City was explored in 1970s, in Maziköy which is 26 km from Ürgüp which is 18 km away from Nevşehir city center. Contrary to other underground cities, there is no clear information about when and by whom this underground city was built (Nihal Ergun Architecture, 2008). Typical Anatolian culture is sustained in the village and social structure constitutes of farming families in general. This underground city which is among the 18 can-be-visited underground cities is temporarily closed to visitors because of the ongoing restoration.
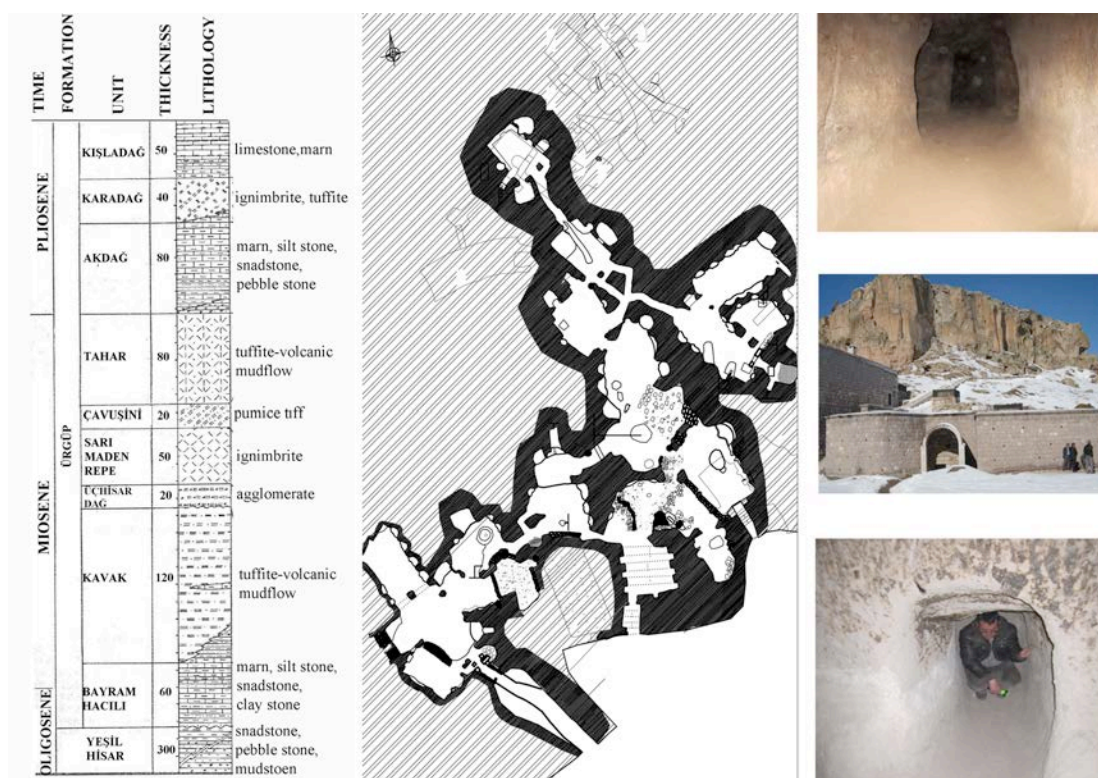
Figure 4: Generalized Urgüp formation and its units, ground floor plan of Mazi Underground City and general view of Mazi Underground City from inside and outside (Foundation of Istanbul Technical University Mining Faculty, 2008 and Nihal Ergun Architecture, 2008)

In the Fig. 4, generalized Urgüp formation and its units which belong to Nevşehir are seen. Not all of these units in this formation are seen in the Mazi Underground City. There is Kavak Unit having tuffite-volcanic mudflow feature on the bottom and on top of that Karadağ Unit with ignimbrite-tuffite feature appears. The whole city is carved in the Kavak Unit. These rocks have features of sound and thermal insulation, and they have a massive structure (Foundation of Istanbul Technical University Mining Faculty,2008). As the rocks falling down from the vertical cracks formed in the Karadağ unit can harm the city below, they are stabilized with steel ropes.

Even though this underground city will be conveyed to the next generations after the completion of the restoration and its opening, it is clear that social and cultural sustainability cannot be achieved by only opening up underground cities for public visits. Every intervention made without associating it with its periphery will abstract this hundred –maybe thousand- year-old structure from the historical area around it, and it will turn into a place to pass-by. While this structure could be a focus of socio-cultural sustainability, because of the inadequate and irrelevant project-designing it neither reflects the values of the society by serving for the periphery it is located in, nor can it use the unparalleled feature brought by the geography around it. Cultural heritage should be protected; but for the sustainability of this structure in real terms, it should support the sustainability of the overall social and cultural structure it belongs to.

4.2. Kayakapi (Stonedoor) Neighborhood

Kayakapi is an old neighborhood of Ürgüp which is 18 km away from the city center. This neighborhood is located in the Northeast cliff of Esbelli Hill which is a historical area (Fig. 5). In addition, this neighborhood is located in the site of "Goreme National Park and the Rock Sites of Cappadocia" (Ulusay et. al., 2006). In the neighborhood which is approximately 27 hectares, there are 1215 cliff settlements, masonry houses and ruined structures. In the neighborhood, there are about 20 officially registered structures including rock-cut churches, mosques, fountains and bath (Özdem, 2012). Neighborhood community moved to other parts of the city between 1966 and 1983 because of the rock-fall danger. After people moved from this site, it got looted and ruined (Savaş, 2012). While local population in Ürgüp displays the typical feature of Anatolian people, growth of tourism in Ürgüp caused the alteration of the authentic culture of the society (Tosun, 1998).

Figure 5: Kayakapi Neighborhood and cliff settlements (5)

In the site, as it was the case in Mazi Underground City, Kavak unit of Urgüp formation has been observed. Section of Kavak tuff can be seen in the Fig. 6 (Ulusay et. al., 2006). The feature of thermal insulation of the tuffs supported the formation in the underground sections. Although some problems such as block falls, overbreak, bending, spalling, erosion and shearing of pillars (Ulusay et. al., 2006) emerge in the rock structure of the area, solutions have been provided for these problems within the scope of the restoration.
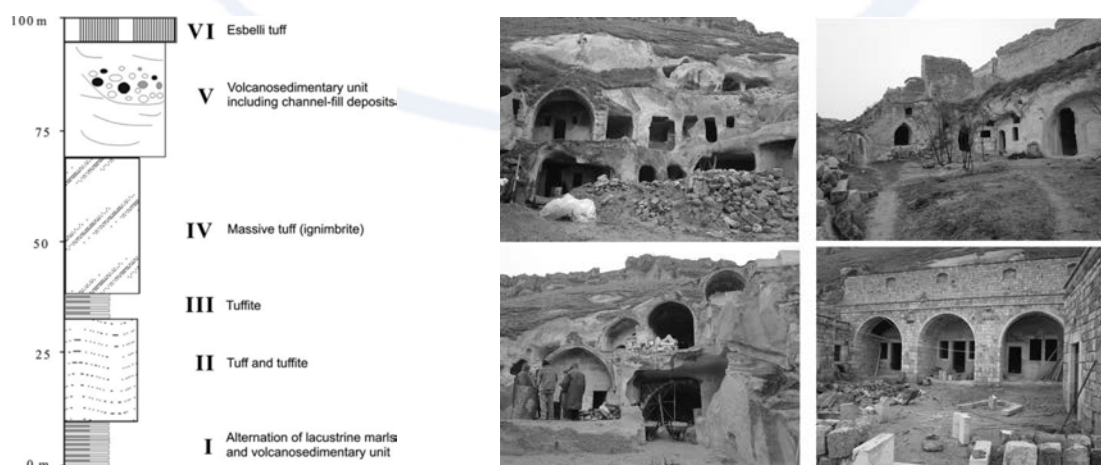
Figure 6: Section of Kavak unit of (Kayakapi) Urgüp formation (Ulusay et. al., 2006) and views from ongoing restoration of Kayakapi neighborhood

In Kayakapi Neighborhood, a different understanding of protection has been developed and implemented compared to the similar cases. According to this understanding, the main aim is to protect and develop the cultural and natural resources while using them for tourism in the socio-economic development process, and to convey them to the next generations without deteriorating (Güçhan, 2012). In addition, the understanding does not only address cultural and natural issues, it also covers all aspects of the previous life in Kayakapi Neighborhood. This understanding is consistent with the clause of ICOMOS Paris Declaration (2011) under the title of "Developing a Permanent Tourism," which proposing to protect cultural resource as the capital of tourism, and foreseeing this resource as a "condition for the long-term development of tourism" (Güçhan, 2012).

With this protective understanding, primarily the problem of transportation in the area has been resolved. As the tuff, dominant in the area, can be carved and shaped easily, a new road for vehicles has been formed, thus the problem of transportation has been resolved. Project is not restricted to the restoration of the traditional structures in the area. The restoration part constitutes only one-third of the project. Restored and unregistered structures will be reused as hotels. The other one-third will be open to the public visit for daily use. In Kayakapi: there are 2 mosques, 1 rock-cut church, 1 historical bath, 8 fountains, and most importantly House of Aziz Yuhannes (House of St. John the Russian / Esat Ağa Konağı). These historical monuments will be opened to public visits when the restoration is completed (Özdem, 2012). In the last part of the project, as there are agricultural fields around the slopes of the neighborhood, these fields will be reserved for organic agriculture and endemic fruits will be grown. In addition, a marketplace will be formed for the craftsmen in order to liven up the craftsmanship, which is about to disappear, peculiar to the region (Özdem, 2012). The project named as "Protection and Development Project of the Cultural and Natural Environment" (Güçhan, 2012) has become a good example of how socio-cultural sustainability can be achieved within local architecture as it has protected and livened up the local architecture by containing social, cultural and economic factors.

5. Discussion and Conclusion

Binan (1994) states that geologic structure of Cappadocia has become an important factor for the historical development and for the formation of man-made physical environment for ages. Thanks to the facilities provided by the geology of the Cappadocia Region, people have been able to form a physical environment quickly and in an unparalleled way in order to meet their social, cultural and economic needs for centuries. Even though those geologic features still exist, their influence in the environment has decreased. Changing social, demographic and cultural structure of the society requires the facilities of the modern architecture, thus traditional architecture gradually disappears. Regional architectural traditions have been gradually forgotten, and this situation causes serious problems for the socio-cultural continuity between generations. One of these problems is the formation of a monotype culture. Every society exists with its own social structure, values and traditions. Turning these into a monotype thereby destroying them will be equal to abandoning a-thousand-year heritage of the society. As social values, norms and features are conveyed by the society, all these data should be conveyed by turning into a form which can be accepted by the society. Therefore, for socio-cultural

sustainability, certain projects; which are based on the past as their source, applicable to the present conditions, and foreseeing the future, should be designed. In order to achieve socio-cultural sustainability by designing such projects:

•   Every region should be examined carefully with its own geologic and architectural data, and the decision should be made on which of the features should be used today for the best results in the future.
•   As every society exists with its own values, while working for the future generations, one should be inspired from the past.
•   In order to achieve sustainability in a society, it should not be forgotten that sustainabilities are related to and dependent on each other, and strategies should be defined accordingly.
•   If the monopoly of an institution conducting a project prevents the participation of the people, this prevention should be removed, and the society, as the lead actor shaping the values, should be directly included in the project. Otherwise failure of the project will be highly possible.

Especially in the regions like Cappadocia where geology of the region has direct or indirect influence on nearly all the activity areas from living spaces to material gain, geologic and architectural structures should be examined in detail and conveyed to the next generations with all the features for socio-cultural sustainability. One should not be contented with the sustainability of material values and data, because every single feature of the society which can contribute to the future generations is worth sustainability.

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Effects of Elevated Temperature and CO$_2$ on Jasmine Rice: Case Study in Thailand

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Abstract

Effect of elevated temperature and CO$_2$ on Jasmine rice was investigated in the greenhouse. Thai jasmine rice namely Khao Dok Mali 105 (KDML105) variety was planted in pot experiment. The experiment design by split plot in CRD with 5 replicates and 3 different planting conditions was compared 1) ambient temperature (Control), 2) planting under high temperature (~2 ºC over the ambient) (HT), and 3) planting under combination of high temperature and high CO$_2$ concentration (HTC). Rice plants of HT and HTC were remaining under ambient air temperature in vegetative period then the pots were stored inside HT and HTC chamber from panicle initiation stage to harvesting. Rice plant growth and yield were observed throughout growing season. Plant height, number of tiller, number of panicle among 3 treatments were significantly different ($p \le 0.05$). Panicle number of HTC treatment was highest and 2 times higher than that control but no filled grain was observed from HTC treatment. However, highest amount of unfilled grain per panicle was observed from HTC treatment and significantly different compared to control and HT treatment ($p \le 0.05$). The result concluded that growth rate and yield of Thai jasmine rice declined under elevated temperature and CO$_2$. Further experiments are needed in order to avoid the insufficiency of jasmine rice yield for consumption.

Keyword: Thai jasmine rice, rice yield, elevated temperature and CO$_2$

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1. Introduction

Jasmine rice sometimes known as *Thai fragrant rice*, is a long-grain variety of rice that has a nutty aroma and a subtle *pandan*-like (*Pandanus amaryllifolius*-leaves) flavor caused by *2-acetyl-1-pyrroline* rice is originally from Thailand. The grains will cling when cooked, though it is less sticky than other rice as it has less amylopection. It is also known as Thai Hom Mali (Wikipedia, 2011). Favorable condition for jasmine rice is like other rice varieties, which cultivated in water logged paddies but jasmine rice normally planted on high land. The most important cultivation area for Thai jasmine rice is located in the northern part (Thung Ku La Rong Hai) and northern part of Thailand. The jasmine rice cultivation area cover ~ 3 billion hectare in Thailand. The normally growing season for obtained the high quality of jasmine rice is on June-November, which is plowing for land preparation on June, planting on rainy season (July-August) and harvesting on winter (October –November). Only one growing season is conducted in the year in order to control the quality of jasmine rice. However, the external growing season of jasmine rice has been done in some area in order to fulfill the requirement of demand. The quality of jasmine rice is actually good but its yield was declined.

In addition, increasing of greenhouse gases that absorbs radiation may lead to an increase global surface temperature and may have impact on rice production including jasmine rice. Number of research reported effects of high temperature and increasing of CO_2 concentration on rice production (Matsui et al., 1997, Luo et al., 1998, Cheng et al., 2008). High temperature effects on rice growth and rice yield by decreased rice panicle number (Cheng et al., 2008) high unfilled grain (Keawklom et al., 2009) and lead to low rice yield (Luo et al., 1998, Thanacharoenchanaphas, 2008). In order to obtain the effects of cultivation conditions and effects of environmental change on jasmine rice, this study investigates pot experiment in green house in order to simulate of elevated temperature and CO_2 on jasmine rice growth and yield.

2. Materials and method

2.1 Green house for rice cultivation and temperature control equipments

Controlled temperature and CO_2 green house was used in this experiment. The green house was square in shape of base and its roof was semicircle in shape. It was 2 m. x 2.5 m. x 2.5 m. (W x L x H), open front, its frame construct of steel and cover by plastic sheet 0.5 mm. thick. Air conditioner was installed inside the green house. Temperature inside green house was controlled approximately 2ºC over ambient temperature in day time by automatically circuitry for HT treatment. Temperature inside green house was controlled approximately 2ºC over ambient temperature by automatically circuitry and CO_2 concentration was manually control in day time for HTC treatment. Temperature inside green house was continuously record by data logger throughout the growing season. Carbon-dioxide concentration was measured by air quality prove AQ 200 by KIMO instruments.

2.2 Pot experiment

The pot experiment was conduct at Kasetsart University Kamphaeng Saen Campus Nakhon Pathom province in central of Thailand. Thai jasmine rice cultivar KDML105 variety was used in this experiment. Rice plant was transplanting in external growing season on November 24, 2010 in pot with six replicates of three treatments: 1) ambient temperature (Control), 2) planting under high temperature (~2 ºC over the ambient) (HT), and 3) planting under combination of high temperature and high CO_2

concentration (HTC). The pots were flooded on 7 days after planting and the water level in each field was controlled (5-10 cm) throughout the growing period. The final drainage was applied for all treatment at 15 days before harvesting. Chemical fertilizer was applied for basal and top dressing. The soil was Kamphaeng Saen (Kp) soil series and the soil was classified as *Typic Haplustalfs*. Soil texture was classified as clay with a percentage composition of sand: silt: clay of 22: 24: 54. Table 1 descripts soil properties of Kamphaeng Saen soil series before growing season. For ambient temperature treatment, the pot of rice plant was store under ambient temperature since transplanting throughout growing season. Rice plants of HT and HTC treatments were remaining under ambient air temperature in vegetative period then the pots were stored inside HT and HTC chamber from panicle initiation stage to harvesting.

Table 1 Soil properties of Kamphaeng Saen (Kp) soil series before growing season

Soil parameters	Soil properties
pH	7.06
Organic matter (%)	1.80
Organic carbon (%)	1.04
Phosphorus (mg P/kg)	97.71
Potassium (mg K/kg)	61.70
Bulk density (g/cm^3)	1.31
Total carbon	1.50
Total nitrogen	0.06
C/N ratio	23.49

3. Results and discussions
3.1 Rice growth and rice yield
Rice growth data was observed throughout growing period. Plant height, number of plant per pot, and number of rice ear per pot were shown in Table 2. Plant height, number of plant per pot among three treatments were significantly different ($p \leq 0.05$). Number of plant per pot of HT and HTC treatments were 5 and 12% lower than that control. However, rice ear per pot of HT and HTC treatments were 33 and 100% over than that control.

Table 2 Rice plant growth

Treatments	Plant height (cm.)	Plant/pot	Rice ear/pot
Control	168.38a	18.00b	12.93c
HT	160.13a	19.26b	17.20b
HTC	147.50b	29.86a	25.86a
F-Test	**	**	**

CV. (%)	8.11	22.99	24.80

Values in a column followed by a common letter are not significantly different at the 5% level by DMRT. ns: not significantly different

Rice grain yield was recorded after harvested. Number of filled grain per ear, and filled grain weight under elevated temperature and CO_2 were lower than that control. Filled grain was not obtained from HTC treatment. In addition, unfilled grain of rice cultivated under elevated temperature and CO_2 in HTC treatment was highest when compared to HT treatment and control. The HTC treatment presented 56% of unfilled grain lower than that control. In case of elevated temperature and CO_2 (HT and HTC treatments), the pots of rice plants were store in the green house at panicle initial growth stage. Filled grain yield per ear of HT treatment was 6% lower than that cultivated under ambient temperature and filled grain was not obtained from HTC treatment (Table 3, Figure 1). High temperature damage grain yields because high temperature may effects rice growth at panicle initial and flowering (Yan et al., 2008). Rice growth rate, flowering potential, and filled grain activity of rice plant was destroy by high temperature (Wang et al., 2009).

Table 3 Rice yield

Treatments	Filled grain/ear (seed)	Unfilled grain/ear (seed)	Filled grain weight/ear (gram)	Filled grain weight/1000 seeds (gram)
Control	44.99a	72.49b	1.302a	24.385a
HT	42.23a	76.69b	1.319a	24.288a
HTC	0.00b	113.12a	0.00b	0.00b
F-Test	**	**	**	**
CV. (%)	55.27	26.37	43.00	4.35

Values in a column followed by a common letter are not significantly different at the 5% level by DMRT. **: significantly different, ns: not significantly different
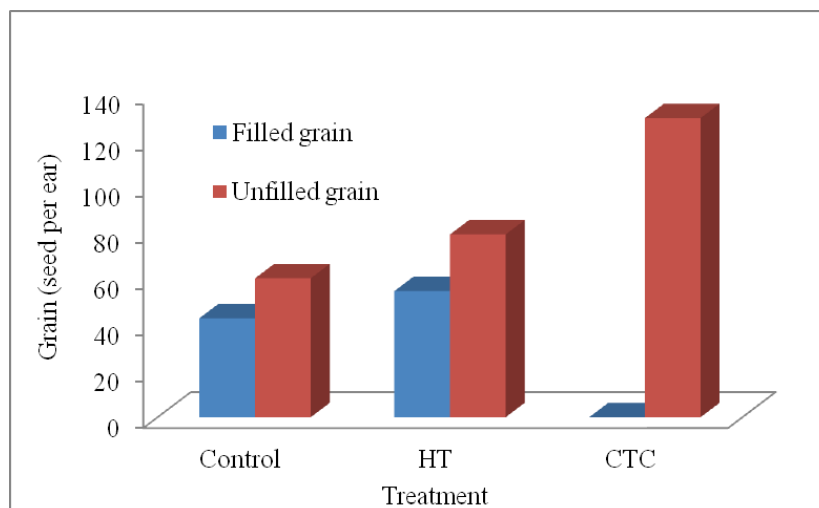
Figure 1 Filled grain and unfilled grain of jasmine rice cultivation under three different conditions, where HT is planting under high temperature (~2 ℃ over the ambient) and HTC is planting under combination of high temperature and high CO_2 concentration

3.2 Soil properties after harvested

Soil properties of Kamphaeng Saen soil after harvested shown in Table 4. Higher organic matter, organic carbon, and potassium remained in soil was observed from HT treatment than that control. However, soil organic carbon and soil organic matter from HTC treatment was not significantly different compared to control. Phosphorus of HT and HTC treatments was higher than that normal condition. High temperature may leads to high activity of decomposition in soil (Akkarathanakul, 1986, Yingjajaval, 1993). Soil pH of HT treatment after harvested period was increasing compared to soil pH before growing period and significantly different ($p \le 0.05$) compared to control but comparison of soil pH between control and HTC treatment after harvested was not different.

Table 4 Soil properties after harvested

Soil properties	Control	HT	HTC
pH	6.647b	7.104a	6.695b
Potassium (mg/kg)	67.634a	91.574a	80.812a
Phosphorus (mg/kg)	13.557a	14.108a	10.686b
Total Carbon (%)	1.274b	1.283b	1.323a
Total Nitrogen (%)	0.103ab	0.098b	0.110a
C/N ratio	11.497b	12.774a	12.071ab
Organic Carbon (%)	1.000b	1.109a	1.004b

Organic Matter (%)	1.724b	1.912a	1.731b
Bulk density (g/cm^3)	0.983a	1.018a	0.990a

4. Conclusion

Pot experiment in green house to simulate of elevated temperature and CO_2 on Thai jasmine rice growth and yield in this study concluded that elevated temperature decrease rice grain yield approximately 6% and elevated both temperature and CO_2 destroyed rice grain yield. Highest amount of unfilled grain was obtained from rice cultivation under elevated temperature and CO_2. Rice yield under elevated temperature and CO_2 on Thai jasmine rice yield was significantly different ($p \leq 0.05$) compared to normal planting condition. The result concluded growth rate and yield of Thai jasmine rice was declined under elevated temperature and CO_2. Further experiments are needed in order to avoid the insufficiency of jasmine rice yield for consumption.

5. Acknowledgements

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Soil fertility Management Practices in Organic and Inorganic Farming System in Chitwan District of Nepal

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Abstract

Soil management practices deserve greater attention for various reasons, one among which is the issue of food insecurity. Nepal remains no exception and faces similar challenges of declining soil fertility along with the need to increase its food yield for growing population. The main objective of this study is to assess how adoption of soil fertility management practices differs among organic, partial and inorganic farmers with various socioeconomic characteristics, in the rural area of Chitwan district in Nepal. Usually organic farmers are known for being better managers of soil. However, in developing countries even though there is an influx of modern inputs such as chemical fertilizers, farmers still incorporate traditional way of soil management practices such as farmyard manure. The collected data was analyzed using multivariate probit model. This model regressed five soil fertility management practices, viz. mulching, compost-shed, bio-slurry, bio-pesticides and others (vermi-composting and/or tunnel farming) against various socioeconomic variables of farmers and their farming system. Results show that soil fertility management practices are influenced by farming system and various socio-economic characteristics. Mulching is the most traditional form, which is still practiced under various farming system, although rest are mostly adopted by organic farmers. Fund assistance and training contributes positively to the adoption. Moreover, farmers are complementing one practice with another and some even act as substitutes. Thus, any effort to enhance such adoption rate can consider these characteristics of various practices.

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1. Introduction

Soil is a principal component that influences farm productivity. It is the basis for plant growth by supplying nutrients, water and root support. It maintains biodiversity by providing habitat for billions of organisms. Soil fertility is a result of both inherent and dynamic soil properties. Inherent soil properties are a result of natural soil forming processes whereas dynamic soil properties are defined by how well it is managed by humans (Green & Brye, 2008). Therefore, adopting various management practices can impact on dynamic properties of soil. Soil management practices deserve greater attention for various reasons, one among which is the issue of food insecurity. It is one of the major challenges facing the world today and is more prevalent in developing countries where agriculture remains a major sector. Declining soil fertility to the large extent is responsible for lower productivity and hence better soil management practice could be one of the ways to combat this situation. The fact that there is continuous growth in demand for producing more on a limited area requires us to focus on management strategies that lead to better soil fertility for enhanced productivity (Green & Brye, 2008; Huili, Dan, Xiaojuan, & Feng, 2013; OECD, 2008).

Nepal remains no exception and faces similar challenges of declining soil fertility along with the need to increase its food yield for growing population. Nepal is naturally highly vulnerable to soil erosion on slopes and flooding in the lowlands because of its rugged geographical setting, active tectonics and concentrated monsoon precipitation. But soil fertility has been further intensified as a result of changes in agricultural practices through changes in technology and farmers' knowledge, resource constraints (through deforestation and erosion brought by changes in land use), increasing use of chemical fertilizers and profit-oriented mono cropping system (Bista, Ghimire, Shah, & Pande, 2010). The main objective of this study is to assess how adoption of soil fertility management practices differs among organic, partial and inorganic farmers with various socioeconomic characteristics in the rural area of Chitwan district in Nepal. Usually organic farmers are known for being better managers of soil. It relies on managing soil organic matter that enhances chemical, biological and physical properties of soil, thus optimizing the crop production. The difference between organic and inorganic way of soil management is that, the former relies on longer-term solutions with the objective of preventing rather than reacting and the latter is based on short-term solutions (Watson, Atkinson, Gosling, Jackson, & Rayns, 2002). However, in developing countries even though there is an influx of modern inputs such as chemical fertilizers, farmers still incorporate traditional way of soil management practices such as farmyard manure (FYM) (Bista et al., 2010; Kabuli & Phiri, 2007). Understanding the determinants of farmers' choices of soil management practices among the various available choices can provide insight on the factors that enable or constrain such actions and guide in developing farm-level adoption strategies.

2. Variables selection

This study considers five soil management practices: mulching, compost-shed, bio-pesticides, bio-slurry and others (vermi-composting and/or tunnel farming). Mulching is a process of covering soil surface around the plants to conserve moisture content, protect plant roots, reduce weed growth and improve overall soil health and fertility.

Farmers in this study are practicing either crop or plastic mulch, which are then combined to form a variable 'mulch'. The study found that farmers are either applying FYM or compost for soil management. Compost is a mix of organic material that includes manure, leaves and any other materials that decompose. It supplies significant quantities of organic matter, improves soil structure and its water holding capacity. This study takes compost shed as a proxy for quality compost or FYM because it preserves the compost/manure pile from volatilization by sun or leaching by rainfall and maintains its nutrient availability (Bista et al., 2010). The survey found that farmers are either buying bio-pesticides from the market or are preparing by themselves. Bio-pesticides are meant for controlling pests through non-toxic means and thus have no harmful effect on soil unlike the conventional pesticides (EPA, 2013). Bio-slurry, on the other hand, is a byproduct obtained from biogas plant after the dung or other biomass has been digested for the generation of gas. It also revitalizes soil fertility and this study takes biogas as a proxy for farmers applying bio-slurry. The variable 'others' include those using tunnel farming and/or vermi-composting. Tunnel farming is the way of covering the plants with a plastic-clad semi-circular structure. It helps to produce higher yield quality products by managing soil moisture and subsequent nutrient availability (Montri & Biernbaum, 2009) which means farmers will rely less on inorganic means that has detrimental impact on soil overtime. Vermi-compost is yet another high-quality compost produced from worm castings. Since the number of respondents undertaking these (whether separately or combined) were very limited (only 6% of farmers did tunnel farming and 7% used vermi-compost), it has been combined to form the variable 'others'.

Literatures were reviewed to learn how adoption of soil conservation technologies might differ among farmers with various socioeconomic variables. Most of the studies were conducted on adoption of Integrated Soil Fertility Management (ISFM), which comprises of mineral fertilizers, locally available soil amendments (such as lime and phosphate rock) and organic matter (crop residues, compost and green manure). ISFM emphasizes on locally acceptable practices leading to nutrient and water use efficiency, thus increasing the agricultural productivity (IFDC, 2014). The soil management practices incorporated in this study also aims to improve soil fertility for enhanced productivity. Hence, it could be assumed that the socioeconomic variables will have similar impact on adoption of both of these technologies.

Studies show that different socioeconomic variables will have varying impact on adoption of new technologies. The age of head of household (HHH)'s influence on a decision to adopt may be positive or negative. The older farmers might feel reluctant to change their old ways compared to younger ones who are more knowledgeable about new practices who might want to take risk of trying out new technology because of their far sighted vision in farming. But on the other hand older farmers have more experience, resources and authority, which might induce them to adopt new technologies as well (Akinola & Owombo, 2012). Study by (Mugwe, et al., 2009) agrees with the former reasoning of impact of age on technology adoption. Studies basically relate age with experience of farmers and conceive to have similar impact on technology adoption. It is revealed that experienced farmers are less likely to adopt new technologies such as mulching because less experienced ones, due to lack of knowledge, are more responsive toward new technologies and with experience, they realize that such technologies are not suitable for the local ecosystem (Kuntariningsih & Mariyono, 2013). Another reason could be that experienced

farmers are more likely to retire in the near future which means that they will have less time to reap the benefit from such investment (Grazhdani, 2013).

Education possesses ability to obtain, process, and use new information and therefore could have positive influence in the adoption of technologies that require technical knowledge (Akinola & Owombo, 2012; Grazhdani, 2013; Adolwa, Esilaba, Okoth, & Mulwa, 2010). Household size can also have both positive and negative influence on adoption of these technologies. It is usually taken as a proxy for labor. With more members there will be higher labor supply to adopt and practice the technologies. But more members also mean more pressure for consumption; meaning labor might have to be diverted for earning higher income. Thus, it is difficult to generalize how it will impact on adoption of these technologies (Akinola & Owombo, 2012). Although studies by (Kuntariningsih & Mariyono, 2013; Mugwe, et al., 2009) agrees with the former assertion, showing that more supply of labor is an indication of technology adoption because such technologies generally require more labor. Livestock holding is shown to have inverse relation to technologies such as mulching because in mixed farming system, livestock holding and crop mulching competes for crop residue (Jaleta, Kassie, & Shiferaw, 2012). But study by (Mugwe, et al., 2009) showed that less livestock holding implies less manure supply which is why farmers will be willing to look for other alternatives or will try to manage in a better way so as to maximize the effectiveness of small quantities of manure they have, to improve soil fertility. Adolwa et al. (2010) suggests that livestock holding is an indication of resource endowment and are more likely to look for information on new agricultural technologies and subsequently practice it.

It is assumed that larger farm size also result in higher adoption rate because it signifies increased availability of capital, which makes investment in such technologies more feasible. It can also be implied that those with small farm size are usually risk averse and thus hesitate to invest in technologies with uncertain results in their limited farm (Akinola & Owombo, 2012; Grazhdani, 2013). In a study by Grazhdani (2013), farm income is a critical variable showing positive correlation with adoption of conservation-oriented farming. Technology being a normal good, it is perceived that farmers with an intention of amplifying the farm income will be more inclined into implementing these technologies. Non-farm income provides the much needed supply of capital, which makes adoption of these technologies feasible (Akinola & Owombo, 2012). Contrastingly (Adolwa et al., 2010) found non-farm income to negatively influence the adoption of soil management technologies, as people preferred investing such income in non-farm activities. Training is undoubtedly an important component, which encourages farmers to adopt these technologies. However it may not have any significant impact if farmers already are knowledgeable about the importance but lacks resource to purchase and implement these technologies (Bizimana, 2013).

3. Methodology

3.1 Study area and sample selection

This study was conducted in Chitwan district, which is in Tarai region, a plain area in southern part of Nepal. It lies between 27° 21' 45" to 27° 52' 30" north latitude and 83° 54' 45" to 84° 48' 15" east longitude. It occupies an area of 2,205.9 km^2 and has climate of subtropical monsoon with an average annual rainfall of 2,318 mm. It has a high agricultural potential with the most fertile alluvial floodplain land, forest, rivers and lakes in Nepal (Devkota, Budha, & Gupta, 2011). Indiscriminate use of agro-chemicals in Chitwan district is rampant resulting in pest resistance towards pesticides, resurgence of new or already eradicated diseases and pests, and other health hazards to people that are not studied well yet. In order to encourage farmers to farm sustainably, the concept of organic farming is being introduced by a non-governmental organization (NGO) mainly in three VDCs, i.e. Phoolbari, Shivanagar and Mangalpur (SECARD-Nepal, 2011). Thus, these three VDCs were chosen as study sites.

The data for the study was collected using purposive sampling method through semi-structured questionnaire from February till March 2013 from a sample of 300 individual households. In all three VDCs, a group has been established particularly for the purpose of organic farming. In Phoolbari VDC a cooperative has been formed currently with 125 members whereas in rest of the two VDCs, an informal group has been formed with 44 members in Shivanagar VDC and 90 members in Mangalpur VDC. The members of such formed groups thus became our potential respondents under the assumption that all farmers belonging to such group would be organic farmers. Initially an effort was made to choose half of the respondents from such group and another half from nearby areas who do not belong to the group. However, during the field survey it was realized that not all the farmers belonging to such group have been practicing organic completely. Therefore, the type of farming system for this study is divided into three groups, viz. organic, partial organic and inorganic farming system.

Organic, in this study, implies a farming system in which use of agro-chemical is completely excluded. On the other hand, partial organic is where farm is segregated for practicing organic and inorganic farming. This is generally applicable for vegetable farming, which is grown organically for home consumption only and is mainly done on a small patch of land but use chemical fertilizers and pesticides on cereal crops, which is rather produced on a larger area. For some it was difficult to grow certain crops, at least during the time of survey, without the use of pesticide. For example, most farmers faced the problem of late blight disease in potato for which using pesticide was inevitable. For others, they chose to grow commercially viable crops like carrot through inorganic means for easier management of weeds and pests as well as to intensify productivity. Likewise in inorganic farming system, farmers would rely on chemical fertilizers and pesticides on various crops without separating the farmland as such or without being crop-specific. As a result, 47% of respondents interviewed from such group include 75% organic, 53% partial organic and 17% inorganic farmers. Similarly, 53% of those interviewed from outside the group were selected randomly based on close proximity with respondents belonging to a group. In total, half of the respondents were interviewed from Phoolbari, 17% from Shivanagar

and remaining 32% from Mangalpur VDC; which was based on the size of group members in a particular area.

3.2 Expected relation of explanatory to dependent variables

Table 1 provides the hypothesized relation of various soil management practices adopted against socioeconomic variables of farmers under one of the three farming systems. The concept of organic farming in the study areas was brought into practice through an NGO which provided basic to specialized training such as preparation of bio-fertilizers and pesticides, insect/pest management, market promotion and network development; distributed pamphlets on Plant Health and Clinic Initiative; set up hoarding boards for raising awareness; develop resource center; operate Farmer's Field School (FFS); technology development and transfer; and other extension services (SECARD-Nepal, 2011). Thus, it is expected that organic farmers will adopt all of the practices incorporated in this study since they will be more conscious of improving soil fertility through organic means. Since partial organic farmers are also aware in farming organically in at least some part of their farm, they too are expected of adopting all of these practices. Conversely, inorganic farmers are expected not to adopt any of these practices as it is assumed that they will prefer to rely on inorganic means of soil fertility enhancement. Referring to reviewed literatures; all the other variables are expected to have direction of relation to dependent variables as shown below in the table:

Table 1. Expected sign of socioeconomic variables against dependent variables

Independent variables	Dependent variables (Expected sign)				
	Mulch	**Compost-shed**	**Bio-slurry**	**Bio-pesticides**	**Others**
Farm_system:					
Organic	+ve	+ve	+ve	+ve	+ve
Partial organic	+ve	+ve	+ve	+ve	+ve
Inorganic	-ve	-ve	-ve	-ve	-ve
Age of HHH	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve
Experience	-ve	-ve	-ve	-ve	-ve
Education of HHH	+ve	+ve	+ve	+ve	+ve
Labor	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve
Livestock holding	-ve	+ve	+ve	+ve	+ve
Farm size	+ve	+ve	+ve	+ve	+ve
Farm income	+ve	+ve	+ve	+ve	+ve
Non-farm income	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve
Training	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve	+ve/-ve

Source: Own elaboration based on literature review and field observation

3.3 Empirical model

Various studies have adopted different models to assess factors influencing one's decision to adopt a certain practice. However, each model has its limitations that make them inappropriate to be used for studies with certain purposes. For example, Heckman sample selection probit model has been used to analyze the binomial choice

of adopting conservation agriculture (Broeck, et al., 2013), and perception and adaptation to climate change (Ndambiri, Ritho, & Mbogoh, 2013) with respect to farmers' socio-economic variables. However, this model does not differentiate between the several kinds of conservation practices, or perception and adaptation measures undertaken by the households. Different farming practices can be impacted by different socio-economic variables. Hence, to combine all the sub-components into one and to assume the impact of certain variable is similar throughout leads to biasness. When the information of variables leading to a certain practice is known, it is clearer to seek out appropriate action to encourage adoption of one practice over another.

Univariate probit model provides another alternative of doing so by modelling each of the farming practices individually as a function of the common set of explanatory variables. But it ignores unobserved and unmeasured common factors affecting the different management practices. In other words, this model is undesirable for reason of failing to see relation among various management practices. Adopting any practices could be complementary or competing to each other. In this case, a farmer might use bio-pesticide and complement it with mulching. Likewise, bio-slurry might compete with compost, as both require animal manure as a primary input. Also since this study incorporates organic, partial converters and inorganic farmers, it would be interesting to see how these farmers differ in soil management practices. Thus, overlooking potential correlations among these practices may lead to statistical biasness and inefficient estimates (Nhemachena & Hassan, 2007). Multinomial logit (MNL) model assumes independence of irrelevant alternatives (IIA) and that the practices be mutually exclusive which again in this case is not true. Farmer's decision to choose a certain practice might change when one or more additional alternatives are available. Similarly, a farmer can choose two or more practices simultaneously. The drawback of multinomial discrete choice model is it fails to interpret effect of independent variables on adopting each practices separately (Golob & Regan, 2002).

Considering the possibility of simultaneous adoption of soil management practices and the potential correlations among these practices as well as between unobserved disturbances, multivariate probit (MVP) model has been used in this study. Furthermore, it relaxes the assumption of IIA. The MVP model assumes that given a set of explanatory variables, the multivariate response is an indicator of the event that some unobserved latent variable that is assumed to arise from a multivariate normal (Gaussian) distribution falls within a certain interval (Tabet, 2007; Belderbosa, Carree, Diederen, Lokshin, & Veugelers, 2004). Referring to Tabet (2007), the multivariate probit model in this study is characterized by a set of binary dependent variables Y_{ij}, where i is the independent observations and j available options of binary responses. Let Z_{ij} be a vector of latent variables so that:

$$Z_{ij} = X_{ij} \beta + \varepsilon_i, \quad i = 1, \ldots, n \tag{1}$$

Where X_{ij} represents vector of explanatory variables which can be discrete or continuous, β is a vector of unknown parameters to be estimated and ε_i is the error term distributed as multivariate normal distribution with zero mean and unitary variance.; $\varepsilon_i \sim N(0, \sum)$, where $\sum$ is the variance–covariance matrix that has a value of 1 on the leading diagonal. The off-diagonal elements in the covariance matrix $\rho_{kj} = \rho_{jk}$ is the unobserved correlation between the stochastic component of the kth and jth

options (Young, Valdez, & Kohn, 2009; Cappellari & Jenkins, 2003). The relationship between Z_{ij} and Y_{ij} can be provided as follows:

$$Y_{ij} = \begin{cases} 1 & if \ Z_{ij} > 0; \\ 0 & otherwise \end{cases} \quad j=1, \ldots, J \tag{2}$$

By integrating over the latent variables Z, the likelihood of the observed discrete data can then be obtained by the following specification:

$$P \ (Y_{ij} = 1 | \ X_i, \beta, \textstyle\sum) = \int A_{ij} \ldots \int A_{i1} \ \varnothing_T \ (Z_{ij} | \ X_i, \beta, \textstyle\sum) \ dZ_{ij} \tag{3}$$

Where A_{ij} is the interval $(0, \infty)$ if $Y_{ij}=1$ and the interval $(-\infty, 0]$ otherwise, and $\varnothing_T \ (Z_{ij} | X_i, \beta, \sum) \ dZ_{ij}$ is the probability density function of the standard normal distribution. To estimate the MVP model this study uses the simulated maximum likelihood (SML) using Geweke-Hajivassiliou-Keane (GHK) simulator, which is considered as the most popular method for evaluating multivariate normal distribution function, in STATA developed by (Cappellari & Jenkins, 2003). According to Cappellari & Jenkins (2003), when number of draws and observations are infinite, the SML estimator is consistent. Simulation (finite sample) bias can be reduced to negligible levels when the number of draws is raised with the sample size. Generally for the large sample size (thousand and above) it is sufficient to have number of draws equal to the square root of the sample size. But for small sample size, the number of draws should be sufficiently large. Thus, for this study the number of draws (R) was set to 100 (from default of R=5) to ensure reliable estimates.

For each individual choice variables, ordinary least squares (OLS) estimates were run against the same set of explanatory variables to conduct a diagnostic tests in order to check if there is any problem of multicollinearity and heteroskedasticity. The variation inflation factor (VIF) value for all the independent variables was much below 10, which means that there is no problem of multicollinearity among the variables. Breusch-Pagan/Cook-Weisberg test strongly rejected null hypothesis of homoskedasticity in four out of total five choices, which means that there are linear forms of heteroskedasticity. White's test, an extended form of Breusch-Pagan/Cook-Weisberg test, was also conducted to see if there are other forms of heteroskedasticity besides the linear form. The result showed significant p-value for variable 'biogas' and 'bio-pesticide', thus again rejecting the null hypothesis of homoskedasticity, meaning that error terms do not have constant variance. To correct heteroskedasticity of any kind, following (Nhemachena & Hassan, 2007), model estimation was conducted using robust standard errors. Using robust standard errors neither changes the significance of the model nor the coefficients, but gives relatively accurate p-values, and is an effective way of solving the problem of heteroskedasticity (Wooldridge, 2006).

The empirical model for the study is given by:

$$Y_{n=5} = \beta_0 + \beta_1 farm\_system + \beta_2 ageHHH + \beta_3 exp + \beta_4 eduHHH + \beta_5 labor + \beta_6 livestock + \beta_7 farm\_size + \beta_8 \ln\_farm\_income + \beta_9 \ln\_nonfarm\_income + \beta_{10} training + \mu$$

$$\tag{4}$$

Where y = mulch, compost-shed, biogas, bio-pesticide and others (tunnel farming and/or vermi-composting), ln is log and μ is an error term. Figure 1 and Table 2 gives

explanation for each variable. Among 10 independent variables considered, farming system is a categorical variable with organic farming as a base category and the rest are continuous.

4. Results and discussion

4.1 Descriptive analysis

Figure 1 provides descriptive analysis of dependent variables along with the farming system practiced by the respondents. About 72% of the respondents did mulching, 23% has a compost-shed, 44% has biogas, 19% uses bio-pesticide and only 4% and 6% uses tunnel farming and vermi-compost, respectively. Out of 289 respondents (after removing outliers), 31%, 32% and 37% are practicing organic, partial organic and inorganic farming system. Mulching is the most traditional form of soil management practice among others considered for this study and farmers practice it almost equally under all farming system. Besides that all other practices are adopted mostly by organic compared to partial organic and inorganic farmers. Compost-shed and tunnel farming has highest share of organic farmers.
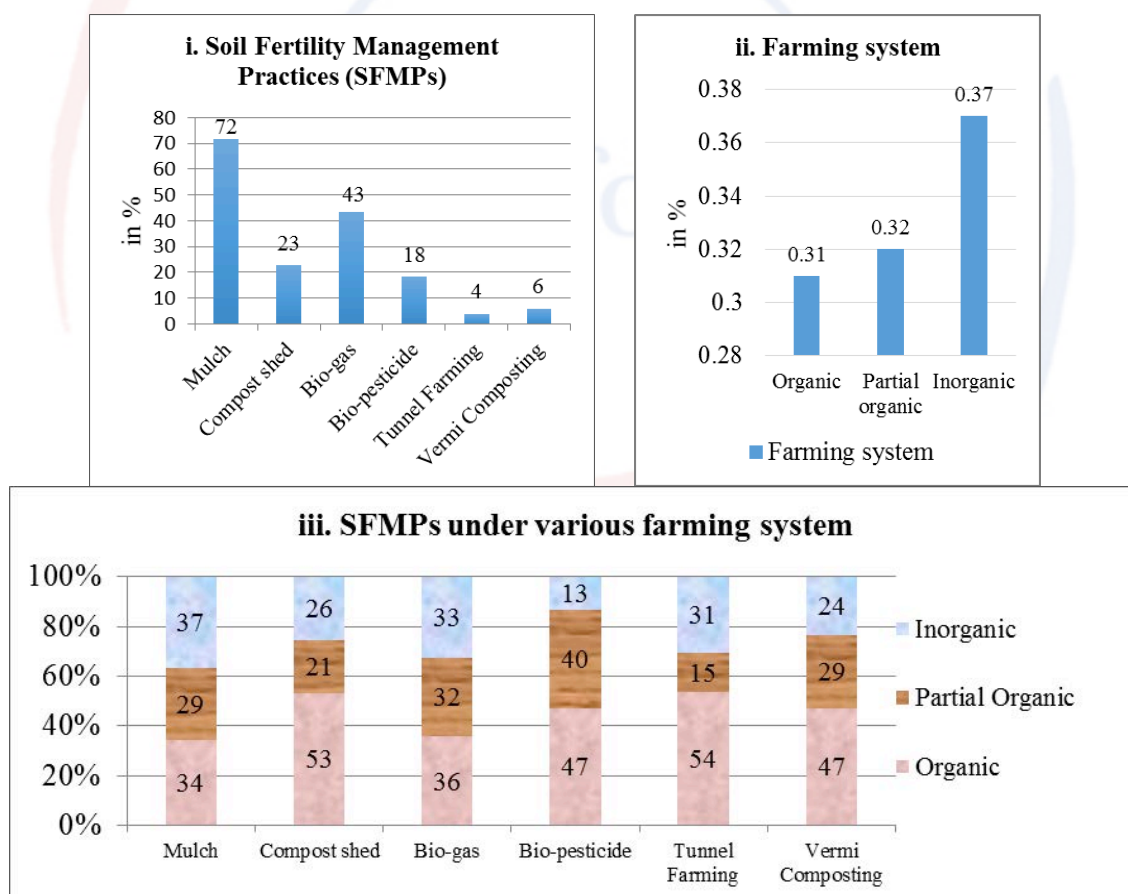
Figure 1. Soil fertility management practices (i), farming practices (ii) and its distribution of each of these practices among farmers practicing various farming system (iii) in the study areas
Source: Field survey (2013)

Table 2 provides the descriptive analysis of other explanatory variables used in the analysis along with their measurement unit. The data shows that average age of HHH is about 50 years and experience of farming in the current system is 14 years. Some 7% of HHHs do not have any educational background or in others words are illiterate. Excluding those, HHHs have on average 7 years of formal education. In this study, labor force unit (LFU) excludes the household (HH) member/s that have migrated whether temporarily or permanently and reflects only those who are available in the HH. Livestock is the integral part of farming in the study area. About 13% of the HHs did not have any livestock unit (LSU). Cow, buffalo, goat and poultry are the major livestock species raised by the HHs. On the whole, each HH has on average 4.35 of LFU and 2.87 of LSU. Farmers have on average 0.51 hectare (ha) of farmland, which is below the nation average of 0.68 ha (CBS, 2012). In this study, about 21% of the HHs derive their income only from farming and the rest 79% have both on-farm and non-farm income. Income from farming includes the monetary value equivalent to the production from farming of vegetables, oil crops, pulses, cereals, fruits, trees and livestock (both self-consumed and those traded in the market) as well as farming wages. Non-farm income is derived from sources such as service, business, rent, remittance and pension. On average HHs have NRs. 200589.3 and NRs. 202237.9 of farm and non-farm income, respectively. Similarly, 56% of the HHs have not taken any training related to organic farming. As previously mentioned, all members of the group are not necessarily practicing organic farming which means that even partial organic or inorganic farmers could have taken these training which are usually given through these groups. Excluding this, the average training received by a HH is 1.2 times.

Table 2. Measurement and summary of dependent and explanatory variables

Dependent variables	Definition and Measurement	Mean±Standard deviation	Min. value	Max. value
ageHHH	Age of HHH; Years (continuous)	49.71±11.65	26	84
exp	Current farming experience; Years (continuous)	14.16±12.98	1	55
eduHHH	Education of HHH; Years (continuous)	6.77±5.45	0	17
labor	Labor available in HH; LFU[1] (continuous)	4.29±1.84	1	11
livestock	Livestock available in HH; LSU[2] (continuous)	1.97±1.74	0	13.7
farm_size	Operational farm size; hectare (ha)	0.51±0.42	0.01	2.7
farm_income	Yearly income from farming activities; Nepalese Rupees (NRs.) (continuous)	200589.3±192613.5	1820	1045006
non-farm_income	Yearly income from non-farm sources; Nepalese Rupees (NRs.[3]) (continuous)	202237.9±199871.3	0	1080000
training	Organic farming related trainings received; number of times (continuous)	1.2±2.01	0	12

Source: Field Survey (2013)

4.2 Result from multivariate probit model

The result of the MVP model is presented in Table 3 The likelihood ratio statistics as denoted by Wald $\chi2$ is highly significant (p=0.0000) which shows goodness of fit, i.e., the variables sufficiently explain the model. Also the likelihood ratio test of the null hypothesis of the absence of correlation among the individual equations is strongly rejected (p=0.0000), thus justifying the rationale to estimate all equations simultaneously using MVP rather than estimating individually. Some of the directions of the signs of explanatory variables are as per the expectation and some are not. More importantly, a single variable do not have similar direction of impact across all dependent variables as was presumed to be.

Table 3. Parameter estimates of Multivariate Probit Model for organic inputs

Explanatory variables	Mulch	P-value	Com post-shed	P-value	Biogas	P-value	Bio-pesticide	P-value	Others	P-value
Partial organic	-0.42	0.056*	-0.67	0.002***	-0.05	0.823	0.32	0.167	-0.13	0.630
Inorganic	-0.12	0.620	-0.63	0.010***	0.03	0.899	-0.1	0.712	0.28	0.306
HHH age	-0.002	0.829	0.01	0.451	0.02	0.065*	-0.002	0.805	-0.01	0.206
Experience	-0.002	0.795	-0.002	0.743	-0.02	0.018**	-0.02	0.094*	-0.01	0.399
HHH education	0.01	0.452	0.001	0.968	0.03	0.088*	-0.01	0.716	-0.04	0.084*
LFU	-0.02	0.713	0.06	0.248	-0.04	0.397	0.05	0.357	0.01	0.898
LSU	0.03	0.516	-0.02	0.644	0.06	0.241	0.05	0.399	-0.01	0.909
Farm size	0.19	0.390	0.27	0.235	0.01	0.955	0.06	0.785	0.18	0.539
Ln_Farm income	0.21	0.048**	0.22	0.046**	0.59	0.000***	-0.09	0.468	0.17	0.269
Ln_Non-farm income	0.01	0.602	0.01	0.572	-0.01	0.542	0.01	0.707	0.01	0.542
Training	0.03	0.556	0.06	0.209	0.12	0.034**	0.29	0.000***	0.06	0.308
Constant	-1.89	0.134	-3.77	0.005	-7.85	0.000	-0.43	0.757	-2.72	0.110

Correlation coefficients			Coefficient				P-value			
$\hat{\rho}_{21}$			0.32				0.002***			
$\hat{\rho}_{31}$			-0.22				0.032**			
$\hat{\rho}_{41}$			-0.04				0.769			
$\hat{\rho}_{51}$			0.27				0.014**			

$\hat{\rho}_{32}$	-0.12	0.319
$\hat{\rho}_{42}$	0.06	0.612
$\hat{\rho}_{52}$	0.17	0.176
$\hat{\rho}_{43}$	0.05	0.696
$\hat{\rho}_{53}$	0.62	0.000***
$\hat{\rho}_{54}$	0.52	0.000***
Draws	100	
Number of observations	289	
Wald $\chi2$ (55)	208.36	
P-value	0.0000***	
Log pseudo likelihood	-632.38933	
Likelihood ratio test rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0, $\chi2$ (10) =52.8465, P-value = 0.0000***		

Note: *** at 1%, ** at 5% and * at 10% level of significance
Source: Field survey (2013)

Compared to organic farmers, partial organic farmers are reluctant to mulch, which is significant at 10%. Partial organic and inorganic farmers are negatively inclined towards using compost shed compared to organic farmers, highly significantly at 1%. Most of the farmers received partial funding (25% of total cost) from an NGO to construct shed. The fund eligibility depends on financial ability of a farmer to supply the remaining cost and active participation in the group activities. Organic farmers in the study areas have received more training (Singh, Maharjan, & Maskey, 2014), indicating active participation in the group activities and so they are prioritized to be recipient of such fund. However, only 2 farmers are selected per year, which has slowed the adoption rate. Usually older farmers tend to have installed biogas, significant at 10% level. During 1990s, as a part of government's Biogas Support Program, many households installed biogas, which is why mainly older HHHs have possessed it. Experience has negative impact on using biogas and bio-pesticide, at 5% and 10% level of significance, respectively. The primary reason for installing biogas is to access energy. With growing access to electricity grid, farmers must have found it less feasible to generate energy from biogas plant in terms of labor and time required. Farmers often perceive bio-pesticides to consume time during preparation and application as well. Further its impact on pests and disease management is perceived to be slow compared to inorganic means. This might have contributed to its lower adoption.

Education has positive tendency to adopt biogas and negative impact on using tunnel farming and/or vermi-composting, both significant at 10% level. Tunnel farming and/or vermi-composting are a relatively new practice in the study areas and are practiced/used by very few farmers. Educated HHHs are not adopting these new techniques as most of them are into inorganic farming (Singh et al., 2014). Other reason could be that educated ones are more attracted towards non-farm sector for their livelihood, paying less attention on activities improving soil fertility.

Farm income has positive impact on adopting mulching, compost-shed and biogas, the former two significant at 5% and the latter at 1% level. It shows that farmers with higher farm income have incorporated various soil fertility management practices. Finally, training has positive impact on using biogas and bio-pesticide, significant at 5% and 1%, respectively. Bio-pesticide is very much promoted through trainings conducted from the formed groups.

Estimated correlation coefficients among various soil fertility management options are significant for five out of ten combinations. Mulching and compost-shed are positively highly significant at 1% level. This means that farmers are combining these practices for soil management. Mulching and biogas are negatively significant at 5% level. It indicates that mulching and livestock which ultimate provides manure for biogas competes for crop residue, thus having negative impact. Farmers are incorporating modern ways of soil management practices (tunnel farming and/or vermi-composting) with biogas and bio-pesticide, both significant at 1% along with traditional practice such as mulching, significant at 10% level.

5. Conclusion and recommendations

Mulching is the most traditional way of managing soil fertility and is practiced by farmers under various farming system. This shows that even though there is influx of modern inputs like chemical fertilizers and pesticides, partial organic and inorganic farmers still incorporate mulching in their farming practice. Although adoption rate for other practices are high among organic farmers, indicating that organic farmers are keener on practicing various ways of sustainable soil fertility management practices.

Although in some instances the adoption can be hindered by lack of fund, such as in the case of compost-shed. Thus, it is advisable that fund assistance should be increased so as to increase the adoption rate of compost-shed by the majority. Those with higher farm income have incorporated various soil fertility management practices. It suggests that these practices can lead to increasing the worth of farm produces. One of the ways to increase the adoption rate is training as it complements technical knowledge required to implement these practices. Farmers also tend to complement most of the practices. They are practicing new techniques (tunnel farming and/or vermi-composting) along with biogas and bio-pesticides and even with traditional ones like mulching. It indicates that any additional soil fertility management practices can be introduced to those households who are already adopting one of such practices. But sometimes these practices become substitutions because of their nature of relying on same input. Thus, any effort to enhance such adoption rate can consider these characteristics of various practices. Thus, adoption of soil fertility management practices is influenced in different ways by various farming system and socio-economic factors, which should be regarded before any intervention.

Notes:

[1]Labor force unit (LFU) is the standard unit of labor force, which takes people, aged 14-59, irrespective of their sex, as 1 and those below 14 and above 59 as 0.5

[2]Livestock unit (LSU) is calculated as: 1 adult buffalo = 1 LSU, 1 immature buffalo = 0.5 LSU, 1 cow = 0.8 LSU, 1 calf = 0.4 LSU, 1 pig = 0.3 LSU, 1 sheep or goat = 0.2 LSU and 1 poultry = 0.1 LSU (CBS, 2003)

[3]NRs. stands for Nepalese Rupees, US$1 = NRs. 98.56 (Source: Nepal Rastra Bank, March 31, 2013)

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Stability of CoMoP Based Catalysts to Hydrodeoxygenation of Guaiacol as Bio-oil Model Compound

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Abstract

Biomass transformation into hydrocarbon fuel so called "bio-oil" is considerably interesting because it does not relate to food chain; nevertheless bio oil has high oxygen content leads to different properties from petroleum fuel. Thus, the purpose of upgrading bio-oil via hydrodeoxygenation (HDO) is emphasized using CoMoP (CMP) based supported on Al_2O_3-TiO_2 (AT) catalysts. However, a research is still required in the area of the stability of catalysts during hydrotreating of bio oil. The effects of Al:Ti molar ratios of supports on HDO of guaiacol over CoMoP/Al_2O_3-TiO_2 catalysts were investigated in a batch autoclave reactor at $300^{o}C$ 50 bars for 2 hours. Five series of supports accordingly in order as such, Al:Ti molar ratios of 8:2, 6:4, 5:5, 4:6 and 2:8, were arranged and prepared by sol-gel method, followed by CoMoP complex co-impregnation. HDO reactivity was improved with the increase and support of Ti. It was found that the molar ratio of Al:Ti with 5:5 had effectively promoted maximum value of HDO reactivity and the selection of benzene, toluene and xylene (BTX) of about 80% and 60% respectively regarded to electronic promotion effect of TiO_2 on the presence of TiMoS phase was behaving similarly CoMoS phase. Comparison of hydrogen consumption on active phase were made based on all catalysts by H_2-TPR with the order of CMP/2A8T = CMP/5A5T > CMP/4A6T > CMP/6A4T > CMP/8A2T indicated that CMP/5A5T had active phase more than any other catalyst in consequence of promoting HDO activity and selecting of BTX.

Keywords: CoMoP/ Al_2O_3-TiO_2 Catalysts; Hydrodeoxygenation; Guaiacol

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1. Introduction

Increasing consumption of energy is the cause of advancement of renewable energy. Bio-oil from the pyrolysis of biomass is an interested option because it comes from agricultural residue. Nevertheless, Bio-oil components consist of oxygenated compounds such as phenol, furans, carboxylic acid, ethers and aromatic alcohols which cause the high acidity, high viscosity, poor stability and low heating value [1-3]. For this reason, it is necessary to upgrade via hydrotreating process or hydrogenation reaction to produce hydrocarbon as petroleum fuel. The hydrotreating or HDO is a process to remove oxygen atom from oxygenated compound such as GUA, phenol or cresol at high temperature and high pressure over a bimetallic catalyst. CoMo based on Al_2O_3 support has been widely used in an industrial hydrotreatment because the catalyst is very active to eliminate oxygen, sulphur and nitrogen atom from bio-oil components [4-7]. The hydrotreating catalyst is usually prepared by impregnation on a support with a solution of ammonium heptamolybdate follow by cobalt nitrate solution resulted in lower edge dispersion of MoS_2 slabs and may occur non-active phase. From several researches, Co-impregnation is the new preparation method to help the catalytic activity HDS and HDN reaction. Because, co-impregnation with chelating ligand will help to occur active phase to from CoMo complex and avoid the formation of bulk Co sulfide as non-active phase. It causes lower activity [5, 8]. Al_2O_3 support have a high surface area and satisfactory dispersion of metal phase but coke formation was found during operation arise from the presence of water, the acidity of the reactant and several reaction occur such as hydrogenation, hydrogenolysis, hydrodeoxygenation, decarboxylation, decarbonylation, cracking/hydrocracking and polymerization [2]. Furthermore, on the alumina support, the surface hydroxyl groups performs as adsorption sites for the metal ions. TiO_2 has high activity, high selectivity and thermal stability but low specific surface area [10]. In consequence, the addition of TiO_2 to Al_2O_3 could adjust the reducibility and sulfidability of $CoMoP/Al_2O_3$ leading to the higher HDO activity and higher selectivity than original CoMo supported on Al_2O_3 [11]. The catalysts with high activity, high selectivity and high stability are required for a good operation with high product yield and long term operation. This research has been focused on development of CoMoP supported catalysts by co-impregnation for hydrodeoxygenation of bio-oils. The HDO activity and The BTX selectivity were interested and considered.

2. Experiment

2.1 Preparation of supports

Aluminium-tri-*sec*-butoxide, Titaniumisopropoxide and 2-Ethyl-1-hexanol were mixed under stirring, proportionally $8Al_2O_3$-$2TiO_2$ (8A2T), $6Al_2O_3$-$4TiO_2$ (6A4T), $5Al_2O_3$-$5TiO_2$ (5A5T), $4Al_2O_3$-$6TiO_2$ (4A6T) and $2Al_2O_3$-$8TiO_2$ (2A8T) and refluxed at 80 °C for 2 hrs afterwards reduced pressure at 180 °C for 1 hr. A mount of water was added to form gel and then was dried under reduced pressure to become powder. The white solid was calcined at 550°C for 4 hrs under an air flow.

2.2 Preparation of catalysts (3%Co10%Mo0.5%P/AT)

Molybdenumtrioxide, Cobaltnitratehexahydrate, citric acid and Ammoniumhydroxide were mixed at 90 °C under stirring till clear solution. Ammonium phosphate was added to CoMo solution before impregnation on the supports. The impregnated catalysts were dried at 50 °C for 24 hrs and calcined at 550 °C for 3hrs.

2.3 Characterization

The series of supports catalysts were measured for specific surface area, pore volume and pore diameter by N_2 Adsorption-Desorption with Brumeur-Emmet-Teller (BET) method. The samples were pretreated at 350 ^oC for 4 hrs. The prepared catalysts were calculated for H_2-consumption at active site by Temperature-programmed reduction (H_2-TPR) with BELSORP-mini automatic analyzer. The series of prepared catalysts were pretreated at 240 ^oC for 50 min under Ar atmosphere. The reduction step was analyzed under H_2/Ar mixture (5%H_2/Ar) at 30 mL/min at 900 ^oC.

 2.4 Catalytic test

The feed stock for HDO reaction consists of Guaiacol, *n*-Hexadecane, 1,2,3,4-Tetrahydronaphthalene, Dodecylcyclohexane and Dimethyldisulfide. The HDO reaction were carried out in a batch reactor at 300 ^oC and 40 bar (H_2-atmosphere) for 2 hrs (respecting on activity and selectivity test) and 30 hrs (respecting on stability test). Before the reaction, 0.4 g of catalyst was presulfided with 5% H_2S/H_2 at 400 ^oC for 5 hrs in fix bedded tubular reactor. After that, excess H_2S was purged by nitrogen stream for 15 min. The liquid products after the reaction were collected and analysed on Gas Chromatography-Mass Spectrometry (GC-MS) technique (Agilent Technologies 5975C) using DB-1 column and Gas Chromatography-Flame Ionization Detector (GC-FID) technique (Agilent Technologies 7890A GC system).

3. Result and discussion

The textural characteristics of supports and catalysts are presented in figure 1 and figure 2 shows that the specific surface area and pore volume are also decreased when increasing TiO_2 ratio because Al_2O_3 is covered by TiO_2 on a surface region and in the pore.
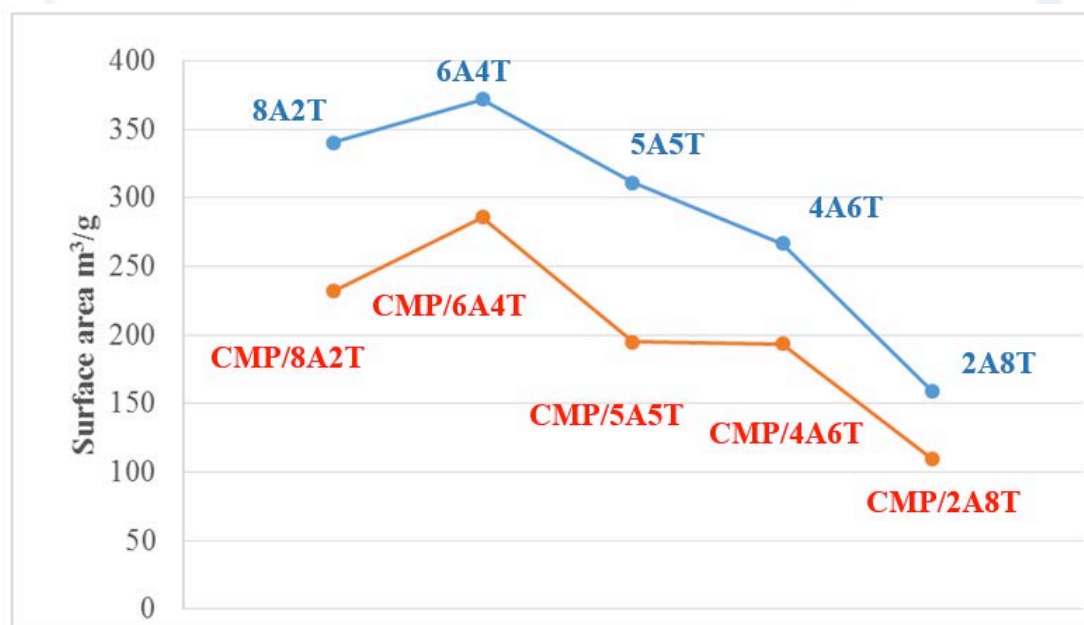
Figure 1. Surface area of all supports and catalysts
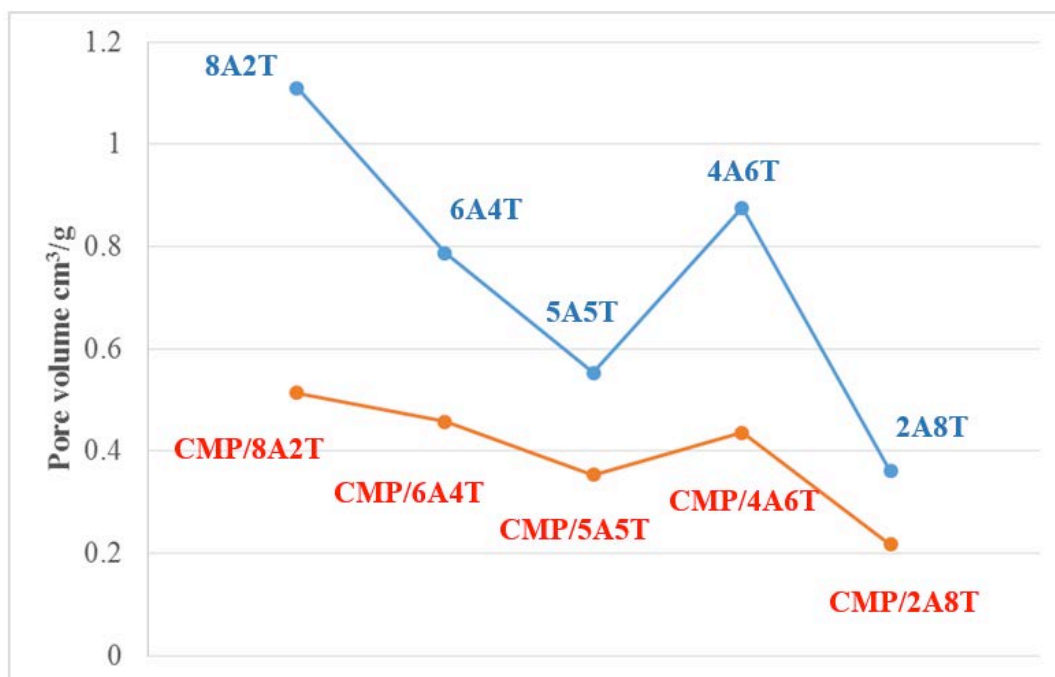
Figure 2. Pore volume of all supports and catalysts
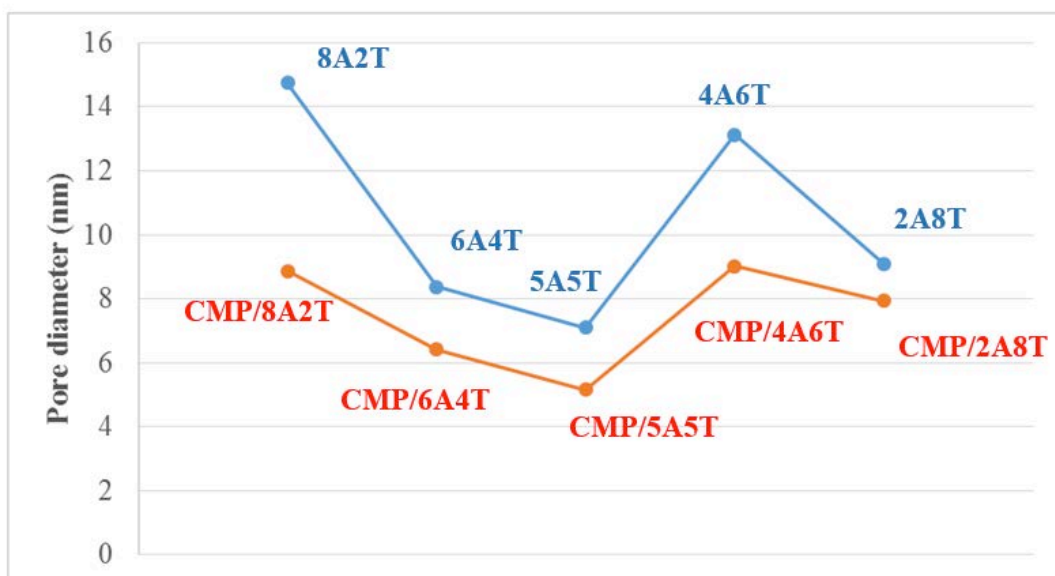
Figure 3. Pore diameter of all supports and catalysts

We found that a pure titania has a less pore diameter therefore, it is a cause that the pore diameter is slightly decreased [12]. The prepared catalysts are resemble with the supports but the catalysts have a lower specific surface area, pore volume and pore diameter than supports due to blocking effect of metal atom on pore mouths of supports by the deposition of metal (MoO_3 and CoO)[13].
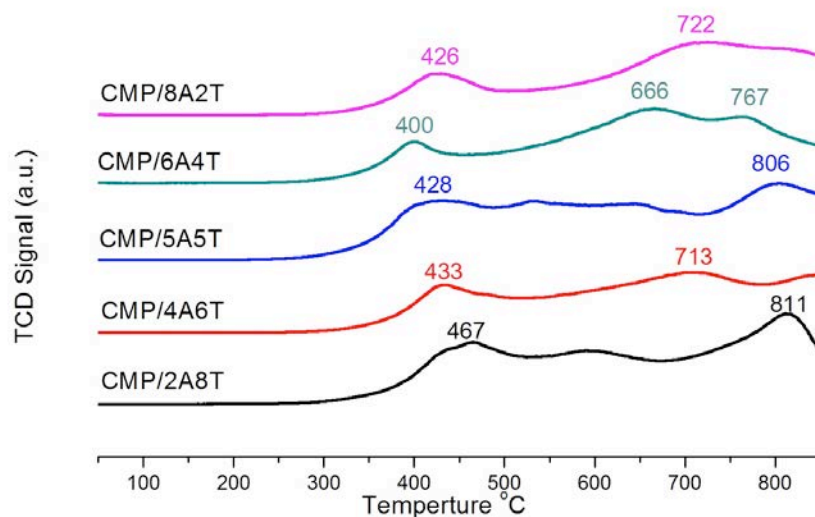
Figure 4. TPR profiles of CoMoP/Al_2O_3-TiO_2 catalysts

The information about the degree of interaction between metal phase and support phase by the H_2-TPR profile results indicated the two major peaks estimated around 400-467 ^{o}C and 713-811 ^{o}C. The first peak could be assigned to the reduction of Mo^{6+} to Mo^{4+}. The second peak can be assigned to the reduction of partially reduced to Mo^0 together with the tetrahedral Mo^{6+} species strongly interacting with the support [5,6,14]. In addition to the reaction of Mo species, the reaction of Co species is included. From literature reviews, the TPR profile of CoMo catalysts is absence of reduction peak because they are overlapped with the reduction peak of Mo species. The two types of cobalt species namely Co_3O_4 and surface Co^{2+} are presented and the series of catalysts are reduced in the temperature range of 300-400 and 600-650 ^{o}C which is the cause of obtained broad reduction peak.

Table 1. The hydrogen consumption to reducing catalysts

Catalysts	Mo oxide (mmol/g) (at low temperature)	Mo oxide (mmol/g) (at high temperature)
CMP/8A2T	1.470	2.382
CMP/6A4T	1.514	2.429
CMP/5A5T	2.103	2.662
CMP/4A6T	1.540	1.965
CMP/2A8T	2.129	3.212

The amount of hydrogen consumption of all catalysts are summarized in table 1. We found that CMP/5A5T and CMP/2A8T have consumed more hydrogen for Mo species at low temperature than other catalysts. The Mo species at low temperature are active phase of hydrodeoxygenation reaction indicating that the high titiania content might be effect on high hydrogen consumption of active phase Mo species.
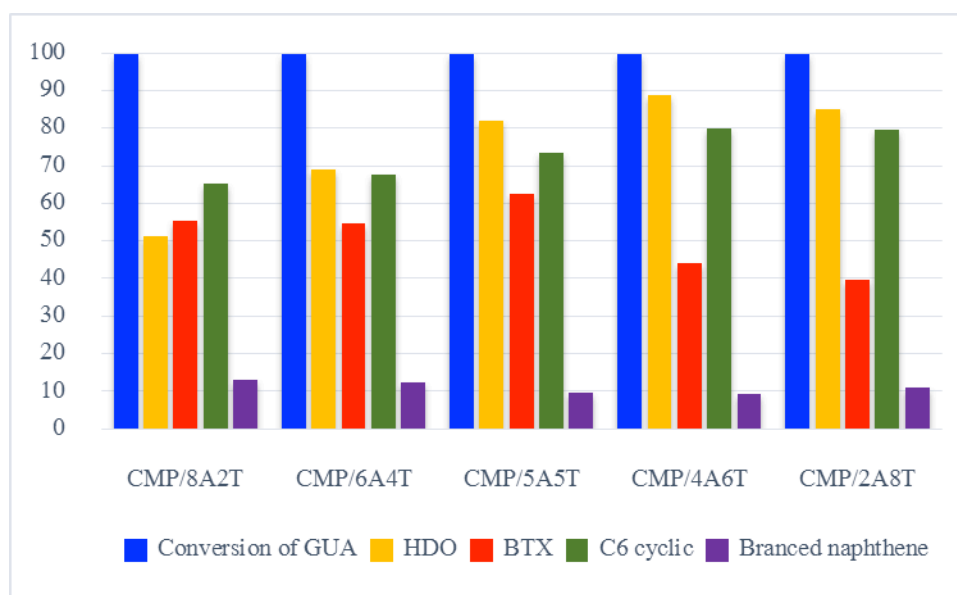
Figure 5. Activity and selectivity of all catalysts

The HDO reaction For 2 hrs shows that GUA conversion is almost 100% for all catalysts. %HDO and C6-cyclic are increased when Ti content in catalysts are increased as well because Ti could be formed a TiMoS phase in the act like CoMoS phase which play role as active phase in hydrotreating reaction. TiMoS phase could promote the motion of sulfur atoms by Ti–S*-Mo formation that induced an increase in the electronic density on molybdenum. In respect of branced naphthene isn't different in any catalysts. We found that CMP/5A5T is selectively to BTX products so it is interesting for catalysts stability study.

For the long term reaction are summized in figure 6, found that the CMP/5A5T is a good activity inwardly 30 hrs in batch reactor. The conversion of GUA, HDO activity, BTX, C6 clyclic and branced napthene are not dropped within 30 hrs, indicating that poisoning of CoMoP catalyst does not happen as reported by Montesinos-Castellanos [6] so the CMP/5A5T is an appropriate catalyst in term of activity and stability.
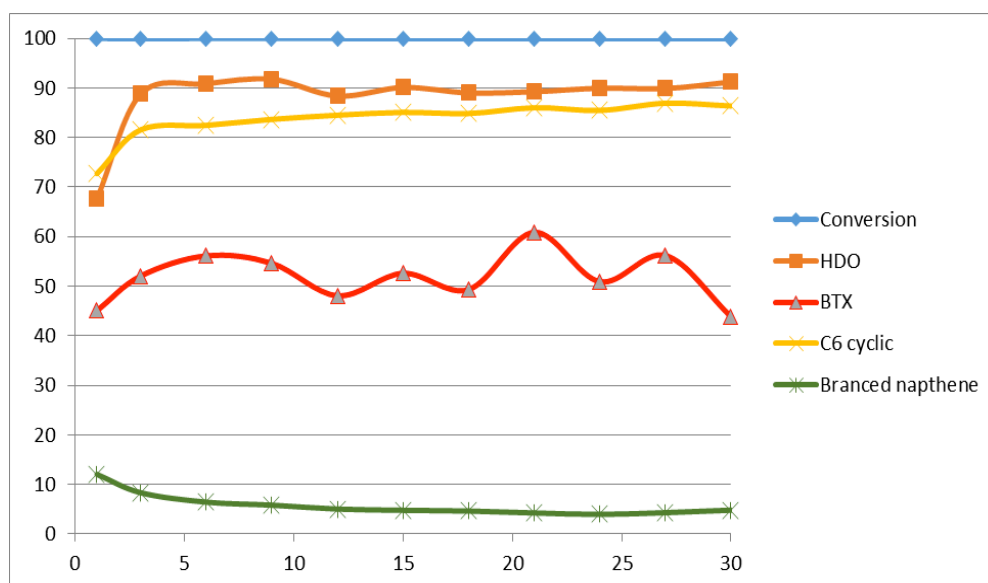
Figure 6. Stability of CMP/5A5T

4. Conclusion

The series of prepared catalysts such CoMoP/A, CoMoP/8A2T, CoMoP/6A4T, CoMoP/5A5T, CoMoP/4A6T, CoMoP/2A8T and CoMoP/T were investigated for HDO reaction with GUA and the reaction over CoMoP/5A5T gave almost 100% conversion with high HDO and the products selectivity for BTX in high yield and also this catalyst was also stable more over 30 hrs.

Acknowledgment

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Effect of Al_2O_3:SiO_2 Molar Ratios on Hydrogenation of Palmitic acid as Palm Oil Model Compound over NiMo/Al_2O_3-SiO_2 catalysts

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Abstract
The alternative bio-hydrogenated diesel (BHD) is most emphasized in many research areas due to the environmental issues and the critical availability of fossil fuel. However, the hydrogenation technology of vegetable oils or animal fats is still interested especially catalytic reactivity. This research is focused on the effects of Al_2O_3-SiO_2 (AS) molar ratios of support on hydrogenation (HYD) of palmitic acid as palm oil model compound over NiMO/AS catalysts. Five series of supports accordingly in order as such, Al:Si molar ratios of 10:0, 7:3, 5:5, 3:7 and 0:10, were prepared by sol-gel method, followed by NiMo complex co-impregnation and then the chemical and physical properties of these catalysts were characterized by BET techniques. The specific surface area of synthesized silica (722.70 m^2 g^{-1}) was significantly the highest surface area in comparison with other supports, which were added with alumina. Moreover, the catalyst reactivity was investigated via the hydrogenation reaction of Palmitic acid in a stirred batch autoclave at a temperature of 300 °C for 1 hour with the support of 10 bars of H2. The liquid parts of the products were then analyzed by Gas Chromatography-Mass Spectrometry and Gas Chromatography-Flame ionization detector. The conversion of Palmitic acid to the hydrogenation reaction were increased with the addition of Si molar ratio in supports however, some side reaction were occurred through cracking reactions. The products selectivity was involved with hydrodeoxygenation (HDO) to obtain C16 and hydrodecarboxylation or hydrodecabonylation (DCOx) to obtain C15.

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1. Introduction

Increasing of CO_2 emissions resulting by the combustion of petroleum sources that concern about environmental problems and global warming [1]. Due to much of the growth in energy consumption occurs in many countries based on renewable resources [2]. It is necessary to develop new alternative routes to produce green renewable fuels for replacement of conventional fossil fuels. The attractive ways to produce fuels from bio-oil sources such as palm oil, sunflower oil, jatropha oil, and Fatty acid Methyl Esters are as known as biodiesel oil which are made from fatty acids or oils using the base-catalyzed trans-esterification with alcohol. However, there are still many disadvantages such as low heat value and low stability because of its auto-oxidation, and high viscosity [3].

The hydroprocessing of vegetable oils is another option to convert vegetable oils to hydrocarbons in range of diesel fuel as known as green diesel using heterogeneous catalysts. The process has shown several advantages such as higher heating value and higher cetane number [4]. The process mainly to remove oxygen functionalities of feed stocks and split off as H_2O, CO_2 or CO, small molecule of gas resulting in long-chain alkanes by different reaction route such as Decarboxylation, Decarbonylation, Hydrogenation or a combination of two or more [5].

Optimizing of the process depend on suitable conditions and type of starting materials such as fatty acids and their esters has been studied on many researches. Conventional hydrotreatment metal catalysts such as Ni/Al_2O_3, Mo/Al_2O_3 and $NiMo/Al_2O_3$ which result in decreasing catalysts reactivity in the order of $NiMo/Al_2O_3$, Mo/Al_2O_3 and Ni/Al_2O_3. The bimetallic NiMo catalysts show higher yields of hydrocarbons than the monometallic catalysts [6]. Mostly hydrotreating temperature range of 330°C –398 °C was explored [7]. Previously, catalytic deoxygenation of model compound in Differences catalysts has also been studied by Eduardo Santillan-Jimenez et al. Catalyst of 5 wt%Pd/C consistently showed higher performance as 98% conversion of tristearin with a selectivity to C10–C17 of 95% and a selectivity to C17 of 81% because the acidity of carbonaceous species on the Nickel catalyst surface increases cracking reactions. The reaction proceeds through the decaboxylation/decarbonylation [8].

Among the most significant factors in the conversion of triglycerides into diesel hydrocarbons, it was demonstrated that triglycerides were reduced to form alkanes via their corresponding free fatty acids [9]. More recently, the reaction pathways was investigated by liquid-phase deoxygenation of stearic acid, oleic acid, and linoleic acids employing a 5 wt% Pd/C catalyst. This results of research demonstrates that the unsaturated C18 free fatty acids, oleic and linoleic must be hydrogenated to stearic, oleic before decarboxylation can proceed at a significant rate. Oleic acid (OA) deoxygenation under He occurs very slowly and primarily via Decarbonylation [10].
Also in semi-batch reaction-mode, Deoxygenation of methyl esters and triglycerides was studied on effects of He flow rate, Olefin yield was increased by use of He (instead of hydrogen) as a carrier gas, but some hydrogenation still occur. No cyclic or aromatic products were observed under these conditions [11].

In the present work we focus on the production of long chain hydrocarbons from Palmitic acid as model compound over nickel catalyst which is different %metal

loading as 5, 10 and 15. Optimum conditions were investigated such as reaction temperature and reaction time in batch reactor.

2. Materials and Methods
2.1 Catalyst preparation
The mixed oxide Al_2O_3-TiO_2 support were synthesized by sol-gel method using Al(s-BuO)$_3$ and Ti(OBu)$_4$ as starting materials. The NiMo based catalysts were prepared by impregnation method. The solution of NiMo complex (Ni(NO$_3$)$_2$.6H$_2$O and MoO$_3$ in water) was impregnated on Al_2O_3-TiO_2 support and impregnated support was dried under reduced pressure at 110 °C. Finally, the greenish powders were calcined at 550 °C for 2 h.

2.2 Catalysts characterization
The total surface area, pore diameter and pore volume of the catalysts were measured by nitrogen adsorption and desorption in BET technique (BEL Japan Model BELSORP-mini). The sample was pretreated under helium flow to purge adsorbent gases and then, the samples were reduced by 5%H$_2$/Ar (25 mL/min) from ambient temperature to 800 °C. The hydrogen desorption of catalyst was investigated by hydrogen gas which consumed via the reduction. It was determined by thermal conductivity detector (GC 6820 Agilent Technologies). The area under TPR profile represents the consumed hydrogen for the reduction.

2.3 Catalytic activity test on (model compounds)
Typically, the prepared catalyst in powder 0.4 g was reduced by hydrogen gas (25 ml/min) at 400 °C for 4 h prior to purging the reactor with N$_2$ before used in the reaction then the autoclave reactor (Parr 4848 reaction controller) was filled with Palmitic acid as model compound which was dissolved in Dodecane (98% pure, ACROS Organics) as solvent and Dodecylcyclohexane (98.0%, TCI) as internal standard. The pressure in reactor was 10 bars with H$_2$ gas as the starting pressure for reaction. The reactor was heated to desire temperature at 300 °C with heating rate 10 °C/min. The pressure in the reactor was raised to 30 bars. In another experimental set the condition of reaction was carried out at 350 °C with heating rate 10 °C/min for 1 h while keeping the amount of Palmitic acid, solvent and internal standard were fixed. When the reactor reached at desired temperature. The product and catalyst were removed and analyzed by GC-MS and GC-FID.

2.4 Product analysis
The compounds in liquid product were analyzed with GC-MS (Agilent Technologies 5975C) using DB1 capillary column at 0.25 μm × 60 m. The temperature of injection and detector was set at 300 °C. A heating program was set from 50 °C to 305 °C at a heating rate of 5 oC/min. In each run, 1 μL of liquid product was injected with a split ratio of 100:1 for detection. GC-FID (Agilent Technologies 7890A GC system) was also used to investigate liquid product by HP-1 capillary column. The injection temperature was set up at 325 °C. The temperature program was carried out from 50 °C to 305 °C at a heating rate of 5 °C/min. In each run, 1 μL of liquid product was injected with a split ratio of 60:1 for detection.

3. Results and Discussion
3.1 Characterization of catalysts

The series of supports and catalysts were characterized by nitrogen adsorption and desorption. Table 1 shows the total surface area, pore diameter and pore volume. It indicated that the specific surface area of synthesized silica (722.70 m^2 g^{-1}) was significantly the highest surface area in comparison with other catalysts which were added with alumina. However, addition of NiMo metal on the different supports decreased the specific surface area and total pore volume but Mean pore diameter leads to increase, suggesting that NiMo metal species blocked some pores in the series of supports.

Table 1: BET results of synthesized catalysts

Catalysts	V_m [cm^3(STP)/g]	a_s, BET [m^2/g]	Total pore volume [cm^2/g]	Mean pore diameter [nm]
S	166.04	722.70	0.77	4.24
NiMo/S	86.46	376.30	0.42	4.47
7S3A	99.66	433.78	1.15	10.56
NiMo/7S3A	59.05	257.03	0.46	7.21
5S5A	73.45	319.69	1.05	13.09
NiMo/5S5A	44.67	194.42	0.67	13.80
3S7A	67.73	294.79	0.64	8.67
NiMo/3S7A	44.55	193.90	0.33	6.86
A	87.06	378.91	0.29	3.07
NiMo/A	47.62	207.02	0.33	6.40

Considering nitrogen adsorption isotherms of catalysts with different kind of supports show in Fig 1. All catalysts compose of pores closed at one end. These isotherms present slightly wide and asymmetrical hysteresis loops which exhibit distinct capillary condensation steps, characteristic of mesoporous materials which confirm that The particle size distribution of all catalysts follows as: 3.07 - 13.80 nm in Table 1. It can indicate that the prepared catalysts are in rage of mesopores structure (2–50 nm) which are characteristic of materials having uniform particles forming ink bottle shaped pores (plates or edged particles like cubes) in the framework [12].
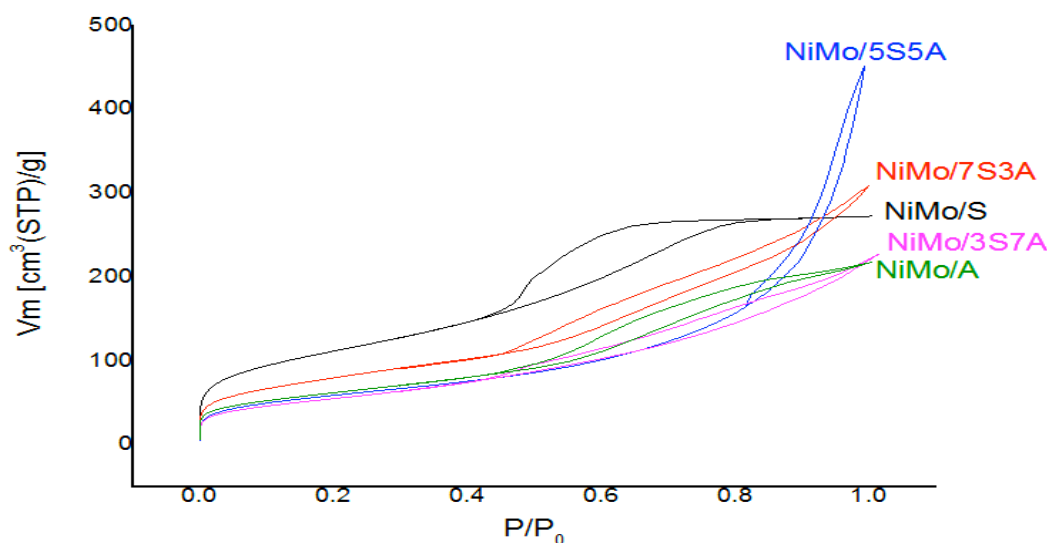
Fig 1. N$_2$ adsorption and desorption isotherms for series of catalysts

Reduction of the NiMo catalysts were studied by means of TPR (Fig.2). Area under TPR profile represents the consumed hydrogen for the reduction. The TPR profile appears in range of 420-570 $^{\circ}$C, the presence of many types of NiMo species with different reduction potentials.
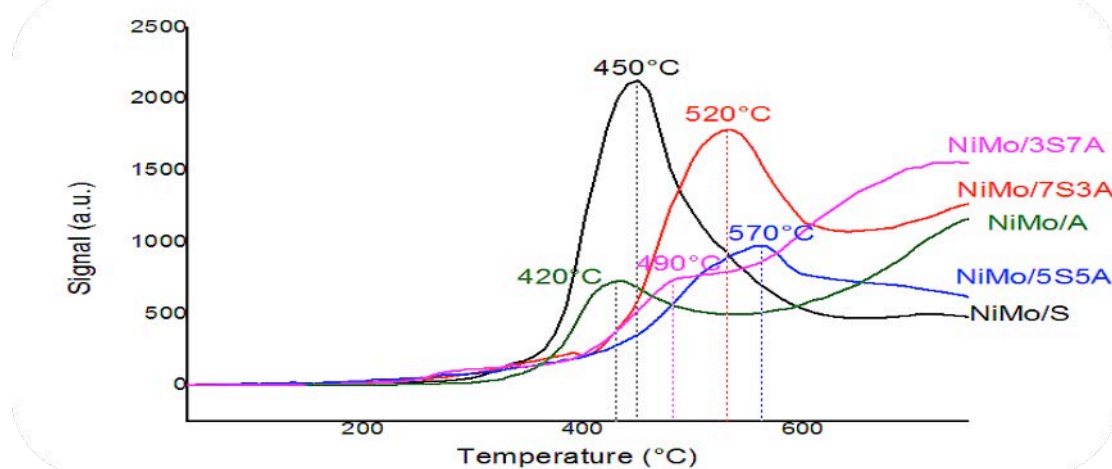
Fig 2. Temperature programmed reduction profiles for series of catalysts

3.2 Catalytic activity test on (model compounds)

The results of Palmitic deoxygenation (model compound) at 300 °C, 10 bar of H$_2$ pressure for 1 h are showed in GC-MS chromatogram. The product was obtained from GC-MS and will be confirmed the quantitative analysis in GC-FID. Fig 3 shows the chromatograms of liquid products of Palmitic acid hydrodeoxygenation over series of prepared catalysts. Palmitic acid was observed in feed stock chromatogram which presents a broad and asymmetric compared to hydrocarbons peak with retention time about 41-42 min due to the polar species of hydroxyl groups (e.g. acids, alcohols and glycerol) exhibit low sensitivity when analyzed directly) The major products were identified as Pentadecane (29 min), Hexadecane (32 min) and their derivatives.
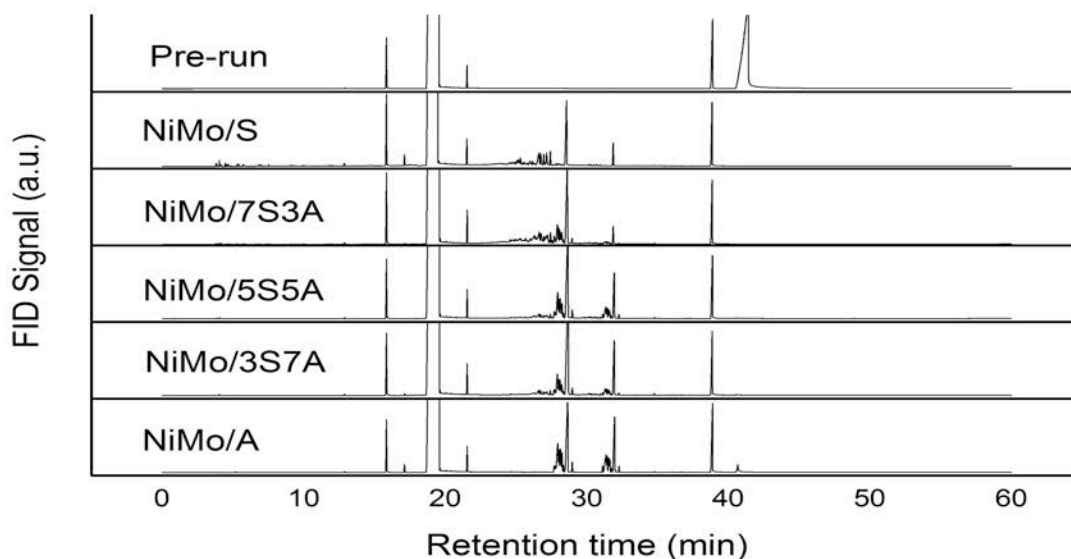
Fig 3. GC-FID chromatogram of liquid products from palmitic acid hydrodeoxygenation over series of catalysts

The %yield and conversion over series of catalysts are shown in Fig 4. According to the result, it could be seen that the hydrodeoxygenation of Palmitic acid demonstrates the remaining of paraffins and olefins hydrocarbon. The difference in catalytic activity depend on the different type of supports. An increase molar ratio of Si in supports enhances the %DCOx and %cracking reaction. This result can indicate that all catalysts prefer to produce a mainly product Pentadecane (C15) and their derivatives more than Hexadecane (C16) and their derivatives through Decarboxylation or Decarbonylation pathway. The possible route of reaction can be explained by propose the mechanism of as shown in Fig 5.
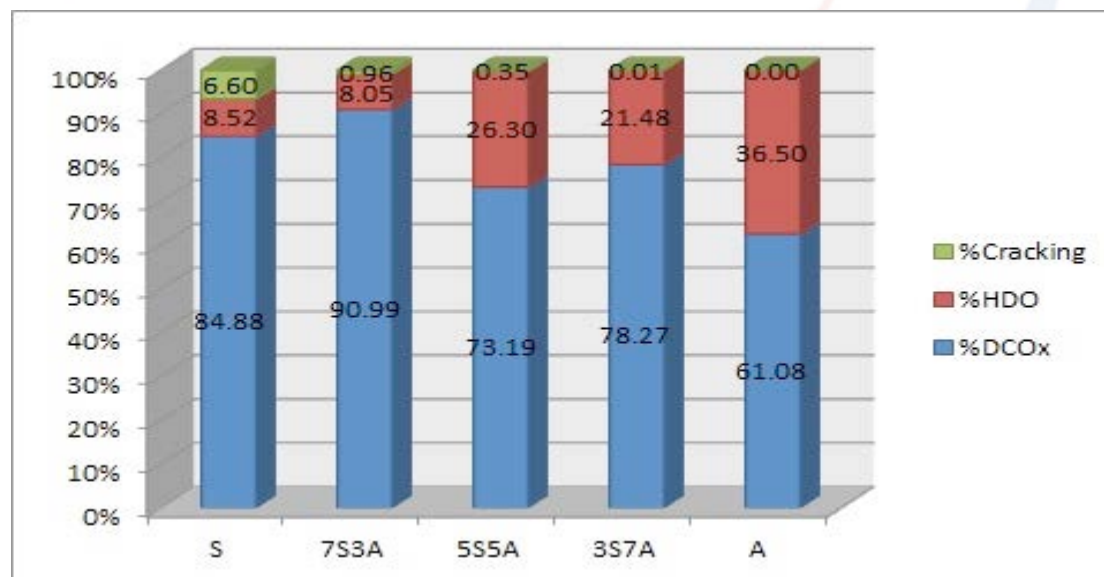
Fig 4. Comparison of %Palmitic conversion, %Decarboxylation or %Decarbonylation %Hydrogenation, at 300oC over 5%Ni/Al2O3, 10%Ni/Al2O3 and 15%Ni/Al2O3 catalysts.

Hydrodeoxygenation
$C_{16}H_{34}$

$+2H_2$
$-2H_2O$

$+H_2$
$-H_2O$

$C_{15}H_{31}COOH$
(Palmitic acid)

$\xrightarrow[-H_2O]{+H_2}$

$C_{15}H_{31}\overset{\overset{O}{\|}}{C}H$

$\xrightarrow{+H_2}$

$C_{15}H_{31}CH_2OH$

Hydrogenation

$C_{15}H_{32} + CO_2$
Decarboxylation/Decarbonylation
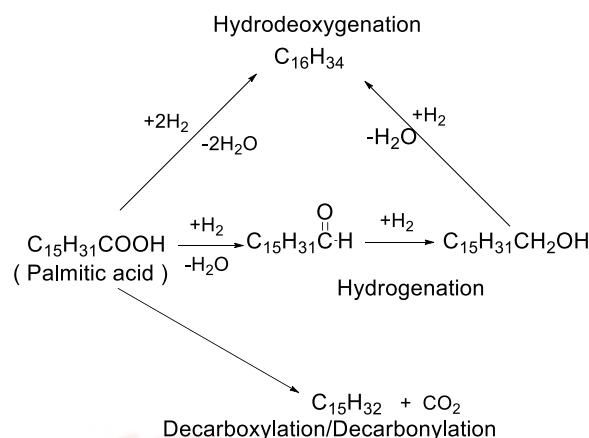
Fig 5. Propose Mechanism of palmitic acid converted to hydrocarbon compound

4. Conclusions

The series of prepared catalysts with NiMo bimetallic species are synthesized by Sol-Gel method followed by impregnation of NiMo complex solution show the high hydrogenation reactivity over Palmitic acid as a palm oil model compound. The major products occurs from Decarboxylation and Decarbonylation pathway are higher than hydrogenated products. The effect of activity on DCOx is improved with increasing of Si molar ratio in support. However, increasing of Si molar ratio in support induce the cracking reaction of paraffin to hydrocarbon with carbon less than 15 atoms.

Acknowledgements

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Conditions Impacting the Growth and Survival of Legionella in Compost

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Abstract

While commonly associated with aerosolized water, species of the bacterial genus *Legionella* are native to soil and can be responsible for legionellosis transmission, particularly in potting soil, compost, and mulch, with the soil-borne *L. longbeachea* being the most common causative agent of Legionnaires' disease in certain countries. This study aims to investigate factors responsible for the persistence and amplification of *Legionella* during compost processing, storage, and use. Samples of a food waste and woody material based compost containing naturally occurring *Legionella* were hydrated and incubated at 25, 32, and 37 °C. The compost supported increasingly greater growth of *Legionella* with higher temperature, with more than a three-log increase observed in the 37 °C incubation after eight days. In a separate experiment, two sets of the compost were incubated at an internal temperature of 58 °C, one set supplemented with calcium silicate to raise initial pH. *Legionella* growth was significantly inhibited in the alkaline compost, with concentrations nearly two orders of magnitude lower than in the non-treated set after two weeks. Microscopic examination of co-cultures of fungus isolated from the compost and *Legionella* indicated potential interactions between the microbes, possibly in the form of endoparasitization and/or necrotrophic consumption of the fungus by *Legionella*. The results from this work demonstrate the varying capacity for compost to support *Legionella* growth under different conditions, highlighting the relevancy of research aimed at investigating the potential microbial risk associated with the production and application of compost products for the development of sustainable waste management and agriculture.

Introduction

Bacteria of the *Legionella* genus are a respiratory pathogen of increasing concern (Hicks et al., 2011), causing more drinking water borne disease outbreaks in the US than all other microbes combined (Brunkard et al., 2011). Legionellosis is typically associated with transmission via water (Hlady et al., 1993), particularly aerosolized heated water sources, such as cooling tower vapour (Fields et al., 1993). While ubiquitious in fresh water, *Legionella* can occur naturally in soil (Steele et al., 1990), with the most common species in this environment being *L. longbeachae* (Whiley et al., 2011). Analogous to heated water systems providing an ideal environment for water borne *Legionella*, additive containing soil mixtures intended for gardening, such as potting soil and compost, are the most common sources of soil transmitted legionellosis. Despite identification of soil borne legionellosis in the US (Duchin et al., 2000) this remains a rare source of these infections in this country, contrary to what is observed in other regions such as Australia (O'Connor et al., 2007) and New Zealand (Graham et al., 2012). Combined with the fact that *Legionella* have been isolated in gardening soils in a variety of other countries including the UK (Potts et al., 2013), Greece (Velonakis et al., 2010), and Japan (Kubota et al., 2007), it is clear that *L. longbeachae* and other soil borne *Legionella* spp. have the potential to pose a significant public health risk.

Compost is a form of mulch reliant on the activity of microbial communities to convert waste products into stable and useful compounds typically utilized as soil additives (Mehta et al., 2014). With the exception of environmental monitoring studies, limited research has been performed to examine the survival and growth of *Legionella* in compost. While it is known that these bacteria commonly, yet not always (Travis et al., 2012) occur in soil and compost, factors increasing the likelihood for *Legionella* to flourish in this environment are poorly understood. *Legionella* are fastidious in nature and in order to replicate they require sufficiently high temperatures (Kusnetsoz et al., 1996) and a source of nutrients in the form of eukaryotic hosts to endoparasitize (Borella et al., 2005) or dead microbes to necrotrophically consume (Temmerman et al, 2006). A variety of additional environmental conditions can affect the survival of these organisms, such as pH, presence of disinfectants, and competing microbes. The goal of this study was to examine factors contributing to the increased growth and survival of *Legionella* within compost, focusing on two abiotic conditions (temperature and pH) with additional experiments examining the potential for native fungi to serve as a nutrient source for these pathogens.

Methods

Media and Laboratory Strain of *Legionella*

All laboratory experiments were performed using a stock of *Legionella pneumophila* ATCC strain 33152 (American Type Culture Collection, Manassas, VA, USA) cultured in Buffered Yeast Extract broth (BYE) media. Laboratory and environmental water samples were assayed for the detection of *Legionella* using Buffered Charcoal Yeast Extract agar (BCYE) media (Procedures for the recovery of *Legionella* from the environment, 2005). BYE media contained: 10.0g yeast extract, 0.25g ferric pyrophosphate, and 0.4g L-cysteine HCl per liter of distilled water.

BCYE media consisted of BD BBL Buffered Charcoal Yeast Agar (Diagnostic Systems, Sparks, MD, USA) supplemented with 0.4 g/1000 mL L-cysteine HCl, 0.3% glycine, 100 units/mL polymixin B, 5µg/mL vancomycin, and 80 µg/mL cyclohexamide. Bacterial stocks were prepared by culturing *Legionella* in BYE broth in a tabletop shaker incubator at 37 °C for 72 hours before quantification via optical density and enumeration of colony forming units (CFU) via the spread plate technique. BD Trypticase Soy Agar Media (Diagnostic Systems, Sparks, MD, USA) and Oxoid Brilliance *E. coli*/Coliform Selective Agar (Oxoid Limited, Basingstoke, UK) were used to culture fungal isolates and *E. coli*/coliforms, respectively.

Compost Sampling

Compost derived from food and green wood waste at a reported ratio of approximately 1:3 respectively was obtained from an organic composting facility in central Arizona in the winter of 2014. Samples were collected from two feet within the base of active composting piles at least two months old and stored in polyethylene containers at room temperature for several weeks until experiments were conducted. Compost samples were analysed for various microbial assays by first collecting known volumes of the compost in 50 mL polyethylene tubes. The samples were then over-saturated in sterilized deionized water to a final volume of 10 mL and vortexed, with liquid supernatant used for culturing.

Microbial Culturing

Culturing of *Legionella* from compost samples followed procedures modified from those for sampling of these bacteria from environmental water (Procedures for the recovery of *Legionella* from the environment, 2005). *Legionella* concentrations were determined for all samples via the spread plate technique on BCYE agar media. Plates were incubated at 37 °C under atmospheric CO_2 between 3 and 7 days and colonies were recorded. Prior to spread plate assays, environmental water samples were subjected to a heat treatment at 50 °C for 30 minutes to reduce the growth of non-*Legionella* organisms (Wullings et al., 2011).

E.coli/coliform levels were determined for select compost via spread plating on Brilliance *E.coli*/coliform selective agar media at 37 °C for 18 hours under atmospheric CO_2, respectively. Fungal colonies growing on BCYE plates were subcultured onto TSA for isolation. Several strains of morphologically distinct fungi were isolated, with one highly filamentous, ceanocytic isolate co-cultured with *Legionella* for later microscopic examination.

Growth of *Legionella* in Compost at 25, 32, and 37 °C

To determine the effect of temperature on the growth of *Legionella* in compost, samples of the collected compost were incubated at three temperatures. The temperatures chosen were 25, 32, and 37 °C, as they fall within the *Legionella* growth range and represent temperatures compost may reasonably be stored at. 25 °C represents compost stored indoors at room temperature and is near the low end of the growth range. *Legionella* growth should be minimal at this temperature and could potentially be hindered or prevented in the presence of stresses. 37 °C is near the ideal growth temperature for many *Legionella* spp. and represents compost storage

outdoors in hot climates. *Legionella* growth should be near optimal at this temperature, barring competition from the growth of other organisms native to the compost. 32 °C represents a moderate temperature for growth of *Legionella*, while also being an ideal growth temperature for many mesophilic microbes, including fungi (Mehta et al., 2014).

After determining native *Legionella* levels in the bulk compost sample, 25g aliquots were placed in sterile 90mm X 15mm polystyrene petri dishes and incubated at 25, 32, and 37 °C. Samples weighing 1-2g were periodically obtained and suspended in sterilized deionized water before culturing for *Legionella*. The compost aliquots were routinely hydrated to maintain a moisture content of approximately 20%.

Effect of Calcium Silicate Additive on the Survival of *Legionella* and Other Bacteria in Compost

The effect of pH on the survival of *Legionella* and other microbes in compost was tested by inoculating a mixture in bioreactors containing compost, food waste, and polylactic acid (PLA, a compostable biopolymer), with or without the addition of calcium silicate. Each contained 200g food waste, 40g PLA, and 400g compost. One reactor contained 60g of wet form mineral CSA (Harsco Corporation, Mechanicsburg, PA, USA), a calcium silicate steel industry by-product often used in acid mine remediation due to its basicity. The 2L borosilicate bioreactors were sealed, air fed, and hydrated throughout their incubation at 58 °C. The initial pH for the bioreactor containing the additive was 7.6, decreasing to 7.0 by the day of sampling. For the reactor with the additive, these pH levels were 7.0 and 6.7.

Thirteen days after the reactors had been operated, approximately 10g of compost were collected from each, with 1-2g suspended in sterilized deionized water to produce a solution for spread plating. Three microbiological assays were performed on the compost samples: 1) for *Legionella* detection and quantification, the samples were plated onto BCYE agar media and 2) for coliforms, the samples were plated onto Brilliance *E. coli*/Coliform selective media.

Microscopic Examination of Interactions between *Legionella* and Fungi Isolated from Compost

Phase contrast microscopy and transmission electron microscopy (TEM) were performed on the fungus isolate co-cultured with *L. pneumophila* to examine interactions between the two microbes. 25mL polystyrene vented tissue culture flasks were filled with 5mL of sterilized tap water and inoculated with 10^8 CFU *L. pneumophila* and actively growing hyphae from the fungal isolate. Over the course of a 21 day incubation at 25 °C, phase contrast microscopy was performed directly on the culture in the flask. At day 13, samples of the culture were taken and prepared for examination by transmission electron microscopy.

Phase contrast imaging was performed on an Olympus IX70 (Olympus America Inc., Center Valley, PA, USA) using a 20x/0.4 Ph1 objective. TEM images were obtained with a Philips CM12 TEM (Philips Innovation Services, Eindhoven, The Netherlands) operated at 80kV. For TEM, 1mL samples of the fungus/*L. pneumophila* co-culture (containing visibly large amounts of fungal filaments) were prepared in the following

steps: samples were fixed in glutaraldehyde, post–fixed in osmium tetroxide, block stained in uranyl acetate, embedded in Spurr's epoxy resin, post stained in uranyl acetate and Sato's lead citrate, then trimmed and sectioned at 70 nm. TEM was performed at the Electron Microscope Lab in the School of Life Sciences Bioimaging Facility at Arizona State University with the assistance of David Lowry.

Data Analysis

Excel (Microsoft Corporation, Redmond, WA, USA) was used for all data analysis and graph generation.

Results and Discussion

Growth of *Legionella* in Compost at 25, 32, and 37 °C

Growth of *Legionella* occurred in the compost samples inoculated at each 25, 32, and 37 °C, increasing in rate with higher temperature. Cultures taken on the initial day of the experiment displayed a concentration of 6.0×10^2 CFU/mL compost. By day 8, this concentration increased to 4.0×10^3, 1.6×10^4, and 2.4×10^5 CFU/mL for the samples incubated at 25, 32, and 37 °C. A decrease in the rate of growth occurred between day 4 and 8 (compared to day 0 and 4), which was most drastic in compost incubated at 37 °C. While *Legionella* were detectable for up to three weeks in the compost samples, reliable quantification was prevented after day 8 due to the growth of non-*Legionella* microbes interfering with spread plating.

Results from this experiment correlate well with commonly accepted information on the temperature growth range of *Legionella*, as increasing concentrations were positively correlated with temperature. Though possible, growth of *Legionella* at the lower end of the range is often inhibited by environmental stresses, such as toxic compounds and microbial competition. The growth of over one order in magnitude observed at 25 °C thus indicates *Legionella* in the compost either did not experience a certain level of stress or were able to overcome it. Regardless of the explanation, the growth of these pathogens at this relatively low temperature is significant for two reasons. First, heated water systems are often thought necessary for the replication of *Legionella* in the environment, a notion that the results indicate may not be accurate in all situations, particularly in nutrient rich environments such as soil and wastewater. Second, the growth of *Legionella* at room temperature indicates the commonly suggested practice of storing compost and potting mixes indoors to prevent the growth of these bacteria may not be an effective measure to do so. The growth rates for *Legionella* incubated at each temperature significantly decreased after the first 4 days, potentially due to the increasing influence of microbial competitors, such as those seen with increasing concentration as the experiment proceeded. Interestingly, though the rates of growth varied drastically between the temperatures during the first 4 days (over an order difference between 25 and 37 °C), this difference was substantially lower for the following 4 days (a 50% difference between 25 and 37 °C). Again the inhibitory activity of competition on *Legionella* may have been responsible. It should be noted that quantifying growth rates using spread plate technique derived concentrations of *Legionella* could be as easily inhibited by sufficient background microbial growth on agar media for both relatively low and high *Legionella* levels.
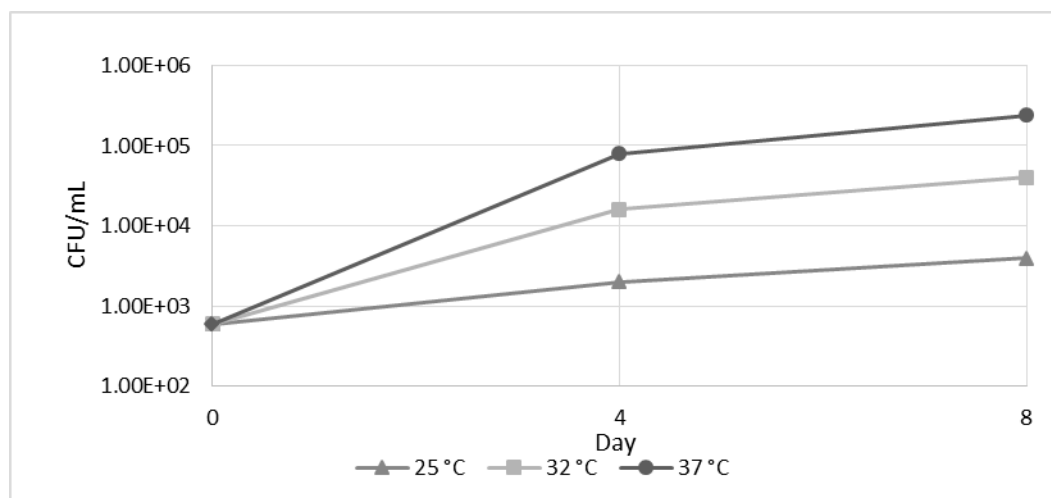
Fig. 1 – Growth of *Legionella* in compost incubated at 25, 32, and 37 °C

Effect of Calcium Silicate Additive on *Legionella* Survival in Compost

Compost sampled from the bioreactor containing mineral CSA contained significantly less *Legionella* and coliforms than the untreated compost (Table 1).   The concentration of *Legionella* in the treated compost was 1.9 log higher than in the untreated compost. The difference in coliform levels was not as great, with a 0.6 log difference between the compost in the two bioreactors. Not shown in the table, *E. coli* was present in 10^{-2}mL from both composts but was not quantifiable due to background growth, though concentrations appeared higher in the untreated compost. Incidentally, a qualitative assessment of general microbial growth on TSA agar media showed that microbial diversity and overall concentration appeared substantially lower in the treated compost.

The drastically lowered levels of *Legionella* in the presence of increased pH suggests this factor could play an important role in the survival of *Legionella* within compost. The measurable effect on coliforms and other microbes demonstrates that presence of mineral CSA in compost can have a significant effect on other microbial populations as well. The difference in variation between initial and final pH levels measured for the two bioreactors would seem to indicate that the pH altering effects of the additive occurred more substantially in the earlier portion of the incubation and were mitigated as time passed.   This could lead to either a temporary or permanent shift in the microbial population of the compost depending on how dominant a foothold could be established by pH tolerant organisms. Having a relatively high pH tolerance, it is possible that an altered microbial community led to the decline in *Legionella* observed for the treated compost, although the increase in pH combined with other stresses such as the high temperature of the reactors could have produced a cumulatively detrimental effect on *Legionella* survival. Interestingly, the difference in coliform levels between the two bioreactors was substantially less than the difference in *Legionella* concentrations. The fact that *Legionella* are generally more resilient to environmental stress (specifically to heat and pH) than coliforms suggests that

dormant *Legionella* in the form of viable but non-culturable cells (Al-Bana et al., 2013) could have skewed the results observed.

Compost	Initial/Final pH	*Legionella* CFU/mL Compost	Coliform CFU/mL Compost
With Additive	7.6/7.0	4.8×10^2	4.8×10^4
Without Additive	7.0/6.7	3.4×10^4	1.9×10^5

Table 1 – Effect of mineral CSA on concentration of *Legionella* and coliforms within compost incubated at 58 °C

Examination of Interactions between *Legionella* and Fungi Isolated from Compost

Phase contrast microscopy revealed distinct morphological changes in the fungal isolate when co-cultured with *Legionella*, generally proceeding from healthy (Image 1) to sickly (Image 2) more rapidly when incubated alongside the bacteria. In both pure culture and co-culture, the fungus eventually died in the sterilized tap solution, displaying distinctive morphological and physiological traits associated with stress. Several of these traits noted during phase contrast microscopy included: septae formation, fungal cell debris accumulation, and shrivelling of cells accompanied by negative space within cell walls. The characteristics of stress occurred more rapidly, more drastically, and more commonly when co-cultured with *Legionella*, and could be clearly seen in many fungal filaments after 9 days (Image 2). Also visible in this image is a trait only observed in the co-cultured fungus: accumulations of motile, bacteria sized and shaped particles within the confines of certain dying or dead fungal cell walls.

While the rapid alterations observed in the co-cultured fungal morphology could not be directly linked to the activity of *Legionella* endoparasitization, a correlation between the presence of *Legionella* and increased signs of fungal cell stress was demonstrated. The presence of potential *Legionella* within stressed fungal cell walls would seem to indicate that at least necrotrophic consumption of the fungi by *Legionella* may have been occurring in the co-cultures. This idea is further supported by observed morphological and physiological differences in pure and co-cultured *Legionella* (data not shown) indicative of metabolically active cells seeking hosts organisms or other nutrient sources when cultured alongside the fungi.
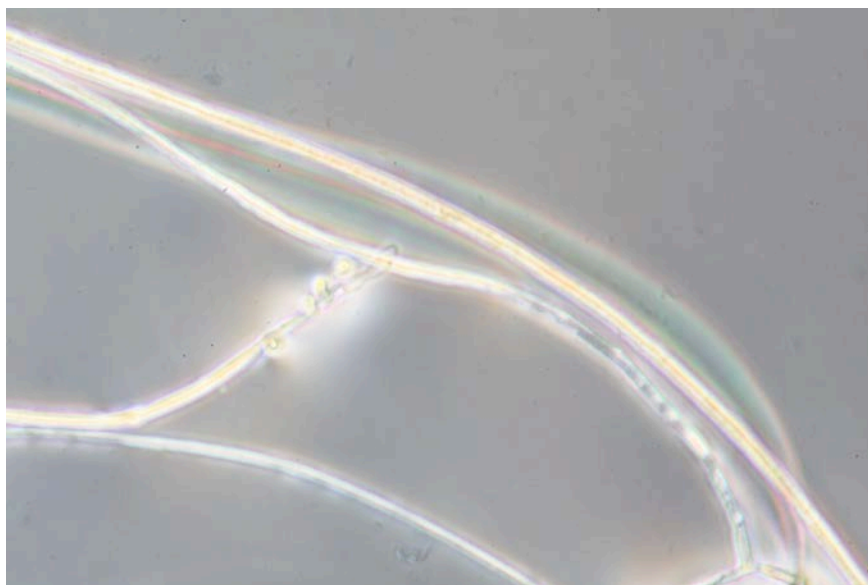
Image 1 – Metabolically active fungal hypae from a pure culture without spiked *Legionella*. 300X magnification using phase contrast.
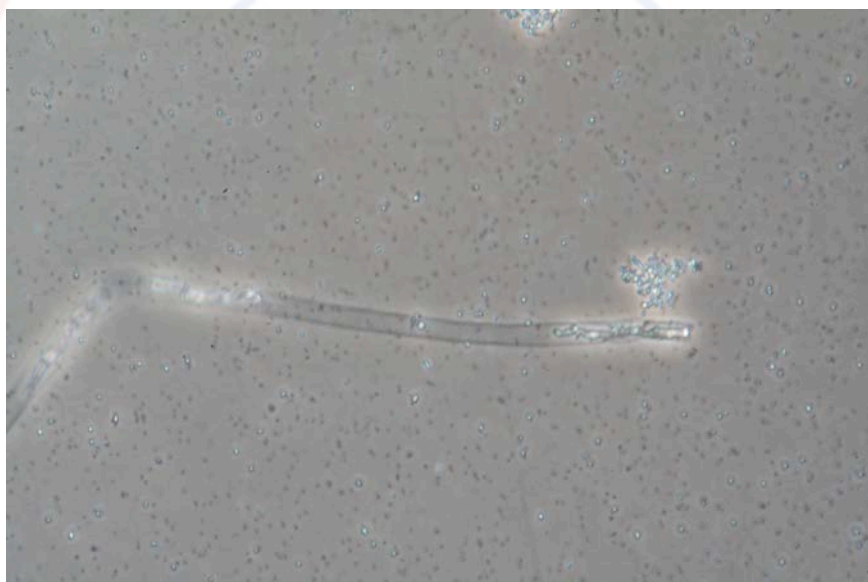
Image 2 – Dying fungal hyphae surrounded by *L. pneumophila* after a 9 day co-culture in sterilized tap water. 300X magnification using phase contrast.

Transmission electron microscopy of day 13 samples collected from both pure culture and fungus co-cultured with *Legionella* produced similar results to those observed via light microscopy. Generally, the pure culture displayed healthier cells with more metabolic activity as indicated by substantially higher levels of mitochondria. Though rare, several examples of what appear to be fungal cell walls containing high concentrations of bacteria were observed in seemingly dead fungal filaments (lacking organelles or cytoplasm) in the co-cultured fungus (Image 3). In one example, a single 70nm cross section of approximately 4μm in diameter contained 24 bacteria similar in size and morphology to *Legionella* from pure culture (Image 4). These bacteria ranged in size from 0.5μm to 1.5μm bacilli and possessed double membranes, with the outer ones often wavy, characteristics distinct of gram-negative bacteria. These bacteria exhibited a range of pleimorphicity as would be expected of

recently and actively replicating *Legionella* cells (Al-Bana et al., 2013), including electron dense cocci, cell wall protrusions, and inclusion bodies, examples of which are visible in several cells depicted in Image 4.

The results obtained from TEM provide additional evidence in line with those from phase contrast microscopy supporting the notion that direct interactions occurred between the compost isolated fungus and *Legionella*. The high concentration of *Legionella* within the single fungal filament cross section depicted in Image 3 indicates non-random, preferential association between the bacteria and the fungus. The internalization of *Legionella* within the confines of intact fungal cell walls, as well as morphologies indicative of replicative cells suggests nutrient acquisition and growth of *Legionella* took place within fungal cell walls. Due to the fact that no TEM images were produced demonstrating clear examples of *Legionella* within metabolically active fungal cells would seem to indicate that dead, or perhaps dying, fungus had served as a necrotrophic nutrient source for the bacteria. This fact alone does not rule out the possibility of the fungus having served as a host for endoparasitic replication of *Legionella,* as several limitations of the microscopic techniques used (reflective properties of live fungal cells for phase contrast microscopy and low fungal filament yield per prepared sample in TEM) resulted in difficulties producing reliable data demonstrating the presence of *Legionella* within live fungal cells.
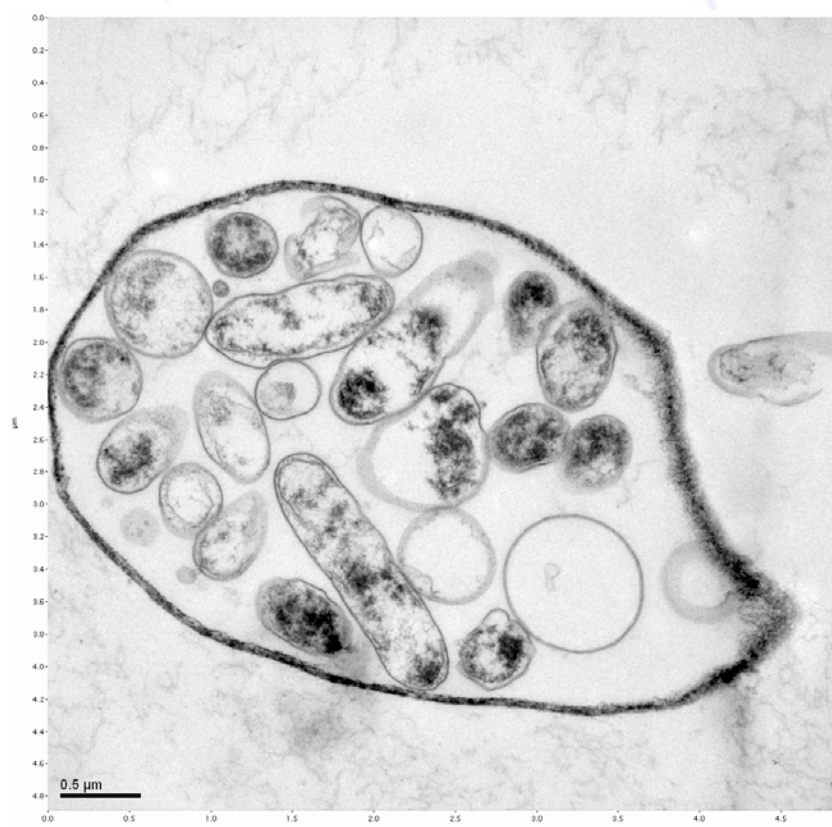
Image 3 – TEM micrograph of a 70nm thin slice hyphae cross-section containing bacterial cells after a 13 day incubation with *L. pneumophila*.
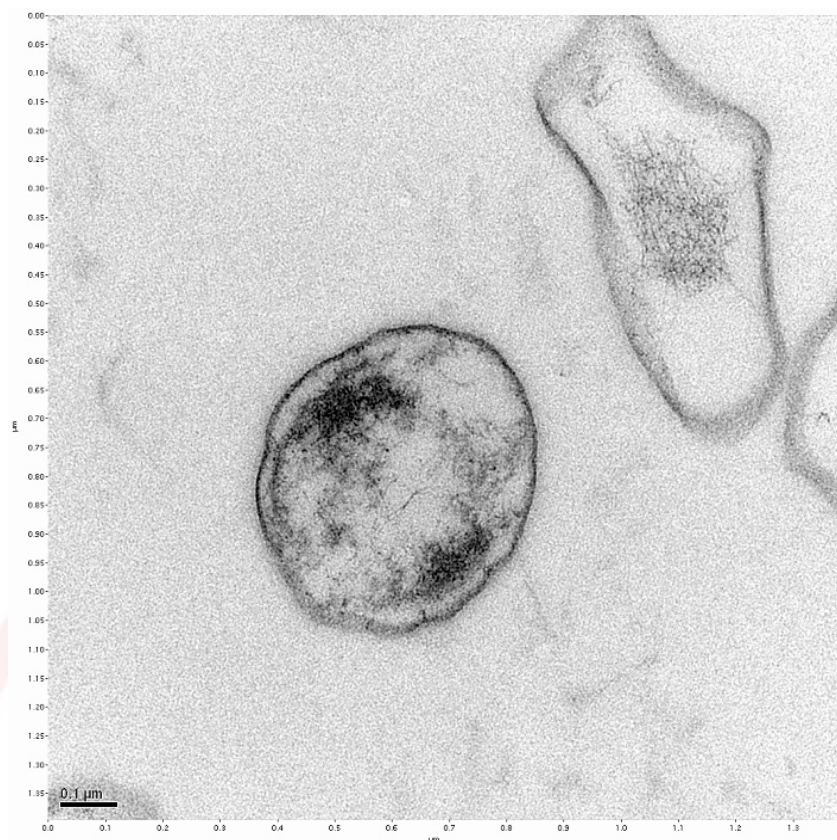
Image 4 – TEM micrograph of a *L. pneumophila* cell from pure culture.

The results from this study help to address knowledge gaps concerning the growth of *Legionella* within compost by measuring the effect of temperature and pH, as well as demonstrating fungus to be a potential novel nutrient source commonly occurring within compost. By gaining insight into the conditions that can allow these pathogens to increase in concentration in poorly understood media to the point of posing a public health risk, future maintenance and monitoring practices could be developed to limit the amplification and dispersal of *Legionella* through compost and other soil-associated transmission routes.

Acknowledgements

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An Appraisal of Environmental Management Strategies in Malaysia's Towards Achieving Sustainable Development Goals Target

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Abstract
Malaysia is a developing rich country with her beauty natural resources concern about management of their surrounding environment. Like others developing country, Malaysia also point out strategies to ensure her natural beauty remain sustain and rehabilitation. To achieve of their aims to become developed country, they made a strategies for that kind of things. Moreover, for maintain the good condition component of environment, government should provide a good mechanism and strategies. The objective of this paper is to examine how Malaysia governments appraise its environmental management strategies. There is much method to appraise some of the programme or activities. In these papers, some of the methods will provide towards that. Appropriate instrument was choosing to answer the objective. The instrument is using a survey and interviews for expert group who involve in this area directly. The questions limited for certain aspect likes management and government efforts. Besides, government report which is related on this part also used to fulfill the objective particularly. However, SWOT analysis for this study also will attach in discussion as well. The raw data analyzed using frequency analysis to looking the percentage of reliable in the data measuring. To sum up, the results will present in bar graph and pie chart separately.

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1.0   Introduction

Malaysia is a developing rich country with her beauty natural resources concern about management of their surrounding environment. Like others developing country, Malaysia also point out strategies to ensure her natural beauty remain sustain and rehabilitation. Malaysia was serious in the management of environment when the environmental act 1974 announced by government. Like others developing countries, Malaysia also concerned about the matters of environmental resources and environmental degradation issues. Even though forwarding towards sustainable development countries, all developments in this country always carried out by regulations and fundamental assessment. Likewise in 1970 there were only 10 ministerial departments of environment in the world (Ausubel et.al., 1995). For instance, others were developing country doing the same things like Malaysia at all. They put some tremendous attempts to ensure the development would never give huge impacts to environment directly.

In other hand, Malaysia also had a strategies to ensure the environmental resources would rehabilitation and useful. Malaysia itself is gifted with natural resources in areas such as agriculture, forestry and minerals. Malaysia is one of the top exporters of natural rubber and palm oil in agriculture sector. Tin was once a major contributor to Malaysia's economy until the collapse of the tin market in early 1980s. Since then, petroleum and natural gas took over from tin as stronghold contributor to the economy. In 2004, Malaysia is ranked 24th in terms of world oil reserves and 13th for natural gas. 56% of the oil reserves exist in Peninsular Malaysia while 19% exist in East Malaysia (Chua & Oh, 2010). Moreover, concerns for developing countries can be clearly seen in the most oft-cited definition of sustainable development by the World Commission on Environment and Development (WCED or the Brundtland Commission), 'the development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987, p. 43).

2.0   Study Framework
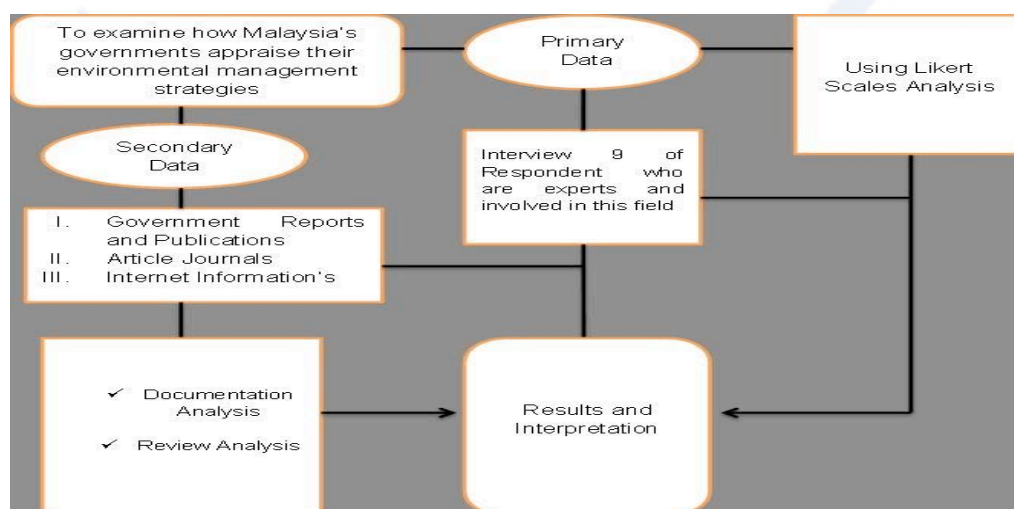
Figure 2.0: Study Framework for Malaysia's Environmental
Management Strategies Appraisal

3.0   Study Region

Malaysia's is the developing country in Asia. Malaysia starts concerned in environmental issues since colonial times. Malaysia actively participates in for example, the Association of South-East Asian Nation (ASEAN) and in Asia-Pacific Economic Cooperation (APEC). Malaysia has also participated in partnerships for the implementation of economic strategies, such as regional growth triangles (UNDP, 2005). Malaysia is an independent nation state, a parliamentary constitutional monarchy, with a federal government structure. The country, one of 10 nations in South-East Asia, comprises thirteen states spread across two major regions separated by the South China Sea (Peninsular Malaysia and East Malaysia on the Island of Borneo, and three Federal Territories. Kuala Lumpur was established in 1974, Labuan was established in 1984 and Putrajaya was established in 2001. Peninsular Malaysia and East Malaysia had a common background of British colonial administration, though this administration began at different times in different states. Malaysia also represents one of the success stories of a developing economy. Malaysia succeeded in reducing its incidence of poverty from 49.3 percent in 1970 to 6.3 percent in 2002 (Anuar, 2003).

Subsequent development policies such as the National Development Policy (NDP), National Vision Policy (NVP) and Vision 2020 had continued to incorporate elements of poverty eradication strategies in their implementation. With effective implementation of these policies, Malaysia's poverty index has declined further and now stands at less than five per cent. The program of poverty eradication will continue and the development policies will focus on the objective of reducing the incidence of hardcore poverty to zero per cent in the 2009 (Muda, 2005).

The total land area for Malaysia is about 33 million hectares of which 19.5 million hectares or 59.1 percent of the total area are under forest cover. Out of the 19.5 million hectares, 14.3 million hectares, 14.3 million hectares are gazette as Permanent Reserve Forest (PRF) or Forest Reserves (Sabah and Sarawak) and are managed under the Forestry Department of each state. The forest reserves are managed with the objective of maintaining the forest ecosystem in perpetuity, while allowing for the use of the forest products and services. Within these areas, there are classifications for different categories of use, such as for timber production, water catchment, soil protection, recreation, research and wildlife protection. In addition to these areas, Malaysia has also gazette a total of about 3.3 million hectares as protected areas, under the network of Wildlife Sanctuaries, National Parks, State Parks and Wildlife Reserves scattered throughout the country (Pereira, 2005).

Malaysia is a country that has been recognized as one of twelve mega biologically diverse countries in the world. It is estimated that there could be over 15,000 known species of flowering plants, 286 species of mammals, 150,000 species of invertebrates, over 1,000 species of butterflies, 12,000 species of moths, and over 4,000 species of marine fish in the country. To ensure the protection and conservation of its biodiversity, Malaysia has created a network of protected areas that are representative of the ecosystem found in Malaysia. As previously noted the network of protected areas for forest is covered under Wildlife Sanctuaries, National Park, State Park, and Wildlife Reserves and totals up to 3.3 million hectares.

The quality of air and water directly affects the socio-economic condition of society. As a result of the rapid economic growth in Malaysia over the past two decades, air and water pollution is generally expected to become more challenging. Rapid urbanization and industrial growth account for the continued increase in air pollution. The sources of air pollution are from the transportation and industrial sector through the burning of fossil fuel. The increasing number of vehicle remains the main cause of the deterioration of air quality, particularly in major cities such as Kuala Lumpur (Pereira, 2005).

4.0   Methods and Techniques

The data gathered for these studies is by primary and secondary data. Primary data were collected by interviewing respondent. The respondents who are selected are based on the criteria shown below:

i.   The person who is experts in environmental management fields in Malaysia;
ii.   The person who involved as a directly towards the research or project deal with environmental area;
iii.   The person who managed the projects dealing with governments and private sector as well;
iv.   The person who are participate in academician, research & publication project, NGO's, project implement and policy makers particularly in environmental concern in ten years and above experiences.

While, for the secondary data were chosen by documents which are related with this study. Among the documents are Economic Planning Unit reports, Malaysia Plan Reports, Department of Environment Reports, research and publications journals report, NGO's annual reports, government & private project reports and newspaper cuttings. Besides, observation approaches also done by the certain assessment.

For the primary data, the methods were used Likert scale analysis. Likert scale is a psychometric response scale primarily used in questionnaires to obtain participant's preferences or degree of agreement with a statement or set of statements. Likert scales are a non-comparative scaling technique and are unidimensional (only measure a single trait) in nature. Respondents are asked to indicate their level of agreement with a given statement by way of an ordinal scale (Dane Bertram, n.d).

5.0   Results and Interpretations

5.1 Road to Vision 2020 and Sustainable Development

Outline Perspective Plans	Malaysia Plan	Main Focus
OPP1 (1971-1990) National Economic Plan	Second, Third, Fourth & Fifth Malaysia Plans	To improve Malaysia's socio-economy, especially in poverty alleviation and the restructuring of society

OPP2 (1991-2000) National Development Plan	Sixth & Seventh Malaysia Plans	To provide balanced and equitable development for Malaysia.
OPP3 (2001-2010) National Vision Plan	Eighth & Ninth Malaysia Plans	Striving to build a resilient and competitive nation to withstand domestic and global challenges.
OPP4 (2011-2020) National Sustainable Development Plan	Tenth & Eleventh Malaysia Plans	Achieving sustainable development through sound economic, social and environmental principles and integrated practices.

Table 5.1: Road to Vision 2020 and Sustainable Development in Malaysia

5.2 Environmental Strategies in Malaysia's Planning

An environmental strategy is carried by the means the strategies underline by governments to ensure their planning would become the pillars into the great details. Like others developing country, Malaysia also put their attempt in order to make their aims would achieve by the target of time period. Based on the table 5.1 above, there are some of the efforts by Malaysia government to get the real objective towards achieving as sustainable development country instead of developed country as well. There has been different approaching of the focused into prior environmental perspective and after Malaysia announced as independent country.

Malaysia looked serious into environmental management perspective since 1970's. They realized that all over of the natural resources should be protect and preserve before being late. Besides of the planning scratch into paper, they also encouraged towards their aims. Each of the planning were arranged and managed followed by the rules. The results by the interviewing people with the different cohort would show the successful of appraisal in environmental management strategies in Malaysia towards achieving sustainable development goals target.

5.3 Timeline of Environmental Strategies in Malaysia

There are the attempts by Malaysia government to ensure that environment is managed. The explanation is about Malaysia announced as independent country. Independence in Malaysia is at 1957. During that time, Malaysia has been done put their own effort to grow up for their economic activities. In order to develop their country, doing exploration of natural resources is one of the parts to generate for the economic activities. Since 1970, Malaysia had been seriously towards environmental aspects. During that time, the Environmental Act was proposed at 1974. The

regulations and rules complete with the enactment and act in terms of enforcement by federal governments, state governments and local authority. After certain period, they upgrade the environmental system with the proposed of Environmental Policy at 2002. Under these policies, miscellaneous topic and approaching about environment is upgraded to enhance the monitoring and implementation methods.

5.4   The appraisal of Environmental Management Strategies in Malaysia

The theme of appraisal in these study are refers to two themes namely Theme A and Theme B. Theme A is appraise for management, assessment, monitoring, implementation and enforcement part. However, Theme B focusing on Environmental Resources Development (ERD), Environmental Degradation Issues (EDI), Environmental Effects (EE), Environmental Impacts (EI) and Environmental Management (EM). The both of themes were chosen based on the appropriate of the related questions to achieve the objectives of these studies.

According to results of interviewing of selected respondent, the summary of results as shown below:

Table 1: Theme A

Theme	Academician	Researcher	Policy Maker	NGO's	Public Persons
Management	M	W	G	W	G
Assessment	W	W	G	D	M
Monitoring	M	W	G	W	G
Implementation	M	M	E	W	G
Enforcement	M	W	G	D	G

The table shows the results of opinion by 9 selected respondents about the Malaysia's environmental management. Based on the Likert scales analysis, the results of different opinion and respondents already collected. Likert scales analysis representative by different scales namely E= Excellent, G= Good, M= Moderately, W= Weak, D= Disable. Different role of respondents shows the different opinion based on their experience and also the involving of the activities or projects. From the questionnaire, the questions were given to them for select the best ranks for Malaysia government towards achieving their goals towards sustainable development country. The questions are chosen based on the objective of the environmental aspects. The results on the table determined the summary of findings of selected answer by them. The raw data were put on the statistical analysis to get the final results. The ultimately, each of respondents were given different opinion for their perspectives.

Table 2: Theme B

Theme/ Timeline	Academician	Researcher	Policy Maker	NGO's	Public Persons
ERD	E	E	E	E	E
EDI	M	M	G	W	G
EE	M	M	G	W	M
EI	M	W	G	W	G
EM	M	W	G	W	G

Table 2 above shows the findings of the respond by interviewing 9 different of respondents based on their experience and opinions for the Theme B. The scales also same goes to with Theme A, but only the different of the question approaches. The questions of Theme B is more refers to the timeline analysis of environmental management in Malaysia namely concerns about Environmental Resources Development (ERD), Environmental Degradation Issues (EDI), Environmental Effects (EE), Environmental Impacts (EI) and Environmental Management (EM). The scale of measuring using Likert scales is same as Theme A. The result on the table shows the findings of the different answers by the respondents.

6.0   SWOC Analysis

6.1   Strength

These studies refer to the appraisal about environmental management strategies. The appraisal of management would give good impact to the countries. Participant by variety of cohort in terms of government side or others are needs to support all the programs or activities towards that issue. The strength of this appraisal are realized like Malaysia has a rich of natural resources in four main component of environment namely land, water, air and ecology. Based on the variety of natural resources, Malaysia could preserve and ensure all the component of environment always monitored by them. Malaysia also has been proposed and stated the rules and regulations of environmental law. Based on the previous research and observation, it's recognized that Malaysia is taking serious action to ensure that their environments are always in actions.

6.2   Weaknesses

Nevertheless, there are some weaknesses in these studies. Among that, they already put the regulations should obey by the parties who involved in environment as a directly or indirectly cases. Somehow they didn't done with the good implementation and monitoring process. They just put the laws as unimportant aspects instead of follow the rules. Some of the parties like industry just looking profit are more

important rather than the negative effects came when they pollute into the environment. Moreover, the less of quantity of good experts in the certain fields are also weaknesses in this study. There are some of ministry and department in government line who pointed out towards environmental part. When they don't have enough capabilities to handle all the problems in environment, hence they couldn't achieve their target wisely. Besides, they also not were taking seriously into the some aspect which is in part of environment.

6.3 Opportunity

However, instead of the weaknesses, through these the result of appraisal in terms of environmental management strategies, there are some opportunity should concern too. A management strategy is the best attempt to achieve the goals. Prior, Malaysia as a developing country has been doing the development without taking serious about the effects for future. Until they had some of the problems in environment which could effected to economic and social aspect, then only Malaysia taking an action to more concern about this matters. Moreover, Malaysia is still not too late to preserve their environment, but then they should enhance the enforcement so that the area are not polluted more could be conserve and preserve wisely. In the other hand, through the environmental management strategies also could collaborate with the others developing country to discuss about the same problems and the way to overcome the environmental problems.

6.4 Constrain

The constrain means some of the problems which had been cross into the planning and aims to achieve goals. In these case, constrain were recognize are the environmental management strategic still not giving the good effects for the certain part. This is because the lack of budget allocation to implement of the project objectives. If they have enough of allocation, they could do more research towards environment; also they could buy good equipment for settle down the problems of environment particularly. Besides that, as we know environment is entirely effects. Environmental problems is not occurred in the only that country, but would effected to others country. For instance, if the neighbour country doing some pollution in the air, the effects could going to others nearby country because air is moving as entirely and not static at the same place or areas.

7.0 Conclusion

To sum up, the environmental management a strategy in Malaysia is still need approve in the some part. Based on the captured of previous document and recent of the environmental management in Malaysia, they should combine the good structure in terms of management like sector government together with others private sector and NGO's. When they unite to manage the environment without put the responsibilities towards one sector, so that the environment would come out with the best qualities. Another action, they should educate all the society to practice the good attitude into environments. Also, stress out the environmental education to students since pre-school until the higher level of education. When they doing together to preserve and protect, so the environment would be save and the pollution also will decrease by slowly. Education is the root to improve all over the problems. If we

straight concern about the level of environmental education, it would giving the good quality of people and societies.

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Climate Change Impacts on Southeast Asia's Marine Biodiversity

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Abstract

Southeast Asia's status as a global marine biodiversity hotspot is challenged by heavy anthropogenic pressure from rapid economic expansion and a fast-growing population. Increasing attention to the erosion of marine ecosystem integrity is evident in the last three decades but management response continues to lag. Climate change is expected to exacerbate biodiversity loss particularly when ecosystem resiliency has already been largely compromised by human pressure. Equatorial biodiversity, functioning within the higher extreme of the temperature range will shift towards higher latitudes in the most simplistic sense as temperature elevates, but since species exhibit differential behavioural and physiological responses, habitat community structure will inevitably change through trophic disruptions, disorders in ecosystem processes and species-specific differences in temporal and distance migratory shifts. Apart from temperature elevation, other climate change impacts such as increased frequency of extreme weather, sea-level rise, and ocean acidification will also affect marine biodiversity. Some of these impacts can be seen from present conditions depicting climate change. A suitable response is to reduce present anthropogenic pressures and restore ecosystem health so that ecosystem resiliency can improve and strengthen against the impacts of climate change.

INTRODUCTION

Southeast Asia straddles the equator between latitudes 210N to 120S and longitudes 930E to 1410E. The combined marine area of 9 million km2 represents 2.5% of earth's ocean surface but holds almost 30% of the world's coral reef ecosystem (Burke et al., 2011), one third of the world's mangrove ecosystem (FAO, 2007) and 17% of the world's seagrass ecosystem (Green & Short, 2003). The region also has a great variety and extent of coastal and marine ecosystems, known throughout the world for their high species richness (Chou, 1996). Filled with numerous islands of varying size, the seas form a link between the Pacific and Indian Oceans while separating the continents of Asia and Australia. The seas are characterised by the extensive shallow continental shelves of the Sunda and Sahul as well as deep basins, trenches, troughs and continental slopes.

The world's two largest archipelagos, Indonesia and the Philippines, have about 25,000 islands and almost all the region's countries along the Asian continent possess extensive coastlines and numerous offshore islands, most of which are coral or volcanic. The combined coastline length of 92,451km amounts to 15.8% of the world's total and the extensive coastline supports a wide variety of coastal and marine ecosystems. Coastal features such as cliffs, coves, beaches (rocky, sandy, muddy), deltas, spits, dunes and lagoons provide the potential of harbouring high species richness. The high diversity marine habitats are favoured by the tropical climate and heavy precipitation that transports nutrients from land to sea.

The high nutrient content of Southeast Asian seas is facilitated by the scattering of numerous islands, each contributing terrestrial inputs to the marine system. Some of the larger seas remain remote from this direct nutrient source. The warm tropical climate further contributes to boosting primary productivity, enabling mangrove forests to reach their maximum development and greatest luxuriance in parts of the region (Rao, 1986). A comparative review of mangrove ecosystem productivity based on different parameters such as phytoplankton production, primary production, benthic primary production and total litter production showed that the region's mangrove forests maintained the highest values than elsewhere in the world (Singh et al., 1994)

Rapid industrialisation and strong economic development combined with the fast expanding human population exerted high pressure on marine biodiversity through habitat loss and degradation, pollution and overexploitation. Economic growth generated mainly by industrialisation and international trade remained high during the 1980s and early 1990s (JEC, 2000). Evidently, economic development remained the clear focus of Southeast Asian states with the pace intensifying from the 1960s (UNEP/COBSEA, 2010). The link between biodiversity and climate change is clear (IPCC, 2007). While climate change will affect biodiversity, the latter has a role in mitigating climate change influences (Djoghlaf & Ganapin Jr., 2010). The region's marine biodiversity is already under high threat from anthropogenic impacts that compromise its ability to provide ecosystem services that can mitigate climate change impacts.

GLOBAL MARINE BIODIVERSITY HOTSPOT

The region's geomorphologic and oceanographic features together with the tropical weather make the seas highly productive and supportive of rich and extensive marine habitats. Recognised as the faunistic centre of the entire Indo-Pacific (IUCN/UNEP, 1985), species richness of corals and other reef-associated flora and fauna is the highest throughout the world making the region a global hotspot for coral reefs (Kelleher et al., 1995). It has about 80% of the world's hard coral species (Spalding et al., 2001), 60% of mangrove species (FAO, 2007) and 50% of seagrass species (Green & Short, 2003).

A major significance is that many taxa are present only in the region and their loss means a global extinction. This species uniqueness has to be guarded against further loss. Investigations into population genetics of reef organisms such as corals (Knittweis et al., 2009), fish (Lourie & Vincent, 2004; Timm & Kochzius, 2008), crustaceans (Barber et al., 2006), molluscs (Kochzius & Nuryanto, 2008) and echinoderms (Kochzius et al., 2009) indicate high levels of genetic structuring with distinct signatures from the Indo-Pacific.

A high proportion of coral, fish, gastropod and lobster species have restricted geographic ranges (Roberts et al., 2002) and remain at high risk of extinction from localized reef degradation. Bellwood & Meyer (2009) demonstrated that the recognized (but arbitrarily defined) hotspots of the Indo-Australian Archipelago do not necessarily support high numbers of endemics or serve as a speciation source, and suggested that conservation of areas beyond these hotspots is also important. Weeks et al. (2010) also recognised from their assessment of community-based Marine Protected Areas (MPAs) in the Philippines that these small protected areas should be supplemented by larger no-take reserves for biodiversity conservation targets to be more effectively met.

ANTHROPOGENIC IMPACTS

Marine biodiversity of the region has suffered significant loss and degradation (UNEP/COBSEA, 2010). Anthropogenic impacts are significant and increasingly depressing delivery of ecosystem services essential to the well-being of human society and national economies (UNEP, 2001; MEA, 2005; ASEAN, 2006; UNEP/COBSEA, 2010). Signs of decline in the rate of mangrove loss have emerged for the rest of the world but not in Asia, which has the greater proportion of the ecosystem (SCDB, 2010). Long-term decline of Indo-Pacific reefs is evident with the proportion of reefs having at least 50% live coral cover falling from 66% in 1980 to 4% in 2004 (SCBD, 2010).

CLIMATE CHANGE IMPACTS

There is increasing evidence that climate change can cause significant impacts to biodiversity (IPCC, 2007). Climate change exposes marine biodiversity to a wide range of impacts that include sea level rise, elevated sea temperature, and increased frequency of extreme weather and intensification of water column stratification (Chou 1994). These impacts generate accompanying environmental effects on coastal and marine systems through coastal erosion, sudden salinity fluctuation, increased

sedimentation, nutrient loading, salt water intrusion, coastal inundation, and changes in coastal geomorphology and circulation patterns (Chou, 1992). While it is not easy to isolate climate change impacts on natural systems from adaptation and other drivers not directly related to climate change, it is possible to get some idea of climate change impacts from existing scenarios that simulate climate change conditions (Chou, 2010).

Impacts on biodiversity can occur at the species and community levels. At the species level, physiological constraints limit the individual's tolerance to environmental changes. At the community level, changes in the community structure alter the ecosystem functioning of the habitats. A review of the implications of expected climate change impacts on natural coastal ecosystems in the region has been made by Yap (1994). Climate change impacts on species will vary. Some species can move to new areas with more suitable conditions, while sessile and sedentary ones will have to cope or perish. Many are not expected to adapt to the rate and intensity of projected climate change scenarios and risk extinction (SCBD, 2010). In the most simplistic sense, a shift to the higher latitudes is expected of fish and other pelagic species resulting in a possible decrease in equatorial biodiversity. However, large changes in community structure will take place as intact communities fragment from the departure of some species resulting in trophic cascade modification and ecological imbalance. The same effect will be seen at sites receiving the immigrating species.

Rising sea levels inundating low-lying coastal plains can overwhelm adaptation response of coastal biomes and temperature elevation is expected to elicit physiological and behavioural responses from species that could be detrimental to entire biological communities and ecosystem integrity. Further warming of estuarine and near-shore habitats may make them inhospitable to species that already live close to the upper temperature tolerance limit. Increased precipitation will also test the tolerance limits of these species.

Ocean acidification from increased dissolved carbon dioxide is detrimental to many marine species such as corals, shellfish and plankton. Coral reefs in particular are highly vulnerable to lowered ocean pH and the region, with its high proportion of the world's reefs will suffer a greater loss. Should atmospheric CO_2 concentrations reach 500ppm after 2050 as projected by Rogeli et al. (2009), coral growth will be arrested as dissolution takes place (Silverman et al., 2009). The loss of coral reefs will be significant to the region where millions of people depend on it for subsistence.

Elevated sea temperature and increased precipitation are two impacts that have occurred in the recent past, the former at a global scale and the latter at a local scale. They give a fair warning of what can be expected and both impacts are examined further.

Elevated sea surface temperature

The 1998 El Niño event provided a good opportunity to observe the effects of global warming. Elevated sea surface temperature occurred from mid-1997 to late 1998 and coral reefs displayed the most dramatic effect. Mass bleaching of corals took place worldwide at an unprecedented scale and highlighted the urgency of protecting reef resiliency. Management is thus needed to prevent compromise of reef system

integrity. Mortality of shallow water corals was as high as 95% in some parts of the world while no mortality was observed in other places (Wilkinson & Hodgson, 1999).

Moderate to extensive bleaching was reported throughout Southeast Asia and all countries noted the extent of this event, which was unprecedented (Chou et al., 2002). In Indonesia, bleaching started in early 1998 in West Sumatra resulting in over 90% mortality. It then spread to other reefs throughout the country causing decreases in live coral cover ranging from 30 to 90%. Recovery was variable after a few years with some reefs retaining depressed live coral cover of less than 10%, while for others it reached 40%. In the Philippines, mean live coral cover decreased by 19% after the 1998 bleaching in Tubbataha with no further loss or recovery after two years. At Danjugan Island in Negros Occidental where coral mortality from the bleaching was high, recovery was observed over the next two years. The species Pavona clavus recovered better in medium depths of 12m compared to shallow waters of 6m.

Widespread bleaching of shallow reefs in the Gulf of Thailand affected also the coral recruits. Corals on pinnacles in deeper water (10-15m) escaped the bleaching. Local extinctions of some Acropora species were recorded while Goniopora showed complete recovery. Recovery in the inner Gulf of Thailand took a longer time because of low coral recruitment, but the east and west coasts of the Gulf had large numbers of coral recruits that facilitated recovery. In Vietnam's Con Dao islands, 37% of coral colonies bleached. Recovery was reported to be slow over the next two years. In Singapore, widespread mass bleaching occurred as sea surface temperature remained unusually high from January 1998, reaching 34.30C in June. All hard coral species bleached, together with some species of soft corals and colonial sea anemones. However, sea surface temperature returned to normal (29.5 to 31.50C) after June, allowing the bleached corals to recover and limit mortality to 20%.

Wilkinson & Hodgson (1999) noted that the 1997/98 bleaching event was the most severe ever observed and raised the question of whether this was just an isolated event or that similar events will follow at greater frequency as global warming continues. In the early part of 2010, the seas warmed up to temperatures higher than in 1997/98 and triggered widespread bleaching once again. Investigations revealed that species that were severely impacted in the 1997/98 bleaching appeared to be less impacted this time, while those that showed little effect to the earlier event were heavily bleached. The differences in species response and mortality patterns suggested some adaptive ability to thermal stress by coral species (Guest et al, 2012).

Sudden salinity depression

Increased frequency of extreme weather events is expected from global warming. Periods of drought interspersed by intense precipitation will cause wide salinity fluctuations in shallow waters and affect intertidal life. The impact of sudden lowering of salinity on intertidal biological communities was observed at a location in Singapore after unusually heavy rainfall over many decades occurred at the end of 2006 and early 2007 (Chou, 2010).

Excessive discharge from Malaysia's Johor River northeast of Singapore caused a sustained decline of salinity in that part of the Johor Strait. Chek Jawa, a protected intertidal habitat on the island of Pulau Ubin was fully exposed to the freshwater

outflow for weeks. Mass mortality of sessile and sedentary osmotic-conforming species was observed and many species such as carpet anemones, sea stars and sea cucumbers, unable to regulate the osmotic concentration of their body fluids against the lowered salinity, literally burst open as the less saline water infused their body cavities. The intertidal flat was scattered with the fragmented remains of these species.

Investigations showed that recovery was good within a year after the event. Many species that suffered the mass kill had reappeared in abundance. At the same time, some species, which were not common before, became more abundant. These findings indicated that biodiversity can generally recover as environmental conditions revert to normal but long-term changes in the community structure are inevitable as indicated by the new appearance of the invasive Asian mussel, Musculista senhousia, a native of northern Southeast Asia that has spread to Singapore, Australia, New Zealand, the United States and the Mediterranean. In Singapore, Musculista senhousia established only in degraded habitats and its opportunistic colonization of Chek Jawa after the excessive rainfall in December 2007 demonstrated the potential of an invasive species to dominate a biodiversity-rich natural habitat following an abrupt environmental change and disrupt full recovery to the original community structure.

DISCUSSION

Climate change together with elevated sea surface temperature and ocean acidification are looming threats to the region's marine biodiversity. It will test the resilience of marine ecosystems, which are already compromised by intense anthropogenic pressure. The capacity of marine ecosystems to adapt to climate change impacts is severely undermined by present human demands that lead to excessive overexploitation, degradation, fragmentation and pollution. These pressures erode ecological integrity and depress ecosystem services.

Ecosystem resilience needs to be strengthened to minimise damage from climate change impacts (SCBD, 2010) and the immediate focus is the reduction of anthropogenic pressure and more efficient management of marine biodiversity. This is one of the great challenges facing the region, which has relied heavily on the services of marine ecosystems but not doing enough to maintain sustainability.

A sensible investment is to improve efforts at increasing the resiliency of ecosystems. This can be done through better management that includes more effective protection and restoration of degraded habitats such as seagrass, mangroves and coral reefs. There is much scope for research into reef restoration (Edwards & Gomez 2007) and many reef restoration techniques have been initiated (Chou et al., 2009). They include low cost approaches to hasten reef recovery from blast fishing where rubble stabilization and rock piles were found to encourage better coral recruitment and growth compared to scattered rubble. (Fox et al., 2005; Raymundo et al., 2007).

Against the gloomy outlook of habitat destruction are successful protection and rehabilitation measures at local levels (Tun et al., 2008) and demonstration sites on reversing degradation trends have been established under different regional projects such as the UNEP/GEF South China Sea project (UNEP 2004).

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The International Normative Socialization of Japan: Securing the Global Tuna Fishing Industry

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In March 2010, the United Nations Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which is an international agreement between governments aiming to preserve wild animals and plants engaged in international trade submitted a formal proposal seeking to ban international trade of the reportedly endangered Atlantic bluefin tuna and to have it included in the UN's list of endangered species. Although supported by the United States and Europe, this proposal was opposed chiefly, but not solely, by Japan which consumed 80% of the world's bluefin tuna catch from the Mediterranean and of the world's fresh-chilled yellowfin tuna supply. The votes having been cast in a secret ballot, the proposed ban did not prosper with 72 states disagreeing, 43 affirming, and 14 abstaining. However, in August 2013, the Japanese government expressed its intent to lead the worldwide effort of promoting the natural reproduction and recovery of the tuna species, stating that the state would reduce its tuna catches to mature ones by 15%. This paper would look into probable reasons behind the said normative change and, at the same time, explore the events which might have caused the continuous decrease in tuna catches and persistent hike in tuna prices in Japan. "Capture" (wild) and "aquaculture" (farmed) are the two types of fish production; note that only the former type was considered in this paper.

Possible Concurrence

According to Burchill et al. (2005), Habermas's communicative action theory proposes that one of the functions of international conventions is to facilitate deliberations where the state can explain and support its behavior. These deliberations help manage conflict and thereafter arrive at a resolution which reflects the interests of *all* concerned states. At the 2010 United Nations convention, Japan refused to adopt the proposed ban arguing that, contrary to the report submitted by CITES, the tuna species were not endangered and that the International Commission for the Conservation of Atlantic Tunas (ICCAT), and *not* CITES, should be managing the conservation measures on Atlantic bluefin tuna catches. ICCAT is an inter-governmental regulatory body that oversees the world's annual tuna catch.

Burchill et al. (2005), echoing Risse, affirmed that social institutions (international organizations) acquire higher legitimacy by holding international conventions. However, as Griffths et al. (2009) described, using Reus-Smit's view on the discursive nature of social institutions, only when the state recognizes the social institution as fair and just, and its proposed rules as ethical and moral, that the said social institution can successfully legitimize and implement new norms and rules. In this case, Japan, given its perception of CITES' identity, did not deem CITES as the authority that should be managing the Atlantic bluefin tuna, thereby disregarding the proposal.

As stated by Griffiths, Roach, and Solomon (2009), the state's consent necessary in the social institution's act of legitimizing new norms and rules can only be given if the said state can relate to the moral efficacy of the proposed norms and rules. In this case, it was probable that the domestic normative behavior compelled a continuing consciousness that Japan should maintain its custom of serving tuna recipes. This signalled to the Japanese state that it could not meet the terms of the proposal, hence the refusal to grant its consent.

A New Identity

Three years after declining the conservation measures proposed by CITES, the Japanese Fisheries Agency (*Suisancho*), the body responsible for the state's public and private fishing industries, expressed its desire to lead the international community in promoting the conservation of tuna species. The initial step undertaken by the Japanese government was to reduce its tuna catches to mature ones by 15%. On the other hand, the National Marine Fisheries Service of the United States responsible for regulating the state's offshore fishing declared that the United States would cut its tuna catches by 25%. Since 75% of the Pacific bluefin tuna catches were consumed by Japan, and the United States was one of the major bluefin tuna catchers, these proposed conservation measures could then contribute to the recuperation of the endangered tuna species.

Constructivism proposes that state identity and interest are constantly changing; and the state acts or behaves depending on its identity and interest. As Weber (2009) argued, the state's identity is "contentious," "unstable," and "conflictual." Wendt, cited in Weber (2009), argued that the state constructs its identity in conformity with the relationships it has with other states; the constructed state identity then defines the state interest. If the state identity is not constant, then neither are the state interest and state behavior. Particularly, social constructivism looks at "the construction and regulative influence of international norms" (Griffiths et al., 2009, p. 134). In this case, Japan decided to take on a new state identity: from being the leading tuna catcher and consumer to wanting to be the leading state in promoting conservation measures on the endangered tuna species. This change in identity could have been brought about by the persistent protests by international tuna fisheries management organizations such as the Western and Central Pacific Fisheries Commission (WCPFC) and CITES, conservation groups such as Greenpeace International and World Wildlife Fund (WWF), and other fishing states like the United States and the United Kingdom, to limit its tuna catches. Japan, acting on its newly formed interest to conserve the depleting tuna stocks, had adopted conservation measures limiting its tuna catches.

A Perception of Civilization

As previously stated, international tuna fisheries management organizations, together with conservation groups, had been lobbying Japan to limit its tuna catches and participate in the total banning of the endangered tuna species from the international trade. This, among other possible reasons (*infra*), influenced Japan in finally limiting its tuna catches and aiming for the recovery of the depleting tuna stocks.

As Hobson (2003) asserted, implying Finnemore's first level of the international structure – the normative structure, various international norms constitute the normative structure of the international society; these international norms which are always perceived to be appropriate and benevolent influence or socialize the state to act in accordance with behavioral patterns which are consequently perceived appropriate. When the state behaves properly by complying with international norms, it is then to be perceived as civilized.

Hobson (2003) further interpreted Finnemore's second level of the international structure as "surface structure" which involves international non-state actors and international organizations. These international organizations are "norm carriers" and in so being take the responsibility of informing or reminding the state how to behave appropriately. In this case, Japan had finally given in to the protests of the international organizations as regards the conservation of the tuna species by limiting its tuna catches and in so doing redeemed itself as a civilized state. The United States' statement that it would also limit its tuna catches, even beyond what Japan had set for itself, emphasized its being civilized as well; or perhaps it was trying to tell the international community that it was more civilized than Japan.

Burchill (2005) implied that since the civilized state has the tendency to feel superior to its neighboring states, it can find concluding negotiations or agreements with other states easier and more attainable. In this case, Japan might have felt superior to other states as regards tuna fishing and management, hence its proposal to lead all the other states in conserving tuna species. Moreover, though Japan's economic profit from its tuna industry would decrease and its custom of consuming tuna species would weaken as it implemented its conservation measures, its identity as the leading state in the global tuna industry and as a civilized state would be reinforced. Consequently, Japan would be perceived by other states as important and influential in concluding agreements and implementing conservation measures concerning tuna fishing. This perception of Japan by other states would entitle the former to forward its interests more conveniently through the agreements it would enter into. This, however, would not mean disregarding the interests of other states.

Paradigm Shift

Interpreting Bull's perspective on maintaining "order among all mankind" belonging to a "multicultural society of states," Burchill (2005) also supposed that the state, whenever possible, should always seize opportunities that can improve the international society. Japan's decision to finally comply with international norms as regards tuna fishing, and thereby implement its own conservation measures, would be important to improving the international society. As Goldstein (1999) affirmed, fishing states should cooperate to prevent depletion of fish stocks in international waters. The state's failure to cooperate does result in reducing the catches of all fishing states.

Hobson (2003) recalled that in 1945, a remarkable normative change was undertaken by Japan which also contributed to improving the international society. With respect to its foreign policy stance or external security posture, Japan undertook a major paradigm shift from being militaristic and imperialistic to being pacifist. Since then, Japan focused on strengthening its economic sector, making the state technologically and economically advanced. These two normative changes (becoming pacifist and aiming to be the leading tuna conservator) contributed to the worldwide effort of making the international society orderly and emphasized Japan's being civilized. Considering that Japan's decision to be pacifist eventually resulted in positive political and economical consequences on the state, its decision to comply with the international norms as regards tuna fishing might also likely bring in the same on the state in the long run.

Japan's decision to finally comply with international norms as regards tuna fishing also supported Hobson's interpretations of Finnemore's claims: (1) "international forces can shape national policy" or specifically that international organizations can lead the state to constructing policies guided by international norms of behavior, (2) the international norms of behavior adopted by the state "might either fail to enhance the power of a particular actor, or might even go against the actor's power-interests," and (3) "society not anarchy, is the source of constraining and permissive effects" (Hobson, 2003, pp. 151-153). In this case, the international tuna fisheries management organizations and conservation groups (international forces) influenced Japan to construct and implement conservation measures (national policy) on the endangered tuna species. These newly constructed conservation measures would certainly lessen Japan's tuna catches, affecting the state's economic profit from the tuna fishing industry and disturbing its custom of consuming tuna recipes. In other words, the newly constructed national policy of Japan as regards the conservation of the tuna species would diminish its economic power or hamper its power-interests. Japan's decision to conform to the norms established by the international society as regards tuna fishing would bring about *immediate* effects - economic and cultural constraints - on the state.

An Alternative

In November 2012, the Scottish Development International and the Scotland Food and Drink instigated a trade mission in Japan. Echoing the Scottish government's claim, Richard Lochhead, Scotland's Rural Affairs Secretary, confirmed that salmon was becoming the favored choice for *sushi* in Japan, replacing tuna. He added that Scottish seafood, particularly salmon, had an exceptional ability to attract the Japanese consumer. As further pointed out by Scott Landsburgh, a chief executive of Scottish Salmon Producers' Organization, Japan was becoming known as Scotland's major salmon importer and was consistently displaying great potential as such. It was thus possible that Japan decided in August 2013 to lead the international effort of conserving tuna species and conform to international norms as regards tuna fishing because it was confident that it could nevertheless sustain its custom of consuming *sushi* and *sashimi* with another type of specie that was salmon.

This particular booming economic relationship between Japan and Scotland would benefit both states: the cultural and economic value of consuming *sushi* and *sashimi* by the former would be sustained while the value of salmon exports of the latter would dramatically increase, bringing in huge economic opportunity to the state.

As stated earlier, there could also be other reasons or events which might have influenced Japan to commit to, and even lead, the worldwide effort to recover tuna stocks. Japan is globally recognized as the leading tuna catcher and consumer. If, as asserted by D'Anieri (2012), states possessing advanced weapons systems can secure their identity as advanced states, then Japan which uses the biggest and most advanced tuna catching fleets for its tuna fishing operations can secure its identity as the leading state in the tuna fishing industry. It is also widely known that the Japanese were the ones to introduce *sushi* and *sashimi* to the rest of the world. It is then to the best interests of Japan to value its tuna fishing industry and maintain the said custom. To pursue the said interests, the tuna fishing activities of Japan are not just limited to the use of boats, or ships, or fleets; it also uses spotter planes. Given that it needs to

satisfy the huge demand for tuna and that it has to operate through its advanced fishing technologies, one can just imagine how much fuel Japan needs to sustain its tuna fishing activities.

The Ripple Effect

In June 2008, Japan decided to suspend tuna fishing operations for the next two months due to the increasing cost of fuel triggered by the political chaos in oil-producing countries. This suspension was likewise implemented by China, South Korea, and Taiwan. The chief oil for fishing fleets is called the A fuel. The table below shows how the cost of the said fuel surged from 2003 to 2008.

The A fuel per kiloliter	
Cost in Yen	Year
39,000	2003
69,000	2007
105,000	2008

Shimbun, Yomiuri. "Rising fuel costs cut down tuna fishing." *The Spokesman-Review*. June 29, 2008.

Espejo (2008) reported that Japan initially planned to halt the operations of 20% of its 20,000 tuna catching vessels; however, the said plan was only implemented on 1% or 233 of these tuna catching vessels in August, a month later than the schedule. The said suspension contributed to the international effort of recovering stocks populations of the endangered, highly valued marine resources. Since there was a decrease in tuna catches, Japan resorted to raising the prices of bigeye and yellowfin tuna. With the huge demand on tuna, Japan also had to multiply import. Espejo (2008) further asserted that the Philippines from which Japan was a major importer radically increased its prices of yellowfin tuna.

A Will for a Way

Other factors could have also influenced Japan's decision to suspend tuna fishing, or at least lessen tuna catches. As reported by Foster (2013), although the proposal of CITES in March 2010 which was to ban international trade of Atlantic bluefin tuna was rejected, the said organization was able to successfully impose quotas on tuna catches for conservation purposes. Noting the efficiency of the adopted conservation measure, Masanori Miyahara, the deputy director-general of the Japanese Fisheries Agency, stated that there had been more than a quarter of reduction of juvenile catches. In 2011, Japan also complied with the conservation measures adopted by the WCPFC by limiting its tuna fishing vessels operating on the high seas. The WCPFC ensures the long-term conservation and management of highly-migratory fish stocks in the Western and Central Pacific Ocean – the region which produces 50% of the global tuna catch on an annual basis.

Tainted Waters

In March 2011, when tsunami and earthquake struck Japan, the Fukushima Dai-Ichi nuclear plant situated northeast of Tokyo and operated by Tokyo Electric Power Co. Inc. (TEPCO) was significantly devastated, becoming the world's worst nuclear accident following the Chernobyl disaster which happened at the Chernobyl Nuclear Power Plant in Ukraine on April 26, 1986. Radioactive particles and radiation leaks had been reported to be polluting North Asia, streaming into the Pacific Ocean. As reported by Pesek (2013), radioactive elements were subsequently found in bluefin tuna, causing the public to be suspicious of food safety and quality, thus limiting catches of the said tuna specie.

In Demand

No one can deny that *hon-maguro,* or the business of catching bluefin tuna in Japan, is indeed a very rewarding industry. As mentioned earlier, though Japan conducts its own tuna fishing operations, it still finds the need to import from other countries such as the Philippines. Tuna products in the Philippines are categorized into four quality grades:

Philippine Tuna Quality Grades	Exported/Sold To
Sashimi grade	Osaka/Narita, Japan Seattle/Los Angeles, USA
Manila grade	refined hotels in the Philippines
Davao grade	Filipino tuna traders/sellers
General Santos grade (leftover tuna)	General Santos City folks

In 2012, a kilo of *sashimi* grade tuna sold at the General Santos City Fishing Port Complex cost US$10; however, when the same was exported to and sold in Japan, it cost US$1,160. According to Espejo (2012), there was even an auction held in Tokyo where tuna cost US$2,480 per kilo. Harvey (2013) asserted that in January 2013, a bluefin tuna was sold at an auction in Japan for more than US$10,000, followed by a report a week after stating that the bluefin tuna stocks in the Northern Pacific Ocean had declined by more than 96%. Also, Foster (2013) affirmed that in February 2013, a mature bluefin tuna was sold at US$22,000 at Tokyo's Tsukiji fish market. While these incidents could prove the continued demand for tuna despite its near extinction, they could also emphasize the domestic cultural value of tuna in Japan. Foster (2013) added that in the same period, Masayuki Komatsu, a former senior official of the Japanese Fisheries Agency, affirmed that Japan, being concerned about profit and culture, could not fulfil its international responsibility to conscientiously conserve tuna species – the endangered bluefin tuna could still be seen on *sushi* bars' menu. Mr. Komatsu further revealed that the government itself, through the help of media, withheld the information regarding the depletion of tuna species and thus denied public awareness thereof.

Both tuna suppliers and consumers can barely explain how tuna prices have soared that much. As previously mentioned however, the catch limits imposed by CITES, the two-year ban on tuna fishing on Pacific Commons 1 and 2 imposed by the WCPFC, and the increase in oil prices induced tuna suppliers to impose towering prices. We may also speculate that the increase in tuna prices is an effect of the increasing global

demand for tuna, triggered by the changing diets of individuals most of whom are Chinese who now prefer fresh-chilled tuna, and by the inconsideration or ignorance of *sushi* bars with respect to tuna depletion.

On the Brink

The consistent drop in tuna catches signifies the alarming condition of tuna species; different conservationist groups and international conventions held by international organizations have been asserting that tuna species are nearly extinct. The forthcoming extinction of tuna species may be strongly attributed to the use of industrial fishing techniques such as fishing down and pelagic longline fishing, consumer behavior, poor implementation of conservation measures, overfishing, and global warming.

According to the National Geographic article entitled "Overfishing," as early as 2003, industrial fishing had already decreased the population of large ocean fish to 10% of their unscathed population. Fishing down is one of the industrial fishing techniques being practiced today which damages the seabed and destroys the balance of the biological system of the seas. Pelagic longline fishing is specifically designed to catch swordfish and yellowfin tuna; fishermen deploy onto the open seas long strings of baited hooks supported by buoys. Dolphins, turtles, and bluefin tuna are usually some of the bycatch of the said fishing method. The increasing bluefin tuna bycatch has caused the National Oceanic and Atmospheric Administration (NOAA) to restrict fishermen from loading the said tuna species, dead or alive, on their catching vessels. The NOAA disclosed that in 2012, because of pelagic longline fishing, 239.5 metric tons or about a quarter of the annual catch of the United States was a bycatch of bluefin tuna, indicating a 70% increase from that of the previous year.

According to Satran (2013), illegal fishing and bycatch are two of the main threats to the conservation measures adopted by international tuna fisheries management organizations such as CITES and the WCPFC.

Overfishing is the state of catching marine resources, consuming them before they can even reproduce. It had caused the incessant drop of catch volume of mature yellowfin tuna: 33, 369 metric tons in 2007 to 9, 061.13 metric tons in 2011. According to marine scientists, it was in 1989 when the world's annual fish catch reached 90 million tons and since that time, the fish stocks have never recovered and even further declined.

According to Hood (2010), Tudela of WWF Spain stated, "Japan has the key, and the means to convince fishing countries to accept the necessary conservation measures." Lubchenco of the US National Oceanic and Atmospheric Administration confirmed Japan's influence on the present challenges of the international community concerning the conservation of the endangered tuna species saying, "Japan has an absolutely critical role to play." In August 2013, as Japan finally disclosed to the international community its interest to conserve the endangered tuna species, granted that it would efficiently implement the conservation measures it had constructed and act upon the role it had claimed to execute, positive and favorable changes concerning the conservation of valued tuna species would not be far behind.

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A Novel Catalyst for Treatment of Textile Wastewater by Ozonation

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Abstract

Textile industry employs large quantities of water for processing. Considering the volume and composition, textile wastewater is thought to be the most polluting wastewater among all industrial sectors. Through environmental concerns and regulations, growing pressure is being placed on textile plant to reduce the volume and improve the reuse percentage of the wastewater. Ozonation is an effective pre-treatment before the wastewater were further purified in reverse osmosis or ultrafiltration system for reuse. However, the cost for ozone is not at an acceptable level currently for the textile plants. In this paper, a novel catalyst was fabricated for ozonation of wastewater to improve the utilization rate of ozone and treatment efficiency, so as to reduce the cost incurred from ozone assumption. Commercial reactive dyestuff that frequently used in cotton dyeing was adopted in this study as the target pollutants. The performance of the catalyst in ozonation of colored wastewater was evaluated in varied conditions. Color removal and COD reduction were two main targets to assess the treatment results of the polluted water containing dyestuff. The results implied that the catalyst prepared was capable to improve the degradation percentage of dyestuff in wastewater, providing an economical solution for degradation of pollutants in effluents from textile dyeing plant for reuse.

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1. Introduction
In recent years, numerous dye sources release to wastewater, causing a danger to the environment, animals and human beings (Gosavi, Sharma, 2014). In order to afford the inexpensive and efficient technologies for the dye removal from wastewater, a series of works including chemical, electrochemical, and biological treatment were used to purify the wastewater containing dyes. However, most of them are of low efficiency and limited due to high cost in operation.

Ozone has been used for sewage purification because of its environmentally friendly property and strong oxidizing ability. However, only limited mineralization level was achieved by ozonation alone in textile effluents due to the low oxidation efficiency and selectivity. Catalytic ozonation is considered to be a promising technology for removal of organic dyes in aqueous solution. Various supported metals and metal oxides are the most common catalysts that have been tested in the ozonation of dye compounds (Martins, Quinta-Ferreira, 2014). Among the studied support materials, porous carbon materials are usually chosen as promising substrate.

We have obtained optimum results on preparation techniques and performance improvement for various carbon materials (Shang et al., 2013, Shang et al., 2009) and composite materials (Shang et al., 2009a, Shang et al., 2011, Shang et al., 2012, Yang et al., 2010, Zhang et al., 2012) in our previous study. In the present manuscript we intend to develop a novel efficient catalyst by using highly dispersed copper oxide on mesoporous carbon aerogel (MCA) for catalytic ozonation of dye wastewater. The work aimed at (a) synthesis and characterization of copper oxide/mesoporous carbon aerogel catalyst; (b) compare the degradation efficiency of C.I. Reactive Blue 19 (RB 19) in different processes; and (c) investigate the degradation efficiency of four common dyes having different chemical structures in water by catalytic ozonation.

2. Material And Methods
2.1. Dyes and Chemicals
Reactive dyes were obtained from Zhejiang Longsheng Group Co., Ltd, China and used without further purification. The dyes were dried at 378 K for 3 h before use. The experimental solutions (800 mg/L) were prepared by dissolving accurately weighed 1.600 g of different dye in 2 L volumetric flask. All Chemicals used in the catalyst preparation were of analytical grade.

2.2. Preparation of Catalyst
In the present study, resorcinol, formaldehyde, water, and surfactant were mixed according to predetermined recipes to fabricate supporting material as literature described (Wu et al., 2008). The mixture was transferred into a glass bottle and put into an oven at 85 °C for 120 h. The sample were then stored at room temperature for 2 d, and further dried at 60 $^\circ$C for 24 h, followed by drying at 105 $^\circ$C for 3 h and finally calcined 1173 K for 3 h under Argon gas flow. Then, the prepared sample was added into 0.2 M $Cu(NO_3)_2 \cdot 3H_2O$ aqueous solution and the mixture was loaded into the water-bath shaker at 30 $^\circ$C for 24 h subsequently. After the impregnation, the sample was dried at 105 $^\circ$C for 3 h and finally calcined at 450 $^\circ$C for 4 h. The patter of X-ray diffraction was obtained with a diffractometer (Rigaku, SmartLab) using Cu Kα radiation. The microstructures and morphology of the prepared catalyst was investigated using TEM (JEOL Model JEM-2100F) operated at 200 kV.

2.3. Ozonation Procedure

Ozone gas was introduced by ozone generator (Medozons BM-02, Russia) and the gas fed into a porous glass diffuser to produce fine bubbles in the bottom of the glass reactor. 400 mL dye solution was fed into the 0.5 L glass reactor in each run. The experiment was timed when the stirring and ozone gas supply were started. At predetermined time intervals, 5 mL reaction solution was carefully withdrawn from the glass reactor using a digital micropipette. The solution obtained was centrifuged at 6000 rpm for 10 min in a centrifuge (K3 Centurion Scientific Ltd, UK) to remove traces of catalyst. All treated solutions were diluted and determined by a UV-VIS Spectrophotometer (Perkin-Elmer, Lambda 18) at the maximum wavelength. The treated dye solutions were digested in COD reactor (Model DRB 200, HACH, USA) and then analyzed by COD colorimeter (Model DR 900, HACH, USA).

3. Results And Discussions
3.1. Characterization of Prepared Catalyst
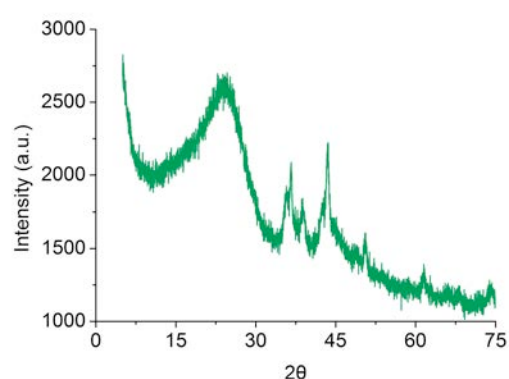
Figure 1: X-ray diffraction pattern of copper oxide/MCA

Powder x-ray diffraction pattern of copper oxide /MCA is shown in Figure 1. As it can be seen, the synthesized copper oxide /MCA catalyst are mainly exists as CuO and Cu_2O. The copper oxide /MCA catalyst only display partial peaks due to the low metal oxide concentration and small copper oxide particles in the MCA support.
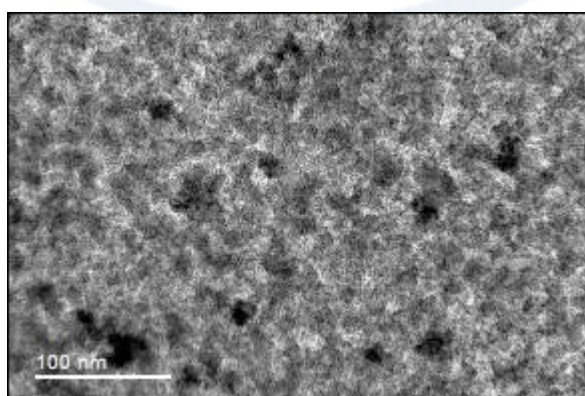
Figure 2: TEM of prepared copper oxide/MCA

TEM image was used to detect the shape and size of the copper oxide. As seen in Figure 2, the solid phase is composed of nanosized copper oxide particles (about 10 nm) and carbon nano-particles (20 to 30 nm).

3.2. Decolorization of RB 19 in the Different Processes

The color removal of ozonation alone, pure adsorption of copper oxide /MCA, and copper oxide /MCA catalytic ozonation under the same condition were compared to explore the behavior of the copper oxide /MCA in the process of dye degradation. It was clear that the decolorization of RB 19 (Figure 3) was improved with increasing the treating time in both the systems of ozonation alone and catalytic ozonation in the first 60 minutes, of which the difference was not significant. Under the same experimental conditions, the color removal rate of RB 19 only obtaintd 2.5% by the adsorption on the copper oxide/MCA catalyst surface. Therefore, the lower color removal rate can be ignored in this study. These data implied that the catalyst prepared won't adsorb dyes but has little effect on decolorisation.
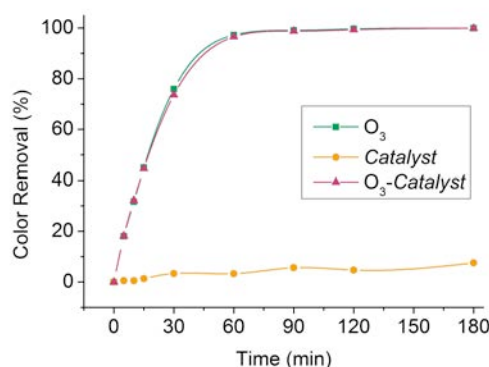
Figure 3: Comparison of the decoloration ratio of RB 19
(Temperature: 30 ^{o}C, Ozone: 4.0 mg/min, Catalyst: 1 g)

3.3 Removal of COD in the Different Processes

Dyes cannot be oxidized instantaneously to carbon dioxide and water in the degradation process and the oxidation pathway presumably proceeds via a number of intermediate species.
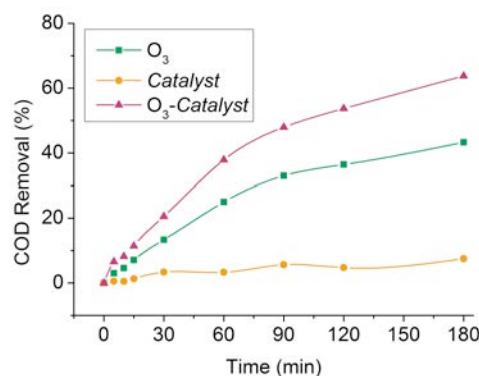
Figure 4: Comparison of the COD removal of RB 19
(Temperature: 30 ^{o}C, Initial COD: 625, Ozone: 4.0 mg/min, Catalyst: 1 g)

Thus COD removal of the three different processes including ozonation alone, adsorption of copper oxide/MCA catalyst and catalytic ozonation were also investigated. The results are shown in Figure 4. It was suggested that the degradation degree of RB 19 was drastically enhanced by copper oxide /MCA catalyst. It also can be seen that the COD removal rate was much less than color removal rate at the same conditions by comparing Figure 3 and Figure 4.

3.4. Catalytic Ozonation of Various Dyes

In order to examined the feasibility of the novel catalyst in treatment of some synthetic dyes having different chemical structures, we attempted to choose four dyes that belonging to the most representative classes such as RB 5 (C.I. Reactive Black 5), RB 19 (C.I. Reactive Blue 19), RR 239 (C.I. Reactive Red 239) and RY 176 (C.I. Reactive Yellow 176) as degradation targets.
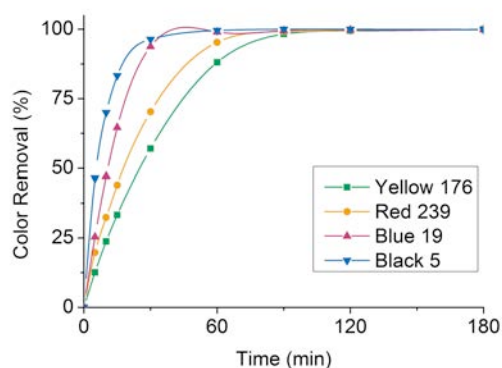
Figure 5: Comparison of the decoloration ratio of different dyes
(Temperature: 30 $^{\circ}$C, Ozone: 4.0 mg/min, Catalyst: 1 g)
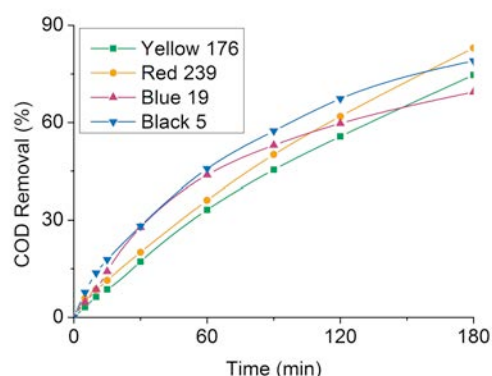
Figure 6: Comparison of the COD removal of different dyes
(Temperature: 30 $^{\circ}$C, Initial COD: 625 (RB 19), 720 (RB 19), 396 (RY 176), 420 (RR 239), Ozone: 4.0 mg/min, Catalyst: 1 g)

All selected syhthtic dyes are commonly used in dyeing processes of cotton and cellulose substrates. The results are shown in Figure 5 and Figure 6. It can be observed that the catalytic ozonation is effective for decolorization of all dyes, with color removal rates reaching 99% after 90 min treatment under the selected conditions. The COD removal rate of four dyes could reach 69%~83% at 180 min. The novel copper oxide/MCA catalyst has a good prospects of application in treatment of dye pollutants in wastewater.

4. Conclusion

The novel copper oxide/MCA catalyst has been successfully prepared and characterized by XRD and TEM. The results demonstrated that the copper oxide nano-particles were well-dispersed in the mesoporous carbon support. This research also showed that the prepared catalyst was a good candidate for catalytic ozonation of dye and the degradation degree of the dye solution notably enhanced by the combination of copper oxide/MCA with ozone. This investigation opens new perspectives in ozonation of textile wastewater with high efficiency for wastewater purification.

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Discussions on Photovoltaic Power Conditioners
Installed in Veranda of Apartment Houses

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Abstract
Various types of utility-interactive photovoltaic power generations including domestic applications have been presented and widely accepted in a society. A lot of innovative researches about power converters that interface between photovoltaic arrays and ac utility system have been also discussed. The actual application style of such solar panels is almost ones on top of the roof of detached house. However, some residents living in the apartment house are having a fairly strong desire to install the PV panel and contribute for natural energy generation. In order to give a reply, a simple and concise photovoltaic power conditioner installed in verandas of apartment house is presented. Considering fairly reduced generated power and narrow space to install, the system constructions should be more simple and concise. In this paper, the system construction which gratifies their wishes is introduced. These PV system can be easily connected like usual home electric appliances by attached plug For reverse power flows and increasing harmonics, their protection circuits might be provided on the input power line. System construction and system performance are presented and discussed.

iafor

1. Introduction

It is an important assignment for humanity to make efforts for conquering the problems against environmental conservation, resource and energy, with keeping the developments of economy, science and technology,. This background is outlined by Hu etc. (1994) [1]. The usage of the renewable energies is expected to be able to mitigate these problems. Among them, photovoltaic power generation system has various advantages like usage of inexhaustible and unpolluted sunlight. This is advantageous for easy maintenance and construction from small power to large one, and also can be installed in various location even in city center. Thus, this power generation system is a promising one with bright future.

As an utilization form, utility interactive power generation system has been accepted and widely applied. In such power generation system, it is necessary to install the chopper, in which the lower voltage of solar cell should be boosted to suitable voltage and inverter, by which the dc power of boosted voltage should be converted to ac power of the power system.

Various innovative PCSs, power conditioners including inverter and the like have been presented by many authors such as Takahashi etc. (1991) [2]. It is said that, however, it should be reduced the cost even more. It is also said that the systems are approaching to an ideal ones as efficiency and the like, but present cost prevents to spread in a wide application.

In such discussions, there are many subjects to be solved to utilize the PV power in utility interactive power generation form. Even more, various safeguard equipments required for regulations make the cost increase [3], [4]. Thus, it is required to obtain even more low cost PCS. In such extremely small capacity PCS as discussed in this paper, a way of handling would be different compared to usual power ones. In such case of reduced generating power, quantities of reversed power to the power system would be much reduced, where another mitigated regulation or deregulation would be required. Thus, in such photovoltaic power generation systems, there are so many subjects to be resolved.

Under such states accepted by electrical utility industry as recognitions and assessments for renewable energy, spread of application is strongly sustained by financial supports of public organizations. As a result, the number of consumers hoping to install such PV power generation system are increasing gradually. For financial supports, however, installation of solar panel is restricted to house having roof.

From these situations, there are alao many residents living in the apartment house who wish to install the PV panel. In the present state, however, there is no scheme to perform these requirements subject to such residents. System construction and system performance are presented and discussed in this paper.

2. Circuit Configuration

Fig.1 shows the proposed conversion scheme which converts the power from solar cells to ac utility system.

The particularity of the scheme lies in that a full-wave rectified waveform is supplied from the dc side and converted into sinusoidal current by an interactive inverter which is controlled in-phase with the utility voltage.

The dc power in the primary circuit is converted to the secondary circuit by a forward converter with a single switching device of high performance. Consequently, a dc power flow into the ac utility system due to abnormality can be prevented by the insulating transformer. It is essential that there should be no dc power-flow from the solar array to the ac utility system. Moreover, the output voltage can be easily boosted by varying the turn ratio of the transformer.

When the main switch Q_m turns on, the current flows through the primary winding 1. In the secondary winding, the current flows through winding 2, diode D_2, inductor L_O, and IGBTs-Q_1, Q_2 or Q_3, Q_4 in accordance with the polarity of the ac utility voltage.
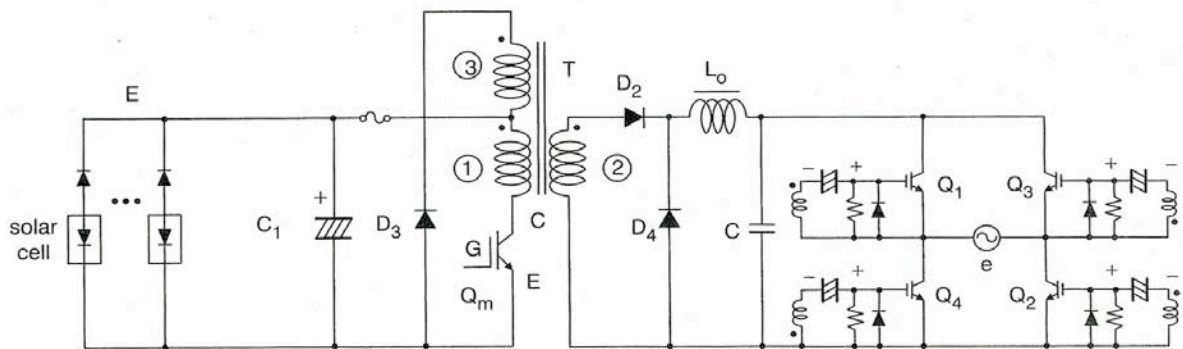
Fig..1. PCS constructed in forward converter.
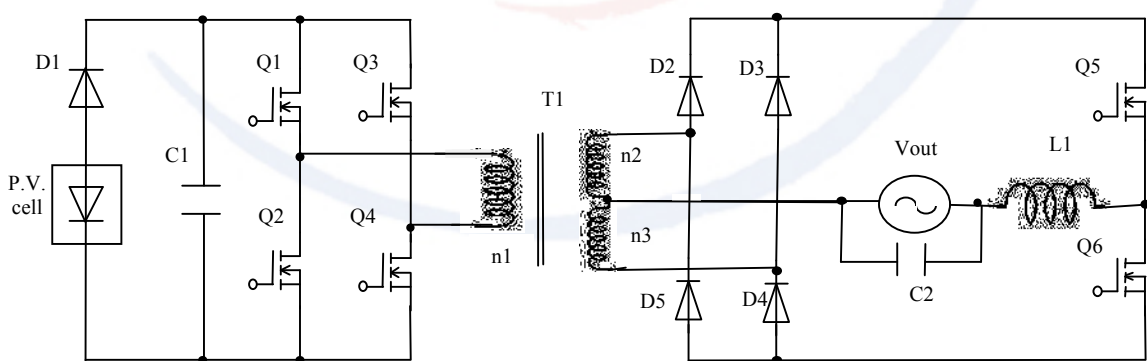
Fig.2. PCS constructed in center-tapped converter.
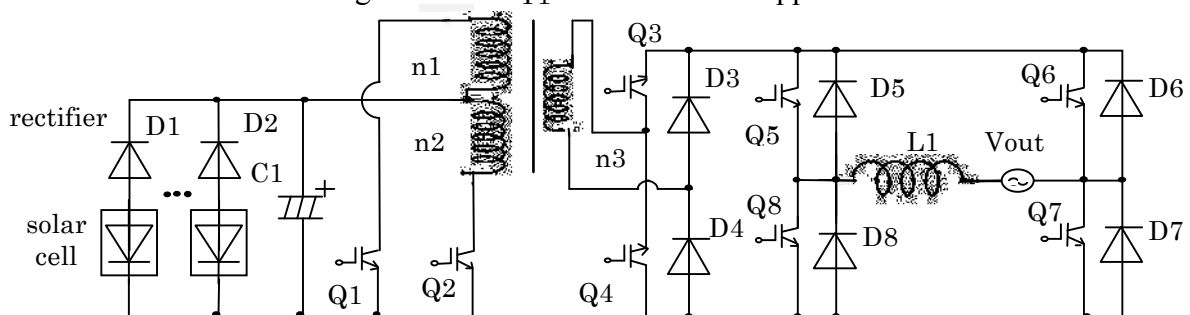
Fig.3. PCS constructed in center-tapped converter.

When Q_m turns off, the current by the magnetic energy stored in the filter inductor L_O flows into the ac utility through the free wheel diode D_4 and the corresponding inverter legs. The winding 3 performs a role to discharge the energy in the core during the switching-off period.

The wave shaping method for output sinusoidal one is performed by main switch Q_m. The output bridge circuit of Q1-Q4 is operated in lower commercial frequency. This system is reported as utility-interactive power conditioner of 3kW, whose efficiency is fairly large in 92 %.[1] In this PV panel in veranda, however, the capacity is fairly reduced like three or four hundred watts, so the significant effect for efficiency might not be expected. But, because of small power, it is important to improve the efficiency effectively. By means of using single high frequency switch with hifh performance, improvement for efficiency could be expected. Actually, application could be realized to 3kW utility interactive power conditioner. The remaining four switches are constituted in lower frequency and lower voltage drop switches, so the efficiency could be more improved in this portiont.

The almost all compact dc-dc power supplies are constituted by forward converters, so this construction knowhow could be available in easy way. The proposed veranda solar power is 200W per unit and the like, so this converter application to the veranda solar is promising. The only week point is that the high voltage in double is applied across the main switch at turning-off period. Thus, the protection circuit like snubber is necessary.

Fig.2 shows center-tapped converter proposed by Takahashi etc.(1995), which is developed from [1] but another original result can be obtained as compact 200W power conditioner.

Fig.3 shows PCS having center tapped converter proposed by one of the author and Naruse etc.(1999), which operates as 1kW PV power generation. This PCS has double main switches compared to above mentioned forward converter having single switch, where the size of transformer is reduced in half and magnetizing current is also reduced. By means of this, circuit efficiency can be increased.
Bridge circuit of the output operates lower commercial frequency. Transistors in the secondary winding can be replaced by diode bridge, but the output bridge connected to power system must be operate in an high frequency for sinusoidal wave shaping.

Fig.4 and Fig.5 show schematic diagrams for forward converter type power conditioner and center tapped type power conditioner, respectively. Each circuit shows characteristic of operations, in which the proposed upper circuit described splendid feature that is operated with no dc power flow due to inter-mediate transformer and no dc boost chopper. Instead of these, in a case of lower case of circuit, it is necessary to install boost chopper and dc power detector to prevent the dc power flow.

Fig.6 shows MPPT and charge controller. The proposed circuit construction is more simple because of single feedback signal instead of double one. These three schematic diagram represent that each construction becomes very concise and simple.
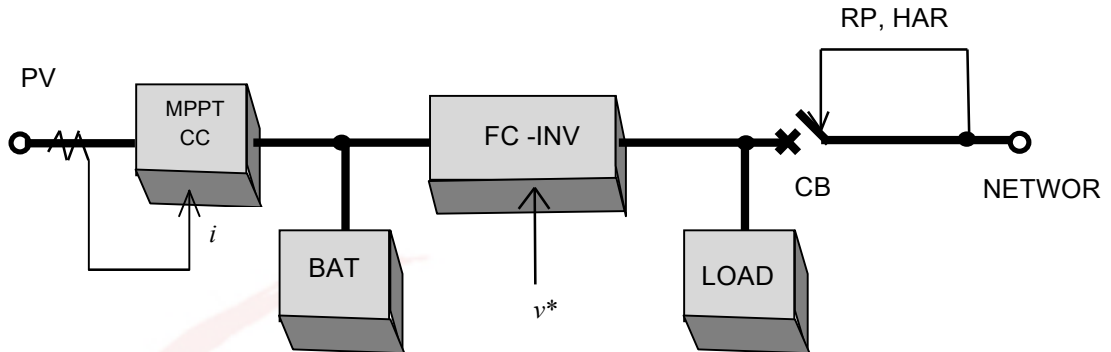
Fig.4. PCS constructed in forward converter.
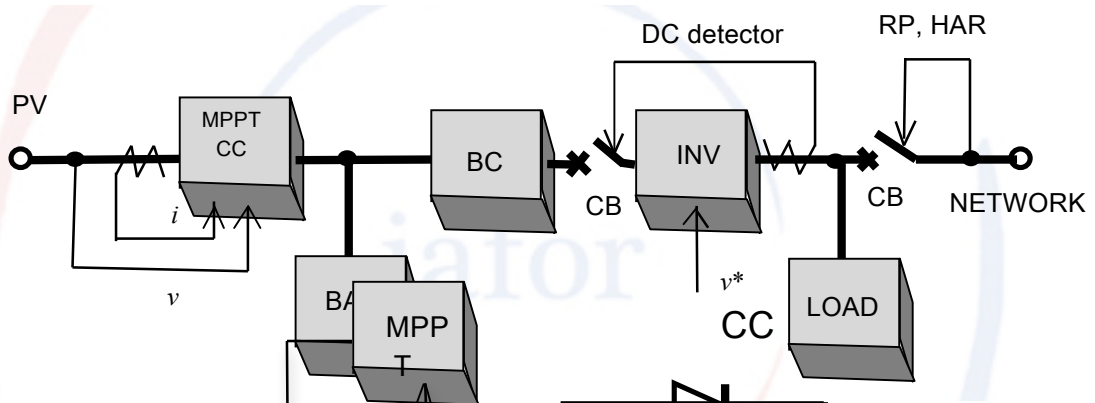
Fig.5. PCS constructed in Boost Chopper.
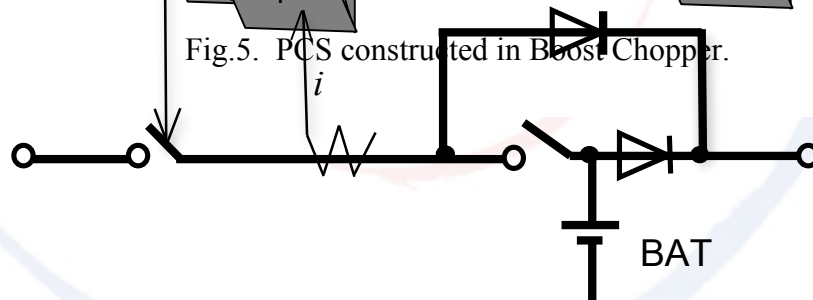
Fig.6. MPPT and Charge Controller.

INV: Inverter, RP: Reverse Power Flow Detector
HAR: Harmonic Detector, CB: Circuit Breaker, CC: Charge Controller
MPPT: Maximum Power Point Tracker, BC: Boost Chopper
FC: Forward Converter

3. Maximum Power Point Tracker

There are so many strategies to take the electric power more efficiently out of the solar battery. One of these is a mountain climbing method which is often used as control theories for the conventional PV power generation. It makes the operating

point of the solar battery oscillate artificially by the microcomputer in order to pursuit the maximum power point.

In this conventional control theory, however, the operating point always fluctuates around the maximum point. Therefore, it is insufficient to make operate effectively. In order to solve these problems, the control theory should be modified efficiently.

The proposed control theory in this paper can be realized by application of simple electronic circuits, which distinguishes a sign of each differentiation of the output power P and output voltage V of the solar battery. It always makes an operating point keep at the maximum power point as following.

The proposed control theory will be explained by the P-V characteristic curve in Fig.7. A sign of each differentiation such as dP/dt and dV/dt is examined when a certain operating point is varied on the characteristic curve. If the operating point moves towards I, differentiation of P and V becomes $dV/dt<0$ and $dP/dt<0$, respectively. On the other hand, if the operating point moves towards II, differentiation of P and V becomes $dV/dt>0$ and $dP/dt>0$, respectively.

In other words, even if the operating point moves toward either direction in the section i, the differentiation of P and V always becomes the same sign each other. Then, the product of dV/dt and dP/dt always becomes positive sign, that is $(dV/dt)*(dP/dt)>0$. Secondly, let us explain a case where the operating point is in the section ii. In this section, the product becomes always negative, that is $(dV/dt)*(dP/dt)<0$, even if the operating point moves towards either III or IV.

Accordingly, the output voltage V is made increased if the resultant value is positive in region i. The output voltage V is made reduced if value is negative in region ii. Consequently, the operating point can be kept staying at the maximum power point.
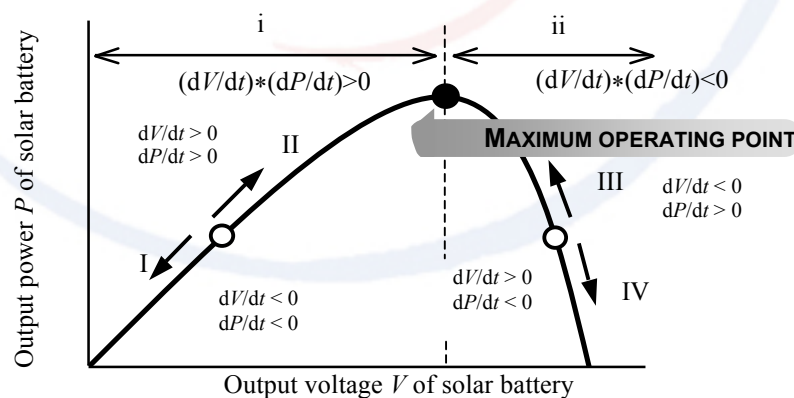
Fig.7.   P-V characteristic curve.

4. Actual Electronic Control Circuit

The output current I and the output voltage V of the solar battery are detected. Then, the output power P is calculated by the multiplier. This value and the output voltage V are transmitted to each differentiator. Then, dP/dt and dV/dt can be obtained after processing in differentiator. The product of dV/dt and dP/dt can be obtained by

another multiplier, whose output signal goes through the PI controller. In such a way, this control signal is given to the chopper circuit for the solar battery.

Fig.8. shows the control circuits to realize an inter-connection of such solar battery to the power system. This control circuit is operated according to the operation in Fig.7.

Solar voltage is replaced by the duty factor d of the chopper circuit, where the first stage is operated by chopper. The input voltage E_1 is inversely proportional to the duty factor. Namely when the duly factor increases, E decreases, and vice versa. Consequently, the detection of the output voltage and the calculation of the output power P become unnecessary. As previously mentioned, the maximum current can be obtained by controlling the output current.
The method by means of Exclusive-OR is the same way as usual. It can be seen that the control circuit shown is very simple. The distinctive point is that there is no need of the multiplier for detection of the power. This characteristic is a remarkable feature.
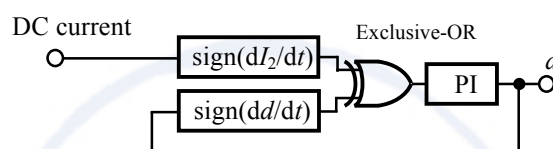
Fig.8. MPPT control circuit.

5. Circuit Configuration of Indoors Wiring
5.1. Method of Utilizing Existing Wiring
Fig.9 shows indoor wiring from PV panel to utility network. For PV panel installed in veranda, there are various types such as from board type panels (BTP) to flexible PV panels (FSP) which can be rolled up like a curtain. In BTP, PCS like a thin box is attached to reverse side of board. These are selected in accordance to installed location. For usual roof installation type, in the connection box, a group of diodes protecting the reverse current, handling switches to each line and circuit breaker of lines with double polar and dual element are installed. In this case, handling switch is operated manually, while circuit breaker is made turned off by over current automatically. In thin type PCS, manual switches and line circuit breakers are installed in PCS. In FSP, PCS could be attached to outer side of cylindrical box.

When the load is connected to the line from PV panel, it is necessary to avoid the large power load to this line. This line is used for important load with reduced power like at interruption. When emergency power supply for interruption is expected at night, it is necessary to install the battery as optional equipment. Because of minimum capacity of exclusive line for interruption, battery capacity could be reduced as a matter of course. Recently, domestic battery storage systems with small PV panel are put on the market and can be available. These equipments might be connected to this exclusive line. In this situation, it might be necessary to supply the battery for charge from the ordinary power system, but it would be the prospective one in a practical use. In such a way, the line from PV panel uses the existing one. In order to utilize as the emergency power supply, it is important to select appropriate apparatus carefully for interruption.

For example, the important apparatuses such as light equipment, PC for collecting information, charger for cellular phone and refrigerator to protect foods are connected to this line at interruption. For the conventional refrigerator, however, the large rush current flows at turned-on, so this PV power could not respond to such power. Thus, the inverter type refrigerator can be used which suppresses the rush current and mitigates the power flow. Consequently, the inverter type would be recommended.

For other lines except such PV one, the ordinal electric apparatuse is connected. Usually, the PV line and ordinary line are supplied in the same way. The large capacity air conditioner, cocking heater, washing machine and large capacity light should not connect such PV line.

The excess power from the exclusive line with PV panel can supply to the ordinary lines. Even though the generated power is small, the regulations are necessary where circuit breakers for reverse power flow and increased harmonic generation should be installed. However, in the power system, these detectors could be equipped simply. In such a way, for the circuit break against reverse power flow and increased harmonic generation, such quantities are merely detected in the power system, and the breaker is operated in the exclusive line. Consequently, the line is disconnected from the ordinary line that does not break from the power system. Thus, the PV line is supplied in succession.
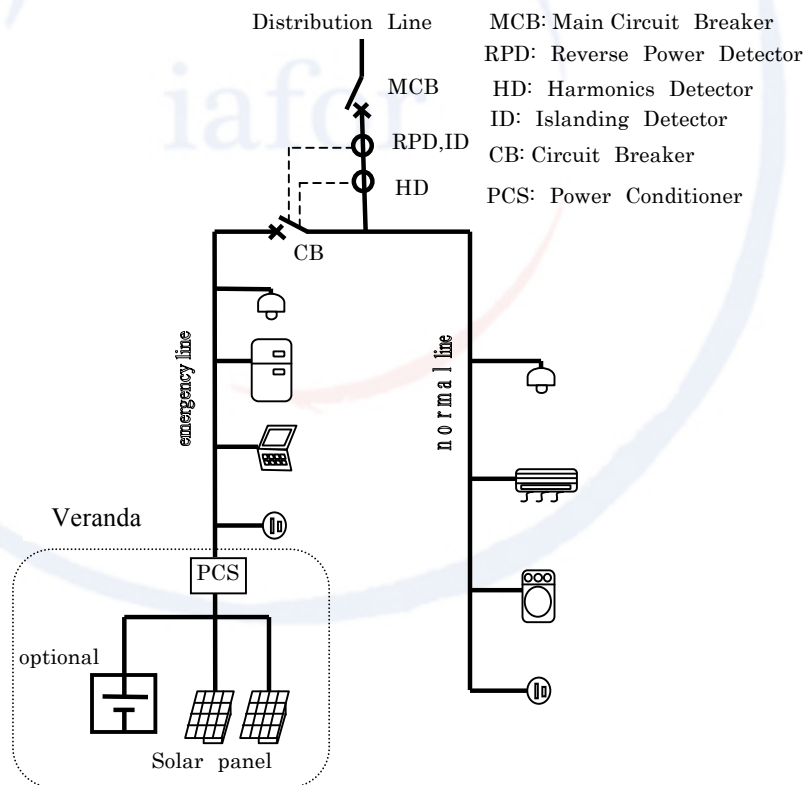
Fig.9.   Indoor wiring from PV panel to utility network

5.2. Method of New Construction for PV Line
In Fig.10, another line is placed for exclusive use from PV panel to the switch board. This line is turned-off from the power system when interruption at disaster and the like. However, the power from the PV is supplied to this exclusive line, from which

important loads are supplied even at interruption. When the circuit breaker is closed, that is turned-on, the ordinary load is supplied as usual, or excess power flows inversely to utility line if generates.

As compared to above mentioned method using existing line, the wiring route can be selected flexibly and placed to the necessitated room, so it is advantageous in effectiveness. In a case of wiring in the already built house, destroying the scenery would be worried. In newly-built, however, there is no problem of such concern, so it is advantageous in such situation.

5.3. Method by Placing Exclusive and Important Load Lines
Exclusive line and important load line are newly placing as shown in Fig.11. When the harmonics and the like generated from PV panel are detected, the exclusive line from the system is disconnected. Other ordinary line and important line for the interruption are supplied in succession.

In a case of interruption, the under voltage relay detects it and the improved loads at interruption are supplied from PV panel. The ordinary loads are disconnected. In an inconvenient of PV power, this line only is disconnected. The normal loads and important loads are not influenced. It is advantageous that the important loads can be supplied at interruption. However, it is necessary to place double lines as new built, so it is disadvantageous for additional installation for existing line.
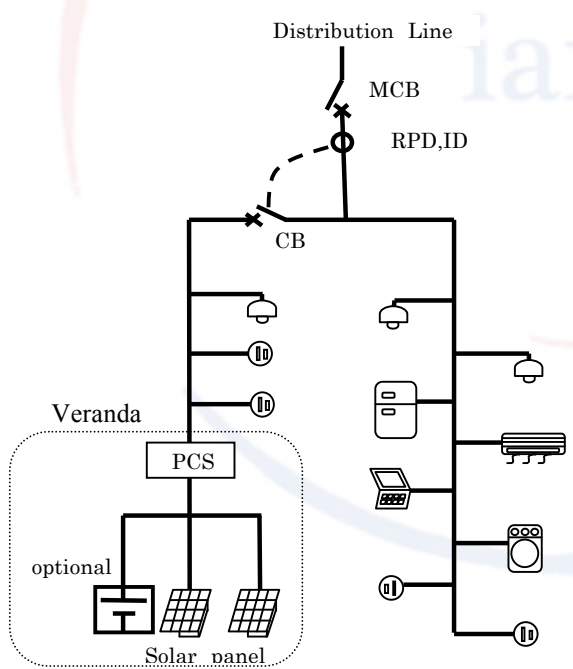
Fig.10. Circuit configuration of
veranda solar
(Method by new construction
for exclusive line)
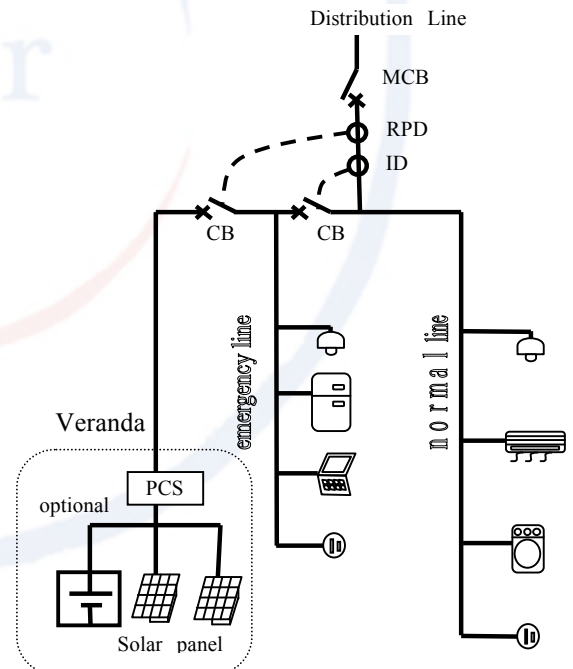
Fig.11. Circuit configuration of
veranda solar
(Method by placing exclusive line
and important load line)

Fig.12. shows one example of actual appearance in the veranda, where the solar panel in 200W can be winded up in the cylindrical storage box. The solar panel is constructed in flexible sheet form. At strong wind, long absence or another usage of veranda, the solar panel can be winded up in the storage box. According to the space

of veranda, another solar panel can be installed more. The panel is pushed out forward a little and curved outside as shown. By means of this situation, effective area for light receiving can be enlarged.
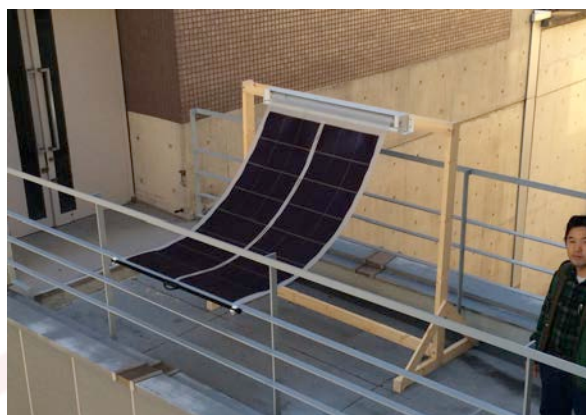
Fig.12. Actual appearance of the installed veranda solar.

7. Conclusions

In a perception of that improvement of environment is obligation for humanity, a lot of people are wishing to settle the PV panel. It is a truth that many residents living in apartment house not only have interesting, but also desire to install the PV panel.   An adequate scheme to be realized for residents living in the apartment house is discussed and proposed as an actual method of veranda solar.

In settlement at a narrow space like verandas, amounts of generating power is restricted, so even lower cost is required. If the PV panel is handled as like home apparatuses having attachment plug, the settlement cost can be much reduced. In addition, if the unified specification is introduced and the mass production is promoted, more reduced cost apparatus is supplied to the market such as compact power conditioner.

In a system interconnection, there are many problems coming from regulation, so it is an obligation to break the circuit when detecting reverse power flow or increased generation of harmonics. However, only by means of breaking the solar panel circuit from the power system, reverse power flow is prevented, so such regulation is not applied to such system. As a result, settlement of solar panel can be easily accepted. In a case of power selling, it is necessary to provide an additional power meter, and a new troublesome would arise regarding to the cost

In dealing with an interruption, the system cannot be used for uninterruptible power supply to all loads, but can be supplied to the selected important load. In a method of providing the exclusive line for interruption, this line is supplied even in normal time. In long term feeding for interruption, for instance, during night, it is necessary to provide a battery system, which is installed at primary side of transformer of power conditioner.

On the other hand, in roof top solar system, to make PV panel cost low is significant, but in veranda solar, to make power conditioner cost low is much significant. In this

paper, the forward converter type power conditioner is presented, which has only single switch that is high cost in high frequency. The other switches for inverter are in low operating frequency, low voltage drop and low cost ones. This proposed photovoltaic power conditioner system is suitable for comparably small capacity one.

Acknowledgement

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Water for Coal Production in Mongolia

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Abstract

Water resources of Mongolia are vulnerable because of low precipitation and melting permafrost by climate changes. Under the situation, its economy is rapidly growing and especially coal production has significantly increased by a rise in its exportation. At the same time, coal requires much water in the production process. For sustainable development of coal production, we analyze water requirement of coal production in Mongolia using a bottom-up approach. We found that 103 million m^3 of water, corresponding to 30% of industrial water withdrawal, is consumed to produce coal for 2013. Additionally, it reveals that impact to domestic water resources increased since the water requirement of 2013 rise to three times of 2007. Furthermore, 65 million m^3 of water is consumed to produce exported coals, so the importing countries indirectly use the water resources in Mongolia. Almost all exported coal (more than 99%) is shipped to China, but water is scarcer in China, whose water stress index (WSI; 0.478) is higher than Mongolia (0.053). Thus, by weighting with the WSIs, stress-weighted water requirements for coal production to export from Mongolia to China estimated as 3 million m^3 in Mongolia, while the value is 31 million m^3 in the case of China. The result suggests that Mongolia may contribute to mitigate water scarcity in China by exportation of its coal.

Keywords: Water-energy nexus, coal mining, Mongolia, water footprint analysis

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Introduction

Water resources of Mongolia (the Mongolian People's Republic) are vulnerable because of low precipitation and melting permafrost by climate changes (Wu et al., 2012a; Wu et al., 2012b; Wu et al., 2013). At the same time, Mongolia has rapid economic growth and the annual GDP growth ratio recorded at 25% in 2010 (NSOM, 2011). Especially mining, whose annual growth ratio was 40% for 2010 (NSOM, 2011), has a great contribution to the economic growth. Especially coal production based on gross output, which shares 22% of industrial gross outputs, sharply increased by 115% from the previous year (NSOM, 2011). However, coal production requires much water for mining, beneficiation, delivery and so on (Gleick, 1994). Thus it is important to produce coal under the limitation of vulnerable water resources, for sustainable development in Mongolia. Then we analyze water requirement of coal production in Mongolia. In this paper, we explain a methodology to calculate the water requirements with a summary of the related previous studies. Next, we show the results of water demands of the coal production. Furthermore we discuss the impacts to water resources by coal production.

Methodology
Description of Study Area

Mongolia is a country which has a land area of 1,564,116 km^2 in East Asia that located between Russia (Russian Federation) and China (the People's Republic of China). Mongolia has dry and cold climate, whose annual average temperature recorded from -3.3 to 5.5 degrees C, while annual mean precipitation was 87-324 mm in 2010 (NSOM, 2011). It is estimated that total renewable water resources are 34.8 billion m^3 and per capita has declined to 12,236 m^3/inhabit, 36% of that in 1962, by 2011 (FAO, 2013). 558 million m^3 of water is used for agriculture, industry and daily life (FAO, 2013). There are 2.8 million people and 63% of the people settle in urban areas (NSOM, 2011). The 2010 GDP was 8,255 billion Mongolian Tugrik (4,540 million US dollars) and 22% of that is produced by mining and quarrying sector (NSOM, 2011). 33% of the gross output of mining and quarrying sector is contributed by coal mining, whose gross outputs doubled for one year in 2010 (NSOM, 2011). 66% of coal is exported (NSOM, 2011).

Figure 1 Location of Mongolia

Water for Coal Production

Numerous studies have investigated water requirements to produce energy commodities, which can be categorized into three groups. First is water for bioenergy (Gerbens-Leenes et al., 2009a; Gerbens-Leenes et al., 2009b), whose feedstock production has a big contribution (Gheewala et al., 2011; Gheewala et al., 2013). Second is water for power generation, such as cooling water of thermal power plants (Sovacool, 2009; Sovacool and Sovacool, 2009a; Sovacool and Sovacool, 2009b) and evaporation from reservoirs for hydro power plants (Carrillo and Frei, 2009; Gerbens-Leenes et al., 2009a). Third is water for fossil fuels including coal (Carrillo and Frei, 2009; Gleick, 1994).

Coal production consumes water in the process of mining, beneficiation, slurry pipe control and other plant operation (Gleick, 1994). Water requirement of coal production is calculated by multiplying coal production by water use parameters (water requirements per coal production).

Mongolia, however, has no data of water requirements for the coal production processes. Thus we refers to the results of previous research, water consumption of 136-199 m^3 water /TJ, thus we adopt the average value (0.17 m^3 water/ GJ) (Okadera et al., 2014) for this study,.

Coal production is defined by a coal balance sheet (NSOM, 2011) and energy statistical data (NSOM, 2013) of Mongolia in the last 7 years (2007-2013). The original data are organized using a physical unit (thousand ton), so we convert it to an energy-based unit (GJ) assuming coal's calorific value 21,000 MJ/ ton coal. Finally we calculate water consumption of coal production by multiplying coal production and water intensity to produce coal (Okadera et al., 2014).

Results

In the last 7 years, water consumption of coal production has been increasing, and 103 million m^3 of water, corresponding to three times of the amount of 2007, is consumed to produce coal for 2013 (Figure 1). In 2009, the industrial water withdrawals are estimated as 238 million m^3 (FAO, 2012), thus it is considered that the coal production consumes water corresponding to 30% (51 million m^3) of industrial water withdrawal. Furthermore the water consumption sharply risen from 2010, thus it is considered that more than 30% of industrial water is consumed by coal production.
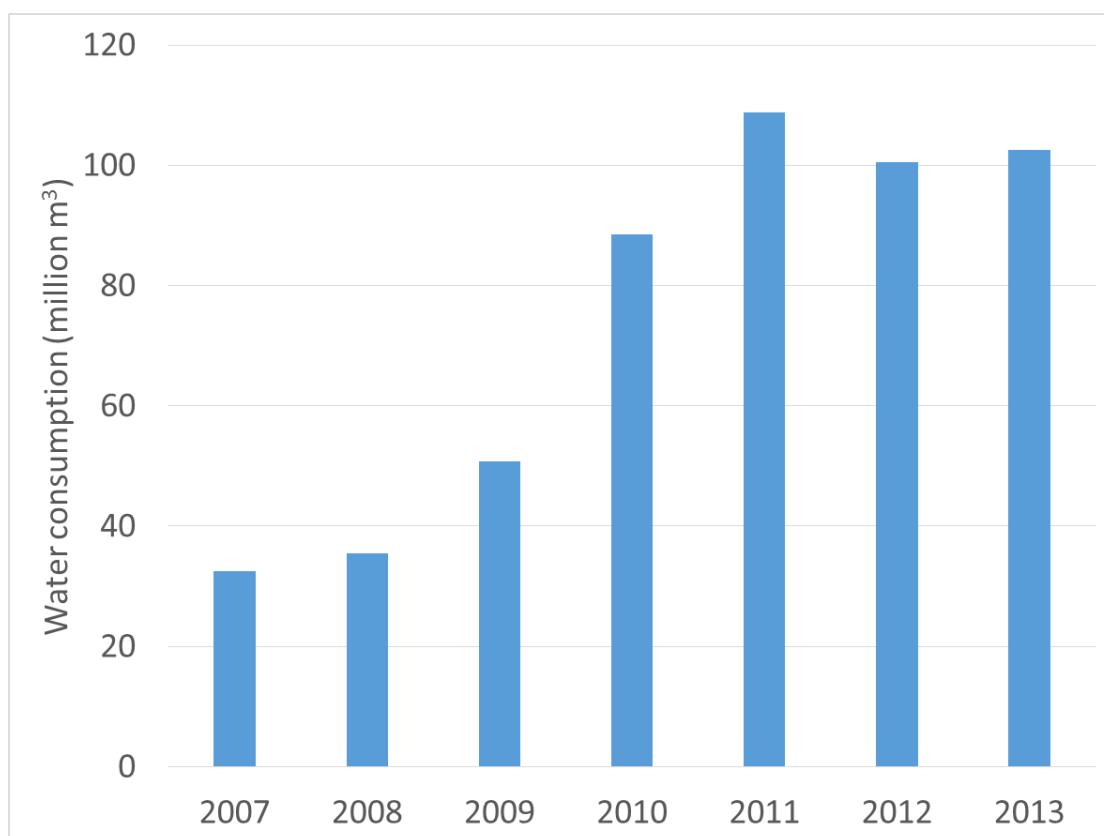
Figure 2 Water consumption for coal production in Mongolia

Discussions

Water for Exported Coal in Mongolia

In 2013, 63% of produced coal is exported (NSOM, 2013), so the importing countries indirectly use the water resources in Mongolia. Then, we estimate water consumption to produce the exported coal in the past 7 years by using data of exported coal in Mongolia (NSOM, 2011: 2013). Figure 2 shows that water amount for the exported coal. The water consumption has significantly risen since 2007 and in 2013 the value is six times larger than 2007, and it reveals that the growth ratio is double of the ratio of water consumption to coal production. At the same time, the percentage of water consumption for the exported coal in that of coal production also has increased. Then 63% of water to produce coal is consumed for exported coal currently whereas that of 2007 was recorded at 35%. Thus we found that the exported coal is a big contributor of water consumption for coal production in Mongolia.
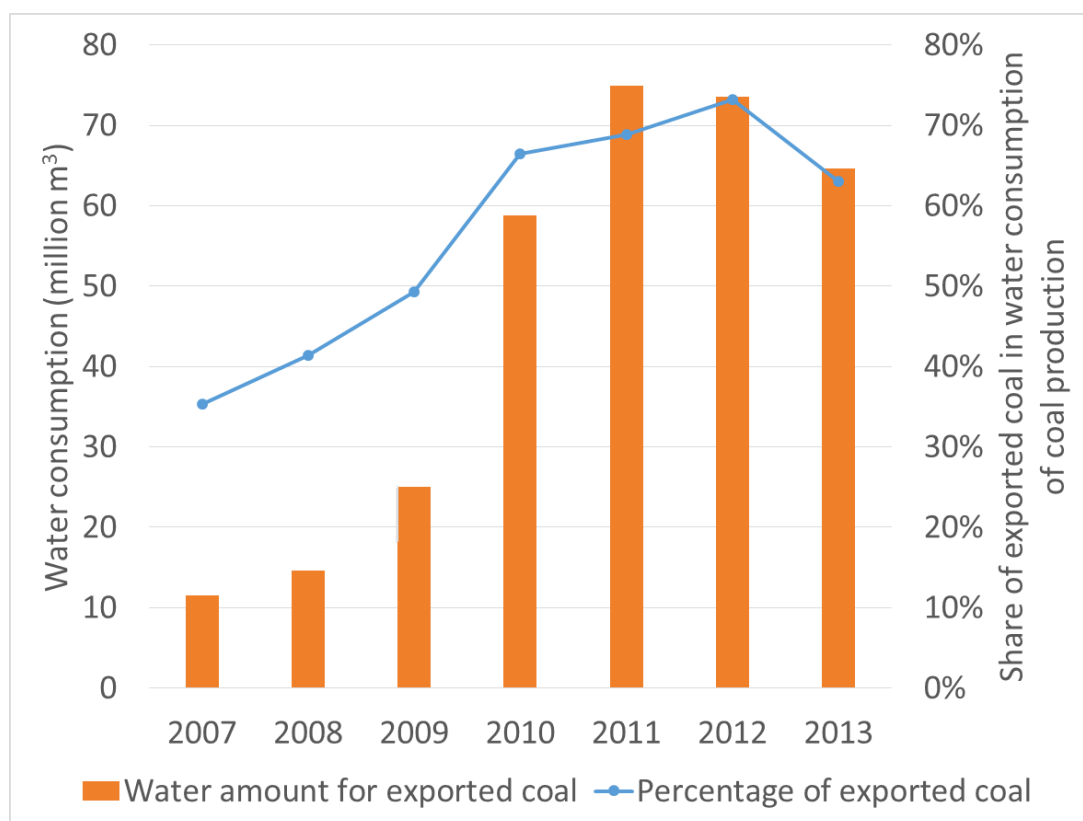
Figure 3 Water for exported coal in Mongolia

Environmental Implication of Coal Exporting System in Mongolia

The exported coal clearly has a big contribution, shown as Figure 2, to the water consumption for coal production in Mongolia. In addition, the coal is exported to China, United Kingdom, Russia, Germany and other countries from 2011 to 2013 (NSOM, 2013). With taking account of the current situation, we should consider the exporting system for an environmental implication, because water capacity differs by regions (Pfister and Hellweg, 2009). Indeed water stress indices (WSI) of the countries which Mongolia has exported from 2011 to 2013 are different by country (Pfister et al., 2009). Especially we focus on the exported coal to China from Mongolia because almost all exported coal is shipped to China (NSOM, 2013).

Then, we summarize the situation of water in Mongolia and China (Table 1). China has 2,526 billion m^3 of renewable water resources and the annual mean precipitation is in the range of 159-1,690 mm. Thus the water supply capacity is larger than Mongolia, whose renewable water resources are 34.8 and annual mean precipitation is 87-324 mm. On the other hand, per capita renewable water resources of China is estimated as 1,918 m^3/inhabit (MWR, 2008) while that of Mongolia accounts as 13,257 m^3/inhabit (FAO, 2013). Furthermore, WSI of China is estimated as 0.478 whereas that of Mongolia is 0.053 (Pfister et al., 2009). Therefore, it is considered that water resources in China are scarcer than Mongolia, although its water supply capacity is better than Mongolia.

Table 1 Water situation in Mongolia and China

	Mongolia	China
Annual mean precipitation (mm)	87-324[*]	159-1,690[**]
Renewable water resources (RWR; km^3)	34.8[#]	2,526[**]
Per capita RWR (m^3/inhabit)	13,257[#]	1,918[**]
Water stress index (WSI)[+]	0.053	0.478

Notes: *In 2010 (NSOM, 2011); ** In 2007 (MWR, 2008); # In 2007 (FAO, 2013); + Climate normal period 1961-1990 (Pfister et al., 2009)

The fact indicates that the impact to water scarcity by coal production in China is more serious than Mongolia. For taking account of the regional character for water scarcity, we apply a revised approach weighting with the WSIs of Mongolia and China (Ridoutt and Pfister, 2010) and calculate stress-weighted water consumption for coal production to export from Mongolia to China. As the results, the stress-weighted water consumption based on Mongolian WSI estimated as 612 to 3,993 thousand m^3 while the value based on Chinese WSI is 5.5 to 35.8 million m^3 in the last 7 years. The stress-weighted water consumption based on Chinese WSI is 4.9-31.8 million m^3 larger than that based on Mongolian WSI. The result suggests that China acquires coal without increasing domestic water stress by importing from Mongolia. Namely Mongolia contributes to mitigate water stress corresponding to in China by exportation of its coal.
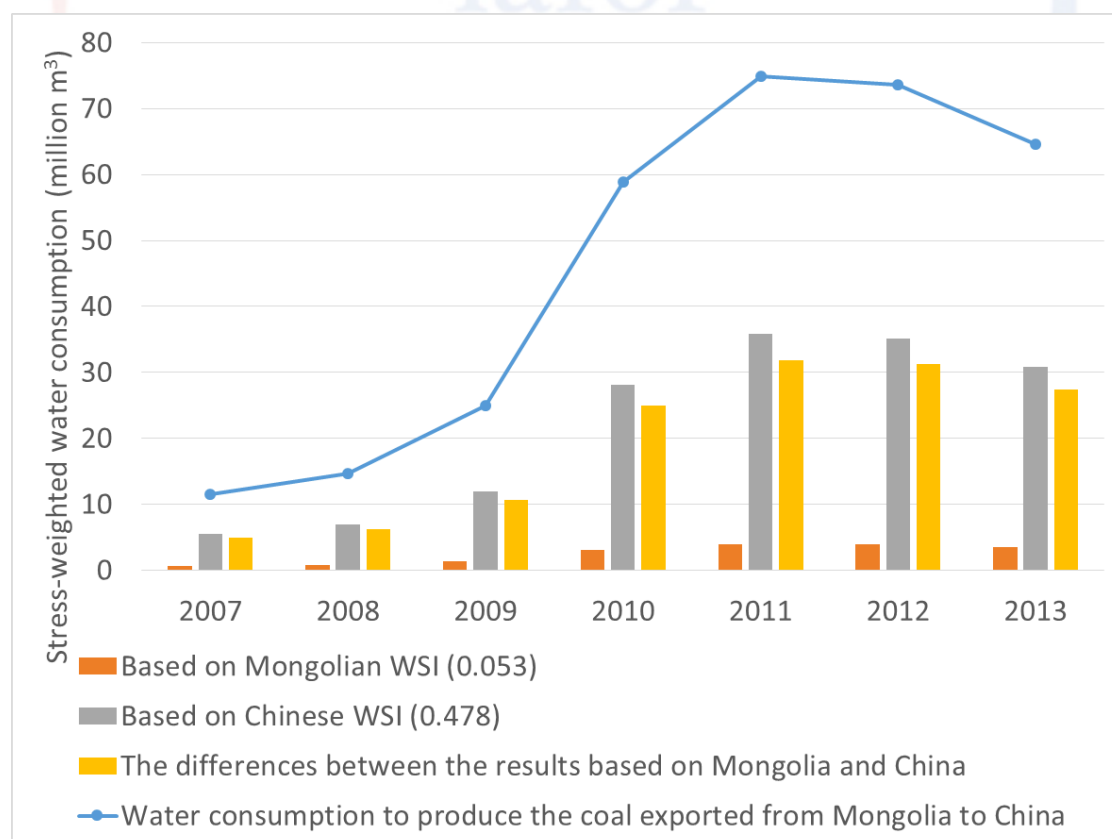
Figure 4 Stress-weighted water consumption of exported coal from Mongolia to China

Conclusion

Water consumption for coal production, which is one of the driving forces for economic growth in Mongolia, has significantly increased and it is considered that more than 30% of industrial water withdrawals of Mongolia are consumed by coal production at the present. Especially exported coals have a big contribution to water consumption of the coal production. Furthermore, we found that the exportation of coals brings a benefit to mitigate water scarcity in China because China can acquire coal without increasing water stress. Nevertheless, we guess that, value to avoid the water scarcity by exporting coal from Mongolia does not include a price of the exported coal. Thus it is important to estimate the value as a future task.

Acknowledgement

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Study on Local Participation in Payment for Environmental Services Program in Citarum Basin, West Java, Indonesia

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Abstract
Increasing literature reflects the significance of pro-poor aspects in payment for environmental services programs (PES) towards a more promising and workable program in regions like Asia. Although much effort is being made, pro-poor PES programs are still small and limited in many countries like Indonesia. More understanding particularly on the participation of the rural poor seems to be needed in order to advance and scale up programs that could generate greater impacts on the country. Different socioeconomic factors like income, and social networks are important determinants in participation, but their influences are not clear in many of the PES cases in Asia. Therefore, a comprehensive analysis on factors affecting participation in these kinds of programs, tinted with social goals like the inclusion of the poor, is necessary. This study seeks to clarify the influence of socioeconomic factors on farmers' participation in PES and their principal characteristics. Although, cash incentives seems to be an important determinant in participation, this is not the sole and most important factor as farmers concern for their environment and for non-financial aspects that enhance their community. This study also highlights the importance of social networks, which allow farmers to obtain relevant information to act together to address common environmental or social problems, as well as to participate and implement PES programs. On the other hand, weak social ties and networks due to farmers' poor situation tend to disadvantage the flow of information to activate synergies to participate in PES or other different activities in the community.

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Introduction

In Indonesia, agriculture system is very diverse due to its different demographic characteristics, where upland areas' major agricultural systems include intensive farming, among others. Depending how agriculture systems are managed, they can produce positive or negative externalities to the environment. In the case of the intensive vegetable upland farming, distributed on steep slopes with high chemical inputs, negative externalities are common, affecting flood control and water quality and quantity in the downstream areas due to soil erosion and sedimentation, and fertilizers' pollution. This system also affects environmental services like carbon sequestration, and biodiversity. It is well recognized that population pressure and poverty are important forces of overuse of steep land for agriculture, among others (Agus, & Manikmas, 2003).

Java is characterized by intensive farming systems; example of negative externalities due to such systems is found in the Citarum Basin, area characterized by its critical environmental degradation. This basin figures significantly in the overall concerns of watershed management in Indonesia. The upper area of the Citarum basin within the Bandung district is characterized by pervasive upland farming and harvest practices that lack adequate cover and protection from soil erosion. Upland farming expanded from 6,000 hectares (ha) in 1992 to 37,000 ha in 2001. This has come mostly at the expense of primary forests, which declined from 35,000 ha in 1992 to 19,000 ha in 2001, constituting more than 40% reduction. Meanwhile, urban settlements also expanded through the conversion of surrounding fields (ADB, 2007). In the last ten years, land conversion has reached almost 80% in the Citarum watershed, consequently intensifying land degradation problems, sedimentation, and water contamination, as well as increasing the frequency and severity of natural disasters, such as landslides and floods (LPM Equator, 2012; ADB, 2007; Munawir & Vermeulen, 2007).

Upland cropping system has been recognized as the system with the highest soil loss because of minimum soil protection by crops most of the year, compared to others systems as rubber plantations, agroforestry, paddy fields, shrubs and tea plantations (Agus & Manikmas, 2003). Data on erosion due to steep slope vegetable farming is abundant. In fact, erosion and sedimentation control, and flood mitigation have been central targets of the national re-greening and reforestation programs. However outcomes of these programs have fell below expectations. In the presence of ecosystem alterations that have triggered a series of negative impacts affecting human well-being, one option for environmental recovery in the basin is payment for environmental/ecosystem services (PES). PES is a market-approach instrument based on the principle of "beneficiary pays" rather than "polluter pays." The scheme consists of offering incentives, commonly cash payments, to farmers, landowners, or others entrusted, in return, with protecting or enhancing the ecosystem and thus providing an environmental service (ES). This promising tool for environmental conservation, expected to be more cost-effective than indirect financing approaches and accessible for multi-stakeholder participation (Kosoy, Martinez-Tuna, Muradian, & Martinez-Alier, 2007), has produced successful results in some Latin American countries, like Costa Rica. As a result, there is a growing interest in PES, evidenced through an increasing number of projects being implemented around the world. In Indonesia there are about eight recognizable PES programs nation wide, and two of them are located in the Citarum basin. Efforts towards understanding PES schemes in

the Asian region where programs are still small and limited are increasing.

PES have attracted substantial interest from the academia as well as from policymakers, as a mechanism for achieving conservation on private land (Engel et al., 2008; Wunder et al., 2008;). Literature in the environmental field emphasizes that "biodiversity and landscape are often more effectively approached on a scale greater than that of a single farm" (OECD, 2013,14), referring to synchronized measures to cooperate and act together in what is called collective action; as the bigger the engagement the bigger the impacts. However, the voluntary nature of PES schemes "means that the desired socially-efficient outcomes will depend on the sufficient enrollment of landowners in the relevant programs, and the fulfillment of their management requirements (Mulan & Kontoleon, 2012). This implies that it is necessary to understand the factors that determine landholders participation, while understanding who participates and why can facilitate program's design improvement.

This study seeks to clarify the influence of socioeconomic factors on farmers participation in PES and farmers' principal characteristics by answering what variables influence participation in PES? This study focuses on a first stage and necessary descriptive analysis based on primary data through a survey conducted in March, 2014. Survey included 30% of farmers' population, representing a total of 146 farmers, in addition to 25 PES farmer participants (of a total PES population of 35 members), for a total sample of 173 farmers. Further analysis is encouraged and to be continued by the authors.

Empirically based literature: determinants for participation in PES
There are diverse variables influencing participation in agri-environmental programs and in PES, which are being summarized in table 1. The review includes studies (Knowler & Bradshaw, 2007) based on quantitative approaches via logistic (logit) and probit regression from a total of 23 papers that seeks to explain farmers' adoption of particular agricultural innovations, and 5 papers based on participation in PES programs.

Table 1: Summary of variables influencing participation in
agri-environmental programs and in PES

About Farmer	About Farm	External Factors
− Age	− Land size	- Source of information (e.g.: other farmers, media)
− Education	− Management system	
− Off-farm income	− Farm title;	- Membership in organizations
− Debt levels	− Types of crops;	- Extension/technical assistance
− Access to information	− Expected price of their crop;	
− Assets	− Payments offered	
− Health	− Slope	
− Experience	− Distance to paved road	
− Gender	− Distance to market	
	− Available machinery	

Source: Knowler & Bradshaw, 2007; Mulan & Kontoleon, 2012; Zbinden & Lee, 2005; Arriagada, Sills, Pattanayak & Ferrarro, 2009; Ma, Swinton, Lupi & Jolejole, 2010; Jolejole, Swinton & Lupi 2009.

Studies regarding agricultural innovations and agri-environmental programs based on quantitative approach with samples ranging from 43 to 1425 landholders in various countries like United States (13 studies), Canada (3 studies), Latin America (Panama, Peru, Honduras)(3 studies), and Africa (Rwanda, Nigeria, Burkina Faso)(4 studies) generally show the following remarks in their findings:

- Financial viability is an important consideration and may limit interest and therefore participation.
- Other non-financial factors may be constraining further adoption, such as farmers' knowledge of conservation agriculture techniques or the availability of appropriate technologies.
- Social capital seems to be a more universally influential factor in conservation agriculture adoption. However due to limitation of the studies, they point towards further research into the influence of social capital.

Findings from studies focused on participation in PES programs also based on quantitative approach, present the following characteristics. A case study in China with small landholders involvement prove that participants tend to have higher incomes on average than non participants; participants also tend to have bigger land size (average 16 ha); and more remote villagers (distance from main road) are more likely to participate and to have more land enrolled. (Mulan & Kontoleon, 2012) On the other hand studies of PES conducted in Costa Rica demonstrate that none of the landowners participants depend on their farms to survive; legal issues also influence program participation (since land under PES is automatically protected by governmental organization which means that the property cannot be occupied by anyone); and people with high environmental awareness should be more inclined to participate, but interviews show that this is not important factor that influences participation (Arriagada, et al, 2009).

Costa Rica is a pioneer in PES among developing countries, which have provided important lessons regarding efficiency in PES programs to many Latin American countries like Mexico, Bolivia, and Brazil. However Costa Rica context is very distant from Asian realities, for example Zbinden & Lee (2005) describe that most participants hold a university degree, and were more likely to be urban-dwelling with an average income of US$ 1,000, owning land size ranged from 35 to 100ha.
As opposed to the Latin American context, the Asian region depicts rural areas characterized by high poverty ratio and high population density, where there is a large number of farmers working on small size land areas. The Indonesian context presents farm size for most farmers in Java ranging "from 0.2 to 0.5 ha while in the outer islands it ranges from 0.3 to 3 ha" (Agus, & Manikmas, 2003, 4), and other aspects that do not match the Latin American context.

On the other hand, studies regarding community-based environmental management grounded on qualitative approach emphasize on social variables rather than the opportunity cost highlighted in studies based on quantitative approach with the principal objectives on efficiency. Bodin and Crona (2009), and Bremer (2014) agree with social networks as important predicting and denominator factor in PES

participation, and in promoting sustainable development in PES programs. In some case studies, social networks were instrumental in people's awareness of and enrollment in PES. Other scholars like Lyon (2000) also emphasize the importance of social capital in resource management in a case study in Ghana. He shows that there is a wide range of circumstances where poor farmers develop cooperation or draw on existing networks, allowing them to enter into new markets and increase incomes. Boum, et al's (2008) work also shows social capital positive correlation with participation in community resource management (with the case study in India). Social Networks, generally referred as a set of links and ties among individuals or groups, and it is the most visible and clearly definable part of social capital, which along with norms and trust facilitate co-operation and co-ordination (Lyon, 2000). In the context of farmers communities, "social networks help farmers develop collective action, as well as to exchange information and leverage resources, as farmers are in favor of co-operating with their neighbors" (OECD, 2013, 12).

Different aspects influencing PES, whether financial or not, could be understand within the livelihood framework. Implementing hybrid forms of PES, like pro-poor PES particularly in Asia, implies limitations with the pure market approach, reason why different analytical lenses to look at PES are necessary. Muradian's (2013) argues that PES should be seen as an "incentive for collective action" (1155). PES has been presented as an alternative to traditional approaches, which has the potential to advance both conservation and rural livelihood development goals. Therefore, Hejnowicz, (2014) and other scholars point that it is necessary to jointly assess both environmental and social effects to ensure long-term PES validation and effectiveness. To this end, various papers use the sustainable livelihood approach (SLA) based on the capital framework.

The capital assets framework (SLA) that includes physical, natural, human, social and financial capital, has been used in diverse situations. Hejnowicz, et al, (2014) reviews 44 studies, which considered 23 PES programs. The main geographic focus was Latin America, which has historically been the main testing ground for PES. In general, studies assessed PES in terms of additionality (66%), livelihood sustainability (22%), and participation (20%). Hejnowicz emphasizes that the SLA may help reach an optimal balance between conservation and development outcomes. On the other hand, Leimona, (2011) studies about the livelihood impacts of PES in West Java, Indonesia; while McLennan, and Garvin (2012) uses SLA to evaluate landholders' access to livelihood resources. The latter findings point to the importance of locally tailored interventions that reach beyond the field of forest conservation and management. These would include interventions to strengthen rural peoples' access to resources needed to adapt livelihoods to changing socio-economic conditions.

Literature review implies that despite advances on the recognition on the importance of pro-poor or social aspects in Asia, there is no comprehensive analysis on the factors affecting participation (which may differs from Latin America and developed countries). Provision of practical lessons from case studies on PES participation is still insufficient, particularly in the Asian region. (Bremer, et al 2014). Petherama and Campbell (2010) also highlight that PES studies have been largely addressed by economic, political and ecological perspectives, which are indeed important given the dependence of PES on market forces, however more attention is also needed on social aspects like the perceptions and preferences of local participants about PES, and

characteristics and influence of different factors and actors. Furthermore, among different factors like education, income, social networks seems to be an important determinant in participation, but its influence is not clear in the case of PES in Indonesia and other Asian countries. Addressing such gaps in the literature would be essential to build up on current and increasing literature that intends to contribute to the knowledge and evidence that socio economic factors influence participation in PES programs in Asia and support the expansion/scale up of programs like the one in Indonesia.

Findings and Discussion
Research Site and PES Program

With the intention of improving water quality and watershed service for downstream users, the project identified as its main objective the reduction of erosion caused by agricultural farming in hilly areas. In terms of environmental conservation, shifting the land use to forests would be the most efficient way to reduce erosion. However, this is not a viable option due to the area's high population density and the role of agriculture as the inhabitants' main occupation; instead, the intercropping (agroforestry) of annual crops with trees was chosen. Suntenjaya village with an area of 4.55 km2, within the Lembang sub-district of the Bandung regency was deemed appropriate to address sedimentation and erosion problems and was selected for PES scheme development. The PES project was initiated through the support of an Indonesia NGO (LP3ES) known as the Institute for Social and Economic Research, Education and Information (In Indonesian: Lembaga Penelitian, Pendidikan dan Penerangan Ekonomi Sosial) initiated in 2009.

Income (part of financial capital)

Income regarded as one of the most important variables in most of the studies of participation in environmental programs, including PES, is also accounted in this study as an indicator of financial capital. Based on a descriptive analysis PES-participants may have a slightly higher income than non-participants. However the difference between the groups is not as significant as revealed in other studies. Further analysis is needed in order to understand how significant income is as a determinant for PES participation. Other indicators like assets, debts, savings and so forth part of the financial capital will also strengthen the view on the financial aspect. Following table 2 and plot box 1 illustrate part of the findings. PES participant' minimum household monthly income represents 450,000 Rupiah while Non-PES participant' minimum household monthly income represents 125,000 Rupiah, which is quite low. Although PES programs in Asia, considered as pro-poor program, suppose to encourage participation of the poor, the poorest of the poor may not be eligible due to their landless condition, and others. Regarding maximum monthly income, one PES participant's has a maximum of 10,000,000 Rupiah, which is considered high within their context; on the other hand, one Non-PES participant' has a maximum of 8,000,000 Rupiah, which is also a significant amount.

Table 2: monthly income of PES participants and non-participants
in Suntenjaya village

		PES participants	Non-PES
	Min	450,000	125,000
Monthly income (Rp.)	Max	10,000,000	8,000,000
	Avg	1,800,000	1,300,000

Plot box 1: monthly income of PES participants and non-participants
in Suntenjaya village
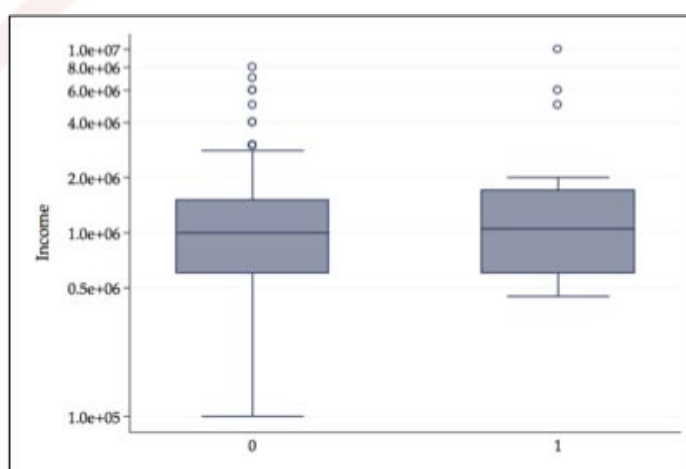
Social networks (part of social capital)
This variable reflects the highest difference between the two groups, in this study. PES participants value and perceive positive benefits from community interaction, like learning and sharing ideas and information about issues related to agriculture, to loans, to processing coffee, and others. High perceptions most likely lead to join social networks and facilitate collective action. For non-participants, their lower perception is related to their low experience in actually joining groups. Others factors may influence their perception, such as location of their homes, financial constraints, and others. Table 3 describes the results concerning social networks and perception about interaction within the community.

Table 3: social networks of PES participants and non-participants
in Suntenjaya village

	PES participants			Non-PES		
Involvement in associations	**%**	N°		**%**	N°	
	72%	18		**18%**	28	
Perceived benefit from interacting with the community	Yes	No	Little	Yes	No	Little
	72%	16%	12%	**58%**	38%	3%

Education and training (part of Human Capital)
Although income level should be co-related to education level, the following results show how PES participant whom tend to have a higher income also tend to have lower education level compared to non-participants. In terms of trainings, PES participants tend to have more trainings than non- participants. Types of trainings involve coffee grow from extension workers from local office, and other farming related issues. It might be assumed that extension workers would contribute to farmers' conservation knowledge, which might raise their environmental awareness. It was also emphasized from interviews that the head of farmer association and leader of PES have significant trainings. Many farmers stated that he is a trustworthy and capacitated person to lead the PES. Table 4 contrast both group of PES and non-PES participants where the majority's education level reach elementary school (above 80% of the sample in both groups).

Table 4: education and training of PES participants and non-participants in
Suntenjaya village

		PES participants	Non-PES
		%	%
	Elementary	**88%**	**82%**
Level of Education	Junior H.	**8%**	**14%**
	Senior H	**4%**	**3%**
	Bachelor	**0%**	**1%**
Training related to agriculture		**36%**	**20%**

In summary some characteristics of the two groups based on some variables suggested by empirical literature are presented in the next table 5. More variables are expected to be included in further analysis in order to build up a more comprehensive view concerning the characteristics of the two groups.

Table 5: characteristics of PES participants and non-participants in Suntenjaya village

Variables			PES participants	Non-PES
Farmer	Age	Min	22	27
		Max	86	76
		Average	51.5	45.6
	Level of education	Elementary	88%	82%
		Junior High School	8%	14%
		Senior High School	4%	3%
		Bachelor	0	1%
	Monthly Income	Min	450,000Rp	125,000Rp
		Max	10,000,000Rp	8,000,000Rp
		Average	1,800,000Rp	1,300,000Rp
	Social networks	Associations/groups	72%	18%
		Perceived benefits from interacting with community	72% (yes) 16% (no) 12% (little)	58% (yes) 38% (no) 3% (little)
Farm	Farm tittle		Community land (state owned)	
	Crop type		broccoli, potato, cabbage, tomato, cauliflower, banana, coffee	

Conclusion

Although cash seems to be an important incentive for participation in a rural area context where farmers have low income, this is not the sole and most important factor as farmers concern for their environment & consider their association as part of group members (non-financial aspect).

This study also highlights the importance of social networks, which allow farmers to obtain relevant information to act together to address common environmental or social problems, as well as to participate and implement PES programs. On the other hand, weak social networks tend to disadvantage the flow of information to activate synergies to participate in PES, or even consider further aspects like collective action.

As further steps: the first level of descriptive analysis allow us to see different signs that point toward the consideration of social variables in PES programs in Asia. More indicators of different capitals need to be included to strengthen the comprehensive analysis within the capital framework. Further analysis intends to cover a multiple regression based on survey's data and qualitative analysis based on interviews and group discussion.

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Heavy Metals Determination in Raw Milk Fed by Contaminated by Cow Feed

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Abstract
One of the key problems in lifestock, Central region, Thailand, was the toxic and heavy metals contaminations in animal feeds produced via harmful environment due to industrial estates. Cow's milk and dairy products are the important foodstuff and beneficial to human health. In this study metal contents in 84 of commercially available in cow's milk (powder and liquid) and dairy product (yoghurt and cheese), samples from different zones in central region were chosen. The heavy metals were determined by Inductively Coupled Plasma-Optical Emission Spectrometry. In accordance with the present survey and studies the amount and level metals has been specified in the cow's milk. Organic matter is digested with nitric acid and perchloric acid; the most suitable acids in wet digestion of milk and dairy products. Mean concentrations of metals ($\mu g/g$) in milk and dairy samples analyzed ranged between 0.028-0.061 for Cd, ND-0.89 for Pb, 0.72-0.91 for Cu and 3.1-12.91 for Fe. Results indicated high concentrations of Pb and Cd especially in powder milk samples. The lowest concentrations of metals were found in cheese followed by liquid milk. Finally, further investigations are needed to identify the cause of elevated Pb and Cd levels especially in milk and dairy products.

Keywords: metals, cow's milk, dairy products, Inductively Coupled Plasma-Optical Emission Spectrometry

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Introduction

One of the key problems in lifestock, Central region, Thailand, was the toxic and heavy metals contaminations in animal feeds produced via harmful environment due to industrial estates. Cow's milk and dairy products are the important foodstuff and beneficial to human health. Elements are essential micro-nutrients and have a variety of biochemical functions in all living organisms. Some of them form an integral part of several enzymes. Although they are essential, they can be toxic when taken in excess; both toxicity and necessity vary from element to element and from species to species. Thus, information on the intake of heavy metals through food chain is important in assessing risk to human health.

As trace metals, some minerals are essential to maintain the metabolic systems of the human body. However, at higher levels they can lead to poisoning. Some toxic elements are introduced into animals and human organisms through plants. The mammary glands are the most physiologically active part of dairy cows, and therefore the input and output of toxic elements in these organisms are clearly reflected in the milk. Monitoring the route of toxic elements in relation to the soil–fodder–milk pathway is important since the consequences of their activity have a great impact on both the environment and people' health [1].

Milk has been part of the human diet for millennia and is valued as a natural and traditional food. Milk and dairy foods are considered to be one of the main food groups important in a healthy balanced diet, and as such feature in the majority of national food-based dietary guidelines from the British Eatwell[2] and Australian plate model[3], to the Chinese Pagoda[4] and the Japanese Spinning top[5], the US pyramid[6], the Guatemalan pot[7]and many others. As milk provides a substantial amount of vitamins and minerals in relation to its energy content, it is considered a nutrient dense food[8].

Cows" milk provides a wide range of essential nutrients to the diet. Whilst milk as a source of calcium is often recognized, it is perhaps less commonly known that milk and milk products are also an important source of good quality protein, the B vitamins, B2 (riboflavin) and B12, and the minerals iodine, potassium and phosphorus[9]

Milk and dairy products make an important contribution to the supply of nutrients for the human diet. The ash of cow's milk contains some major elements such as calcium, phosphorus and magnesium, in addition to potassium, sodium and chlorine and a wide range of trace elements including zinc, copper, iron, manganese and iodine. Thus cow 's milk is an important source of protein, minerals and vitamins in the human diet. Thus, contamination of milk and dairy products by toxic metals can be a possible health risk to human population. The presence of toxic metals in the food chain is the result of environmental pollution and their concentrations need to be controlled constantly. The composition of the mineral fraction of milk and milk products has been frequently considered, but only a few published investigations deal with minor but only a few published investigations deal with minor in food.

Milk and dairy products become contaminated with heavy metals either through food stuff and water or through manufacturing and packaging processes[10-12] investigated the concentrations of Cd, Co, Cr, Cu, Mn, Ni, Pb, Se and Zn in cheese

samples packaged in plastic and tin containers. They found that there were considerable differences among of the studied element contents of cheese samples packaged in tin and plastic containers. They concluded that, cheese types and packaging materials play a key role in the content of trace metal

The present study aimed at evaluating the heavy metal quality of cow's milk (powder and liquid) and dairy product (yoghurt and white cheese), samples from different zones in central region were chosen. A total of 84 samples were analyzed after " Wet digestion" for four trace elements using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

Aim of Research

The aim of the present study is to heavy metals determination in Raw Milk Fed by contaminated by cow feed

Materials and Methods
Collection of samples

Samples of commercially available cow's milk (powder and liquid), dairy products (yoghurt and white cheese). Sample collection took place twice during 2013. The selection of dairy products was based on estimates on their potential consumption in Pathumtani Province. The samples were collected that they were high probability contamined by heavy metals. The collected white cheese samples were homogenized. White cheese and raw milk samples were kept in clear polyethylene cups. 200 g sample was taken from each product. All samples were stored below −18°C prior to analysis.

Reagents

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) standard solutions for Zn, Cd, Cu, and Pb were purchased from Fisher Scientific Company, USA. Working standard solutions were prepared by diluting the stock solution. Nitric acid and perchloric acid were all of AR quality. De-ionized water has been used when required.

Sample analysis

A microwave system was used for acid digestion of all the samples. All the samples (Milk and Dairy products) were dried at 100°C in a forced stove until dry weight. Thereafter, dry samples were ground to powder using a grinder with stainless steel knife, then stored in clean glass vials for later analysis. Approximately 1.0 g of milk, yogurt and 0.5 g of other dairy products samples were weighed into the TEFLON-vessels, mixed with 5 ml of HNO_3 plus 2 ml of $HClO_4$ and digested by microwave irradiation in steps, increasing power from 250 to 650 W by 5 min increments. Within 15 min, completely clear and colourless solutions were obtained which were subsequently diluted with double-distilled water. Samples were prepared in triplicate runs[13]. Finally, concentrations of Cu, Cd, Pb and Fe were measured using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES).

Results and Discussion

The range of linearity of concentration vs. absorbance curve is of great importance in determining the elemental concentration of the milk samples. The calibration curves for Zinc (Zn) and Cadmium (Cd) are shown in Fig. 1 and Copper (Cu) and Lead (Pb) are shown in Fig. 2
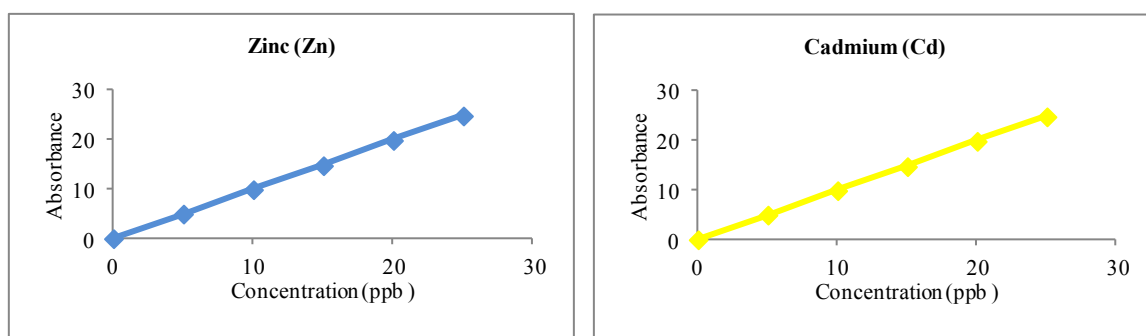
Fig. 1 Concentration versus absorbance curves for Zinc (Zn) and Cadmium (Cd)
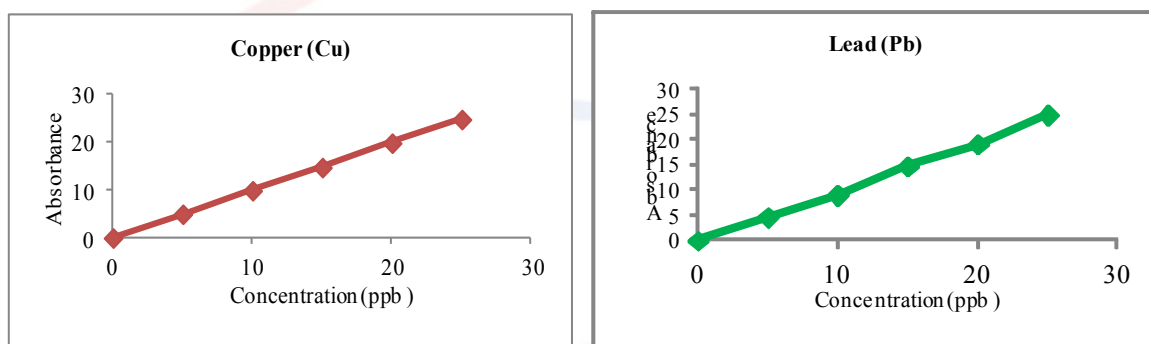
Fig. 2 Concentration versus absorbance curves for Copper (Cu) and Lead (Pb)

Table 1. Concentrations of metals (Means±S.D.) in powder milk consumed in Pathumtani Province. Minimum and maximum values are shown between brackets.

powder milk (pm. District)	Cd±S.D. µg/g	Pb±S.D. µg/g	Cu±S.D. µg/g	Fe±S.D. µg/g
pm.1	31.0 ± 0.0	0.81 ± 0.0	0.51 ± 2.0	18.1 ± 0.1
pm.2	45.0 ± 0.2	0.92 ± 0.2	0.53 ± 1.9	17.1 ± 0.2
pm.3	44.1 ± 0.5	0.74 ± 0.5	0.53 ± 2.1	18.2 ± 0.4
pm.4	32.0 ± 0.4	0.92 ± 0.4	0.43 ± 1.7	18.0 ± 0.0
pm.5	55.1 ± 0.6	0.25 ± 0.6	0.27 ± 1.7	17.0 ± 0.1
pm.6	35.1 ± 0.8	0.15 ± 0.8	0.41 ± 1.6	19.2 ± 1.0
pm.7	23.2 ± 0.4	0.28 ± 0.4	0.44 ± 1.7	17.1 ± 0.3

Metal contents of powder milk and liquid milk are summarized in Tables 1 and Tables 2. In all samples analyzed, concentrations of Fe were the highest and those of Cd were the lowest. Table 1 show metal concentrations in milk powder from 7 district. Cd and Fe levels indicated significant differences between district however ; Cu and Pb levels were similar in powder milk from 1 district. Mean Cd levels in powdered milk from 1 district was significantly higher those from other districts and mean Fe levels in powdered milk from 1 district was significantly higher than other districts. The mean levels of metals were: 14.04, 0.84, 0.53 and 19.1 µg/g for Fe, Pb,

Cu and Cd respectively. The high concentration of Fe is caused by the enrichment of powder milk with iron that is practiced by most companies. Lead concentrations in powder milk were found to exceed the maximum allowed limit for Pb in milk powder and cheese that was set as 0.19 µg/g. However, Cd concentrations were below the maximum allowed limit of 0.4 µg/g Cd in powder milk.

Table 2. Concentrations of metals (Means±S.D.) in liquid milk consumed in Pathumtani Province. Minimum and maximum values are shown between brackets.

Liquid milk (lm. District)	Cd±S.D. µg/g	Pb±S.D. µg/g	Cu±S.D. µg/g	Fe±S.D. µg/g
lm.1	29.0 ± 0.0	0.71 ± 0.1	0.21 ± 1.5	6.1± 0.3
lm.2	49.0 ± 0.5	0.72 ± 0.5	0.24 ± 1.2	5.1 ± 0.5
lm.3	57.1 ± 0.5	0.74 ± 0.5	0.21 ± 1.1	5.2 ± 0.6
lm.4	47.0 ± 0.1	0.72 ± 0.2	0.20 ± 1.2	5.0 ± 0.2
lm.5	33.1 ± 0.8	0.75 ± 0.4	0.17 ± 1.3	6.0 ± 0.2
lm.6	32.1 ± 0.5	0.75 ± 0.6	0.21 ± 1.2	6.2 ± 1.1
lm.7	31.2 ± 0.2	0.78 ± 0.2	0.16 ± 1.4	5.1 ± 0.8

Metal concentrations in liquid milk from 7 districts s are summarized in Table 2. No statistically significant differences between liquid milk of districts were observed for Cu, Pb and Fe. The only significant difference was observed for Cd concentrations, where liquid milk from 1 districts contained significantly higher Cd content (98.9 µg/g) than other districts. The mean concentrations of metals in different liquid milk samples were: 6.15, 0.71, 0.27 and 41.21 µg/g for Fe, Cu, Pb and Cd respectively. Levels of metals in liquid milk were having the following order: Fe>Cu>Pb>Cd and were less than those measured in powder milk. However, mean Pb and Cd concentrations in liquid milk exceed the maximum allowed limits of 0.04 and 0.02 µg/g for Pb and Cd in liquid milk respectively.

Table 3. Concentrations of metals (Means ± S.D.) in powder milk consumed in Pathumtani Province. Minimum and maximum values are shown between brackets.

yoghurt (yoghurt. District)	Cd±S.D. µg/g	Pb±S.D. µg/g	Cu±S.D. µg/g	Fe±S.D. µg/g
yoghurt.1	12.0 ± 0.0	0.31 ± 0.1	0.41 ± 1.5	4.2± 0.3
yoghur.2	14.0 ± 0.5	0.58 ± 0.5	0.24 ± 1.2	5.1 ± 0.5
yoghur.3	27.1 ± 0.5	0.42 ± 0.5	0.42 ± 1.1	6.2 ± 0.6
yoghur.4	11.0 ± 0.1	0.91 ± 0.2	0.29 ± 1.2	8.2 ± 0.2
yoghur.5	9.1 ± 0.8	0.27 ± 0.4	0.47 ± 1.3	4.2 ± 0.2
yoghur.6	12.1 ± 0.5	0.93 ± 0.6	0.54 ± 1.2	3.9 ± 1.1
yoghur.7	11.3 ± 0.2	0.88 ± 0.2	0.25 ± 1.4	4.1 ± 0.8

Concentrations of the four metals in yoghurt is shown in Table 3. No statistical differences in Cd, Pb and Fe concentrations were observed for yoghurt from all districts. Significant differences were observed for Cu concentration where yoghurt from all districts contained the highest level of Cu. According to their concentrations in yoghurt, metals were having the following order: Fe>Pb> Cu>Cd. This may be caused by the loss of some metals by the drainage process.

Table 4. Concentrations of metals (Means ± S.D.) in liquid milk consumed in Pathumtani Province. Minimum and maximum values are shown between brackets.

white cheese (white cheese. District)	Cd±S.D. μg/g	Pb±S.D. μg/g	Cu±S.D. μg/g	Fe±S.D. μg/g
white cheese.1	10.0 ± 0.0	0.21 ± 0.1	0.31 ± 1.5	3.1 ± 0.1
white cheese.2	9.0 ± 0.8	0.48 ± 0.6	0.14 ± 1.2	6.4 ± 0.5
white cheese.3	6.1 ± 0.5	0.32 ± 0.5	0.32 ± 1.1	4.2 ± 0.3
white cheese.4	8.0 ± 0.1	0.41 ± 0.1	0.21 ± 1.3	2.1 ± 0.4
white cheese.5	9.9 ± 0.5	0.29 ± 0.4	0.67 ± 1.3	5.3 ± 0.2
white cheese.6	14.1 ± 0.3	0.54 ± 0.4	0.41 ± 1.2	4.1 ± 0.1
white cheese.7	12.5 ± 0.1	0.89 ± 0.1	0.45 ± 1.4	3.8 ± 0.6

White cheese is the main and traditional form of cheese made and consumed in the Pathumtani Province. Results of elemental white cheese analysis from 7 all districts are summarized in Table 4. Generally, cheese is characterized by low concentrations of metals except Cu. Compared to all products analyzed in the present study, white cheese contained the lowest concentrations of Fe and Pb (below detection limits) and the second lowest Cd concentration.

Ranking biological samples according to metal concentration gives a clear idea about metal richness[14]. When ranked according to metal concentrations milk powder was found to have the highest total rank score and cheese the lowest. The 4 products examined had the following decreasing order in total rank score powder milk>yoghurt>liquid milk>white cheese. Milk is the raw material for all other dairy products and the final concentration of metals in any dairy product is affected by the concentration of metals in the milk used and the industrial processing. The results indicate that milk in the present study contains higher levels of metals than most other countries. This is obvious especially in the case of Pb. Although Palestine is not an industrialized country, leaded fuel is still largely used which might be one reason for the high Pb levels recorded. In addition, processing and packaging of milk and dairy products may lead to an elevation in metal concentrations.

Conclusions
Concentrations of Cd, Pb, Cu and Fe in milk, dairy products consumed in the Pathumtani Province showed little variability with districts. Generally, Pb and Cd concentrations in milk and dairy products (white cheese) exceeded the maximum allowed values. The elevated levels could be related to contamination during industry processing and environmental pollution. Powder milk was found to be the richest in metals while white cheese was found to be the poorest. Among the four metals studied, Fe concentrations were always the highest and Cd concentrations were always the lowest. Comparing results of the present study with those of other studies revealed higher levels of metals, especially Pb, in milk and dairy products investigated in the present study. Finally, the elevated levels of heavy metals (Pb and Cd) need further investigations to identify the cause of these elevated levels.

Increased awareness and controlled manufacture of these products are necessary in order to decrease the contents of elements, in addition to Pb, which showed a wide range of contents. It is vital to inform both farmers and company managers about this issue. The using water for producing and cleaning in milk and dairy factory must be controlled side of trace metals.

Metal migration from the milk containers is important. Therefore, used containers for milk must not contain those toxic metals, or those containers must be isolated with right matter. Dairy factories must using new technology and techniques. The milk and dairy products must not be allowed to sell without package and in open locations.In addition to information, an effective control mechanism (e.g. ISO series) imposed by government would play an important role in the prevention of contamination of milk and dairy products with these metals.

Acknowledgement

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      3. Determination of Heavy Metals in Thai Herbal Plants
      4. Determination of Heavy Metals Concentrations in Soil and Plant Samples by Inductively Coupled Plasma-Optical Emission Spectrometry
      5. Herbal Extract of Efficiency For Metal Reduced From Vegetables Washing Water
      6. Contamination of Microbial in Thai Traditional Medicines

Bio-fertilizer from Agricultural residue to Pathum Thani 1 Rice Production

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Abstract

The objective of this research was to study the Pathum Thani 1 Rice production using prepared bio-fertilizers. Two bio-fertilizers, formula 1 and formula 2 were prepared from local agricultural residues; leaves and twigs of *Sananea saman Merr*, leaves and twigs of *Sesbania aculeate*, rice straw, husk and duck's feces, *Eichhornia crassipes* (Mart.) Solms, mixed leaves from mango, *Morinda citrfolia* Linn, *Erythrina indica*, grass and hen's feces. The production of Pathum Thani 1 rice was monitored by the comparison of the total weight of 1,000 grain rice, total average production per treatment and total average production per 1 rai. The production of Pathum Thani 1 rice results found that the total weight of 1,000 grain rice was investigated that the third treatment (derived from the mixture of the formula 1 of the bio-fertilizer and one-forth of chemical fertilizer) has the highest weight average, then following by the first and second treatment. Moreover, The total average production per treatment, the sixth treatment (derived from the mixture of the formula 2 of the bio-fertilizer and three-forth of chemical fertilizer) gave the highest amount of the production, then following by the fifth and third treatment. In addition, the total average production per 1 rai, the sixth treatment (derived from the mixture of the formula 2 of the bio-fertilizer and three-forth of chemical fertilizer) gave the highest amount of the production, then following by the fifth and third treatment.

Introduction

Rice is the main source of food for Thai people as well as other neighbor countries namely Laos, Cambodia, Vietnam, Myanmar and China. Farmers in the past often fertilized rice sprouts with natural or organic fertilizer. After the replacement of chemical fertilizer which contained more nutrients for rice in following periods, the growth and the products had increased. However, the use of chemical fertilizer can cause bad effects to environment for example, the lack of natural nutrients in the soil which damages the soil quality. Farmers often solve the problem by adding more chemical fertilizer which produced more expenses in farming. Moreover, in chemical fertilizers also contain heavy metals which are going to be stored in the soil and water and spoil the quality of it. Therefore, researcher is interested in using the left-over of farming materials and plants in the local area to develop bio-fertilizer which can provide enough nutrients for Pathum Thani 1 Rice. (*Oryza sativa* L.; GRAMINEAE)

Pathum Thani 1 Rice is very popular in Singburi Province. It is fragrant rice, withstands light and its height is about 104-133 centimeters, smooth and almost sticky when cooked. The rice seeds look similar to Jasmine Rice and can withstand brown plant louses and leaf blight disease. As a result, researcher wants to observe the products of this rice which are fertilized by the developed bio-fertilizer.

Objective

1. To develop bio-fertilizer from local agricultural residues for Pathum-Thani 1 Rice.
2. To study the increasement of Pathum Thani 1 Rice after fertilized by the bio-fertilized.

Materials and Methods

There are two formulas. Both are made from various parts of local plants.

1. **Bio-Fertilizer Formula 1**
   Materials
   1. Leaves and twigs of *Sananea saman* Merr 14 Kilograms
   2. Leaves and twigs of *Sesbamia aculeate* 14 Kilograms
   3. Rice straw   16 Kilograms
   4. Paddy husks   16   Kilograms
   5. Duck's feces   16   Kilograms
   6. Urea Fertilizer   120   grams
   7. p.d.1   Suggested rate based
   8. p.d.12   Suggested rate based
   9. Pure Water   1.2   liters

Methods
1. Mix animal feces and other plants from number 1-5 together.
2. Dissolve 1 in 1.2 liters of water. Stir for 10 minutes then pour into the mixing materials from number 1) until the percentage of moisture reaches 60. (Testing by gripping the mix ingredients, it will merge together into a ball but not sticky. When it is dropped from the height about 1 meter, the ball will break but still has the fingerprint on its surface.)
3. Set the fertilizer at the height about 15-30 centimeters. Cover it with canvas or other material that is capable. Hays and piles of leaves can be used in order to keep fertilizer damp.
4. Flip the pile back and forth and water it every 10 days until the materials decompose into natural fertilizer.
5. Add p.d.12 when the materials are fully decomposed into fertilizer.

2. **Bio-Fertilizer Formula 2**
    Materials
    1. *Eichhornia crassipes*(Mart.)Solm leaves   8   Kilograms
    2. Mango leaves, *Sananea saman* Merr leaves, *Morinda Critifolia* Linn. and
       Erythrina indica leaves   16   Kilograms
    3. Grass   8   Kilograms
    4. Rice straw   8   Kilograms
    5. Fresh husks   8   Kilograms
    6. Paddy husks   8   Kilograms
    7. Hen's feces   8   Kilograms
    8. Brans   8   Kilograms
    9. Biofermentation 3 tables with molasses 3 tables dissolve in water 20 liters
    10. p.d.12   Suggested rate based

Methods
1. Mix materials number 1-8 together.
2. Water the biofermentation into the mix until the percentage of moisture reaches 60. Set the fertilizer at the height about 15-30 centimeters. Cover it with canvas or other materials e.g. hays or leaves in order to keep the fertilizer damp.
3. Flip the pile back and forth and water it every 10 days until all materials are decompose into natural fertilizer.
4. When materials are decompose into fertilizer, add p.d.12

3. The Experiment of the Bio-fertilizer in the rice fields.
   We did the experiment with 10 treatment, 3 times each
1. 1st treatment with bio-fertilizer formula 1
2. 2nd treatment with bio-fertilizer formula 2
3. 3rd treatment with bio-fertilizer formula 1 and ¼ of chemical-fertilizer
4. 4th treatment with bio-fertilizer formula 2 and ¼ of chemical-fertilizer
5. 5th treatment with bio-fertilizer formula 1 and ¾ of chemical-fertilizer
6. 6th treatment with bio-fertilizer formula 2 and ¾ of chemical-fertilizer
7. 7th treatment with bio-fertilizer formula 1 and ½ of chemical-fertilizer
8. 8th treatment with bio-fertilizer formula 2 and ½ of chemical-fertilizer
9. 9th treatment with chemical-fertilizer
10. 10th treatment with no fertilizer

Results

treatment	Weight of Rice 1,000 seeds (grams)	Average of products/ treatment (grams)	Average of products/Plantation (1 rai; kilograms)
bio-fertilizer formula 1	28.2351	4274.1400	341.9310
bio-fertilizer formula 2	27.8885	4255.6667	340.4530
Bio-fertilizer formula 1+ Chemical-fertilizer ¼	29.9280	4438.5100	355.0810
Bio-fertilizer formula 2 + chemical-fertilizer ¼	27.5009	4025.0770	322.0060
Bio-fertilizer formula 1 + chemical-fertilizer ¾	27.0264	5770.4970	461.4000
Bio-fertilizer formula 2 + chemical-fertilizer ¾	27.8279	5875.6800	470.0540
Bio-fertilizer formula 1+ Chemical-fertilizer ½	26.6646	3858.6100	308.6890
Bio-fertilizer formula 2 + chemical-fertilizer ½	26.7475	4356.8030	348.5440
Chemical-fertilizer	25.8885	4056.6500	324.5320
No fertilizer	27.2472	3658.8770	292.7100

Conclusion and Discussion

1. In scale of 1,000 rice seeds; third treatment (Bio-fertilizer formula 1 + ¼ of chemical-fertilizer) weighs the most, first treatment (Bio-fertilizer formula 1) weighs secondly and second treatment (Bio-fertilizer formula 2) weighs thirdly.

2. Average of products/ treatment ; Sixth treatment (Bio-fertilizer formula 2 + ¾ of chemical-fertilizer) gives the largest amount of average products while fifth treatment (bio-fertilizer formula 1 + ¾ of chemical-fertilizer) and third treatment (bio-fertilizer formula 1 + ¼ of chemical fertilizer) gives lesser product in orderly.

3. Average of products/Plantation(1 rai) ;Sixth treatment (Bio-fertilizer formula 2 + ¾ of chemical-fertilizer) gives the largest amount of products per plantation while fifth treatment (bio-fertilizer formula 1 + ¾ of chemical-fertilizer) and third treatment

(bio-fertilizer formula 1 + ¼ of chemical fertilizer) gives lesser products per plantation in orderly.

From the research's result, we found that bio-fertilizer in both formula have enough required nutrients for Pathum Thani 1 rice. They are high in Nitrogen because the materials that are used are also high in Nitrogen. Moreover, with the help of p.d.12, it numbers the bacteria that can also help increasing Nitrogen. This Nitrogen is good for making hormone that can speed up the growth of root and body of the plants. It is also help increasing the quality of dissolving nutrient in plants. As we used both formulas of fertilizer in rice paddles, the products and the weight of 1,000 rice seeds are higher than the treatment that used only chemical-fertilizer. However, according to this research, in order to increase the amount of products per plantation we should add ¼ - ¾ of chemical-fertilizer since the experiment plantations had long been used with chemical-fertilizer. So it is better to add chemical-fertilizer together with bio-fertilizer at first then gradually decrease chemical-fertilizer until we can eventually use only bio-fertilizer.

Acknowledgements

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Corporate Environmental Practices in Thailand: Will the Social and Individual Goals Mutually Be Achieved?

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Abstract

This research aims at proposing a research model to assess the environmental practices of Thai manufacturing firms based on the international standard, mainly represented by ISO26000, and the effects of such practices on factors in individual investor's investment decision. Corporate Environmental Responsibility (CER) is expected to promote sustainable development of society and benefit corporate stockholders. Numerous studies have highlighted the advantage of CER as it leads to better corporate reputation, higher sales and competitiveness. Although investors' goal is to maximize return from investment, they have become more increasingly aware of CER importance and related CER in their factors in investment decision. Nevertheless, differences between western where CER is rooted and Thailand, as an eastern country, where CER is implemented may create diverse CER consequences. Thai CER is still in an early stage. CER implementation may result in an instant cost to firms while benefit takes time to yield. Management may hesitate to fully implement CER. Investors may not like it. After a comprehensive review of literature, related CER papers and factors in investment decision in behavioral finance theory, a model and set of hypotheses are specified. Critically, this research provides the very first model proposing association of CER and factors in investment decision as there is very limited study on Thai investors' responses to CER adoption. Empirical model is proposed to be tested whether CER theories are held in the Thai context. If they are held, social and individual goals can mutually be achieved.

I. Introduction

Corporate Social Responsibility (CSR) is broadly known as the corporate actions, making corporate profit and contributing to society well-being at the same time. In this case, the corporation takes into account its impact on relevant stakeholders including customers, employees, shareholders, supplier, and community. The concept of CSR is composed of various dimensions depending on the variety of frameworks. The Corporate Environmental Responsibility (CER) is regarded as one of the dimensions included in CSR. It is the corporate commitment to adopt the precaution and policies in order to prevent deterioration on the environment (Kusku, 2007). Based on the study of Prayukvong and Olsen (2009), environment is the important dimension and included in every framework. This implies the high concerns of people on environmental issues.

For decades, CER has received high attention. It was provoked from corporate hazardous actions on environment. Evidences have shown the severe environmental damage such as pollution, climate change, and huge waste caused by the poor corporate environmental practices. The consequences of such poor behavior have led to the adverse impact on corporation and society. Furthermore, there has been both external and internal pressure arising from many parties including government, community, suppliers, employees, and shareholders forcing the corporation to adopt CER (Sindhi & Kumar, 2012). Internationally, there are several organizations which are relevant to CER implementation such as United Nations (UN), the Kyoto Protocal, playing important roles in forcing industrialized countries to reduce the emission of Greenhouse Gas, the main source of climate change. Other international organizations are, for instance, the World Business Council for Sustainable Development (WBCSD), the Organization for Economic Co-operation and Development (OECD), and the Global Reporting Initiative (GRI).

Although the cost of implementing CER is observed, the benefit of CER is also well noted. CER is pinpointed for creating corporate competitive advantage (Porter & van de Linde, 1995), corporate reputation (Fombrun & Shanley, 1990), and corporate performance (Hart & Ahuja, 1996). It is no doubt that CER is critical for today's business success. In fact, it has become an imperative practice for corporate survival. Additionally, it is believed that shareholder is another group that benefits from CER adoption. Numerous scholars have posited the positive relationship between environmental performance and corporate performance (Hart & Ahuja, 1996), and equity price (Klassen & McLaughlin, 1996; Wahba, 2008). In other words, the CER practice is expected to be incorporated in the investors' investment decision.

In Thailand, the effort in bringing CER into practice can be observed concretely via the implementation of CSR-DIW which is fully adopted from the international standard, ISO26000. CSR-DIW has set out the CSR guideline for the Thai manufacturing firms. In this guideline, CER has been included and has been applied to the Thai manufacturing firms. According to various sizes of Thai manufacturing firms, guidelines are applied differently. Some of the guidelines appear to be a strict requirement for only the big-sized Thai manufacturing firms while some of them strictly require all Thai manufacturing firms to follow. Four dimensions of CER are covered in the CSR-DIW including 'prevention of pollution', 'sustainable resource

use', 'climate change mitigation and adaptation', and 'protection of the environment and restoration of natural habitats'.

Several studies have reported the diverse CER development and consequences that emerge from the variant orientation (Jamali & Mirshak, 2007; Saleh et al., 2011). It is documented that the place where CSR is rooted, the West, and Thailand, the East, where CSR is applied have several differences including culture (Hofstede, 1980), institutions (Chapple & Moon, 2005), economic development (Singhapakdi, Karande, Rao, & Vitell, 2001), and legal/political systems (Singhapakdi et al., 2001). Notwithstanding, the implementation of CSR-DIW in Thailand is still in an early stage. It is doubted that the implementation of CSR-DIW, fully adopted from ISO26000, is applicable in Thai context and is related to factors in investment decision. CER implementation may result in an instant cost to firms while benefit is observed in the long term. Management may hesitate to fully implement CER because the benefit takes time to yield and investors may not like it. This implies the need to conduct the empirical study in the Thai context.

After a comprehensive review of literature, related CER papers and factors in investment decision in behavioral finance theory, a model and set of hypotheses are specified. Critically, this research provides the very first model proposing association of CER and factors in investment decision as there is very limited study on Thai investors' responses to CER adoption. Empirical model is proposed to be tested whether CER theories are held in the Thai context. If they are held, social and individual goals will mutually be achieved.

II. Literature review
CER
CER is a multidimensional concept embodied in CSR. It is defined as the corporate duty to make a positive impact on the environment and embrace the sustainability (Jamison et al., 2005). The environmental implications may include waste elimination, efficiency use of resource, productivity maximization. Moreover, corporations should avoid the practices that adversely affect the enjoyment of the country's resources by future generation. To date, investment pattern has been changed. Investors are increasingly interested in corporate environmental practices. In some countries, it even is considered in the investment decision context (Fayer, Cocklin, & Holmes, 2000).

From investment perspective, investors incorporate return and risk into investment decision. If CER implementation does generate higher benefit for investors, investors are more likely to invest in the CER stock. To answer the question "does it pay to be green?" several scholars have tried to investigate the linkage between environmental performance, and, environmental practices to the corporate profitability, corporate performance, some of the corporate financial indicators such as Tobin's q, ROA, ROE, ROS. Yet, there is still no conclusive answer (Wahba, 2008). The debate on whether CER creates benefit for corporation or shareholders is still ongoing (King & Lenox, 2002).

Although the effect of CER on corporate performance has been controversy, several scholars have posited the significantly positive relationship between the CER and corporate performance (Hart & Ahuja, 1996; Russo & Fouts, 1997; King & Lenox,

2002). The better corporate performance is driven by higher corporate competitive advantage (Porter & van de Linde, 1995), better corporate reputation (Fombrun & Shanley, 1990), higher corporate return on assets (ROA) and return on sales (ROS) (Hart & Ahuja, 1996), higher stock return (Klassen & McLaughlin, 1996), higher Tobin's q and ROA (King & Lenox, 2002). In contrast, some scholars reported the negative findings. They posited that environmental performance leads to lower corporate performance (Cordeiro & Sarkis, 1997; Wagner et al., 2002).

The benefit of CER can be observed in other areas. Some scholars asserted that the implementation of CER also lead to lower cost of production due to new innovation (Porter & van de Linde, 1995), rises in efficiency (King & Lenox, 2001), and relative cost advantage (Hart, 1997). It is added that the corporations with better environmental practices provides environmentally friendly image for the products and thus being demanded more by environmentally conscious customers. This leads to higher market share and better economic performance (Nishitani et al., 2011). In addition, CER also helps corporation to attract the moral employee. Ekwueme, Egbunike, and Onyali (2013) suggested that the corporation implementing CER is perceived as green corporation or having healthy work environment by employees. Thus, they increase the willingness to work for the corporations. Additionally, the corporation that contributes socially and environmentally to society receives good reputation which induces not only employee to work with but also investors to invest in that corporation.

From the theoretical perspective, Friedman (1970) asserted that the only corporate responsibility is to increase the shareholders' wealth. Later, Freeman (1984) posited the role of corporation in the stakeholders' theory. He stated that corporation must be responsible for all stakeholders whom are affected by its actions both directly and indirectly including shareholders. This is consistent with many studies (Carroll, 1979; Elkington, 1991). Based on this, the concept of CER is supported by the stakeholders' theory. Still, the hesitant of managers may arise due to the immediate cost burden of CER implementation. Nevertheless, the benefit for the corporation will be observed in the long run. The conflict between principal and agent explains that the problem arises because the manager is only an agent of the shareholder / principal (Jensen & Meckling, 1976). Therefore, spending money in any activity that does not generate profit for the owners of corporation might impact manager's future in the corporation.

Although, in the traditional view, the improvement of environmental performance is traded-off with the corporate performance. Numerous scholars have indicated that this is not generally true. Evidently, there are many scholars supporting the idea of "it pays to be green" (Porter & van de Linde, 1995; Hart & Ahuja, 1996; Russo & Fouts, 1997). In the meantime, it is observed that people are more aware of the environmental issues and they increasingly demand corporation to be responsible for it.

ISO26000
The international organization for standardization (ISO), the world largest developer of voluntary international standard, has launched the new CSR guidance, ISO26000, in 2010. The guideline consists of seven core dimensions. They are corporate governance, human rights, labor practices, fair operating practices, consumer issues, community involvement, and environment issues (CER). ISO26000 is the efforts of

many international organizations including UN, ILO, GRI, and is an officially recognized standard around the world. Based on ISO26000, CER consists of four dimensions which are prevention of pollution, sustainable resource use, climate change mitigation and adaptation, and protection of the environment, biodiversity and restoration of natural habitats (ISO26000, 2010). Each of these dimensions is elaborated below.

a) Prevention of pollution

The pollution is referred to the pollutants (mercury, sulphur oxides, nitrogen oxides), waste, toxic or hazardous chemical which are emitted to air or discharged to water and caused environmental or health impact (ISO26000, 2010). There are other identifiable forms of pollution including noise, odor, and radiation. The pollution abatement can be conducted by two means: control and prevention (Hart, 1995). The pollution control is known as the way in which emissions and effluents are stored, treated, and disposed by using the pollution-control equipment, such as end-of-pipe method, while pollution prevention is known as the way in which emissions and effluents are reduced, changed, or prevented through better housekeeping, material uses, recycling, or any process innovation (Hart, 1995). The prevention of pollution does not only save cost of installing end-of-pipe pollution control device, but it also increase efficiency and productivity. Hart and Ahuja (1996) asserted that corporation realizes more saving through pollution prevention because prevention of defects is superior to finding and fixing them after the occurrence.

The effect of prevention of pollution on corporate performance can be listed. Several scholars supported the idea of corporation implementing prevention of pollution as it enhances the corporate performance. Hart and Ahuja (1996) posited the significantly positive relationship between emission reduction and corporate ROS, ROA, and ROE. Moreover, the reduction of pollution helps improve competitiveness over time. This idea is supported by Hart (1995). Consistently, King and Lenox (2001, 2002) also found that lower pollution and waste prevention led to corporate performance and better corporate valuation. However, Wagner (2002) reported no significant linkage between environmental performance, the end-of-pipe strategy, and economic performance. Findings revealed that the implementation of pollution prevention can result in more positive economic performance than the end-of-pipe strategy. In the case of toxic emission, the reduction of toxic chemical emission leads to higher corporate market value (Konar & Cohen, 2001), and higher financial performance (Bosworth & Clemens, 2011). In sum, it is expected that the CER practice, prevention of pollution, has impact on factors in investment decision.

b) Climate change mitigation and adaptation,

The emission of greenhouse gas (GHG) including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2o) has likely caused the global climate change which significantly affects environment and human well-being. There has been risen in temperature, changed in rainfall pattern, and changed in extreme weather events (ISO26000, 2010). In order to control or reduce the impact of such change, the climate change mitigation and adaptation are essential (Aggarwal & Dow, 2012). Several scholars pinpointed the benefit of such practices. By reducing the carbon and GHG emission, it enhances corporate performance (Iwata & Okada, 2010), higher corporate value (Nishitani, Kaneko, Komatsu, & Fujii, 2011), and higher corporate profit (Nishitani, Jannah, Ridwan & Kaneko, 2013). In contrast, Aggarwal and Dow

(2012) reported that there is no clear link between GHG mitigation and corporate value, but the emission of GHG reduces the corporate value. Thus, it is expected that the climate change mitigation and adaptation has effect on factors in investment decision.

c) Sustainable resource use

The sustainable resource use is referred to the use of resource at a rate which is less than, or equal to, the rate of resource replenishment (ISO26000, 2010). It is suggested that the corporation should use resource in a sustainable way by utilizing electricity, fuel, land, and water, etc. in a more responsible way. It is expected that the influence of such CER practice should lead to the improvement of society and betterment of relevant stakeholders. Therefore, the corporation that utilizes the resource sustainably will experience the corporate competitiveness, corporate reputation, and profitability. Additionally it is expected that the factors in investment decision will be influenced by the CER practice.

d) Protection of the environment, biodiversity and restoration of natural habitats

It is suggested that for a corporation to become socially responsible, it should protect the environment and restore natural habitats, ecosystem diversity, species diversity, and natural ecosystems (such as food and water, climate regulation, soil formation). Consequently, the protection of environment, biodiversity and restoration of natural habitats is expected to enhance the corporate competitiveness, corporate reputation, and profitability. In addition, the individual investor's factors in investment decision are anticipated to be affected by such corporate CER practices.

Factors in investment decision

In traditional view, investors take into account the return and risk when considering stock selection (Markowitz, 1952). However, recent evidences have posited the critical impact of other relevant factors other than return and risk in the investment decision. The behavioral finance theory (Statman, 2008) stated the importance of incorporating other factors relating to human behavior, the psychology-based factors, in the investment decision process. Baker and Haslem (1973) proposed 33 factors which can be employed as factors in investment decision. This is based on the fact that individual investors are human with broad interests and backgrounds. This is consistent with Nagy and Obenberger (1995), and Al-Tamimi (2006). The numerous relevant factors utilized in investment decision context are such as expected corporate earnings, dividends paid, broker recommendation, firm status in industry, etc. (Baker & Haslem, 1973; Nagy & Obenberger, 1994; Al-Tamimi, 2006). From large pool of elements presented, attempts have been made to categorize them into few dimensions. Previous studies have presented the groups of factors influencing investment decision. In this regards, Nagy and Obenberger (1994) categorized their elements into seven dimensions: neutral information, self-image/firm-image coincidence, advocate recommendation, accounting information, classic, social relevance, and personal financial needs. Later, the items were adopted by Merikas et al. (2004). In this study, some items such as "Financial press coverage", "Annual report", "Prospectuses", "Tax consequences", and "Recommendations from individual stock broker" have been removed. Nevertheless, there were also new items created such as "Statements from politicians and governmental officials", "Fluctuations/developments in the indices of the major markets", "Current economic indicators", "Past performance of stock", "Get rich quick", "Gut feeling on the economy". Thus, there are 26 items

utilized under the study. Additionally, the study of factors influencing individual investor behavior has been adopted by Al-Tamimi (2006). The study yields 34 items. Five dimensions, namely, neutral information, self-image/firm-image coincidence, advocate recommendation, accounting information, and personal financial needs, were affirmed. As compared to Merikas et al. (2004), Al-Tamimi (2006) added the elements such as "Information obtained from internet", "Stock marketability", "Dividend paid", "Religious reasons", "Reputation of the firm's shareholders", and "Increase of the firm's involvement in solving community problems" in the study while removed some elements such as "Environmental record", "Protection or not of the investor" from the study.

Al-Tamimi (2006)'s work is observed as being adapted from Nagy and Obenberger (1994) and Merikas (2004). Moreover, numerous authors have employed Al-Tamimi (2006)'s items in their recent studies regarding the factors influencing individual investor decision such as Iqbal and Usmani (2009), and Obamuyi (2013). Consequently, the present study utilizes the items and dimensions adopted in Al-Tamimi (2006)'s work for factors influencing investment decision. They are as followed.

a) **Neutral information** refers to information relating to government holdings, fluctuation/developments in the stock index, coverage in the press, statements from government officials, current economic indicators, and recent price movement in a firm's stock

b) **Accounting information** refers to information relating to expected corporate earnings, condition of financial statements, dividends paid, affordable share price, expected dividends, past performance of the firm's stock

c) **Self-image/firm-image coincidence** refers to religious reasons, feeling about firm's product and services, reputation of the firm's shareholders, "get rich quick", firm status in industry, perceived ethics of firm, gut feeling on the economy, reputation of firm, increase of the firm's involvement in solving community problems

d) **Advocate recommendation** refers to broker recommendation, family member opinions, friend or coworker recommendations, opinions of the firm's majority stockholders

e) **Personal financial needs** refers to attractiveness of non-stock investment, diversification needs, ease of obtaining borrowed funds, minimizing risk

III. Research model and Hypotheses

According to the literature, it is doubted whether the practices of CER in Thailand relates to factors in investment decision. CER in this research is based on CSR-DIW guideline fully adopted from the international standard, ISO26000. It consists of four dimensions: prevention of pollution, sustainable resource use, climate change mitigation and adaptation, and protection of the environment, biodiversity and restoration of natural habitats Five factor in investment decision: neutral information, accounting information, self-image/firm-image coincidence, advocate recommendation, and personal financial needs are adopted from Al-Tamimi (2006).

CER has been applied to investment decision for various reasons. CER can signal good reputation (Fombrun & Shanley, 1990), create corporate competitiveness (Porter & van de Linde, 1995), and corporate performance (Hart & Ahuja, 1996; Russo & Fouts, 1997; King & Lenox, 2002). Consequently, twenty hypotheses are proposed as follow.

	List of Hypotheses
H1:	The more corporations prevent pollution based on the international standard, the more the investors consider CER as neutral information factor in investment decision
H2:	The more corporations prevent pollution based on the international standard, the more the investors consider CER as accounting information factor in investment decision
H3:	The higher the corporations prevent pollution based on the international standard, the more the investors consider CER as self-image/firm-image coincidence factor in investment decision
H4:	The higher the corporations prevent pollution based on the international standard, the more the investors consider CER as advocate recommendation factor in investment decision
H5:	The higher the corporations prevent pollution based on the international standard, the more the investors consider CER as personal financial needs factor in investment decision
H6:	The more the corporations use resource sustainably based on the international standard, the more the investors consider CER as neutral information factor in investment decision
H7:	The more the corporations use resource sustainably based on the international standard, the more the investors consider CER as accounting information factor in investment decision
H8:	The higher the corporations use resource sustainably based on the international standard, the more the investors consider CER as self-image/firm-image coincidence factor in investment decision
H9:	The higher the corporations use resource sustainably based on the international standard, the more the investors consider CER as advocate recommendation factor in investment decision
H10:	The higher the corporations use resource sustainably based on the international standard, the more the investors consider CER as personal financial needs factor in investment decision
H11:	The more the corporations adopt climate change mitigation and adaptation based on the international standard, the more the investors consider CER as neutral information factor in investment decision
H12:	The more the corporations adopt climate change mitigation and adaptation based on the international standard, the more the investors consider CER as accounting information factor in investment decision
H13:	The higher the corporations adopt climate change mitigation and adaptation based on the international standard, the more the investors consider CER as self-image/firm-image coincidence factor in investment decision
H14:	The higher the corporations adopt climate change mitigation and adaptation based on the international standard, the more the investors consider CER as advocate recommendation factor in investment decision
H15:	The higher the corporations adopt climate change mitigation and adaptation based on the international standard, the more the investors consider CER as personal financial needs factor in investment decision
H16:	The more the corporations adopt protection of the environment, biodiversity and restoration of natural habitats based on the international standard, the more the investors consider CER as neutral information factor in investment

List of Hypotheses
decision
H17: The more the corporations adopt protection of the environment, biodiversity and restoration of natural habitats based on the international standard, the more the investors consider CER as accounting information factor in investment decision
H18: The higher the corporations adopt protection of the environment, biodiversity and restoration of natural habitats based on the international standard, the more the investors consider CER as self-image/firm-image coincidence factor in investment decision
H19: The higher the corporations adopt protection of the environment, biodiversity and restoration of natural habitats based on the international standard, the more the investors consider CER as advocate recommendation factor for investment decision
H20: The higher the corporations adopt protection of the environment, biodiversity and restoration of natural habitats based on the international standard, the more the investors consider CER as personal financial needs factor in investment decision

IV. Discussion

The research model and hypotheses are proposed based on the literature review. Empirical tests are needed to be conducted to examine the specific impact of CER on factors in investment decision in Thailand. The results are expected to indicate the extent of Thai CER adoption based on the international standard of ISO26000 and whether such adoption will affect Thai individual investor's investment decision. Moreover, findings will benefit the Thai manufacturing firm managers and Thai capital market regulator, including the SEC and the SET, who are in the early stage of developing best practices in CER, to implement their corporate environmental strategy that can be materialized and actually attract investors toward their investment decision. Thai CER investors should incorporate such insights into their strategy for the better investment decision. In the end, the finding will prove whether CER theories are held in the Thai context. If they are held, social and individual goals can mutually be achieved.

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Application of Multi-Stakeholder Multi-Criterion Decision Analysis for Biodiesel Feedstock Selection in Vietnam

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Abstract
Biodiesel has been proposed as a renewable energy source to replace fossil diesel in Vietnam. Vietnam government has a policy to produce and use biodiesel to blend with diesel, from B1 to B5 (1-5% biodiesel and 99-95% diesel). There is however no sustainability assessment of biodiesel production that has been done under Vietnam conditions. Decision-makers in Vietnam need to assess the sustainability that consists of the balance of social, technical, economic and environmental aspects. In order to assess the sustainability, multi-criterion decision analysis (MCDA) may be an appropriate methodology to find the most preferred alternative. Analytic hierarchy process (AHP) is one of the most commonly used MCDA methods, and AHP was applied in this study to rank three possible feedstock options for biodiesel production: namely jatropha oil, fish fat and waste cooking oil. The study could provide the feasible guidance of biodiesel development under current conditions in Vietnam. More specifically, the judgments of different Vietnamese stakeholders, such as university professors, heads of biodiesel projects, managers of Petrovietnam corporation, and engineers were incorporated to evaluate the economic, environmental, social and technical aspects. The results showed that waste cooking oil is the most preferable feedstock to produce biodiesel in Vietnam followed by jatropha oil (second) and fish fat (third).

Keywords: Renewable and Environmental Solutions, Multi-criteria decision analysis, Analytical hierarchy process (AHP), Multi-stakeholders, Biodiesel

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1. Introduction

Currently, the main source of energy worldwide is fossil fuel. However, the amount of fossil fuel is limited. Moreover, the rapidly increasing demand for fossil fuel may result in some big global problems, global warming and environmental pollution (Atadashi *et al.,* 2011). In order to reduce the dependence on non-renewable energy sources, it is necessary to find renewable energy alternatives. Currently, biodiesel, produced from biological sources such as animal fats or vegetable oils, is a promising candidate (Knothe, 2010). Biodiesel production has been investigated for a long time and produced to replace conventional fossil fuel in many countries. However, biodiesel is not a perfect alternative fuel so far because of some shortcomings, such as high cost, energy effectiveness, source of raw materials, land use etc. So the decision makers of each country need to weigh these conflicting options to decide the direction of biodiesel production and development.

Vietnam has had rapid economic growth and energy consumption has rapidly increased in parallel with economic development. The Vietnam energy sector is also facing several challenges , such as ensuring energy supply, protecting environment from energy activities as well as the social and political issues (Minh Do *et al.,* 2011). Vietnam has an area of about 33 million hectares of which 50 percent is in productive use and 21 percent of the total area is used in agriculture. Biodiesel produced from agricultural products or waste would be a promising alternative energy resource (Khanh Toan *et al.,* 2011). In order to diversify the sources of energy, Vietnam government has a policy to develop biodiesel as an alternative to conventional fossil fuel. Decision No. 177/2007/QD-TTg of Government of Vietnam approved the scheme on development of biofuel up to 2015 and the vision to 2015. Decision No. 1842/QD-BNN-LN indicated that Vietnam would focus on using jatropha as a main feedstock and strongly encouraged the use of other feedstocks, such as waste cooking oil, fish fat, for biodiesel production.

Vietnam government has carried out some projects to research and develop biodiesel production. Project No. DTDL.2007G/19 performed by Ha (2007) evaluated the situation of technique of biodiesel production and application testing of biodiesel based on fish fat in Vietnam. Project No. 257.10.RD/HD-KHCN performed by Thinh (2011) investigated jatropha plantation as material for biodiesel production in Vietnam. Biodiesel has been recommended as an effective renewable resource of energy to replace fossil fuel. However, some studies showed that replacing diesel by biodiesel in Vietnam still faces some disadvantages. Particularly, Le et al. (2013) indicated that the biodiesel substitution for fossil diesel in Vietnam may remain not cost-effective but may improve environmental impacts. So we could find that using biodiesel as an alternative energy may have some positive impacts and some negative impacts. In order to build a comprehensive view of biodiesel based on the current conditions in Vietnam, the sustainability development of biodiesel should be evaluated on the overall process from production to use. A completed assessment of biodiesel needs to be addressed on the technical, social, environmental and economic aspects. For the decision makers, the selection of best feedstock among several feasible ones for biodiesel production is the most challenging (Manzardo *et al.,* 2012). The aim of sustainability assessment is to provide decision-makers policy guidance based on science, technology and comprehensive perspectives (Halog and Manik, 2011).

The goal of sustainable development must be a balance between social, technical, economic and environmental aspects (Wang *et al.,* 2009). They might take many conflicting criteria into assessment formulation to optimize the various impacts of biodiesel on human life. In order to make a sustainability assessment, multi-criteria decision analysis (MCDA) would be an appropriate method to support decision-making (Myllyviita et al., 2013). The most applied application of this method is to find the optimum alternative from all of feasible alternative by ranking the criteria (Torfi *et al.,* 2010). There are many tools of MCDA that were used in sustainable energy planning, such as TOPSIS (Kaya *et al.,* 2011), ELECTRE (Beccali *et al.,* 2003), PROMETHEE (Haralambopoulos *et al.,* 2003), VIKOR (San Cristóbal, 2011), SWOT (Terrados *et al.,* 2009) and AHP (Erol *et al.,* 2012). Among these methods, Analytic Hierachy Process (AHP) is the most widely applied method that has been applied successfully in many problem domains (Wang *et al.,* 2009). AHP is relative measurement theory introduced and developed by Thomas Saaty (1977; 1980) to derive priorities among multiple alternatives under multiple criteria. AHP has been used for forecasting the results of a policy and determining the performance of various impacts issued from products or services. It is a structured technique for dealing with complex decisions to give the best suitable answer for the problem (Erol et al., 2012).

2. Methodology

2.1. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is known as a measurement method from pair-wise comparisons of homogeneous elements to derive dominance priorities for alternatives (Saaty, 1977). These comparisons may be obtained from a fundamental scale of the relative preferences between the selected factors (Saaty, 1987). The fundamental scale based on the definition of Saaty (1990) is shown in Table 2.

Table 1. Saty's nine-point fundamental scale for pair-wise comparison

Numerical scale	Definition	
	Criteria	*Alternatives*
1	Equally important	Equally preferred
3	Moderately more important	Moderately more preferred
5	Strongly more important	Strongly more preferred
7	Very strongly more important	Very strongly more preferred
9	Absolutely more important	Absolutely more preferred

The procedure to apply AHP in sustainability assessment of biodiesel development is illustrated via the following steps:

Step 1: forming the hierarchy structure of related elements. The hierarchy system must show the relationships between the goal, criteria and alternatives.

Step 2: determining the weights for each criteria and alternatives. The attributes are denoted by a_1, a_2, …, a_n and the weights are denoted by w_1, w_2, …, w_n, the pairwise comparisons is represented by the following matrix:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix}$$

One of the objectives of AHP is to find the pair-wise comparison $a_{ij} = w_i/w_j$. a_{ij} should be obtained from the preferences of multi-stakeholders. The priority (weight) vector is represented by the vector (w):

$$w = \begin{bmatrix} w_1 \\ w_2 \\ \cdots \\ w_n \end{bmatrix}$$

Step 3: finding the eigenvector (w) with respective λ_{max} for $(A - \lambda_{max}I)w = 0$.

Step 4: checking the consistency ratio that is an indicator to measure how a given matrix compare to a random matrix in terms of their consistency indices (Chang et al., 2007). If the consistency ratio is equal or less than 0.1, the degree of consistency is satisfactory and the AHP may yield meaningful results (Mateo, 2012).

Step 5: ranking the sequence of the alternatives. The alternative that has higher final weight would have higher ranking.

2.2. Hierarchy structure

Before establishing the pair-wise comparison in the AHP method, it is necessary to make the hierarchy system of various levels according to criteria and sub-criteria. The criteria consist of major issues in producing and using biodiesel. And each criterion was decomposed to sub-criteria: economic aspect would consist of investment cost (Jovanovic et al., 2009; Doukas et al., 2007), operation cost (Pilavachi et al., 2009; Mamlook et al., 2001) and profit (Ding, 2009); environmental aspect would consist of CO_2 emission, NO_x emission into the air and land use (Wang et al., 2008); technological aspect would consist of safety (Mohsen et al., 1997), applicability (Zabaniotou et al., 2008) and efficiency (Dinca et al., 2007); social aspect would consist of social acceptability (Liposcak et al., 2006), job criterion (Doukas et al., 2007) and political acceptability (Ding, 2009). The hierarchy structure used to rank the alternatives in this study is shown in Table 2.

Table 2. Hierarchy structure for selection of the feedstock of biodiesel production

Goal	Level 1st (Criteria)	Level 2nd (Sub-criteria)	Level 3rd (Alternatives)
The most appropriate feedstock for biodiesel production	Economic (**Ec.**)	Investment cost (**I.**) Operation cost (**O.**) Profit (**P.**)	1. Waste cooking oil (**W.**) 2. Fish fat (**F.**) 3. Jatropha oil (**J.**)
	Environmental (**En.**)	CO_2 emission (**CO_2**) NO_x emission (**NO_x**) Land use (**Land**)	
	Technological (**Te.**)	Safety (**S.**) Applicability (**A.**) Efficiency (**E.**)	
	Social (**So.**)	Social acceptability (**Soc.**) Job creation (**Jo.**) Political acceptability (**Po.**)	

As mentioned above, there are three main feasible feedstocks for biodiesel production in Vietnam: waste cooking oil, fish fat, jatropha oil. In order to choose the best one according to the current condition in Vietnam, the perspectives of multi-stakeholder were used in this study to evaluate the impacts of biodiesel production and use on all aspects: social, technical, economic and environmental aspect. Four groups of decision-makers and experts were invited to participate in making sustainability assessment in this study. The first group consists of 5 engineers, the second group consists of 4 heads of biodiesel projects in Vietnam, the third group consists of 3 university professors who have experience on biodiesel production, and the last group consists of 6 managers of Petrovietnam corporation. All of them are experts in the biodiesel field and play an important role in decision making of biodiesel development in Vietnam.

In this study, a survey questionnaire was designed to compare the priorities of two criteria or two alternatives, and distributed to stakeholders to evaluate the feasibility of each alternative. The weights of criteria and alternatives were obtained from the judgments of multi-stakeholders and quantified by AHP. In order to combine the different options from different respondents, geometric mean method of all the entries was applied to aggregate individual priorities (Aczel & Saaty, 1983). The calculation was followed the above steps to determine the priority of criteria and alternatives. Each evaluation result is checked the consistency ratio to make sure that the preferences of stakeholders are consistent enough to be satisfactory. The final result incorporated the judgments of multi-stakeholders may show the sustainability assessment index of biodiesel feedstock from WOC, Fish fat, Jatropha oil. Sensitivity analysis was applied to test the stability of the priority ranking of alternative (Chang et al., 2007). It is performed by selecting and varying a criterion weight and observing the changing score and ranking order of alternative (Chatzimouratidis et al., 2009). In this study, sensitivity analysis was carried out in the Super Decision Software version 2.2.3 (Adams et al., 2012).

3. Results and discussion

3.1. The perspective of professors

Under university professors' judgment, the calculation of preference is shown in Table 3. The weights of criteria indicated that ranking priorities are decreasing according to following order: Environment impact (0.394), Economic impact (0.364), Social impact (0.124) and Technical impact (0.118). It is found that environmental and economic impact is much more important than technology and social impact in professors' opinion. It is clearly shown in level 2nd that profit is most preferred with respect to economic aspect, CO_2 emission and land use is given higher priority than NO_x emission. In the social aspect, political acceptance is the most important factor affecting the decision making of biodiesel development. In other words, the government policy would pay important role in decision making according to the judgments of professors group.

Table 3. The priority of criteria under the perspective of professors (Meanings of abbreviations may be found in Table 2).

Leve l 1st	Ec.			En.			Te.			So.		
	0.364			0.394			0.118			0.124		
Leve l 2nd	I.	P.	O.	CO_2	NO_x	Land	S.	E.	A.	Soc.	Po.	Jo.
	0.241	0.613	0.144	0.371	0.223	0.406	0.336	0.252	0.412	0.169	0.498	0.332

The ranking order of alternatives is shown in Table 4 of sustainability index. It indicates that WCO (0.446) > Fish fat (0.315) > Jatropha (0.239).

Table 4. The rank of alternatives under perspective of professors

Alternative	**Jatropha**	**Fish fat**	**WCO**
Final weight	0.239	0.315	0.446
Ranking	3rd	2nd	1st

3.2. The perspective of engineers

The engineers' perspective is shown in Table 5, environmental impact is most salient factor among the criteria. The weight of one (0.413) is much more than the weight of economic impact (0.299), social impact (0.157) and technical impact (0.131). So engineers may provide that environment should pay the most important role in decision-making of biodiesel production and use. In economic aspect, the perspective of engineers is quite like the one of professors, profit is most preferred factor followed by investment cost and operation cost. But in environmental aspect, the engineers think that CO_2 emission is higher environmental impact than NO_x emission and land use. In technical aspect, the order of the preference of sub-criteria is applicability > safety > efficiency. The weights of impacts in social aspect are very close so that these are almost equivalent.

Table 5. The priority of criteria under the perspective of engineers (Meanings of abbreviations may be found in Table 2).

Level 1st	Ec.			En.			Te.			So.		
	0.299			0.413			0.131			0.157		
Level 2nd	I.	P.	O.	CO_2	NO_x	Land	S.	E.	A.	Soc.	Po.	Jo.
	0.290	0.572	0.138	0.514	0.253	0.233	0.476	0.364	0.160	0.355	0.369	0.276

The ranking order of alternatives in Table 6 shows that Jatropha (0.410) > WCO (0.298) > Fish fat (0.292).

Table 6. The rank of alternatives under perspective of engineers

Alternative	**Jatropha**	**Fish fat**	**WCO**
Final weight	0.410	0.292	0.298
Ranking	1st	3rd	2nd

3.3. The perspective of heads of biodiesel project

Similarly, the priorities of criteria and alternatives were evaluated and ranked by the heads of biodiesel projects in Vietnam. The results of assessment of technology, environment, economic and society are shown in Table 7. For the first level, the weight of environmental aspect is provided as the highest score (0.584) that is much higher than other aspect, economic (0.235), technology (0.095) and society (0.087), respectively. This indicates that, in their judgment, environment should be considered as the most important factor when making decision for biodiesel development. For the third level, the heads of biodiesel give prominence to the role of profit in economic aspect, CO_2 emission in environmental impact, safety in technical impact and political acceptance in social impact.

Table 7. The priority of criteria under the perspective of heads of biodiesel project
(Meanings of abbreviations may be found in Table 2).

Leve l 1st	Ec.			En.			Te.			So.		
	0.235			0.584			0.095			0.087		
Leve l 2nd	I.	P.	O.	CO_2	NO_x	Lan d	S.	E.	A.	Soc.	Po.	Jo.
	0.23 7	0.55 8	0.20 5	0.40 7	0.25 1	0.34 2	0.66 0	0.10 1	0.23 9	0.25 4	0.55 3	0.19 3

The sustainability index Table 8 that was evaluated by heads of biodiesel projects shows that jatropha (0.392) is the most appropriate candidate for biodiesel production in Vietnam and followed by fish fat (0.306) and WCO (0.302).

Table 8. The rank of alternatives under perspective of heads of biodiesel project

Alternative	**Jatropha**	**Fish fat**	**WCO**
Final weight	0.392	0.306	0.302
Ranking	1st	2nd	3rd

3.4. The perspective of managers of Petrovietnam corporation

Table 9 summarizes the sustainability measurement based on the preferences of managers of the Petrovietnam corporation. The results show the priority of each criterion as following order, economic (0.410), technology (0.212), environment (0.203) and society (0.175). It is given that economic is the most important aspect in the opinion of managers of Petrovietnam when they decide to use biodiesel as alternative of fossil fuel. It is quite different from other groups that provide the priority of environment higher than economic. The evaluation also indicate that in economic aspect, the order of impacts is profit (0.520) > investment cost (0.315) > operation cost (0.165); in environmental aspect, one is CO_2 emission (0.416) > NO_x emission (0.362) > land use (0.221); in technical aspect, one is safety (0.474) > efficiency (0.280) > applicability (0.246) and in social aspect, one is job creation (0.419) > political acceptance (0.301) > social acceptance (0.279).

Table 9. The priority of criteria under the perspective of managers of Petrovietnam (Meanings of abbreviations may be found in Table 2).

Leve l 1 1st	Ec.			En.			Te.			So.		
	0.410			0.203			0.212			0.175		
Leve l 2nd	I.	P.	O.	CO_2	NO_x	Land	S.	E.	A.	Soc.	Po.	Jo.
	0.315	0.520	0.165	0.416	0.362	0.221	0.474	0.280	0.246	0.279	0.301	0.419

Table 10 is the result of sustainability index according to the preferences of managers of Petrovietnam. WCO (0.371) is most preferred feedstock followed by jatropha (0.351) and fish fat (0.278).

Table 10. The rank of alternatives under perspective of managers of Petrovietnam

Alternative	**Jatropha**	**Fish fat**	**WCO**
Final weight	0.351	0.278	0.371
Ranking	2nd	3rd	1st

3.5. Summary

From the evaluation results of different stakeholders, we could find that there are some differences in their preference. The weights of each criteria and sub-criteria from each group are quite different from other. This could result in the different ranking orders of alternatives when choosing feedstock for biodiesel production. However, almost all groups provide high evaluation for economic and environmental aspect than technical and social aspect in decision making. In the evaluation from professors group, the weights of the economic and environmental aspects are quite close. For the groups of engineers and heads of biodiesel project, the environment is evaluated much higher than the economic aspect whereas the weight of economic aspect is much higher than one of environment according to the judgment of managers of Petrovietnam. If we give equal priority to the perspectives of multi-stakeholder we could get the average value of sustainability assessment. The final ranking order that incorporates multi-stakeholders inputs is shown in Table 11. It indicates that the most appropriate feedstock for biodiesel based current condition in Vietnam is WCO and followed by jatropha and fish fat.

Table 11. The overall rank of the alternatives incorporated multi-stakeholders

Alternative	**Jatropha**	**Fish fat**	**WCO**
Final weight	0.3484	0.2976	0.3540
Ranking	2nd	3rd	1st

The weights of alternatives with respect to each criterion are shown in Table 12. In the economic aspect, fish fat is considered as the most preferred with regard to investment cost and operation cost but it is the least preferred with respect to profit,

while jatropha along with waste cooking oil is given higher priorities with respect to profit. In other words, in the opinion of multi-stakeholders, if fish fat was chosen to produce biodiesel, it would reduce the investment cost and operation cost but get lower profit. For the environmental aspect, the result shows that jatropha has the best impact on CO_2 and NO_x emission but the others could have more positive impact on land use. For the technical aspect, the weights of three alternatives are almost equivalent under safety criterion, jatropha could be the most efficient and waste cooking oil has the highest weight with respect to applicability aspect. For the social aspect, the weights of these feedstock options are quite close but it is found that waste cooking oil is most preferred with respect to social acceptability and followed by fish fat and jatropha. The weights of alternatives in political aspect show that jatropha and waste cooking oil could be supported by the policy of biodiesel much better than fish fat. Lastly, multi-stakeholders judge jatropha as the best selection for the ability of job creation in biodiesel production in comparison with the others.

Table 12. The priority weights of alternatives with respect to each criterion (Meanings of abbreviations may be found in Table 2).

Economic aspect			Environmental aspect			Technical aspect			Social aspect		
I.	J.	0.229	*CO₂*	J.	0.446	*S.*	J.	0.300	*Soc.*	J.	0.324
	F.	0.458		F.	0.225		F.	0.316		F.	0.298
	W.	0.313		W.	0.329		W.	0.385		W.	0.378
P.	J.	0.414	*NOₓ*	J.	0.519	*E.*	J.	0.161	*Po.*	J.	0.414
	F.	0.181		F.	0.233		F.	0.464		F.	0.181
	W.	0.404		W.	0.248		W.	0.375		W.	0.404
O.	J.	0.270	*Land*	J.	0.149	*A.*	J.	0.214	*Jo.*	J.	0.438
	F.	0.412		F.	0.455		F.	0.345		F.	0.268
	W.	0.318		W.	0.396		W.	0.441		W.	0.294

3.6. Sensitivity analysis

The sensitivity analysis of the economic aspect is shown in Table 13. It indicates that there was no change in the ranking of alternatives when the priority value was varied. But the sensitivity analysis of technology indicates that one rank reversal was occurred when the priority of technology increases beyond 0.48. The rank of jatropha would decreases from 2nd to 3rd whereas fish fat has rank reversal. This means that the technical aspect prefers fish fat than jatropha in biodiesel production. For social and environmental aspects, the result also shows that there is a reversal of ranking order when the priority of society come over 0.358 or one of environment come over 0.805. So it is very clear that the social and environmental aspects affect the rank of jatropha positively and one of WCO negatively. The result of sensitivity analysis also indicates that the change of ranking is not highly sensitive to small changes in criteria weight.

Table 13. The sensitivity analysis of each criteria

	Aspects						
	Economic	**Technology**		**Society**		**Environment**	
	Priority						
	0.000÷1.000	*< 0.480*	*>0.480*	*<0.358*	*>0.358*	*<0.805*	*>0.805*
WCO	1st	1st	1st	1st ⟷	2nd	1st ⟷	2nd
Jatropha	2nd	2nd ⟷	3rd	2nd ⟷	1st	2nd ⟷	1st
Fish fat	3rd	3rd ⟷	2nd	3rd	3rd	3rd	3rd

4. Conclusion

The study provides a new approach to investigating sustainability of biodiesel in Vietnam that makes an overall review for the feasibility of biodiesel application under multi-stakeholders' perspective. To our knowledge, most of the previous studies of biodiesel in Vietnam mainly focused on the technology of biodiesel production (Ha, 2009; Thinh, 2011) and a few calculated the environmental impacts and economic impacts, such as the study of Le (2013). These previous studies did not consider all sustainability issues connected with biodiesel production and use. This study serves as another part to complete the comprehensive evaluation to determine the direction of biodiesel in Vietnam in the future.

The sustainability assessment of biodiesel was evaluated by multi-stakeholder to provide a guidance for choosing the appropriate feedstock among some feasible materials, such as WCO, jatropha oil and fish fat according the current conditions in Vietnam. The evaluation incorporates four most important criteria that are technical, social, environmental and economic aspect and 12 sub-criteria. AHP is applied to make the priority ranking of these aspects and alternatives. The sustainability assessments were checked if consistence ratio is less than 0.1 to ensure that the judgments of multi-stakeholder are consistent with AHP model. In the judgment of experts, the priority of economic and environmental aspect was evaluated much higher than social and technical aspect. It is also given that the best feedstock for biodiesel production in Vietnam is WCO and the least favorable option one is fish fat. The sensitivity analysis was obtained by using Super Decision Software. Changing the weight of economic aspect would not change the rank of alternatives that are WCO > jatropha > fish fat. Changing the weight of technical aspect over 0.480 would result in rank reversal between jatropha and fish fat. The sensitivity analysis also indicate that social and environmental aspect affects jatropha positively and WCO negatively. The rank of WCO would be changed from 1st into 2nd and one of jatropha is reverse when the weight of social and environmental aspect increases more than 0.358 and 0.805, respectively.

Acknowledgement

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From Local Agricultural Market Disposals to Environmentally Friendly Products

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Abstract
Taradd Thai Market is one of the biggest agricultural markets in Thailand located in a suburban area of Pathumthani province, in Thailand. Four local tropical fruits, Durian, Mango, Mangosteen, and Marian Plum were selected from the market to study in this research. Two environmentally friendly products, lactic acids and biochars, from agricultural market disposals were focused. The percentage of volatile materials was measured and recorded. For the first product, the tropical juice extracts from the four fruits were separately prepared. The percentages of reducing sugar per 100g were analyzed and the results revealed that the percentage of reducing sugar in Durian juice was the highest with 58.7% w/w. Whereas, in Marian Plum juice, the percentage of reducing sugar was 43.5 % w/w while, in Mango juice, 50.9% w/w of reducing sugar were measured and the percentage of reducing sugar of Mangosteen juice was 35.3 % w/w. *Lactobacillus plantarum* was used to produce the lactic acids with the variation of times. The results displayed that the optimum time to generate the highest amounts of lactic acids was at 50 hrs. For the second environmental friendly product, it was to transform the agricultural market disposals to biochars. Durian and Mangosteen were chosen to prepare the biochars due to their hard skins. Moreover, both physical and chemical properties of these biochars were also characterized. Metal determinations were analyzed via ICP-OES. Heat of combustion was also recorded via bomb calorimeter.

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Introduction

Thailand is one of the prestigious countries in the world for food producers. Not only were rice, tapioca and para rubber produced, but also variety of fruits were planted. However, the market prices of those fruits were unconstanted, mostly quite low. Therefore, those unsold fruits would be wasted. In Pathumthani province, Taradd Thai, one of the biggest and important agricultural markets in Thailand, was also met the problem from fresh fruit waste disposals in this area that could be consider as environmental significant concerns. Therefore, the management solutions to solve those wastes were to transform them to valuable materials such as lactic acid or biochar. Lactic acid was prepared from the fermentation of microorganisms such as *Lactobacilus plantarum* over juices and it could also be used as a biodegradable starting material such as biodegradable suture, prostheses or microcapsule for drug delivery system. In the case of biochar preparation, Durian pell and mongosteen skin were chosen as starting materials due to their hard skin and high carbon content. The properties of biochar productions from those two fruits were varied from both choices of feedstock and process conditions. The biomass transformation to long-lived soil carbon species yields in a long term of carbon sink.

The aim of this research was the preliminary investigation of the production of lactic acid derived from the four thai tropical fruits. The local fruits were Durian, Mango, Mangosteen, and Marian Plum. Physical and chemical properties, including turbidity were under examined. The productions of lactic acid were monitored. In addition, the reducing sugar was analysed via UV-Visible spectrophotrometry at 540 nm by the reaction between the fermented solution and 3,5-dinitrosalicylic acid. In addition, some physical and chemical properties of biochars derived from Durian peel and Mangosteen rind were also characterized. Heavy metal determinations of those biochars were analyzed via ICP-OES. Heat of combustion was also recorded via bomb calorimeter.

Experimental
Lactic Acid Preparation
Four extracted juices of each unsold local tropical fruits, Durian, Mango, Mangosteen, and Marian Plum, from Taradd Thai were collected. The microorganism food was prepared using MRS formula. The microorganism, *Lactobacillus plantarum*, was chosen for the fruit juice fermentations to generate the lactic acid.

- Reducing sugar determination
The reducing sugar was determinated by the reaction of the production of lactic acid. The solutions of dinitrosalicylic and potassium tatrate were prepared and transfered into the sample solution. The standard calibration curve between glucose and absorbance were developped.

- Turbidity determination
The *Lactobacillus plantarum* was selected to ferment unsold juice extracts for the growth of the microorganism for the turbidity determination. The turbidity of each solutions was then characterized at 600 mn using UV-Visible spectrophotometer.

- pH

The pH determination was detected by a pH meter and the meter was then calibrated with the standard solution pH with the two-point calibration at pH=4 and pH=7. The pH of the fermented solutions were then measured. Furthermore, another method for pH determination was the titration of the fermented solution with standard sodium hydroxide (0.01 N). The conversion of lactic acid was calculated.

- Monitoring of Lactic Acid

The progress of fermented juice fruits were monitored by FTIR spectrophotometry focusing on the gaining of C=O peak every 12 hours.

Biochar Preparation

One hundred and fifty grams of durian peel were accurately weighed and transferred into a tray. An oven was preheated to 85 ^{o}C. The tray with Durian peel was placed into an oven and left for 60 hours. The dried Durian peel was kept at room temperature. For Mangosteen rind, the drying process of the waste was repeated dried method was repeated as similar to Durian peel. The dried material was transfered into a metal furnace. The furnace was sealed and heated without oxygen. The Heat of Combustion Determination was determined by Bomb Calorimeter.

- Calcium and Magnesium Determination

The accurated weigh of grinded biochar was placed to porcelain. The 15 mL of the distilled water, 5 mL hydrofluoric acid and 10 mL of concentrated HNO_3 were also added. The porcelain was heated and stirred carefully. The solution was left to ambient temperature. The dilutions were prepared and characterized via ICP.

Results and Discussion

The determination of reducing sugar was shown in Table 1. From Table 1, extracted solution from Durian was displayed the highest amount of reducing sugar content. When the time of fermentation was more forty-eighth hour, the reducing sugars of four local tropical fruits from Taradd Thai were reduced less than half. When the fermentation time was 72 hrs, the percentage of reducing sugar was less than 6%.

Table 1 Percentage of reducing sugar of four tropical fruits after fermentation with Lactobacilus plantarum (%w/w)

Fruits	Percentage of Reducing Sugar (%w/w)	Percentage of Reducing Sugar (48 hrs) (%w/w)	Percentage of Reducing Sugar (72 hrs) (%w/w)
Durian	58.7	16.2	5.6
Mangosteen	35.3	9.7	3.1
Marian Plum	43.5	13.8	4.9
Mango	50.9	14.4	5.0

The turbidity of microorganism was related to the amount of lactic acid due to the dead bacteria after the consumption of sugar (Table 2). It was found that the absorbance at 600 nm of the Durian extracted juice was the highest (1.5637) and then

followed by the Mango extracted juice (1.5008), Marian plum extract juice (1.3211) and Mangosteen extract juice (0.6180), repectively.

Table 2 Turbidity of the extracted juices from the local fruits after the fermentation (absorbance at 600 nm)

Fruits	Absrobance at 36 hrs (at 600 nm)
Durian	1.5637
Mangosteen	0.6180
Marian Plum	1.3211
Mango	1.5008

Figure 1 was shown the fermentation progress of *Lactobacilus plantarum* over Marian plum juice. The results showed the increasing of carboxyl peak of carboxylic acid peak at 1,634 cm^{-1} at 12, 24 and 36 hours via FTIR. The top line represented the C=O peak at 12 hrs while the mid line nominated the C=O peak at 24 hrs. The C=O peak at 36 hrs was the bottom line. This indicated that the increasing of C=O peak was related to the reaction time to consumption of reducing sugar. The results found that the optimum time to generate the highest amounts of lactic acids was at 50 hrs.
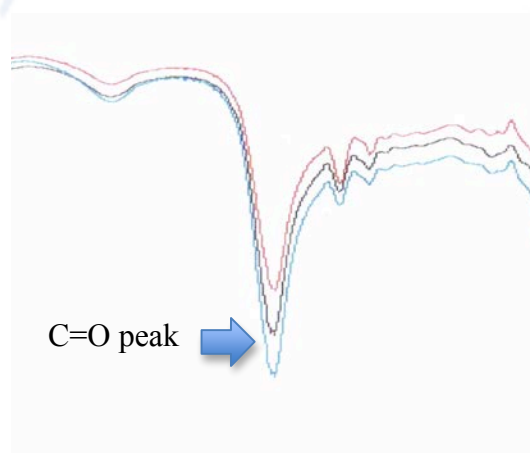

C=O peak

Figure 1 The C=O peak lactic acid production from the fermentation of Marian plum juice using *Lactobacillus plantarum* at varied times (top line) 12 hours (mid line) 24 hours (bottom line) 72 hours

Table 3 displayed that production of biochar from Taradd Thai waste market. The percentage of biochar production from Durian peel was 43.55 while the percentage of biochar from mangosteen rind was 49.33. Moreover, from 1 g of biochars, the combustion heat from Durian peel was 203.619 kJ whereas the combustion heat from mangosteen rind was 157.247 kJ.

Both calcium and magnesium contents were determined using ICP spectrophotometry as shown in Table 3 as well.

Table 3 Percentage of produced biochar, heat of combustion and metal determinations

Materials	% Biochar production(SD)	Average energy	Ca (ppm)	Mg (ppm)
Durian Peel	43.55 (2.44)	48.666 kcal (203.619 kJ)	1.458	99.179
Mangosteen Rind	49.33 (2.89)	37.583 kcal (157.247 kJ)	0.540	2.572

From Table 3, the mangosteen rind biochar was found with lower amount of both cases of Ca (0.540 ppm) and Mg (2.572 ppm) comparing to Durian peel biochar [Ca (1.458 ppm) and Mg (99.179 ppm)].

Acknowledgement

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Eucalyptus Bottom Ash from Paper Industries for Stoneware Pottery Glaze

Sekporn Tansripraparsiri, Valaya Alongkorn Rajabhat University, Thailand

Abstract
Generally, in paper industries, the stems of eucalyptus were only used in the production process. Therefore, branch and leaves of eucalyptus were left and considered as unwanted materials. They were destroyed via the waste combustion process. Then, the eucalyptus bottom ash was become residues. In order to protect the environment and to increase the valuable of the bottom ash from eucalyptus, the eucalyptus ash glaze in Ratchaburi potteries was performed using triaxial diagram table. The clay in this stoneware pottery was chosen from Ratchaburi Province. After that, the glazing formula was then created. The gas kiln was selected. The temperature of reduction fire for glazing was 1,240 degree Celsius. The fifteen testing formula were tested by the variation of eucalyptus bottom ash, soda feldspar, and kaolin. The suitable ratio among of glaze formula eucalyptus ash : soda feldspar : kaolin was eucalyptus ash 5:3:2, respectively. The Stoneware Pottery prototypes were shaped as teapot set by the throwing method. The results showed that the glaze of all products was semi-matt with golden brown color. This developed glazing process was well performed in the Ratchaburi pottery industries. In addition, the mixing between Eucalyptus bottom ash and metal oxides are under investigation to creat a variety of color shades.

Keywords: eucalyptus ash glaze, soda feldspar, kaolin

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Introduction

Generally, in paper industries, the stems of eucalyptus were only used in the production process. Therefore, branch and leaves of eucalyptus were left and considered as unwanted materials. They were destroyed via the waste combustion process. Then, the eucalyptus bottom ash was become residues. In order to protect the environment and to increase the valuable of the bottom ash from eucalyptus, the eucalyptus ash glaze in Ratchaburi potteries was performed using triaxial diagram table. The clay in this stoneware pottery was chosen from Ratchaburi Province.

Objective

To study the suitable glazing ratio of eucalyptus bottom ash, soda feldspar and kaolin for stoneware pottery glazing.

Scope

1. The ingredients for stoneware pottery glazing were eucalyptus bottom ash, soda feldspar and kaolin.
2. The Suitable mixing ingredient was obtained from triaxial diagram table with 15 formula using eucalyptus bottom ash as the main ingredient.

Experimental section

1. The steps of stoneware pottery glazing via the eucalyptus bottom ash were shown as follows.

    1.1 The eucalyptus bottom ash from paper industries as agricultural waste disposal was collected.

    1.2 The eucalyptus bottom ash was soaked with water and left for 12 hour.

    1.3 The excess water was drained out and water was added into the ash. (repeat for 5 times)

    1.4 The ash was well grind and passed the 100 mesh sieve. The ash was then dried for an overnight.

2. The steps to select the suitable eucalyptus ash glazing formula.

    2.1 Each of in ingredients was well-weigh using the digital balance.

    2.2 Each formula was well-grinded for 10 minutes.

    2.3 Testing material was dipped in the prepared solution for 4 sec.

    2.4 The dipped testing material was fired at 1,240 degree Celsius in the reduction atmosphere.

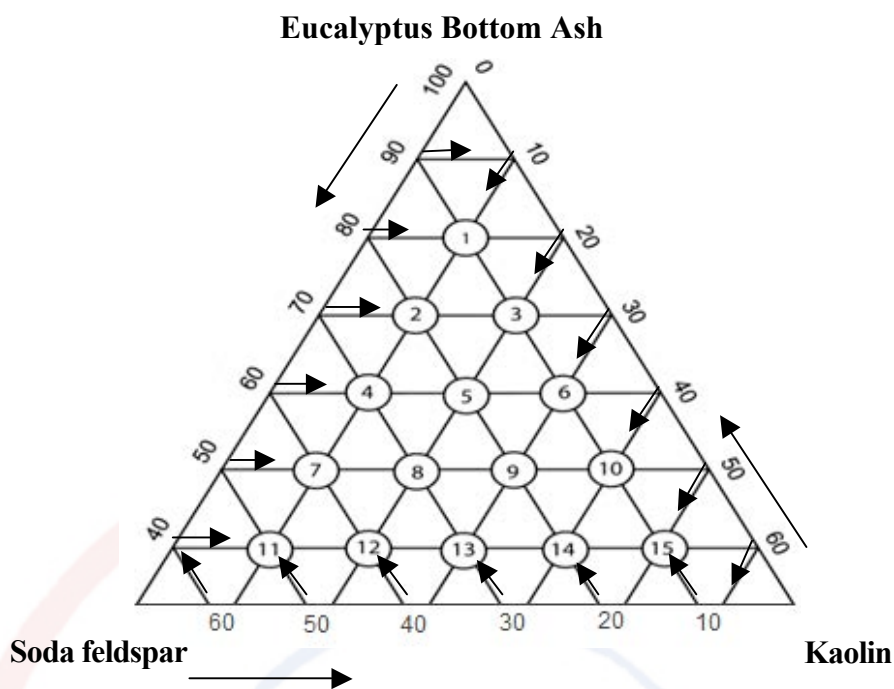   2.5 The testing material well glaze was chosen as a model for teapot set product.

Eucalyptus Bottom Ash

Fig 1. Triaxial diagram table for glazing formula
(Robin Hopper. 2009)

From triaxial diagram table, the 15 formula of eucalyptus ash glazing ratio were displayed in Table 1.

Table 1. The 15 formula of eucalyptus ash glazing ratio.

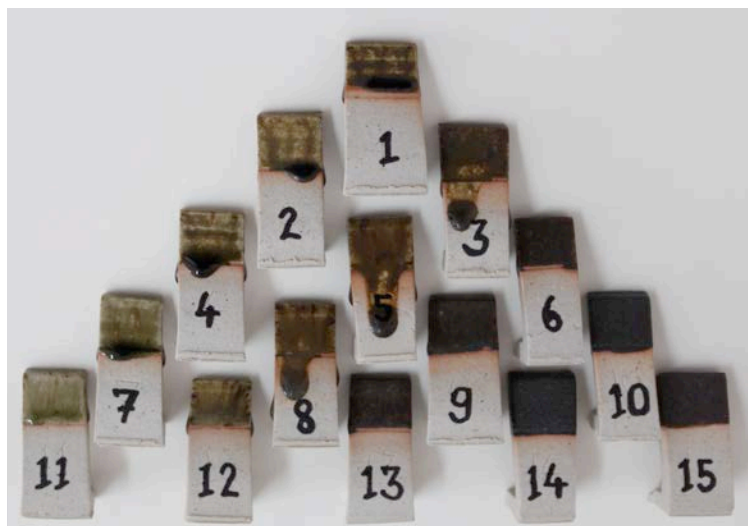| Formula	Eucalyptus Bottom Ash (%)	Soda feldspar (%)	Kaolin (%)
1	80	10	10
2	70	20	10
3	70	10	20
4	60	30	10
5	60	20	20
6	60	10	30
7	50	40	10
8	50	30	20
9	50	20	30
10	50	10	40
11	40	50	10
12	40	40	20
13	40	30	30
14	40	20	40
15	40	10	50

Fig 2. Glazing properties from 15 formula of eucalyptus ash glazing ratio.

Result and Discussions
The research process was followed as mention in the previous part. The various properties of glaze after firing at 1,240 degree Celsius in reduction atmosphere were discussed. The results were exhibited in Table 2.

Table 2. Physical properties derived from eucalyptus bottom ash, soda feldspar and kaolin after firing at 1,240 degree Celsius in reduction atmosphere.

Formula	Glazing properties		
	color	**Gloss / Semi-matt/ Matt**	**Characteristics**
1	Yellow brown	Semi-matt	Semi-opaque
2	Yellow brown	Semi-matt	Semi-opaque
3	Yellow brown	Semi-matt	Semi-opaque
4	Yellow brown	Gloss	Transparent
5	Golden brown	Semi-matt	Semi-opaque
6	Brown	Semi-matt	Opaque
7	Light- green brown	Gloss	Transparent
8	Golden brown	Semi-matt	Semi-opaque
9	Brown	Semi-matt	Opaque
10	Dark brown	Matt	Crawling
11	Light- green brown	Gloss	Transparent
12	Light- green brown	Gloss	Semi-opaque
13	Brown	Semi-matt	Opaque
14	Dark brown	Matt	Crawling
15	Dark brown	Matt	Crawling

The 8th formula was chosen due to the semi-matt. The suitable ratio among of glaze formula eucalyptus ash : soda feldspar : kaolin was eucalyptus ash 5:3:2, respectively. The Stoneware Pottery prototypes were shaped as teapot set by the throwing method.

The results showed that the glaze of all products was semi-matt with golden brown colour. This developed glazing process was well performed in the Ratchaburi pottery industries. In addition, the mixing between Eucalyptus bottom ash and metal oxides are under investigation to creat a variety of colour shades.

Fig 2. Teapot set from the 8th eucalyptus ash glaze formula.

From Fig 2, The teapot set was contained with a throwing Japanese style teapot and four throwing Japanese teacups.

Acknowledgement

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Modeling for Extreme Rainfall in Lower Northeastern of Thailand

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Bungon Kumphon, Mahasarakham University, Thailand

Abstract

The purpose of this research is to model extreme rainfall in lower northeastern of Thailand by using the Generalized Extreme Value Distribution (GEV) and Generalized Pareto Distribution (GPD). The daily rainfall, which are obtained from the Meteorological Department of Thailand, during January 1982 to September 2013; 149,475 values, from eleven stations in the lower northeastern of Thailand are studied. The source code from analyzing the data was provided by R program with extreme function in extRemes library. It is able to directly model a data for each station by using GEV distribution and GPD with stationary process and also estimate the return levels for various return periods. The study finds that the best model is Fréchet distribution and Exponential distribution for GEV distribution and GPD, respectively. Since the Si Sa Ket Agromet station which is set at Muang district of Srisaket province has a highest return level from various return periods for both models, so it should be the first consideration for the preventing or reducing the severity of floods.

Keywords: generalized extreme value, generalized pareto distribution, return period and return level

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1. Introduction

The problem of flooding in Lower Northeast region of Thailand occurs almost every year and is likely to be more severe because of the world climate change. In August to October 2013, this area had big floods because of heavy rain; especially Srisaket, Surin and Ubon Ratchathani province (Meteorological Report, 2013). Model of Lower Northeast region rainfall can have significant value for resources planning and management, e.g. reservoir operations, agricultural practices, and flood emergency responses. In particular increased population stress on the Moon River basin, one of the key regions for Lower Northeast's socioeconomic well-being, is resulting in water quantity and quality problems. To mitigate this, effective planning and management of water resources is necessary. If amount of rainfall at each probabilities level and each return periods for this area can be calculated then the farmers will use both of them for choose suitable crops and managing the efficient crops system that appropriate in their any areas.

For a long period of time, phenomenological cases of extreme events have been studied. For example which is worth to be mentioned is a water levels record of Nile, which have recorded the lowest and highest water levels for over 5000 years in order to analyze hunger or disasters when the levels are too low or too high (Albeverio et al., 2005). As to the statistical method, Fisher and Tippett (1928) first explored extreme value theory then Gnedenko (1943) formalized extreme value distribution to which block maxima converges (Faranda et al., 2011). Over the last 50 years, extreme value theory has been used widely in applied sciences and various disciplines, such as physical, financial markets, insurance industry, environment, failure cases, and so on (e.g., Coles, 2001).

This paper mainly focuses on the analysis of daily rainfall because this area is the agricultural area, the major of framers need to used rainfall for planting. The extreme value theory are applied; GEV distribution and GPD. In Section 2 presents the definitions and theories related to extreme value theory, and estimation methods which are used for empirical analysis. Then, description of empirical analysis of data set is presented in section 3 and the estimation process and the results are shown in Section 4. Finally, a conclusion of the estimation results in daily maxima rainfall is shown in section 5.

2. Background

The theory states that under certain regularity conditions, if the maximum or minimum of random variable taken over suitably large blocks have a non-degenerate distribution, then that distribution must be the generalized extreme value (GEV) distribution. Similarly, for excesses over a suitably high threshold, analogous results state that their distribution is generalized Pareto distributions (GPD) (e.g., Coles, 2001).

2.1 The Generalized Extreme Value (GEV) Distribution

In the block maxima method is supposed to have observed the maximum value of some quantities over a number of 'blocks', a typical example being that a black is a month and the observed quantities may be some environmental quantity such as the rainfall data set at a specific location. In this paper, monthly rainfall in space and time can provide guidelines for crop scheduling, better cropping patterns and the planning and design of water resources development projects.

Suppose $X_1, X_2, ..., X_n$ be a sequence of independent variable with common distribution function $F(x)$, the maximum value of random variable $X_1, X_2, ..., X_n$ is $X_{(n)} = \max(X_1, X_2, ..., X_n)$. The cumulative distribution function (cdf.) of the GEV distribution is (Coles, 2001)

$$F(x) = \exp\left\{-\left(1 + \xi \frac{x-\mu}{\sigma}\right)^{-1/\xi}\right\},$$ (1)

and its probability density function (pdf.) is as follow,

where $1 + \xi\left(\dfrac{x-\mu}{\sigma}\right) > 0$, $-\infty < \mu < \infty$, $\sigma > 0$ and $-\infty < \xi < \infty$.

The GEV distribution has three parameters; μ is location parameter which specifies the center of distribution, σ is scale parameter which determines the size of deviations of μ and ξ is shape parameter which shows how rapidly the upper tail decays.

The representation of Eq.(1) is combined single model which can lead to three types of non-degenerate distribution function families, i) Gumbel family which corresponds to case $\xi = 0$ i.e., GEV family with limits as $\xi \to \infty$, ii) Fréchet family which corresponds to case $\xi > 0$ of GEV family and iii) Weibull family which corresponds to case $\xi < 0$ of GEV family.

2.2 Generalized Pareto distribution (GPD)

In 1975, Pickands proposed "GPD" and it was gained wide acceptance in the EVT. It has all the flexible of exponential distribution and it was developed by Leadbetter et al. (1983). This method considers, instead of annual maxima, excess over a sufficiently high threshold in the time series (Mendes, 2010; Peter, 2011). Hence, the data set is enlarged to decrease the sampling uncertainty. As the meteorological variables tend to present successive dependent extreme values, the technique of de-clustering was applied, which considers successive extremes as belonging at the same event.

This method is supposed to have observed all values which are larger than some suitable threshold, for example all rainfall data in excess of 80 mm. These values are then assumed to follow the GPD function.

It is natural to regard as extreme events those of the x_i that exceed some high threshold, u. For large enough u, the distribution function of $x_i - u$, conditional on $x_i > u$, is approximately, (Coles, 2001)

$$H(y) = 1 - \left(1 + \frac{\xi y}{\tilde{\sigma}}\right)^{-1/\xi}$$ (3)

defined on $\{y : y > 0, 1 + \xi y/\tilde{\sigma} > 0\}$, $\tilde{\sigma} = \sigma + (u - \mu)$ and with scale parameter σ $(\sigma > 0)$ and shape parameter ξ $(-\infty < \xi < \infty)$. If $\xi > 0$ $(\xi < 0)$ then the GPD is simplified into the Pareto (Gamma) distribution. For $\xi \to 0$, GPD is simplified into the Exponential distribution. The family of distribution defined by (1) is called the generalized Pareto family. Denote by σ_u the value of the GPD scale parameter for a

threshold of $u > u_0$, where $\sigma_u = \sigma_{u_0} + \xi(u - u_0)$, so that the scale parameter changes u unless $\xi = 0$. A modified scale is obtained by reparameterising the GPD scale parameter as $\sigma^* = \tilde{\sigma} - \xi u$. A threshold μ_0 is selected as the lowest value of u for which the estimates of σ^* and ξ remain near constant and the probability density function (cdf.) of GPD is

$$h(y) = 1 + \left[\xi\left(\frac{y-\mu}{\sigma}\right)\right]^{\left(-\frac{1}{\xi}\right)} \tag{4}$$

where $\sigma > 0$ and $-\infty < \xi < \infty$.

2.4 Return Levels

Return values contain two quantities: return period $\frac{1}{p}$ and return level (recurrence interval), z_p. For annual maxima as an example, return level is an estimated high value of annual maxima temperature which is expected to be exceeded in any year during return period $\frac{1}{p}$ with probability p where $0 < p < 1$.

2.4.1 Return Level of GEV

In term of quantiles, take $0 < p < 1$ and define

$$z_T = \mu - \frac{\sigma}{\xi}\left\{1 - \left[-\log(1-p)\right]^{-\xi}\right\}, \tag{8}$$

where $p = \frac{1}{T}$. The MLE of return levels can be found interval confidence $100(1 - \alpha)\%$ for $\hat{Z}_T$ as shown the equation,

$$I_{\hat{Z}_T} : \hat{Z}_T \pm Z_{\frac{\alpha}{2}}(\sqrt{V(\hat{Z}_T)}) \tag{9}$$

2.4.2 Return Level of GPD

Suppose GPD has σ and ξ parameter was an appropriate model for the data is higher than u, that note where $Y > u$, can be written the probability function as,

$$\Pr\{Y > y\} = \varsigma_u\left[1 + \xi\left(\frac{y - u}{\sigma}\right)\right]^{-\frac{1}{\xi}}, \tag{10}$$

where $\xi_u = \Pr\{Y > u\}$, return levels note that mean of exceedances over threshold u, for all m observation is as

$$\varsigma_u\left[1 + \xi\left(\frac{y_m - u}{\sigma}\right)\right]^{-\frac{1}{\xi}} = \frac{1}{m} \tag{11}$$

Consider the change of equation is

$$\hat{y}_m = u + \frac{\sigma}{\xi}\left[(m\varsigma_u)^{\xi} - 1\right] \quad, \quad \text{if } \xi \neq 0 \tag{12}$$

where $\hat{y}_m$ is return level of for all of m - observation, if number of observation n_y per year, where N is number of year calculating from $m = N \times n_y$. Therefore, return level of N year is

$$\hat{Y}_N = u + \frac{\sigma}{\xi}\left[(Nn_y\varsigma_u)^{\xi} - 1\right], \text{ if } \xi \neq 0 \tag{13}$$

and the interval confidence $100(1-\alpha)\%$ for $\hat{Y}_N$ is

$$I_{\hat{Y}_N} : \hat{Y}_N \pm Z_{\frac{\alpha}{2}}(\sqrt{V(\hat{Y}_N)}) \tag{14}$$

3. Research Methodology
3.1 Data
This study, the maximum rainfall data of lower northeast of Thailand are used to analyze. They are obtained from the Meteorological Department of Thailand during January 1, 1982 to September 30, 2013 for eleven meteorological stations; Chaiyaphum(CP), Chokchai(NM1), Nakhon Ratchasima(NM2), Pak Chong Agromet(NM3), Nang Rong(BR), Surin Agromet(SR1), Surin(SR2), Tha Tum(SR3), Si Sa Ket Agromet(SK), Ubon Ratchathani Agromet(UB1) and Ubon Ratchathani(UB2), which are located in six provinces; Chaiyaphum, Nakhon Ratchasima, Burirum, Si Sa Ket, Surin and Ubon Ratchathani. The locations and summary statistics of the corresponding data sets are showed in Table 1.

Table 1 Locations and some summary statistics of data

Location	Latitude	Longitude	Mean	Median	Max	Skewness
CP	15.48.0.0	102.2.0.0	11.49	4.60	162.5	5.248
NM1	14.43.8.0	102.10.7.0	9.72	4.00	147.5	5.764
NM2	14.58.5.9	102.5.9.7	10.09	3.80	129.7	5.404
NM3	14.38.38.0	101.19.55.0	9.42	3.90	145.9	5.022
BR	14.35.0.0	102.48.0.0	10.44	4.40	130.5	5.352
SR1	14.53.0.0	103.30.0.0	12.57	5.20	241.6	5.618
SR2	14.53.0.0	103.27.0.0	12.21	5.30	279.5	5.582
SR3	15.19.0.0	103.41.0.0	12.75	5.70	177.7	5.245
SK	15.0.0.0	104.3.0.0	13.69	6.15	263.4	6.059
UB1	15.14.20.9	105.1.24.6	12.96	5.60	254.3	5.038
UB2	15.15.0.0	104.52.0.0	13.79	6.40	173.1	4.952

The package "Extreme" in R program is used which is able to perform parametric inferential analysis of the GEV and GPD distribution for each location in the phenomena listed above.

Fig. 1 Geographical distribution of the eleven stations in lower northeast Thailand

3.2 Analysis of GEV and GPD
The analysis of GEV is formed of three steps; 1) to find the block-maxima to define the extreme rainfall as the maximum of monthly rainfalls within each year, 2) to find the estimates of parameters in the GEV distribution by using maximum likelihood estimation (MLE) method.

Respect to the analysis of GPD is also formed of two steps; 1) to find the extreme rainfall as the maximum of excess over threshold is used. The values of threshold and the number of excesses for each location are presented in Table 4. The GPD is fitted to the tails of daily maxima rainfall data using threshold around 46.6-63.3 mm. (fixed percentile method at 99th) for each stations, 2) the MLE is used with R program. Notice that thresholds are selected similarity to the Meteorological Department of Thailand's criterion for highest rainfall stage.

4. Results of Extreme Value Theory

All estimation and calculation in empirical analysis are implemented in R with package extRemes. First a GEV model will be studied in order to get an overall idea of the annual maxima, this is compared to the GPD method; then follows the analysis of rainfall (the quantities mentioned earlier: frequency, duration, and mean maxima).

4.1 Results of GEV

As introduced above, the estimation of parameter in GEV distribution could be done by MLE method. The results of GEV are shown in Table 2.

Table 2   Locations, scale, and shape parameters of GEV distributions

Locations	μ	σ	ξ
CP	16.55(13.83,19.27)	19.53 (17.24,21.82)	0.22(0.06,0.38)
NM1	16.09(13.67,18.51)	18.37(16.35,20.39)	0.22(0.08,0.36)
NM2	15.98(13.52,18.44)	18.33(16.27,20.39)	0.23(0.08,0.38)
NM3	10.49(8.16,12.82)	14.15(12.02,16.28)	0.49(0.24,0.74)
BR	17.44(14.87,20.01)	19.56(17.44,21.68)	0.20(0.06,0.34)
SR1	19.08(16.04,22.12)	22.32(19.75,24.87)	0.24(0.09,0.39)
SR2	18.39(15.36,21.42)	21.88(19.32,24.44)	0.23(0.07,0.39)
SR3	17.25(13.89,20.61)	21.53(18.58,24.48)	0.34(0.13,0.55)
SK	14.11(10.52,17.70)	19.19(15.85,22.53)	0.57(0.28,0.86)
UB1	16.83(13.36,20.30)	21.46(18.40,24.52)	0.33(0.11,0.55)
UB2	16.19(12.59,19.79)	21.20(17.96,24.44)	0.42(0.17,0.67)

Table 2 gives the details of location, scale, and shape parameters of GEV. Notice that Shape parameter (ξ) values is positive; this implies upper bounded distribution. The 95% confidence intervals are also on the positive side. These are indicated that data are best fitted by the Fréchet distribution at all stations.
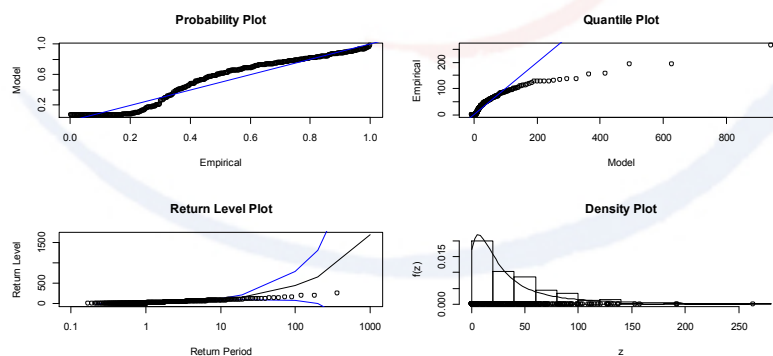

Fig.2 Diagnostic plots for GEV fit to the monthly maxima rainfall at at Si Sa Ket Agromet (SK)

Fig. 2 shows various diagnostic plots for the results of MLE of GEV fit at Si Sa Ket Agromet (SK) Station. The probability plot (P-P Plot) and quantile plot (Q-Q plot) appears approximately linear. This indicates the validity of the MLE fitting result of GEV distribution.

Table 3 Return levels, 95% confidence intervals associated with different return periods for GEV

Location	Return Periods			
	10-years	25-years	50-years	100-years
CP	73.60(65.69,85.72)	107.62(90.94,138.79)	137.93(110.54,194.17)	173.09(130.93,267.48)
NM1	69.43(62.21,79.97)	**101.00(86.34,126.52)**	**129.01(105.34,173.89)**	**161.39(125.27,235.26)**
NM2	69.66(62.28,80.56)	101.77(86.47,128.72)	130.42(105.47,178.27)	163.71(125.38,243.10)
NM3	**68.97(58.21,91.42)**	121.07(90.68,203.19)	178.98(120.72,363.87)	260.26(156.98,645.41)
BR	72.78(65.44,83.33)	104.49(89.87,119.57)	132.14(108.77,175.68)	163.63(128.33,234.38)
SR1	85.53(76.26,99.51)	126.11(106.70,161.47)	162.73(130.89,226.35)	205.68(156.49,312.51)
SR2	82.86(73.89,96.63)	121.72(102.92,157.38)	156.55(125.72,221.20)	197.15(149.66,306.17)
SR3	89.77(78.08,110.19)	141.15(112.71,202.45)	191.41(141.28,312.77)	254.60(172.64,477.28)
SK	**101.69(82.99,146.36)**	**188.38(133.14,365.01)**	**290.67(181.27,722.72)**	**441.88(270.00,969.99)**
UB1	88.89(77.22,110.91)	139.75(11.20,209.01)	189.39(139.08,329.23)	251.70(169.53,512.34)
UB2	96.08(81.74,125.72)	160.45(122.50,262.83)	228.04(158.05,448.63)	318.39(198.92,759.39)

Table 3 gives the details of return levels and theirs 95% return levels confidence intervals of each location. For 10-years return period, the SK has maximum return levels but the NM3 has minimum return levels. For 25-, 50- and 100-years return period, the SK has maximum return levels but the NM1 has minimum return levels. It is clearly to show by the plots for various return periods as in Fig. 3.
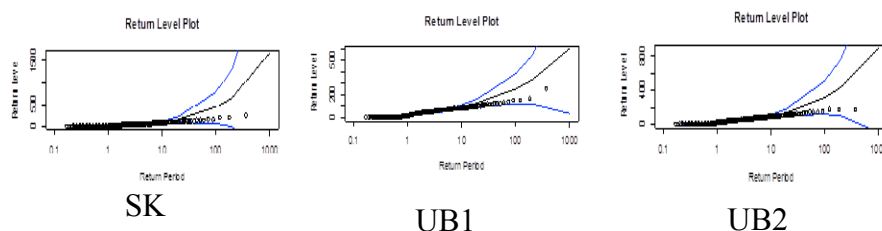

CP   NM1   NM2   NM3

BR   SR1   SR2   SR3
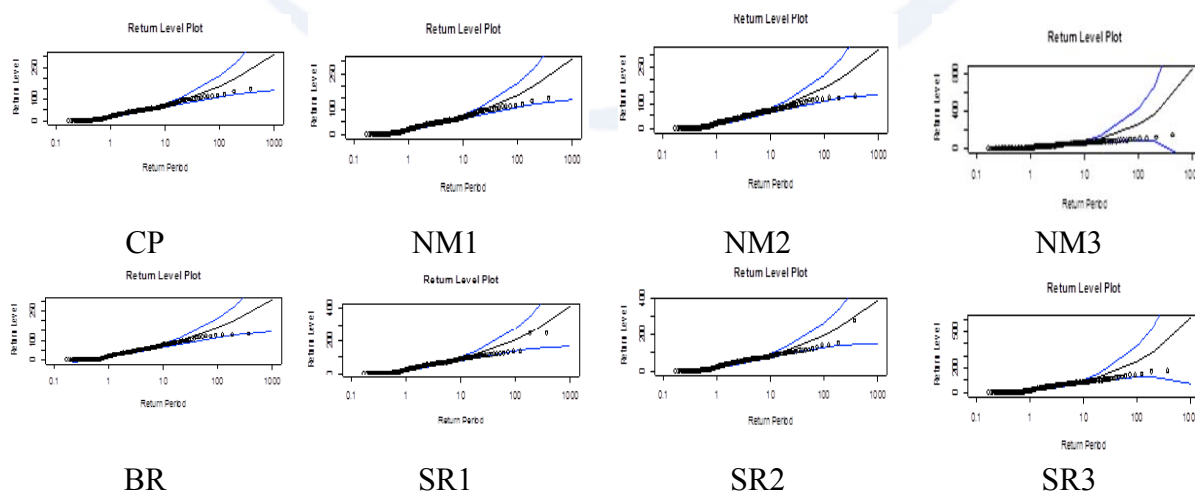
Fig. 3 Return level (mm.) of GEV distribution associated with 10-, 25-, 50-, and 100-year return period of each location.

4.2 Results of GPD

As to the MLE of return values estimation with GEV, method has been presented in 4.1. The corresponding results of GPD are shown in Table 4. And the MLE return level associated with a range of return period between 0 and 100 years is shown in Fig. 4, also.

Table 4 Scale and shape parameters of GPD distributions with the best fitting distribution

Location	u (mm.)	No. of excesses	σ	ξ
CP	51.6	112	18.92(14.02,23.82)	0.03(-0.15,0.21)
NM1	46.6	112	20.75(14.20,27.29)	0.03(-0.22,0.28)
NM2	49.2	113	20.91(14.93,26.89)	-0.06(-0.28,0.16)
NM3	50.1	113	19.56(15.09,24.03)	-0.10(-0.24,0.04)
BR	48.7	110	24.52(17.52,31.79)	-0.11(-0.35,0.13)
SR1	57.4	111	19.88(14.18,25.58)	0.16(-0.06,0.38)
SR2	60.8	113	20.99(15.66,26.32)	0.10(-0.08,0.28)
SR3	60.5	108	20.88(15.04,26.72)	0.06(-0.16,0.28)
SK	60.5	112	27.68(19.86,35.50)	0.09(-0.13,0.31)
UB1	62.1	112	17.78(12.64,22.92)	0.17(-0.05,0.39)
UB2	63.3	113	27.30(19.87,34.73)	-0.05(-0.25,0.15)

Table 4 shows the thresholds selected above with the excesses were fitted to the GPD with the number over the respective thresholds for each station. The parameters of distributions fit by the GPD model for excesses with the best fitting distribution are also shown. Shape parameter (ξ) values indicate that data were best fitted by the exponential distribution at all stations and theirs 95% confidence intervals are good agreement. As can be seen in Fig.5, most reanalysis data fall within the up to 25 years return periods suggesting that the strong rainfall.
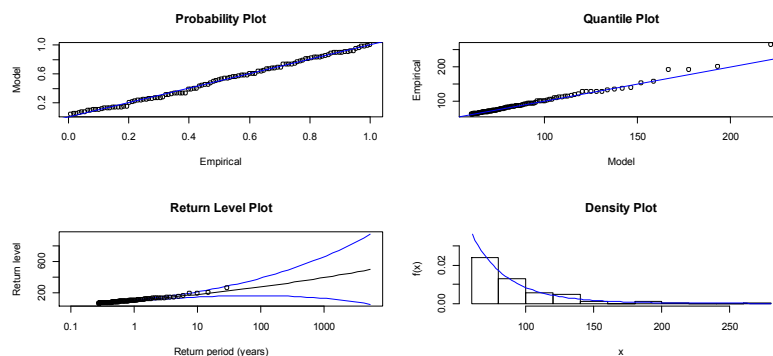
Fig.4 Diagnostic plots for GPD fit to the monthly maxima rainfall at Si Sa Ket Agromet (SK)

Fig. 4 shows various diagnostic plots for the results of MLE of GPD fit at Si Sa Ket Agromet (SK). The probability plot (P-P Plot) and quantile plot (Q-Q plot) appears approximately linear. This indicates the validity of the MLE fitting result of GPD. The corresponding estimate for such a for 10-, 25-, 50-, and 100- year return levels values and 95% confidence intervals are presented in Table 5.

Table 5   Return levels, 95% confidence intervals associated with different return periods for GPD

Location	Return Periods			
	10-years	25-years	50-years	100-years
CP	123.61(110.15,151.25)	143.43(123.86,192.37)	158.83(133.36,230.49)	174.59(142.11,275.91)
NM1	125.19(109.65,163.99)	146.71(122.61,220.48)	163.38(130.93,275.98)	180.41(138.15,345.51)
NM2	117.33(105.88,143.25)	132.64(116.23,178.12)	143.72(122.59,209.21)	154.38(127.86,244.98)
NM3	**107.20(98.58,122.24)**	**119.07(108.28,142.41)**	**127.34(114.71,158.59)**	**135.05(120.39,175.60)**
BR	122.55(111.35,149.07)	136.79(121.06,182.65)	146.63(126.65,211.62)	155.73(131.02,243.99)
SR1	156.65(134.74,210.04)	191.29(155.92,299.29)	221.04(171.85,394.99)	254.24(187.62,524.43)
SR2	147.62(129.19,185.99)	176.42(148.77,247.21)	200.04(163.34,307.12)	225.35(177.65,381.94)
SR3	143.98(127.57,181.06)	168.03(143.14,236.92)	187.08(153.84,291.11)	206.88(163.62,358.24)
SK	**177.52(153.04,233.76)**	**213.97(176.41,320.88)**	**243.60(193.07,408.04)**	**275.13(208.81,518.99)**
UB1	150.74(130.06,200.56)	183.77(149.87,285.15)	212.51(164.84,376.68)	244.94(179.76,501.53)
UB2	152.46(137.68,184.26)	172.54(151.79,227.36)	187.07(160.69,265.24)	201.07(168.24,308.28)

Table 5 gives the details of 95% return levels confidence intervals of each location. Notice that, the return levels of SK is higher than another location and the return levels of NM3 is lower than another location for all return period.
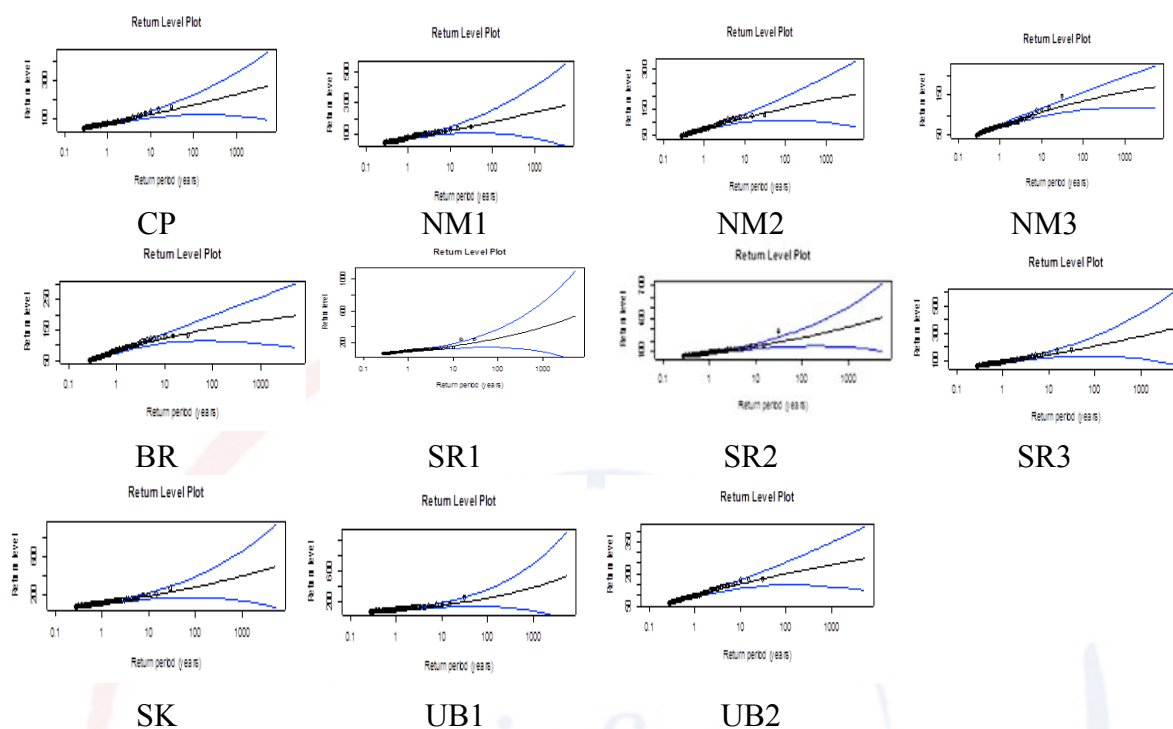

CP   NM1   NM2   NM3

BR   SR1   SR2   SR3

SK   UB1   UB2

Fig. 4 Return level (mm.) of GPD distribution associated with 10-, 25-, 50-, and 100-year return period.

5. Conclusions

The extreme rainfall in Thailand's lower northeast region is occurred during the middle of May through the middle of October in every year. A statistical modeling of the annual maximum rainfall data of eleven locations in this region is developed by selecting from geographical origin of the main river sources, Moon River. By using the GEV distribution and GPD, the Fréchet distribution and the Exponential distribution is the best model selection which had an evidence of stationary for all stations, respectively. The return levels and the 95% confidence intervals associated with different return periods; 10, 25, 50 and 100 years, for GEV distribution and GPD are provided. Since the Si Sa Ket Agomet Station (SK) which is set at Muang District of Srisaket province has a highest return level with various return periods for both models, so it should be the first consideration for the preventing or reducing the severity of floods and other water-related natural disasters.

6. Acknowledgements

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Impacts of Climatic Behavior Changes
in the Terroir Elements of Uji Tea Cultivation

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Abstract

Current on-going changes in the behavior of climatic conditions are very much evident with continuous increase in the degree of intensity. These conditions are very alarming for the agriculture industries especially those, which are utilizing unique *terroir* condition of a certain area for their production. Through these changes, the most affected *terroir* elements are climatic factor followed by soil factor, which can be clearly seen in Uji Area green tea cultivation. As the oldest and most famous green tea producing region in Japan, Uji Tea reputation have been built through its *terroir* characteristic and their long-running traditional agriculture knowledge. Changes on the climatic factors have directly affected the timing for leaf bud break thus changed the timing for harvest. Not only changing the period of cultivation process, damages caused by frost, drought, heavy rain and temperature extremities have directly affected the quality and quantity of the tea production. Observation and surveys conducted in Uji showed that it is necessary to develop new cultivation methods, which is based on a climate change adaptation framework. Through the application of this framework, Uji tea farmers would be able to pro-actively adapt with the on-going changes and ensuring the sustainability of Uji area as a tea-growing region.

Keywords: Climate Change, Tea Cultivation, *Terroir*, Traditional Agriculture Knowledge

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1. Uji Tea – Uji-cha

The term of Uji Tea might not be familiar for most people, only those who have a preference in drinking Japanese Green Tea would probably have heard this word. Even so what is commonly understand about Japanese green tea would be *matcha* or *sen-cha*. Based on the definition by Kyoto Tea Cooperative (2006) (Kyoto Prefecture, 2012), Uji Tea is a definition of tea products which are grown in four prefectures: Kyoto, Nara, Shiga and Mie; and processed inside Kyoto Prefecture by a tea manufacturer which based in Kyoto Prefecture. Although this definition has become rather wide, originally the term of Uji Tea is for tea products which are grown and processed in Uji Area in Kyoto Prefecture.

Uji Tea as a trademark and a geographical indication of tea products are widely known inside Japan as it is the mark of high quality teas. Although there are several tea growing regions in Japan such as Shizuoka and Kagoshima, in terms of matcha and *gyokuro* production, these two tea types which are produced in Uji Area are regarded as the benchmark for highest quality tea. Among Japanese tea ceremony instructors and practicioners, it is a tradition to use the best quality matcha, which is of course those which are produced in Uji Area. Similarly gyokuro tea is traditionally served as delicacy to guest during formal meetings as well as other formal occasions.
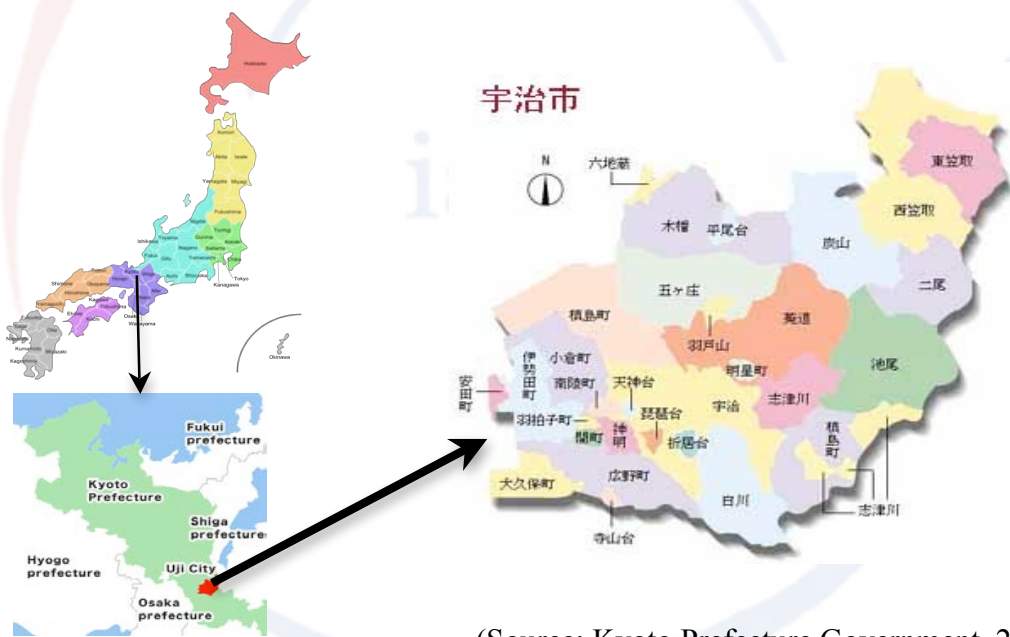
(Source: Kyoto Prefecture Government, 2012)

Fig. 1. Location of Uji Area

Fig. 2. Uji Tea Logo

2. Tea Cultivation in Uji Area

Uji Area also known as Uji City is located in the south of Kyoto City with population of 191,213 as 2014, and a land area of 67.55 km^2. As mentioned previously Uji Area is the most well-known green tea producing region in Japan, with tea cultivation history dating back to 1191 AD. As one of the main reason why the definition of Uji Tea becomes so wide, Uji Area alone only have 81.6 Ha of tea fields whereas to ensure enough production volume, tea leaves from neighboring prefectures are brought inside to Uji Area for processing.

Despite the outsourcing method used by tea manufacturers, the tea farmers in Uji Area retains traditional cultivation methods which relies heavily on manual labor during cultivation process as well as tea harvest. Tea farmers in Uji Area use traditional covering methods in the tea cultivation process, which knowledge of this practice have been passed down through generations of tea farmers.

In this unique method, tea bushes are covered with sunlight blocking materials at the moment of first bud break, which the sunlight intensity is reduced up to 98 percent in three weeks period prior harvesting. Covering materials used in this method are traditionally using woven reeds and straws, although other artificial material like black vinyl sheet is also used. This method contributes directly to the character of Uji Tea flavor and taste. Because of this complex and resource consuming cultivation method, tea harvest in Uji Area can only be conducted once a year.

Fig. 3. Covering method using black vinyl sheet (a); traditional covering method using woven reeds and straws (b) (c) (d); tea bushes under covering method (e); tea harvesting (f)

3. Impacts of Climate Change

Current on-going changes in the climatic conditions have been directly affecting the agriculture and forestry industries, whereas the effects are evident in the tea cultivation especially because tea plants are sensitive towards climatic changes (Ashardiono, 2014). Based on observations climatic changes in Uji Area are: 1) sudden drop in temperature during Spring season; 2) higher temperature during fall season; 3) changes in quantity and period of rainy season; 4) longer period of drought; 5) diminishing morning fog; 5) diminishing characteristic of high quality tea.
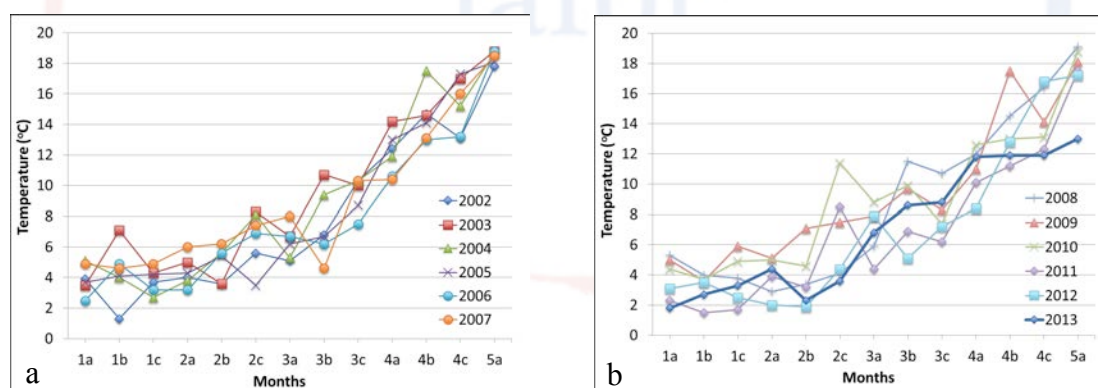
(Source: Kyoto Prefecture Tea Industry Research, 2013)

Note: 1: January; 2: February; 3: March; 4: April; 5: May; a: beginning; b: mid; c: late

Fig. 4. Recorded Average Temperature (°C) between January to May (2002-2007) (a); Recorded Average Temperature (°C) between January to May (2008-2013) (b)

As seen in fig. 4, fluctuations of average temperature are clearly recorded in the year 2002 to 2013. The recorded fluctuations that happened between the year 2002 to 2007 was not as erratic as the fluctuations that happened between 2008 to 2013. Beginning in this term refer to the first ten days of the month, while mid refer to the second ten days, and late refer to the last ten days.
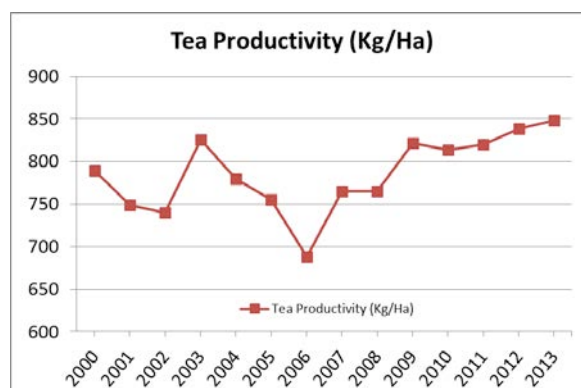
(Source: Kyoto Prefecture Tea Industry Research, 2013)

Fig. 5. Tea Productivity in Uji Area 2002-2013

Observation of these data showed how much changing climatic behavior have been affecting the tea cultivation process in Uji Area. These changes might or might not directly affected the tea harvest yield, but sudden climatic fluctuations will inevitably change the leaf physical composition which automatically affect the quality of the tea harvest. As a continuation of the previous research (Ashardiono & Cassim, 2014), further analysis showed that crucial period for Uji Tea cultivation happened between mid of February to beginning of May.

As a method to further understand the climate change effect towards Uji Tea cultivation, social surveys and observations are conducted on several tea farmers and their tea plantations between late 2013 to early 2014. Currently as there are 113 active tea farmers in Uji Area, whereas this number is actually bigger than what it represent. In each tea farmer's household, at least two to three individual are registered as tea farmer, thus this means the actual number of active tea farmers are only half or one third of the registered number. Through preliminary research, there are 15 tea farmers which cooperated in the social surveys and observations. Although the number is small, each respondent is most likely representing at least two tea farmers from their household, therefore the actual number of respondents would be around 30 farmers.

Interviews are conducted using semi structure method in which it was guided by seven main questions. The questions are structured into: 1) Demographic Information; 2) Agriculture Knowledge; 3) *Terroir* Comprehension; 4) Opinion on Climate Change; 5) Seasonal Cultivation Process; 6) Utilization of Precision Agriculture; and 7) Socio-Economic and Environmental Issues.

On the respondent's age group from 15 farmers, there are 4 farmers in the age group 30-39 years; 9 farmers in the age group 40-49 years; 1 farmers in the age group 50-59 years; and 1 farmers in the age group 60-69 years. Among them 78 percent possess tea cultivation experience for more than 20 years, while 22 percent possess 15 to 20 years of experience. This number correlates with questions about *terroir* comprehension whereas 77 percent of the respondents received knowledge on tea cultivation from their family, while the remaining 23 percent acquired cultivation knowledge through self-experience as well as information from fellow tea farmers. From this data it can be concluded that evidently there are traditional agriculture knowledge passed inter-generations among tea farmers community in Uji Area.
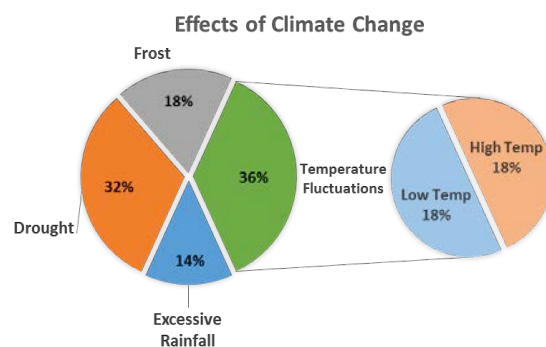
Fig. 6. Climate Change Effects on Uji Area Tea Cultivation

Regarding the questions about climate change effect towards tea cultivation, as seen in fig. 6 generally there are five recorded effects which are drought, frost, excessive rainfall, high temperature and low temperature. Among these events all of the respondents showed their concern especially on longer period of drought and rapid temperature fluctuations whether it is a sudden drop or a sudden climb. These events are seriously affecting not only the harvest yield, but also compromising the quality of harvest.

In response with the climatic changes, the respondents have indicated that there are several changes in the cultivation process such as: early harvesting, late deep soil treatment, early covering, summer covering, and utilization of watering system as well as frost fan. Traditionally, tea farmers in Uji Area previously did not use any watering system, until recently when drought period have become longer and harsher.

Around 69 percent of the respondents rely on external information sources such as television, radio and internet to acquire information on climatic condition, while remaining 31 percent utilized climate measurement equipment such as ordinary thermometer as well as more advanced monitoring station. Developing from the previous question, on the question about precision agriculture system, 62 percent of the respondent did not use any kinds of precision system, while 38 percent are somewhat utilizing the system to a certain extent. The respondents seem to have strong affinity toward soil condition as 54 percent answered that they would like to utilize precision agriculture system for soil management. The remaining answers consist of 23 percent showed their interest in climate control, 8 percent in leaf analysis and 15 percent answered that they are not interested in precision agriculture system.

On the topics on economic and social issues, 77 percent responded that it has becoming more difficult to maintain their household economic condition only with tea cultivation, whereas 23 percent of the respondents are processing and selling their own tea products because for these respondents it is not possible to support their family only with tea cultivation. On a broader discussion it is revealed that out of the current immediate issues faced by the tea farmers in Uji Area, 48 percent is about low sales value of harvested tea leaves, 36 percent on increasing expenses for tea cultivation and 16 percent is on successor problem of the tea plantation.

With the continuing trend of decreasing sales value, some of the tea farmers especially those who have sons, particularly late teens are beginning to show their

concern on the sustainability of the tea cultivation production in Uji Area. Their concern are mostly focused on how to attract the younger generation to continue the tradition of tea cultivation, because at this rate continuation of the tradition is in danger as most of the younger generation will choose to have different job instead continuing their family work.

4. Conclusion and Further Discussion

As mentioned previously although climate change effects are evident, not all of the tea farmers are fully concern about the possible outcome that might happened in the near future. In summary they understand the latent danger if they did not immediately take action to adapt with the rapid changes. Nevertheless as the result of social survey showed, they are more concern about the current economic as well as social situations of Uji Area.

As mentioned in the previous research, in order to swiftly adapt with the on-going climate change, as well as to maintain the economic and environmental sustainability of a climate change affected tea cultivation region, utilization of precision agriculture system is needed as a data gathering tool and to create new agriculture methods (Ashardiono, 2014).

Through analysis of the current Uji Area situation, utilization of precision agriculture system to some extent might further burden the economic condition of the tea farmers, which currently already struggling. Nonetheless by utilizing precision agriculture system, tea farmers would be able to receive many benefits such as detail measurement and monitoring data which is very useful for the traceability elements of their products. Traceability system allows the tea farmers to expand the market of their products as it provide all the necessary information that consumers needed, which in some sense a safe assurance for the tea products.
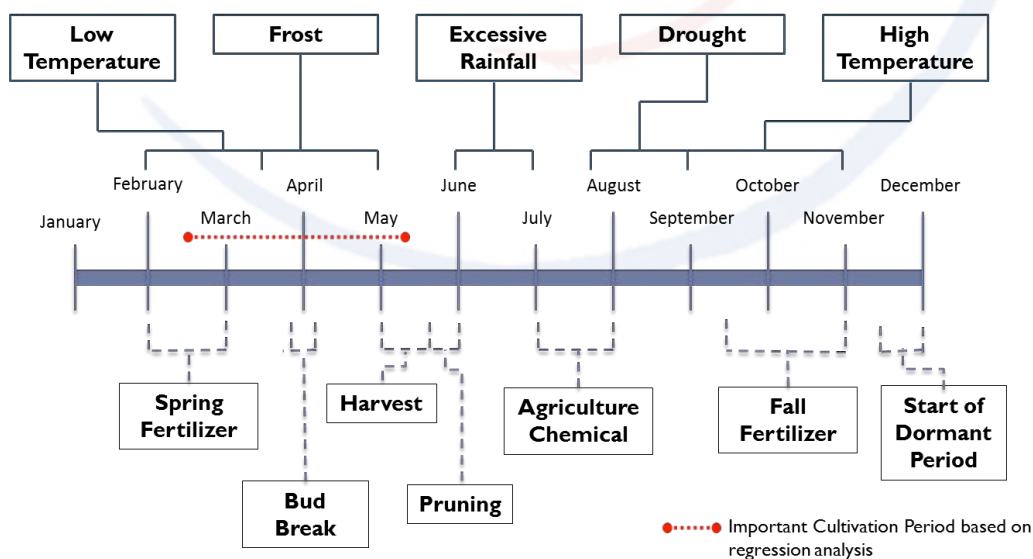

Fig. 7. Tea Cultivation Process in Uji Area

Secondly, utilization of precision agriculture system which is based on traditional agriculture knowledge will further refine the already practiced cultivation system,

thus creating new intervention methods to ensure the quality and quantity of the tea harvest. As seen in fig. 7 tea farmers could focus and conduct intervention during any of the critical phase during tea cultivation process. These methods which utilized precision technology will help young farmers to better understand the conditions of tea cultivation process.

Further use of the precision system will lead to identification and utilization of important bio-climatic indicators which are useful in selection of land and cultivars as well as prediction of tea harvest quantity and quality (Ashardiono & Cassim, 2014). In summary through utilization of precision agriculture system, the sustainability of Uji Area as a tea growing region can be ensured both from economic as well as social perspectives.
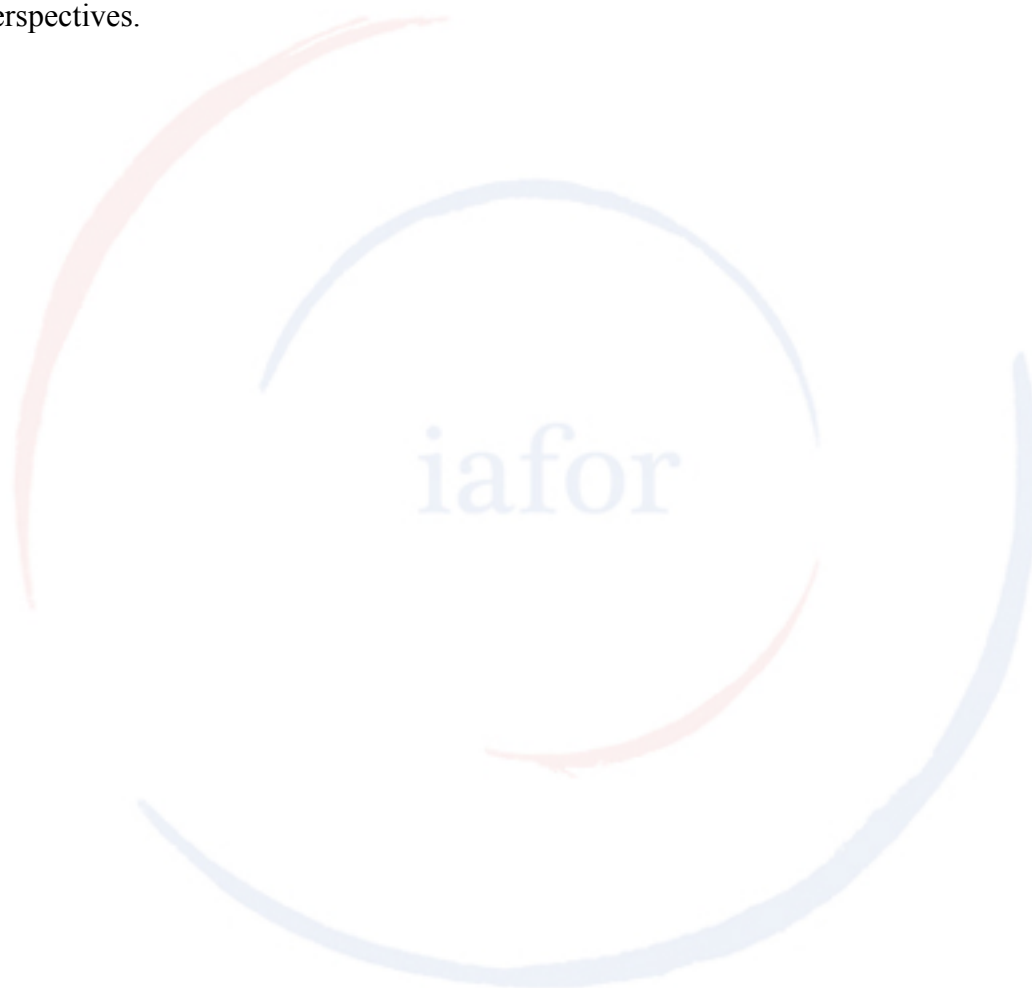
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Resource Consumption, Material Flow And Economic Growth in the Philippines

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Abstract

This study utilizes the method of Economy-wide Material Flow Analysis (EW-MFA) to examine the trends in the resource consumption, material flow and economic growth from 1985 – 2010 in an archipelagic, developing and newly industrialized country, the Philippines. Disaggregate presentation of EW-MFA indicators in terms of material categories such as fossil fuel, biomass, ore and industrial minerals, and construction minerals attempts to elucidate the consumption patterns and the impacts to the environment. Since only few studies on the EW-MFA were done in the developing countries, this research can be regarded as one of the first attempts to study the economic growth of the Philippines in terms of physical dimensions. Results show that the annual amount of per material category of DMC increased significantly with biomass (70%) and construction minerals (13%) as the most consumed materials in 1985, however, construction minerals increased to 41% while the biomass decreased to 42% in 2010. The IPAT (Impact (I) = Population (P) x Affluence (A) x Technology (T)) analysis shows that population (P) and affluence (A) are the key driving forces of resource consumption in the Philippines. The decoupling condition of resource consumption from economic development shows varying trends of non-decoupling and relative decoupling in a 25-year period reflecting the development plans and strategies implemented throughout the study period. The results of this research are intended to assist in the future development strategies towards the sustainable resource management and sustainable development in the Philippines.

Key Words: Material Flow, Consumption, Decoupling, Economic growth

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1. Introduction

It is the ultimate goal of every economy to reach a certain degree of development and so for last decade, global efforts to improve the low-income economies had resulted to unprecedented growth of economies and uplifted the significant number of populations out of the poverty line all over the world. Tantamount to the growth of economies is rapid withdrawal and utilization of the materials and energy from the environment. While these resources provide the basic needs of the socio-economic system, the extraction, processing and utilization of these resources bring disturbance to the natural ecosystem affecting biodiversity, displacement, and wastes discharged to the environmental system. This environmentally unsustainable global consumption of natural resources resulted to the numerous environmental problems being experienced encompassing the developed and developing economies all over the world. The rate of resource consumption has been rapidly increasing, with the industrialized and developed countries consume greater amount of resources than the developing counterparts and more so if the developing countries would follow the trends of resource consumption in these developed regions.

The worldwide uneven distribution and the supply of the natural resources are also important factors to consider in the current trends of resource consumption. While the developed countries such as Japan and other European countries are now gearing towards utilizing technological innovations, putting institutional framework and policies in placed to de-link or decouple the resource consumption and economic growth, the developing economies at the early stage of economic growth should also consider growth patterns and strategies that promote sustainable resource consumption. The resource decoupling would occur when the growth in the resource consumption is lower than the economic growth, and while this concept is not a panacea to the current complex socio-economic and environmental issues, it is still important to look into as decoupling encourages the increase in the resource efficiency and productivity.

The Asia-Pacific region is regarded as not only the center of economic growth in the world in terms of financial production and consumption but at the same time, this region has the highest growth rates in the demand and utilization of materials and energy (Giljum et. al, 2010), registering the regional average of 85% per capita material use terms with that of the rest of the world. The fast phase of economic growth in this region has been considered to be unsustainable as characterized by the rapid growth of population; increased resource utilization and rapid urbanization challenge the region's sustainable development (UNEP, 2013). The current patterns of economic growth in Asia would later affect the global demand and consumption of materials and the subsequently affect the global environment such as increased emission of greenhouse gases and other forms of wastes.

To determine the resource consumption of the region or country, the development of physical accounts to quantify the flow of resources from environmental system to socio-economic system using the economy-wide material flow accounts (EW-MFA) is one of the important methods that gained popularity in providing useful information on the resource extraction, consumption patterns and growth of the economies that could be used and related to the global, regional, national and local socio-economic and environmental issues. The EW-MFA is well studied and adopted framework in the developed countries but not widely applied in the developing countries. Recently, comparative case study on assessment of economy-wide material flow accounts and

implications was conducted for the developing countries such as Myanmar, Bangladesh and Philippines. Similarly, the study on driving factors of resource flows in Myanmar, the Philippines and Bangladesh have been undertaken (Kyaw, et. al, 2014). Studies incorporating resource consumption indicators with economic growth by utilizing the decoupling analysis were done for China, Russia, Japan and United States (Wang, et. al, 2013) and Czech Republic (Kovanda et. al, 2007).

The Philippines is one of the countries in Asia Pacific region that pledged commitment to the joint Asian policy called the Manila Declaration on Green Industry in Asia in 2009. This declaration called for the need to increase resource efficiency, inclusive economic growth in the developing countries and reduction of resource consumption in the high-consuming countries in the region. As a newly industrialized country, it is timely to look into the Philippines' scenario of resource consumption in disaggregated, per material flow and implications on economic growth. This study also attempts to determine the drivers of resource consumption and look into the pattern of economic growth and resource consumption in terms of decoupling analysis to provide basis for the sound resource management in the Philippines.

This research is organized as the following; Section 1 gives the introduction and background of this research, Section 2 presents the socio-economic system of the Philippines while the Section 3 presents the methodology in the calculation of EW-MFA indicators and identifying the driving factors and decoupling trends. Section 4 shows the discussion and analysis of trends of the indicators of EW-MFA. The driving factors of resource consumption and the decoupling trends in the national economy of the Philippines are also discussed in this chapter. Section 5 presents the conclusion and recommendations for future research.

2. The Philippine's Socio-Economic System

The Philippines is an archipelagic country lying in the southeastern coast of Asia composed of 7,107 islands stretching to an area of 300,000- square kilometer or 29.8 M hectares. Manila is the capital city and at center of economic activities in the country. Philippines is one of the member states of Association of South East Asian Nations.

2.1 Gross Domestic Product (GDP) and Population

The Philippine population is characterized by a high birth rate and gradually declining mortality rate. Since the international migration is relatively nil, the growth in population is greatly attributed to the natural increase or the excess of births over deaths (PSY, 2010). The population increased from 54 M in 1985 to 93 M in 2010 (Worldbank, 2014) with compounding annual growth rate of 2%. The disparity in the spatial distribution of the country's population maybe attributed to its geographical, socio-economic and climatic conditions. Similar to the global trend of urbanization, the urban population of Philippines rose from 48% in 2000 to 61% in 2007. It has population density of 308 per square kilometers in 2010 (PSY, 2010).

The performance of the Philippine economy has been characterized by a regular pattern of boom and bust growth cycle since the 1970's. Because of this, the GDP (constant, 2005) modestly increased from 49,277 Million US$ in 1985 to 131,131 Million US$ in 2010 (Worldbank, 2014) with compounding annual growth rate of 4%. The per capita GDP (constant 2005) also grew modestly from $912 in 1985 to

$1,406 in 2010. The potential growth of per capita GDP appeared to be significantly constrained by a high population growth rate.

2.2 Structural Economic Transformation

There is a gradual shift in the Philippines' economic structure changing from the high share of agriculture in the GDP to growing shares of industrial and service sectors. Table 1 shows the changes in the economic structure of the Philippines from 1985 to 2010. In 2010, the industry and service sectors comprised 88% of the shares to national GDP. In terms of per sector share in GDP, the share of agriculture showed decline from 24.6% in 1985 to 12.3% in 2010. Similarly, industry share decreased from 35 % in 1985 to 33% in 2010, while the services increased from 41% in 1985 to 55% in 2010.

Table 1. The Philippines' Key Socio-Economic Indicators from 1985 to 2010

Indicators	1985	1990	1995	2000	2005	2010
Population, million	54	62	70	78	86	93
Population density, (people/km^2)	182	208	233	260	288	308
GDP, million US$ (2005 constant)	49,277	62,100	69,125	82,354	103,066	131,131
GDP, US$ (2005 constant)/capita	912	1,002	993	1,061	1,201	1,403
Agriculture (value added, % of GDP)	25	22	22	14	13	12
Industry (value added, % of GDP)	35	34	32	34	34	33
Services (value added, % of GDP)	41	44	46	52	54	55

(Sources: Worldbank 2014 and Philippine Statistical Yearbook, various years)

3. Methodology
3.1. Sources of Data

The methods for the estimation of the indicators and the categorization of the major types of resources in this study of material flow accounting and analysis are based on the standardized and methodological guidebook released by Eurostat (2001, revised 2009). Table 2 shows the four major resource types or categories of the materials accounted for in this research and the sources of data. The data for indicators of material flow accounts are also presented at this level of disaggregation. The quantity of all material per categories is expressed in terms of their mass (weight in tonnes) per year. In this research, the physical material flow is determined with the focus on the direct material flow or the economically used resources only. This research does not consider the indirect material flows or unused materials associated to the exports or imports and the hidden material flows from the domestically extracted materials such as the mining overburden or unused byproducts from agricultural harvests.

Table 2. Data Sources and the Four Major Resource Categories of EW-MFA

Material Category	Sub categories	Data Sources
Biomass	From agriculture, forestry, and fishery	Philippine Statistical Yearbook Bureau of Agricultural Statistics Bureau of Fisheries and Aquatic Resources
Fossil Fuels	Fossil energy carriers such as coal, oil, natural gas, and others	Philippine Statistical Yearbook Department of Energy
Ores and Industrial Minerals	Precious metals and base metals ores, industrial mineral, and others	Philippine Statistical Yearbook
Construction Minerals	Sand and gravel, and others	Philippine Statistical Yearbook

3.2. Calculation of EW-MFA Indicators

3.2.1 Domestic extraction (DE)

DE refers to the amount of the materials obtained from the Philippine environment. It is estimated by using the equation below.

$$DE_{(t)} = \sum_x^y \{ B_{x(t)} + F_{x(t)} + M_{x(t)} + C_{x(t)} \} \qquad DE_{(t)} = \sum_x^y \{ B_{x(t)} + F_{x(t)} + M_{x(t)} + C_{x(t)} \}$$

The $DE_{(t)}$ stands for domestic extraction at year t totaling of all types of material types from x to y for each type of categories. The material categories are: $B_{x(t)}$ refers to the extracted biomass of specific material x in specific year t, $F_{x(t)}$ is the amount of extracted fossil fuel x in specific year t, $M_{x(t)}$ refers to the extracted metal ores and industrial minerals type x, and while the $C_{x(t)}$ is amount of extracted construction minerals x in specific year t.

3.2.2 Direct material input (DMI)

DMI refers to the direct input of materials into the Philippine economy. It is estimated as equivalent to the sum of amount of domestically extracted materials and the imported materials per category as shown in the equation below:

$$DMI_{(t)} = DE_{(t)} + \sum_x^y I_{x(t)} \qquad DMI_{(t)} = DE_{(t)} + \sum_x^y I_{x(t)}$$

In this equation, the $DMI_{(t)}$ is domestic inputs at specific year t, $DE_{(t)}$ is the domestic extraction at specific year t, and I_x is amount of imports x at that specific year t. Variety of imports material types varying from x to y are taken into account.

3.2.3. Domestic material consumption (DMC)

DMC refers to the amount of materials remained and utilized in the Philippine economy. It is calculated by subtracting the amount of exported materials to the amount of DMI as shown in the equation below.

$$DMC_{(t)} = DMI_{(t)} - \sum_x^y E_{x(t)} \qquad DMC_{(t)} = DMI_{(t)} - \sum_x^y E_{x(t)}$$

The $DMC_{(t)}$ stands for direct material consumption at year t and $E_{x(t)}$ refers amount of exports type x at year t. Same as imports, all export types from x to y are taken into consideration in detail.

3.2.4. Physical trade balance (PTB)

PTB indicates the physical trade surplus or deficit of an economy. It is estimated by subtracting the quantity of the physical imports $I_{(t)}$ from the quantity of the physical exports $E_{(t)}$ in year t as shown in the equation below.

$$PTB_{(t)} = I_{(t)} - E_{(t)}$$

3.3. Analysis of Data

The indicators of EW-MFA depict the physical magnitudes of the economy and show the general and overview of the quantitative picture to describe the material flows in the light of economic activities (Xu and Zhang, 2007). Using these indicators, further analysis can be done to elucidate the complex relationships between the environment and socio-economic systems.

3.3.1 IPAT Analysis: Drivers of Resource Consumption in the Philippines

This study utilized the method of IPAT model adapted as by Eurostat (2002), where the environmental impact (I) is the product of population (P), affluence (A), and technology (T), substituting the DMC to represent the environmental impact (Xu and Zhang, 2007). The driving factors of the resource consumption and economic growth in the Philippines for 25 years is determined with the IPAT expressed as follows,

$$DMC = \Delta P \times \frac{GDP}{P} \times \frac{DMC}{GDP}$$

where I corresponds to the *DMC*, P is *Population*, A refers to the *GDP/capita*, and T denotes the *Material Intensity, MI* or equivalent to the *DMC/GDP*.

3.3.2. Decoupling Analysis

Based on the method introduced by the OECD (2002), decoupling factor is calculated as follows:

$$\text{Decoupling factor (D}_f) = 1 - \frac{(EP/DF)\,end\ of\ period}{(EP/DF)\,start\ of\ period}$$

where D_f refers to the decoupling factor, EP refers is the environmental pressures, and DF is the driving force. In this study, resource consumption or DMC is used to represent environmental pressure and GDP represents the economic driving force and the interpretation of the calculated decoupling factor is based on the table below (Wang et. al, 2013).

Table 3. Decoupling factors and corresponding degree of decoupling

Degrees of Decoupling	Decoupling factor, D_f
Absolute decoupling	$D_f \geq 1$
Relative decoupling	$0 < D_f < 1$
Non-decoupling	$D_f \leq 0$

4. Results and Analysis of Data
4.1. Indicators of EW-MFA in the Philippines
4.1.1 Domestic Extraction

Figure 1 shows the material domestic extraction (DE) in Philippines from 1985 to 2010. The quantity of DE was more than doubled in 25 years, from 116 million tonnes (Mt) in 1985 to 335 Mt 2010. Biomass and construction material were the

two most extracted materials in the Philippines comprising 95% in 1985 and 90% in 2010, respectively. The amount of biomass grew from 94 Mt in 1985 to 157 Mt in 2010. The active construction activities in the economy resulted to the increase in the extraction of construction minerals from 17 Mt in 1985 to 146 Mt in 2010. In 1997, the significant increase in the amount of construction minerals was accounted to the sudden increase of sand and gravel extraction from an amount of 31 Mt in 1996 to 77 Mt in 1997, same year at which the construction industry grew to 21% (MTPDP, 2010), the highest growth from 2004 to 2010. Sand and gravel are the basic minerals utilized in the infrastructures required to support the needs of the growing economy of the Philippines.
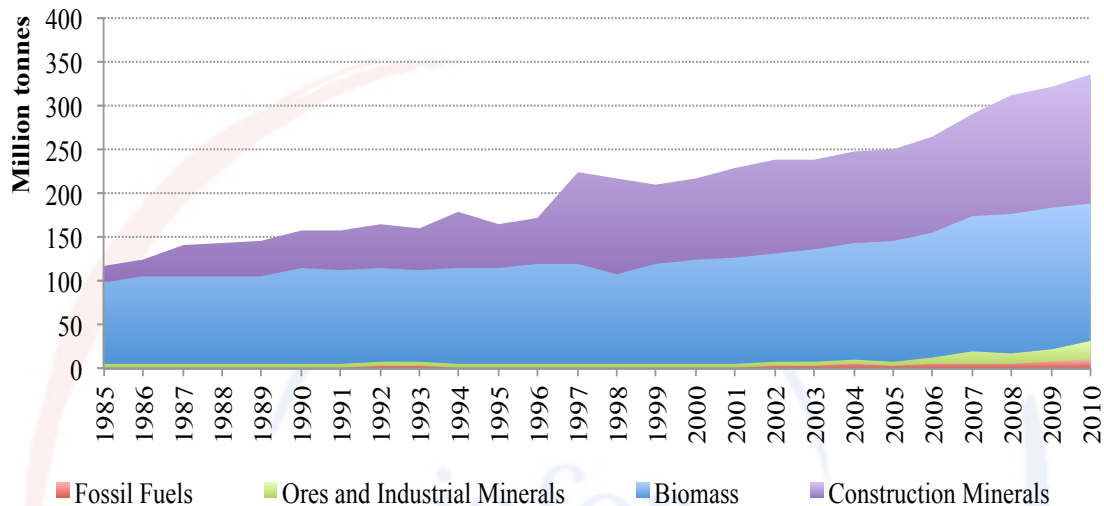
Figure 1. Domestic extraction in the Philippine economy from 1985 to 2010

4.1.2. Direct Material Input

Figure 2 illustrates the trends on the direct material input (DMI) in terms of the four major material types. DMI was estimated from the sum of DE and the quantity of import.   The DMI doubled from 135 Mt in 1985 to 379 Mt in 2010. The biomass remained to be the highest material input for the 25-year period, comprising 44% of DMI. Both the input of fossil fuels and biomass were more than doubled, from 16 Mt and 96 Mt in 1985 to 32 Mt and 169 Mt in 2010, respectively. The ores and industrial materials increased from 6 Mt in 1985 to 29 Mt in 2010. The DMI of construction minerals rose significantly from 17 Mt in 1985 to 148 Mt in 2010. The majority of direct material input was attributed by the domestic extraction (from 86% in 1985 to 89% in 2010), while the share of imports in DMI varied from 9% to 17% in a 25-year period.
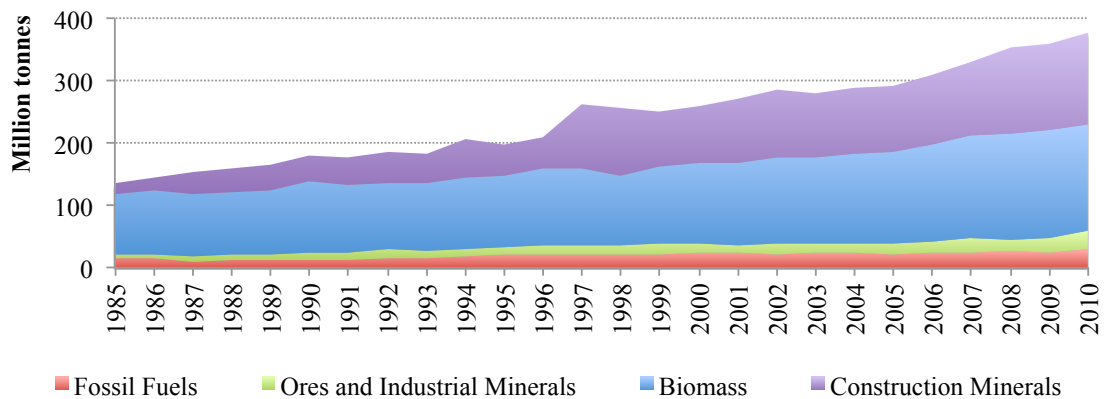

Figure 2. Direct material input in the Philippines from 1985 to 2010.

4.1.3. Domestic Material Consumption

The domestic material consumption (DMC) measured in this study refers to the natural materials (without water and air) obtained from the Philippine environment, used and remained in economy after the exported materials were deducted, and the quantity of the imported materials were added. The amount of the consumed resources in the Philippine economy increased from 128 Mt in 1985 to 353 Mt in 2010 as shown in Figure 3. The biomass had 72% share (92 Mt) and construction minerals had 13% (17 Mt) share of DMC in 1985. In 2010, however, the share of construction minerals rose to 42% (148 Mt), a share almost equivalent to biomass with 43% (152 Mt). While the ores and industrial mineral and fossil fuels grew continuously in amount, it remained within 15% of the annual DMC.
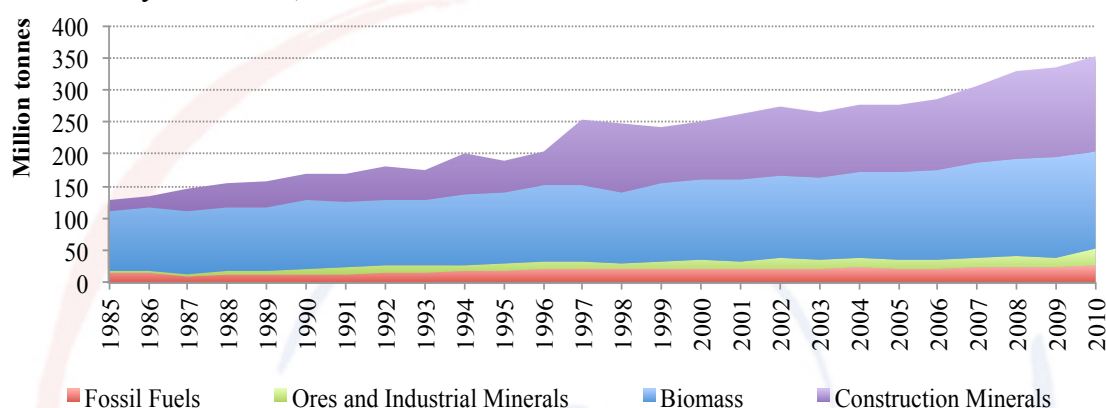
Figure 3. Domestic material consumption in the Philippines from 1985 to 2010.

The quantity of biomass remained to be the significant materials in the Philippine economy, but the quantity and the share of construction minerals in DMC began to increase in 1997. The growing amount of construction minerals shows the increasing important role of the construction industry in the Philippine economy. It is also indicated by the corresponding growth in the GDP in the construction industry with 10.5 % growth in 2010. The increasing quantity of construction minerals also shows that the Philippine economy is moving towards the increase dependence on the nonrenewable materials rather than the renewable materials or the biomass.

Such trends of material composition where the mostly consume materials are biomass and non-metallic minerals are the common characteristic of the low income developing countries while trend in high income developing and developed countries have high share of fossil fuels and metal ores due to shifting demands and consumption pattern and growing industrial demand (Giljum et. al, 2010).

The per capita DMC also increased slightly from 2.37 tonnes in 1985 to 3.78 tonnes in 2010. Figure 4 shows the material consumption per capita broken into major material categories in the Philippines. The higher per capita consumption of biomass is due to the significant agricultural and forestry sector in the Philippines.
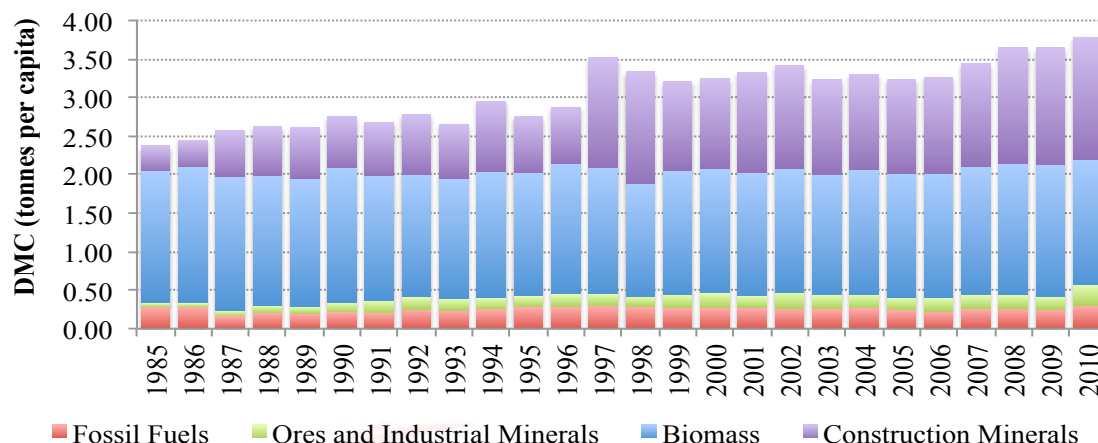
Figure 4. Trends on domestic material consumption (DMC) per capita in Philippines from 1985 to 2010

4.1.4. Physical Trade Balance

The PTB expresses the physical trade surplus or deficit of an economy. The surplus or a positive PTB value refers to the net import of biophysical resources and deficit or the negative PTB value refers to the net exports. PTB is estimated based on the amount of imports less than the exports. The quantity the imports, exports and PTB are shown in Figure 5. Both imported and exported materials increased significantly in 25 years, with the amount of imported material remained greater than the exported material. Imported materials rose from 19 Mt in 1985 to 43 Mt in 2010 while the exported materials rose from 7 Mt in 1985 to 26 Mt in 2010.

External trade is important to a developing economy like Philippines. It does not only open the agricultural products and manufactured goods of the Philippines to open market but the exchange of materials and open trade bring the needed materials and equipment to the country that are durable and necessary to propel industries into further productivity. Biomass consist of agricultural products comprised the highest amount of the exported materials while the Philippines continues to be dependent on the imported fossil fuels to supply the energy needs.
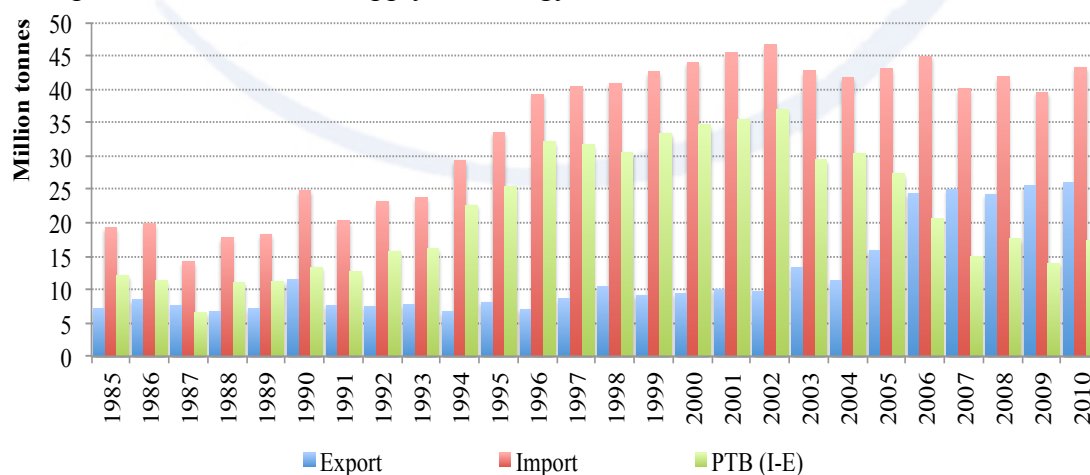

Figure 5. The trends on import, export and physical trade balance in the Philippines from 1985 to 2010.

4.2. Drivers of Resource Consumption and Resource Intensity in the Philippines

With the use of IPAT analysis, the drivers of consumption in the Philippines were determined in terms of the three important factors namely; population, affluence (GDP/capita), and technology expressed as material intensity (DMC/GDP). The 25-year period was divided in five equal periods to determine the drivers of resource consumption for every period as shown in the Table 4.

Table 4. Driving forces of the resource consumption in the Philippines from 1985 to 2010.

Period	$\Delta DMC_{(I)}$ (%)	ΔDMC (Mt)	ΔP (%)	ΔA (%)	$\Delta MI_{(T)}$ (%)	Share Contribution Using Log Transformation		
						P (%)	A (%)	$MI_{(T)}$ (%)
1985-1990	26	39.25	13	10	3	51	39	10
1990-1995	11	20.67	12	-1	1	103	-8	5
1995-2000	26	57.26	11	7	8	42	25	32
2000-2005	18	48.99	10	12	-5	57	69	-26
2005-2010	19	61.08	9	15	-6	47	83	-30

Note: DMC domestic material consumption, P population, A affluence, T technology = MI, Material Intensity

The change in the resource consumption from 1985 to 2000 was driven by the population growth, where the annual population growth rate in the Philippines from 1980 to 2000 was 2.35% and slightly decreased to 2.04% from 2000 to 2007, while the growth of the Philippine economy made the affluence to be the major driver of resource consumption in the last 10-year period of the study (2000 – 2010).

The Philippine economy grew at a respectable pace over the period of 2001 to 2004, with 3 percent in 2001 to 6.7 percent in the first semester of 2004, and expanded at its fastest rate in three decades in 2007, at 7.1% GDP growth. The global economic crisis in 2008 manifested its effect in the Philippines with the decline of GDP growth to 1.1% in 2009 but recovered and rebound to 7.35% in 2010. This growth of economy, driven the resource consumption showing that there is increasing part of the population who are improving in their lifestyles. Those who can afford to buy not only the basic daily needs but enjoy other material things and quality services also demand and consumed greater quantity resources.

The T (as expressed by material intensity measured from amount of material consumed per GDP (DMC/GDP) shows modest decrease in 2000 to 2010 as indicated by the decreasing values of -5% and -6%, respectively, but became negligible due to the increased in P and A. The material intensity needs to improve in a way that is related to the growth of GDP to compensate the extractive pressures of socio-economic activities to the environment. The material intensity is inversely related to the material efficiency, thus decreasing material intensity values means increasing efficiency in the consumption of the material or the resources.

The last decade of this study shows decrease in the material intensity showing the emerging awareness in the Philippine socio-economic system on the importance of efficiency on resource consumption. This awareness should be supported and improved with institutional framework, adequate policies and implementation in the

Philippines that will strengthen the resource efficiency both in the important sectors such as agriculture fishery and industries towards the goal of sustained economic development.

4.3. Decoupling of Resource Consumption and Economic Growth
In the decoupling analysis, it is aimed to depict the mutual relationship of the economic driving force and environmental pressure. The environmental pressure in this research is represented by the resource consumption expressed as DMC, while the gross domestic product (GDP) is taken as the proxy for the quality of life and as economic driving force. Similar to the IPAT analysis, the decoupling analysis was carried out in five equal years in the 25-year period of the study. Figure 6 shows the decoupling trend on the resource consumption and economic growth from 1985 to 2010.
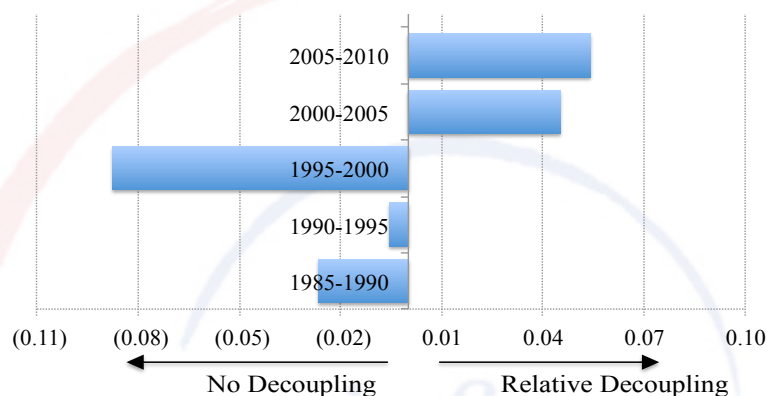
Figure 6. Decoupling of resource consumption (DMC) from economic growth (GDP) in the Philippines from 1985 to 2010

Based on this analysis, no decoupling occurred during the period of 1985 to 2000, as shown by the negative values of the decoupling factors. This indicates that for this period the growth in the resource consumption or DMC (188%) is higher than that of the GDP (167%). Relative decoupling occurred in the periods of 2000 to 2010 as shown by the positive values of the decoupling factors. Relative decoupling occurs when the growth rate of resource consumption (DMC) is lower than the growth rate of GDP. From 2000 to 2010, the GDP grew by 156% while the DMC grew at a lower percentage of 144%.

The relative decoupling in the Philippines is quite modest since the higher the value of decoupling factor ($0 \leq D_f \leq 1$), the greater the degree at which the DMC grows at significantly lower rate than that of the GDP. Nevertheless, it is important to recognize the beginning of the improvement in terms of resource consumption relative to the economic growth in the Philippines. While the Philippines continuously battles with the issues of poverty and inclusive economic growth and where resource extractive industries become the resort of economic growth, it is also important to look into other sectors to improved and be a catalyst to economic development. At the period at which the economy is expanding, the demand on materials such as construction minerals and fossil fuel are expected to grow at a rapid rate, the Philippine government should formulate policies that would develop other sectors and would balance the demands from industrial sectors that would include the promoting the growth from the service sectors such as tourism activities.

5. Conclusion and Recommendations for Future Studies

This research illustrated the trends in the resource consumption, the flow of materials and the economic growth in the Philippines from 1985 to 2010. The extraction of the natural resources (DE) in the Philippines increased to 289% along with the resource consumption (DMC) to 275% in the twenty-five year period of this study, while the economic growth (GD) grew at a lower phase at 266%. The socio-economic system is on transition from the renewable material consumption (biomass) in 1985 to the nonrenewable material consumption (construction mineral) in 2010. While this phenomenon is the usual trend in the growing economies, it is important for Philippines should take a thorough look to improve the current resource consumption with the developing patterns.

The resource consumption was driven by the population growth in 1985 to 2000, while the growing affluence became apparent in 2000 to 2010. The material intensity showed a modest decrease in 2000 to 2010. However, there is a need to improve the material intensity in the utilization of the natural resources. In the analysis of decoupling of resource consumption from economic indicator (GDP) showed relative decoupling from 2000 to 2010.

This study on the physical metabolism of the Philippines socio-economic system suggests that while the country is at the early stage of economic growth and with abundance of natural resources, the resource management should be geared towards resource efficiency to maximize the productivity in the utilization of these nonrenewable resources. Strong institutional framework, develop policies that would achieve the sustainable development in the Philippines.

The future research studies on the output indicators of EW-MFA and the quantifying the quantity of hidden material flow associated with the domestic extraction in the Philippines should be taken into considerations.

Acknowledgement

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An Analysis of Thermal Comfort and Energy Consumption within Public Primary Schools in Egypt

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Abstract

Schools are the most suitable type of building for the application of indoor thermal comfort quality as they represent the main sector of community. Thermal comfort plays a major factor in educational building sector especially in hot-arid climate. It has a big impact on building interior temperature as well as on energy consumption. The present study is an attempt to primarily introduce the existent indoor thermal comfort status as well as energy consumption in Egyptian public primary school building. To meet this objective, a methodological procedure has been followed. A field study is conducted in a school building that are designed based on natural ventilation and air movement through ceiling fans to assess the indoor thermal conditions based on adaptive standard comfort (ASC) model during the students' lesson hours during a three-day. In addition, electrical utility bills have been collected. Then, a dynamic building energy simulation model carried out by using, DesignBuilder/EnergyPlus software for examining indoor comfort conditions as well as energy consumption of a typical school building in Egypt. Findings revealed that lighting sources represent the largest proportion of energy consumption. In terms of indoor thermal comfort, results indicate that a higher level of thermal discomfort within the primary public school classrooms and the pupils stay more than 36.5% of their time daily in classrooms with thermal stress conditions.

Keywords: Thermal comfort; school building; hot-arid climate; naturally ventilated

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1. Introduction

1.1. Background

With increased global concerns on climate change caused by anthropogenic greenhouse gas emissions [1], the need for innovative spaces which can provide indoor thermal comfort and energy efficiency is also increasing. Thermal comfort plays a major factor in buildings sector especially in hot-arid climate. It has a big impact on building interior temperature as well as on energy consumption. According to Bahadoori [2], thermal behaviour of a building is determined by the extent of thermal controls provided in the building and the existing outdoor conditions. Therefore, the thermal performance of the building envelope is one of the most important determinates of the building's energy consumption. Predictions published by the Intergovernmental Panel on Climate Change (IPCC) [3] indicate an increase in global average surface temperature in different scenario ranges of 1.1–2.9℃ to 2.4–6.4℃ from a 1990s baseline towards the end of the 21st century. Across the Egypt, which is the focus of this study, air temperature has already increased between 1℃ and 2℃ since 1970 and is expected to increase another 4℃ by 2100 as the special Report of Emission Scenario states, SRES, A1F [4]. In conjunction with a raised awareness for climate change, energy consumption in buildings is taking central attention in Egypt on the public triggered by the electricity supply shortage in 2012 and 2013 as buildings sector consumes about 42% of energy [5]. Additionally, buildings accounted for 33% of the carbon dioxide which is the primary greenhouse gas associated with global climate change [6].

This study focuses on school buildings as they represent a significant part of the building stock, and also noteworthy part of total energy use [7].Therefore, this research give an insight into thermal comfort and energy consumption for public primary school classrooms in the Egypt through filed investigation and a series of building simulations. It is known that the primary school education system deals with pupils in such a sensitive yet promising age as they are shaping the milestones of their characters. In addition, children are more vulnerable than adults to environmental pollutants [8].

In Egypt, which is the focus of this study, it is reported that there are about 15600 schools all over the country with 37.6% of all pre-university education [9]. This demand had considerably increased after the 1992 earthquake that devastated a considerable number of schools [10]. In response, the Egyptian government established the General Authority of Educational Buildings (GAEB) to design new schools around the country. These designs relied on an infiltration air of cross-ventilation with ceiling fans to achieve thermal comfort within the classrooms. GAEB uses the same prototype designs to establish schools across the various climatic conditions in many regions of Egypt without consideration to the significant variation in all climatic conditions. This led to uncomfortable interior conditions within the classrooms which span from heat stress, lack of adequate ventilation, glare to exposure to excess solar radiation.

1.2. Climate context

In preliminary, Egypt is located between 22°N to 31° 37′ N latitude and 24° 57′ E to 35° 45′ E longitude with an area of approximately 1,000,000 Km² [6].Egypt has a significant variation in the climatic conditions. The Housing and Building Research Centre (HBRC) divides the country into eight different climatic design regions as reported by Sayed *et al.* [11] (see Fig.1). According to Koeppen's climate classification [12], Egypt experiences the 'hot desert climate type' (BWh) in the southern and central parts of the country and the 'hot steppe climate type' (BSh) along the coast. Most parts of Egypt are occupied by the Sahara desert, which represents the most extensive arid area on the planet. In general, Egypt possesses a hot-arid climate throughout the year.
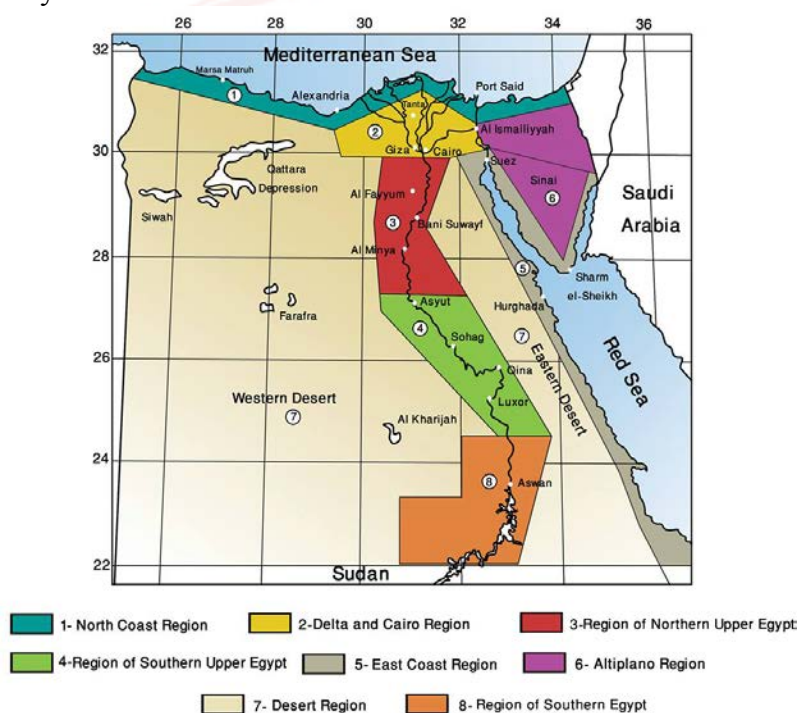
Fig. 1 Classification of climatic zones in Egypt according to HBRC

This implies that the effects of climate change need to be addressed especially in the urban built environment. Consequently, the purpose of the present study are as follows:

- To investigate the thermal performance of an existing public primary school under different bioclimatic zones in Egypt and to generate some specific information regarding temperature and humidity variation during schooling hours.
- To investigate energy consumption within Egyptian school building sector

To this end, a field measurement exercise was conducted in the selected school building, followed by computer modelling work using 'DesignBuilder' software to simulate thermal performance and energy consumption of the school building. Subsequently, the calculated values from field measurement and the simulation results were compared for validation purposes.

2. Methodology

2.1. Field investigations

2.1.1. The case study (visual survey)

Experimental investigation of thermal comfort conditions within public primary schools that are designed based on natural ventilation (infiltration) and air movement within the classrooms by ceiling fans were carried in Assiut city (27°3′ N; 31°15′E) as seen in Fig. (1), which located northeast of the southern Upper Egypt zone [13]. The field study was conducted in three naturally ventilated classrooms from 29th to 31th October, 2013 at Assiut prototype distinct language school that was built in the year 2009. This school mainly belongs to the General Authority of Educational Buildings (GAEB) and has been designed according to one of the prototype architectural system that has been carbon-copied all over the country. All the studied classrooms based on natural ventilation (infiltration) and air movement within the classrooms through ceiling fans. Windows are single glazed and poorly constructed with very high levels of air permeability at both sides (1.5x1.2m), window to wall ratio reaching 32%. There is no solar protection in the windows, only the roof edge slightly mitigates the sunshine. The occupancy rate of this school is $1.1m^2$ for each pupil (the USA ratio is $2.15m^2$).

2.1.2. Measurements and data recording

In this field study, Thermal Comfort Datalogger-INNOVA 1221, shown in Fig. (2), was used for measuring and recording the classroom indoor environmental parameters such as operative temperature, relative humidity and air velocity during the school working hours when the classrooms are being fully occupied with the pupils. Three external sensors were connected to the device which was placed in front of classroom beside the board in order to not to interfere with ongoing teaching activities. The classroom furniture is arranged in three row perpendicular to the whiteboard's wall (see in Fig. 3). The data values were measured and recorded every minute and the average of each 15 minutes was determined and is presented in the results section. Moreover, electricity utility bills has been collected from Egyptian Ministry of Electricity for the whole year 2013 as well as information about occupant density and lighting sources.

Fig. 2 Thermal comfort INNOVA 1221

Fig. 3 Field study inside class (A) shows the disk's distribution

2.2. Modeling and simulation

The analysis of this paper is mainly concerned with assessing the current status of internal building comfort condition, according to ASHRAE standard 55 [14], as well as energy consumption within public primary schools, which belong to GAEB in Egypt. A typical primary school building was selected to act as a case study for this research, this school has a total land area of 3168.37 m^2, is a five-store height. Each store consists of 5 classrooms with the school total of 24 classrooms. Modelling and simulations were carried out using the dynamic thermal simulations tool, DesignBuilder (DB) in its third version (V.3.4.0.033) [15], which is based on the state-of-the-art building performance simulation software entitled EnergyPlus. The following sections define the different configurations and parameters of the case study.

For the simulations, a model of a typical school building in Assiut was applied to address indoor thermal comfort conditions within naturally ventilated classrooms and predict energy consumption for the base model, which constitutes the most prototype architectural design that has been carbon-copied all over the country.

2.2.1. Base model development

DesignBuilder is a commercially available software package, with three-dimensional interface, that provides dynamic and comprehensive environmental and energy analysis for buildings. A three-dimensional DesignBuilder model for the case study was firstly developed (see Fig.4) based on the building's drawings, and after conducting a site visit as well as intensive consultation with GAEB in turn being responsible for the school building even operation time. The simulation is based on 'real' hourly weather data, and taking into account solar gain through windows, as well as heat conduction and convection between zones of different temperatures. For this study, the following properties were implemented in DesignBuilder:
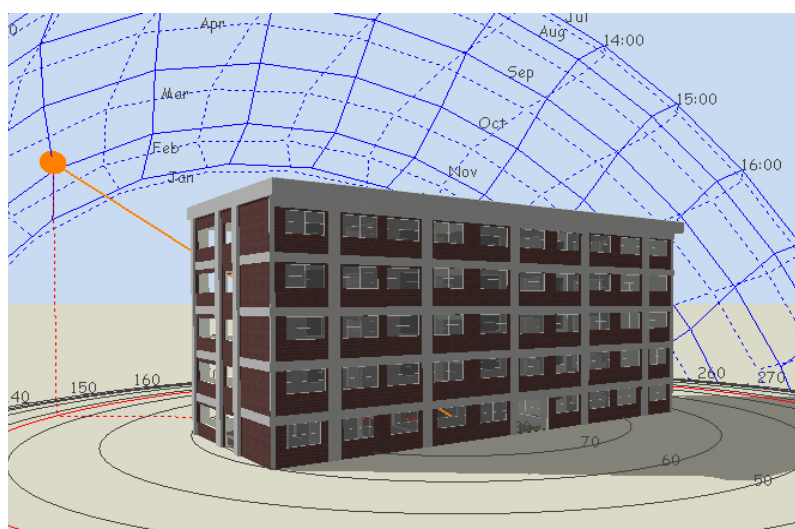
Fig. 4 Reference case model in DesignBuilder

a) Construction material

The construction materials used are conventional according to the Egyptian Code for Buildings. Exterior walls are made of 25 cm red brick with an interior finish of 2.5 cm thermal plaster and paint (acrylic based for contracting and expanding). Interior partitions are of 12 cm thick red brick as well as 4 to 5 cm thickness of cement plaster and paint for both sides. Floors are suspended with 10 cm finishing thickness. Slabs are made from concrete of 12 cm thick according to the spans and structure system. The specifications for construction materials used in the simulation are listed in Table 1, and the section for the aforementioned walls are shown in Fig.5

b) Glazing type and lighting

According to Mahdy and Nikolopoulou [16], there are four main categories commonly used in Egypt, mentioned and specified in (EREC), as shown in Table 2. In simulations, windows are aluminium frames with 6 mm single clear layer glazing. The window to wall ratio (WWR) is 32 %. On the other hand, each classroom has four groups of artificial lighting with three 1200 mm T8 lamps.

c) Activities and schedule

According to ASHRAE standard 55 [14], metabolic rate of seated activity = 1 met which equal 60 w/m^2, and so metabolic rate per person = 60 x 1.8=108 W/per according to ASHRAE standard 55 [14]. In terms of vacations and working days, a combined schedule was applied to the simulation based on The Egyptian school year which starts at 15th September and ends on 30th June.

d) HVAC and infiltration

All classrooms are naturally ventilated with two ceiling fans in each classroom for air movement. Windows are single glazed and poorly constructed with very high levels of air permeability at both sides (1.5x1.2m), window to wall ratio reaching 32%. There is no solar protection in the windows, only the roof edge slightly mitigates the

sunshine. Windows are operable from 8:00 am till 3:00 pm so, the infiltration rate suggested to be 0.5*ach/h*.

Table 1 Physical characteristics of base model building.

Material	Thick. mm	Density kg/m^3	Conductivity W/m.K	Specific heat J/kg.K
External wall from outside to inside (*U-value=1.58 W/m^2.K*)				
Plaster (light)	25	2300	1.3	840
Mortar	20	2800	0.88	896
Brick	250	1500	0.85	840
Internal partitions (*U-value= 1.64 W/m^2.K*)				
Plaster (light)	25	2300	1.3	840
Mortar	20	2800	0.88	896
Brick	120	1500	0.85	840
Mortar	20	2800	0.88	896
Plaster (light)	25	2300	1.3	840
Intermediate floors (*U-value= 1.14 W/m^2.K*)				
Ceramic tiles	25			
Mortar	20	2800	0.88	896
Sand brick	60	2200	1.83	712
Reinforced concrete	120	2300	1.9	840
Mortar	20	2800	0.88	896
Plaster (light)	25	2300	1.3	840
Roof (*U-value= 1.92 W/m^2.K*)				
Mosaic tiles	30	2100	1.4	800
Mortar	20	2800	0.88	896
Sand brick	60	2200	1.83	712
Reinforced concrete	120	2300	1.9	840
Mortar	20	2800	0.88	896
Plaster (light)	25	2300	1.3	840

Table 2. Used glass specifications

Name	Category	SHGC	LT	U-value *W/m^2.K*
Clear 6.4mm	Single	0.71	0.65	5.76
Clear reflective 6.4mm-(stainless steel cover 8%)	Single reflective	0.18	0.06	5.36
Clear 3.2mm Transparent/Transparent (6.0mmair)	Double	0.66	0.59	3.71
Clear reflective 6.4mm Transparent (stainless steel cover 8%)/ transparent-(6.0mmair)	Double reflective	0.13	0.05	2.66

a)   Outer surface   b)

Inner surface
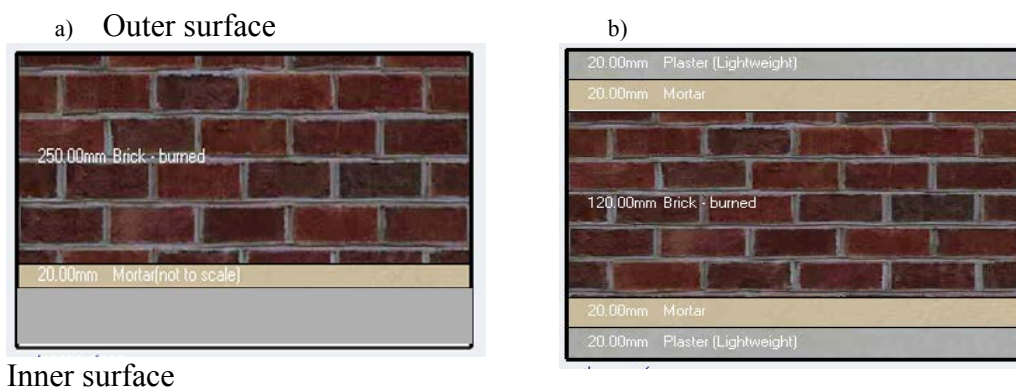
Fig. 5 Wall sections used, (a) exterior wall and (b) internal wall/partitions

2.2.2. Simulation & validation of the base model

Model validation is an essential task to ensure that the architectural, mechanical and electrical systems. Oberkampf *et.al* [17] defined the verification and validation of computer simulation as below: "*Validation is the assessment of the accuracy of a computational simulation by comparison with experimental data*". Kaplan and Canner [18] made recommendations for the allowable difference between predicted and measured (actual) data. For instance, the prediction of energy use is considered satisfactory when the difference is within 5% on a monthly basis for internal loads such as lighting, appliances or domestic hot water system. However, the acceptable difference may increase up to 15–25% monthly and 25–35% daily for the simulation of environmental parameters. In this computational simulation process, three parameters were considered for base model validation. They are internal average hourly temperature, average hourly relative humidity and monthly energy consumption.

3. Results and discussion

3.1. Measured thermal condition

The building monitoring and measuring results for the case study in addition to outdoor measured temperature have been gathered, from the 29th October till 31th October 2013. This period of time in Upper-Egypt is the end of the hot weather condition season and the beginning of moderate weather condition season. In addition, outdoor Assiut summer climatic data were obtained from the meteorological records of the nearest regional weather station (WMO 62392) for the same period in addition to a Mobile Weather station to measure the outdoor temperature in the school yard.

Figure 6 illustrates the measured indoor and outdoor temperatures profile for the monitored building in compliance with Adaptive Comfort Standard (ACS) for naturally ventilated buildings which were employed by ASHRAE standard 55 [14].
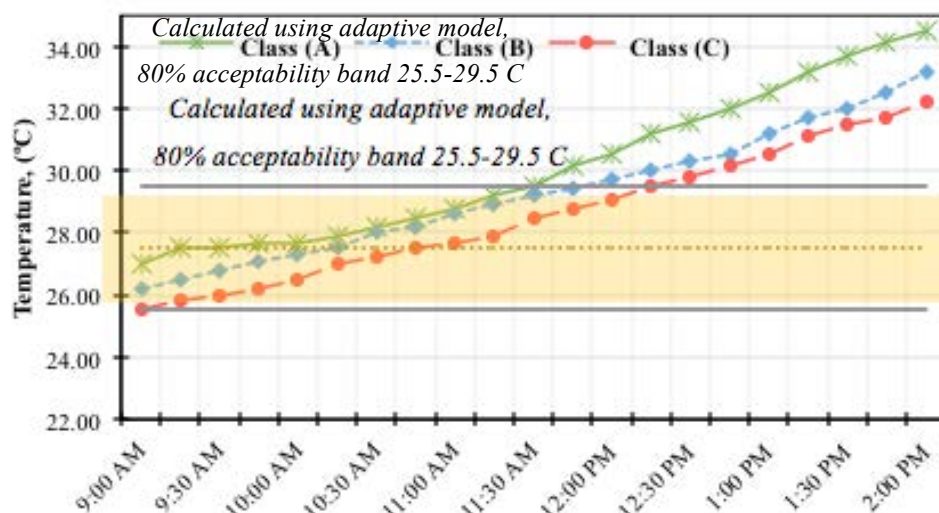
Fig. 6 Indoor operative temperature profiles with (ACS) comfort zone limit

In the ACS, the mean monthly outdoor air temperature determines the acceptable indoor air temperature. This relationship is expressed by the following formula:

$$T_{com} = 0.31(T_{out}) + 17.8$$

Where T_{com} is the optimum comfort operative temperature in °C and T_{out} is the mean monthly outdoor air temperature in °C. Thus, in this context the acceptability ratio of thermal environment decreases less than 80% when the indoor operative temperature exceeds 29.5°C. The measured data clearly show that there has been a steady increase of operative temperature in the measurement within the classrooms ranged from 25.5°C to 34.5°C during that day time. As depicted from Fig. (6), the internal classroom temperature is raised by 7°C. According to the results of Humphreys [19] this level of increase well led to discomfort condition for the pupils. This might be due to the fact that children are sent to the schools wearing relatively warm clothes in the relatively cool morning than required for the range of temperature variation during the school day. Clearly from the figure, the internal air temperature profiles across the three cases studied are within the comfort limit until noon time. While afternoon time, the results indicate that the internal air operative temperature across the three classrooms exceeded the comfort limit which means that pupils are in discomfort for about 39.86% of the time they spent in school.

3.2. Calibration test

In this computational simulation process, two parameters were considered for base model validation. They are internal average hourly temperature, average hourly relative humidity and average of three measured days. Measured average hourly indoor air temperature data are compared with DB simulated results in Fig. 7. As fig. 7 displays the highest indoor temperature during the three days was recorded as 34.5°C and the lowest indoor temperature as 25.5°C, while DesignBuilder simulation showed the highest indoor temperature as 33.1°C and the lowest indoor temperature as 24.8°C. On the other hand, the highest relative humidity during field measurements

was 58.1%, while DB simulation showed the highest relative humidity was 60.48%. In conclusion, the measured data varies within 6.7% of the simulated data.
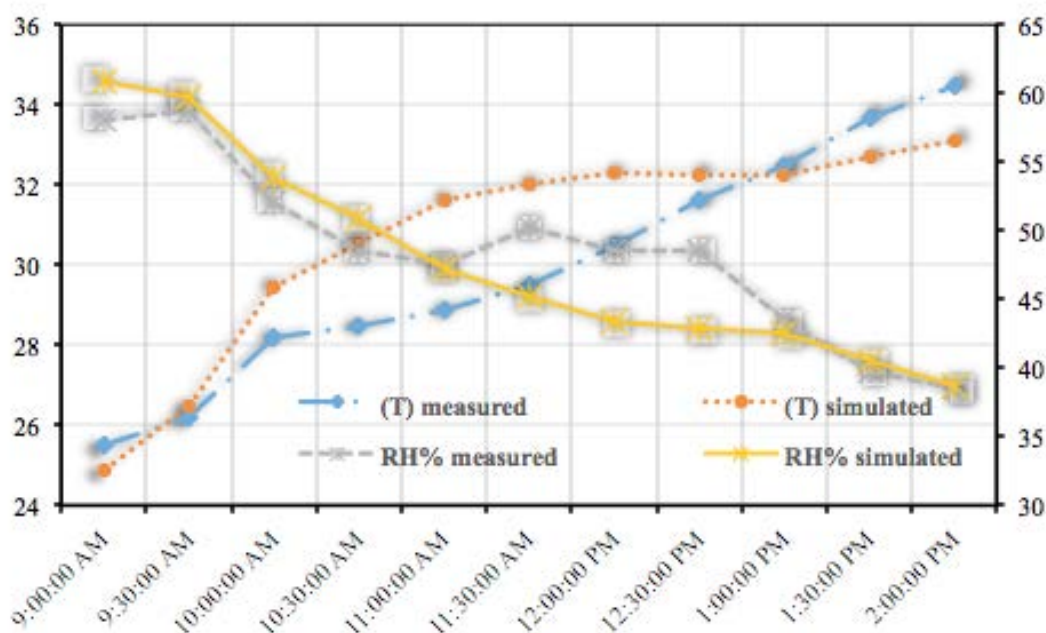

Fig. 7 Measured *vs.* simulated internal average hourly temperature and average hourly relative humidity

3.3. Energy use

Each zone of the building was physically investigated with the assistance of the building's operation in order to obtain information and data on the building lighting, equipment and occupancy for the purpose of knowing details of thermal characteristics of building envelope. Moreover, electricity utility bills for the whole year 2013 has been collected. For the financial analysis, the cost of the energy consumption was calculated in Egyptian pound (EGP), using the electricity tariff by the Egyptian Ministry of Electricity and Energy for the governmental sector, which is referred to as operation cost. Next, the energy use within the building was simulated for a whole year, using real climatic data. It is found from Fig. 8 that the collected data of energy is within 9% of the simulated energy consumption. This demonstrates that the DB predictions are in good agreement with the data collected.

According to the simulation and collected results the annual electricity consumption for the building was 13019 kW per year (9227.27 EGP per year). This means that the building is consuming 1.5 kWh/m^2/year of electrical energy. Based on simulations, lighting sources consume the largest amount of total consumption. Fig. 8 shows that the electricity consumption in simmer months is slightly higher than the winter months, because of appliances auxiliary system (two ceiling fans in each classroom as they are operating all over the school day).
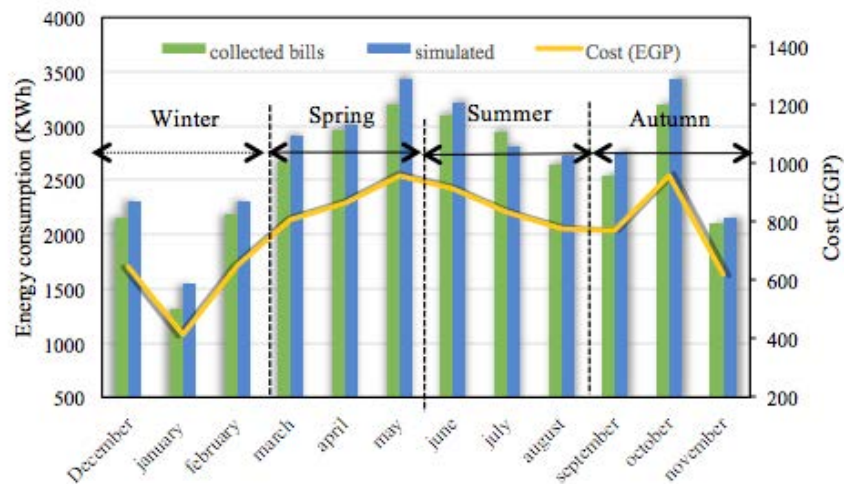
Fig. 8 Comparison between averaged electricity bills and energy simulation

3.4. Comfort analysis

As a result of model validation, a simulation using DB software was applied to get values of indoor air temperature within school day and outside air temperature of Assiut climate zone during the hottest month (October) through the school year. Consequently, specify comfort conditions. All material and construction details, as discussed previously, have been applied to the simulation model. Figure 9 shows the trends in variation of internal air temperatures with outdoor temperature in relation to the comfort limit by adaptive approach employed by ASHRAE standard [14]. According to the expected temperature, Fig. 9 shows that most of occupied time in classrooms, pupils stay in stress conditions. It is apparent that 82% of all hours of Oct/2013 inside classrooms are out of comfort zone. These results show reasonable agreement with results obtained by Gado and Mohamed [20].
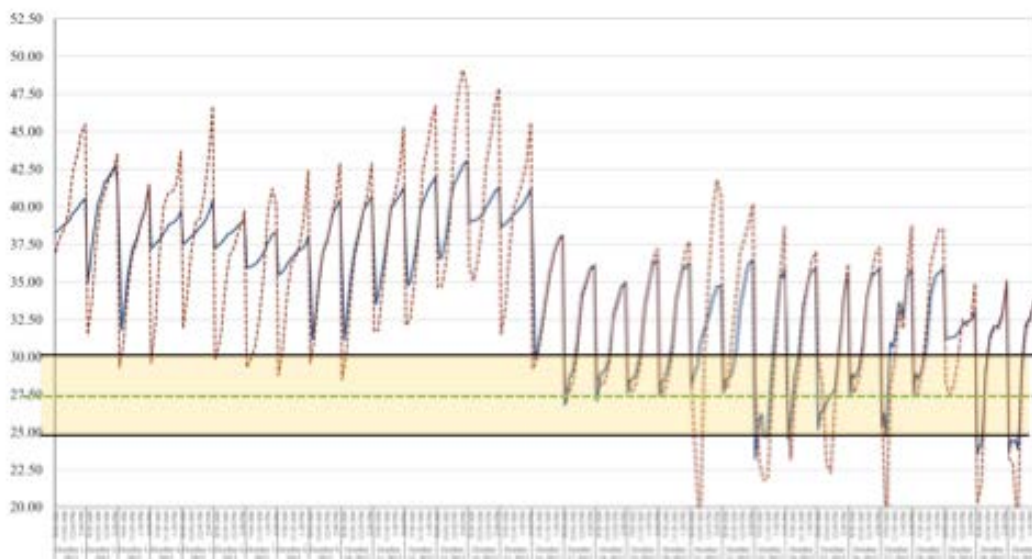
Fig. 9 Temperature variations within occupied hours in Assiut

In terms of heat gains which refer to flows through the fabric due to the air temperature difference between inside and outside. Fig. 10 displays the main sources of heat gain within classroom during school day. As depicted from the figure, solar gains from exterior windows, which increased around noon hors as a result of increasing of solar radiation incident amount, are the largest source of heat followed by the occupants and lighting. While, ceiling and internal walls represent a small proportion of total heat gain of the building.
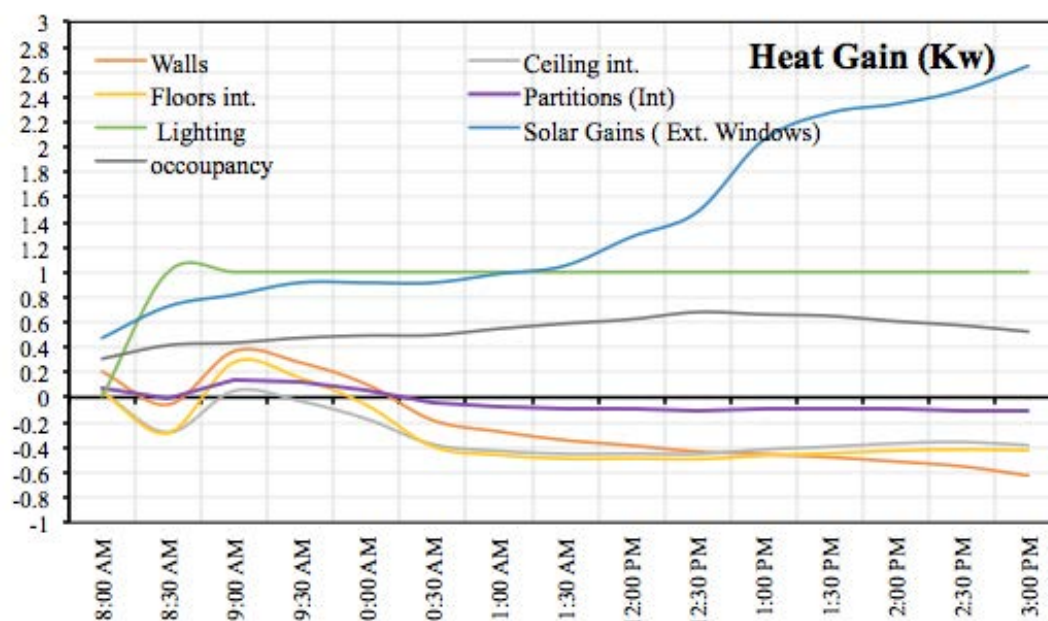
Fig. 10 Heat balances in the classroom for 15 October

4. Conclusion

This study investigated the thermal comfort conditions as well as energy consumption within public primary schools that are designed based on natural ventilation (infiltration) and air movement within the classrooms by ceiling fans. The output results may assist school building designers and stakeholders in the future to improve the thermal environment conditions within the classrooms of such schools. The main achievements of this study are as follows:

- It is reasonable to conclude from this study that DesignBuilder is a satisfactory simulation package with which to assess thermal comfort conditions and predict energy consumption for public school buildings in Egypt.
- The acceptability ratio of thermal comfort calculated by (ACS) model ranges from 25.5°C to 29.5°C. It has been found that 82% of all hours of Oct/2013 inside classrooms are out of comfort zone.
- According to the simulation and collected results the annual electricity consumption for the building was 13019 kW per year (9227.27 EGP per year). This means that the building is consuming 1.5 kWh/m^2/year of electrical energy

Acknowledgment

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Co-digestion of OFMSW with WAS Effect on Bio-Hydrogen Production under Dry Anaerobic Digestion Conditions

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Abstract

Total amount of municipal solid waste (MSW) is continuously rising. Consequently, environmental management of MSW produced every year has to be safely disposed without any negative impact on the environment. On other hand, usage of this waste as sustainable source for energy became a great point of interest. In Egypt, Municipal solid waste (MSW) produced from household only estimated to be about 20 million tons annually. Organic fraction of municipal solid waste (OFMSW) represents 60% of (MSW). In this study, anaerobic batch experiment conducted to explore effect of changing OFMSW to waste activated sludge (WAS) co-digestion ratio on bio-hydrogen production under thermophillic dry anaerobic digestion condition. The experiment was carried out at different co-digestion ratios between OFMSW and WAS as following sequence 0:100, 30:70, 45:55, 55:45, 60:40, 67:33, 70:30, 75:25 and 100:0% (v/v). The highest bio-hydrogen production achieved at co-digestion ratio of 70:30% (v/v). This was 5.2, and 3.1 times higher than co-digestion ratio of 0:100% (v/v) (sludge alone), and 30:70% (v/v), respectively. The maximum cumulative bio-hydrogen production of 23.40 mmol and bio-hydrogen production rate of 1.81 mmol/h were achieved at co-digestion ratio of 70:30% (v/v). This relates to maximum bio-hydrogen yield of 15.11 $mmol_{H2}/gCOD_{consumed}$, and was mainly due to consumption of COD (19.4%). The modified Gompertz equation model was highly fitted to the experimental data with correlation coefficient ($R^2 > 0.986$).

Keywords: Dry anaerobic digestion; thermophillic; OFMSW; co-digestion and metabolite products.

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1. Introduction

Municipal solid waste (MSW) generation is increasing worldwide by rate of 2-3 % per year [1]. In Egypt, Total amount of generated municipal solid waste estimated to be about 21 million ton annually. The major biodegradable organic fractions represent 50-60%. Most of these waste disposed by throw in Dumpsite or landfill. Which Threatens the environment due to odor emanation, vermin attraction, toxic gas emission, and groundwater contamination [2]. However, Anaerobic digestion has been proven to be a reliable and economically feasible technology in full scale operations [3]. Anaerobic digestion is more attractive due to low energy consumption, cost effective, and can deal with several types of substrate for the production of hydrogen or methane, and eco-friendly [4]. Currently, interest in anaerobic digestion has grown due to technological developments in bioreactor design for the treatment of solid organic waste [1].

Nowadays, the environmental problems have brought the interests toward the development of alternative energy. Among the alternative energy sources, hydrogen has been receiving an increasing attention due to its environmentally friendly characteristic and high energy content [5]. Hydrogen is a promising alternative to fossil fuels. As a clean fuel it can be directly used to produce electricity in fuel cells and/or burnt with minimal pollutants emissions [6]. Hydrogen has a high energy yield of 122 kJ/g, which is 2.75 times greater than that of hydrocarbon fuel [7]. Generally, there are four available basic processes for the production of hydrogen from non-fossil primary energy sources. These processes include: (1) water electrolysis; (2) thermo-chemical processes; (3) radiolytic processes; and (4) biological processes. For global environmental considerations, bio-hydrogen production from renewable organic waste represents an important area of bioenergy production [8]. Hydrogen production from biological processes can be divided into two types i.e. photo-fermentation by cyanobacteria, algae, photosynthetic and chemosynthetice fermentative bacteria and dark fermentation by anaerobic bacteria. Hydrogen production from the dark fermentation process has advantages over the photo-fermentation process which is a low operating cost because light is not required and the rate of hydrogen production is greater [9].

Conventional Anaerobic digestion proceeds under wet state (Total solids <5%), which means a large amount of external water is required for diluting solids. This will accordingly not only increase the energy consumption for digester heating and feed slurry pumping, but also the volume of digester effluent that should be dewatered. To overcome these drawbacks, dry digestion or ''high-solids digestion'' can be employed in which solids with over 20% of TS are directly fed to the reactor [10]. In addition, operation temperature defines three different process conditions: thermophilic range (50-60°C), mesophilic range (20-40°C) and psychrophilic range (10-20°C) [11]. Thermophilic conditions are assumed to optimize the enzymatic activity of hydrogenase during fermentation by Clostridia, to inhibit the activity of hydrogen consumers and also to suppress the growth of lactate-forming bacteria [12]. On other hand, microbial analysis of the fermentation medium also indicated that the dominating species were lactic acid bacteria at 35°C and hydrogen-producers at 50°C, thus confirming the role of temperature in dictating the nature of microbial consortium during the process [13].

However, co-digestion involves the digestion of two substrates together as a way to improve digestion efficiency and increase the energy output [14]. OFMSW may have suffered from nitrogen shortage which is an essential nutrient for hydrogen producers.

Therefore, the concept of co-digestion of OFMSW and waste activated sludge (WAS) has been investigated to improve bio-hydrogen production, since the addition of WAS to OFMSW supplied a more balanced carbon to nitrogen (C/N) ratio [15]. As a result, the aims of this study are evaluation the effect of changing co-digestion ratio on hydrogen production and substrate fermentation process of organic fraction of municipal solid waste. Also, study the variations in volatile fatty acids production related to co-digestion ratio. Finally, study the effect of volatile solids content on hydrogen production and hydrogen yield.

2. Methodology
2.1. Substrates

The substrate was a mixture of organic fraction of municipal solid waste (OFMSW) and waste activated sludge (WAS). OFMSW, sampled from restaurant of the campus of Egypt-Japan University of Science and Technology, Alexandria. OFMSW was crushed by an electrical blender. WAS was taken from a gravity sludge thickener into which secondary sludge were added. WAS pre-heated at 100 °C for 15 minutes to inhibit the bioactivity of hydrogen consumers and to harvest spore-forming anaerobic bacteria [16]. All the substrates were filtered through a stainless steel sieve (US Mesh No. 10 with corresponding sieve opening of 2.00 mm), of which the characteristics are summarized in Table 1.

Table 1 characteristics of OFMSW and WAS.

Parameters	Unit	OFMSW	WAS
Density	kg/m^3	1008.4 ± 21.4	804.2 ± 35.9
Total solids (TS)	%, (w/w)	32.29 ± 2.99	4.89 ± 0.31
Volatile solids (VS)	%, (w/w)	30.07 ± 2.03	3.11 ± 0.05
VS/TS	%	93.12 ± 3.02	63.78 ± 3.70
COD	g/L	65.78 ± 0.61	16.67 ± 1.59
Carbohydrate	g COD/L	37.69 ± 2.32	1.32 ± 0.05
Total Kjeldahl nitrogen (TKj-N)	g/L	2.1 ± 0.1	1.9 ± 0.0
Ammonia (NH_4-N)	mg/L	328.7 ± 28.3	411.5 ± 36.1
Lipids	g COD/L	2.97 ± 0.12	---
Proteins	g COD/L	19.72 ± 0.94	17.84 ± 0.63
C/N		31.36 ± 1.29	8.77 ± 0.84
Salinity	ppm	1.1 ± 0.2	---
Total volatile fatty acids (TVFAs)	mg/L	1642.5 ± 162.3	618.26 ± 47.5

2.2. Experimental procedures

Batch tests were conducted in 250 ml serum bottles with working volume 150 ml as shown in Fig. 1. The working volume was firstly filled with pretreated waste activated sludge (WAS) (the volatile suspended solid (VSS) of the sludge was 15.0 g/L). The volume percentages of WAS used in this study were 100, 70, 55, 45, 40, 33, 30, 25, and 0%. Then, the bottles filled with organic fraction of municipal solid waste till reach 150 ml. The initial pH of the mixture in each bottle was adjusted to 5.5 by 1 mol/L HCl or 1 mol/L NaOH. Each bottle was flushed with nitrogen for 3 min to provide anaerobic condition, capped with a rubber stopper, and placed in oven. The batch tests were conducted at 55°C. Each batch test was done three times (triplicate).

Fig. 1 Experimental batch serum bottle design

2.3. Analytical methods

Table 2 illustrate measurements taken in this research, and the method followed for each one.

Table 2 Methodology of measurements.

Parameter	Method
Gas volume	Displacement method
Gas composition	Gas chromatograph (GC) (GC-2014, Shi-madzu, Japan)
Volatile fatty acids (VFAs)	High performance liquid chromatography (HPLC) (LC-10AD, Shimadzu, Japan)
Total solids (TS) , Volatile solids (VS), Chemical Oxygen Demand (COD), Total Kjeldahl nitrogen (TKj-N), Ammonia, Salinity and Lipids	According to APHA [17]
Protein	6.26 × TKj-N [18]
Carbohydrate	Phenol–sulfuric acid method [19]

2.4. Kinetic model

The hydrogen production curve was fitted to a modified Gompertz equation (1), which was used as a suitable model for describing the hydrogen production in batch tests [20].

$$H = P \times \exp\left(- \exp\left[\frac{R_m \times e}{P}(\lambda - t) + 1 \right] \right) \qquad (1)$$

Where: H was cumulative hydrogen production (ml), P was ultimate hydrogen production (ml), R_m was maximum hydrogen production rate (ml/hr), λ was lag-phase time (hr), and e was exponential 1.

3. Results and discussion
3.1.   Effect of co-digestion on hydrogen production

The cumulative hydrogen production at different co-digestion ratios between OF-MSW and WAS for all batches are shown in Fig. 2. Maximum and minimum deviations of the triplicates are shown also in the figure. The results showed that hydrogen production in batch tests increased with increasing co-digestion ratio from 0:100 to 70:30%. However, it decreased with increasing co-digestion ratio from 70:30 to

100:0%. In this study, the maximum hydrogen production potential of 23.40 mmol was obtained at the co-digestion ratio of 70:30%. This demonstrated that in an appropriate range, increasing substrate concentration could increase the hydrogen production potential during the fermentative hydrogen production, but substrate at much higher concentration could decrease it with increasing concentration.

In this study, the modified Gompertz model eq. (1) was used to fit the cumulative hydrogen production data obtained from each batch test to obtain R_m and λ. The correlation coefficient between the experimental and simulated data was relatively high ($R^2 = 0.986$), which indicated that the modified Gompertz model could describe the progress of cumulative hydrogen production in the batch tests of this study successfully. The maximum hydrogen production rate (R_m) was 1.81 mmol/hr. achieved at co-digestion ratio of 70% OFMSW to 30% WAS. In which, lag phase was 7.5 hr.
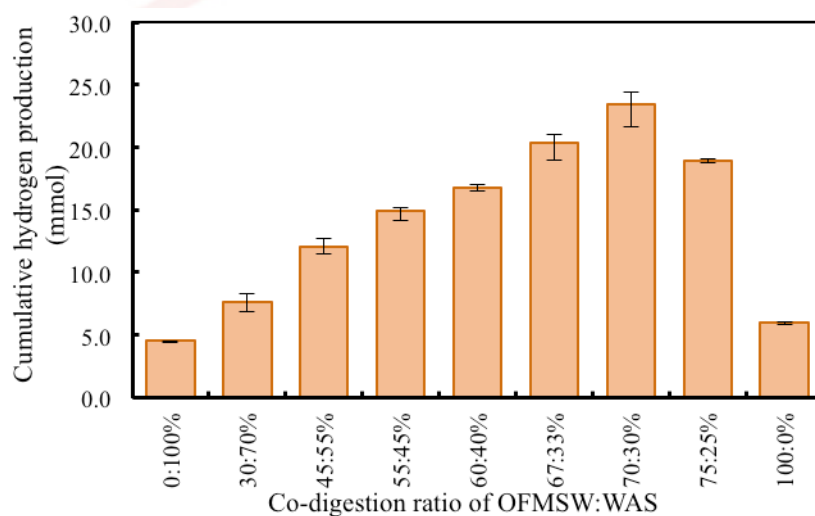
Fig. 2 Hydrogen production due to changing co-digestion ratio.

3.2.   Effect of co-digestion on substrate degradation

The effect of co-digestion ratio on COD removed and efficiency of removal shown in Fig. 3. The results showed that increasing the percentage of OFMSW increase the removed COD from 0.66 g at 0% till reached 1.55 g at OFMSW percentage of 70%. Further increase in OFMSW (%) decrease the removed COD till reached 1.41 g at 100% OFMSW. However, the removal efficiency percentage calculated by dividing the removed COD on the initial COD decreased with increasing OFMSW percentage. As, removal efficiency percentage started with 30.1% at OFMSW 0% till reached 14.3% at OFMSW 100%.
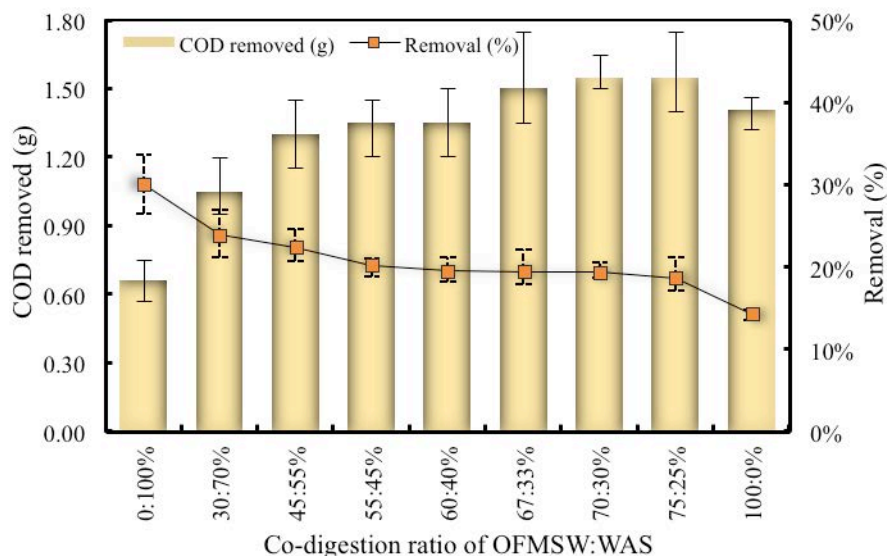
Fig. 3 COD removal due to changing co-digestion ratio.

3.3. Effect of co-digestion on hydrogen yield:

The hydrogen yield was calculated by dividing the cumulative hydrogen production by the amount of COD removed in each batch test. Fig. 4 shows the effect of co-digestion ratio on hydrogen yield. Hydrogen yield increased from 6.93 $mmol_{H2}/gCOD_{consumed}$ at co-digestion ratio (OFMSW: WAS) of 0:100% till reached 15.11 $mmol_{H2}/gCOD_{consumed}$ at 70:30%. Additional increase in OFMSW beyond 70% decrease hydrogen yield.
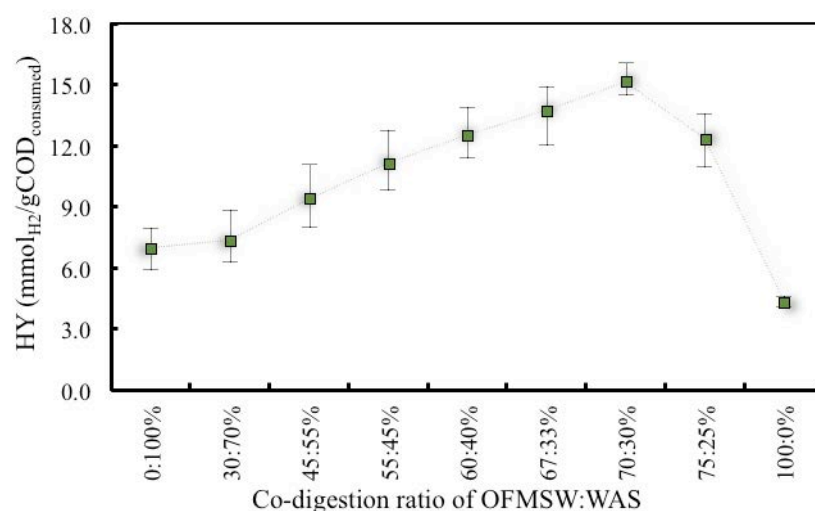
Fig. 4 Hydrogen yield due to changing of co-digestion ratio.

3.4. Effect of volatile solids content (%) on hydrogen production and yield

Changing co-digestion ratio between OFMSW and WAS, significantly effect on initial volatile solid content. As a result, Fig. 5 shows the effect of initial VS content (%) on hydrogen production and hydrogen yield. Results indicated that VS content of 24.1% achieved maximum hydrogen production of 23.40 $mmol_{H2}$ and hydrogen yield of 15.11 $mmol_{H2}/gCOD_{consumed}$.
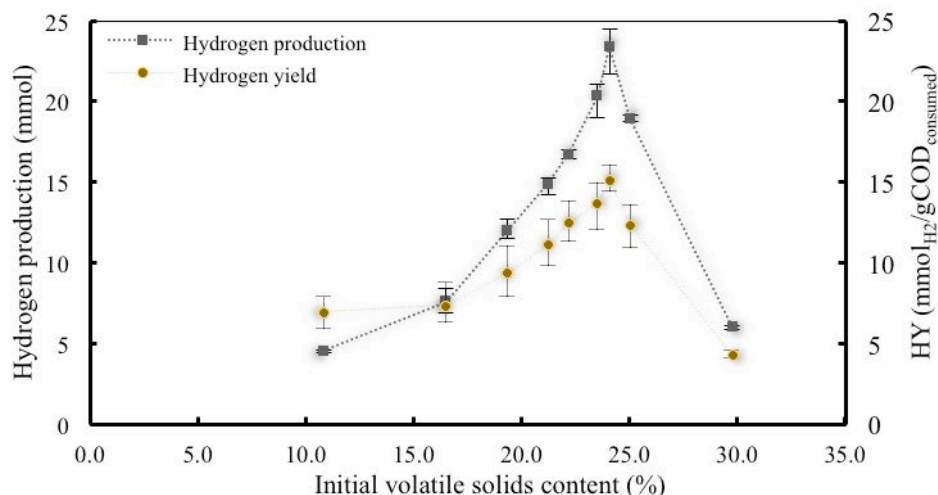
Fig. 5 Hydrogen production and yield with different initial VS content (%)

3.5. Effect of co-digestion ratio on total volatile fatty acids production.

The volatile fatty acid produced as intermediate product accompanied with hydrogen production. Total volatile fatty acids (TVFAs) generated from different co-digestion ratio are presented in Fig. 6. Maximum volatile fatty acid (VFAs) was 1.36 g registered at co-digestion ratio of 70% OFMSW to 30% WAS.
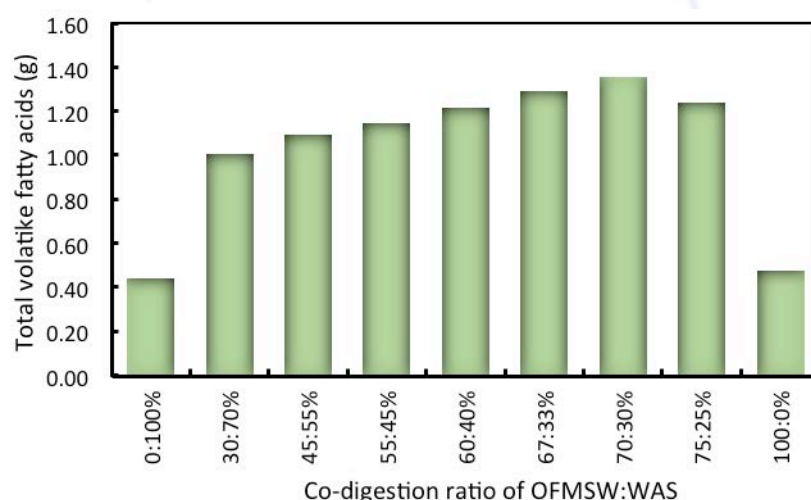
Fig. 6 Volatile fatty acids production due to different co-digestion ratio.

4. Conclusion

This study investigated the effect of different co-digestion ratio on hydrogen production and its metabolite products. The main achievements of this study are as follows:

- Maximum hydrogen production and hydrogen yield were 23.40 mmol and 15.11 $mmol_{H2}/gCOD_{consumed}$ achieved at optimum co-digestion ratio of 70% OFMSW to 30% WAS.
- Volatile solids content has great impact on hydrogen production and the proper percentage was 22%.
- Maximum volatile fatty acids were 1.36 g achieved at co-digestion ratio of 70% OFMSW to 30% WAS.

Acknowledgment

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Wind Catcher Earth Air Tunnel for Passive Cooling:
Annual Energy Performance of Residential Home in New Cites of Egypt

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Abstract

Wind catcher Earth air tunnels systems are proposed to be used in modern buildings to minimize the consumption of non-renewable energy. A tunnel in the form of a heat exchanger burns at a depth of about 4 m below the ground level will acquire the near temperature as the surrounding earth. Therefore, when the ambient air passes through this tunnel, it will be cooled in summer and warmed in winter seasons. This study explore the effect behaviour of using Wind catcher Earth air tunnel in designing energy efficient home with renewable energy utilizations during early stages of the planning of new societies in Egyptian desert cities. A prototype home for single-family detached houses of 240 m^2 in two floors, each floor of 120 m^2 with best utilization of the available renewable energies resources is proposed. This prototype home can be suggested to be the design for new single-family detached homes for Egyptian new towns. In order to achieve the above objective, this paper presents a reviewing for passive cooling techniques used in hot arid areas. Then a detailed analysis of the Wind catcher Earth air tunnel used in the suggested energy efficient home. The present study showed that using natural ventilation in the efficient home design for single-family detached houses in new societies in Egypt could save home energy bill and regulate the indoor air movement to achieve indoor thermal comfort, consequently, reduce the need for an electric mechanical means for indoor air movement.

Keywords: Egypt new cities, New societies of Hot arid areas, Wind Catcher Earth Air tunnel, Energy Efficient Homes, Passive Cooling/heating

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1. Introduction
Wind catcher as a natural ventilation system is increasingly used in modern buildings to minimize the consumption of non-renewable energy and reduce the harmful emissions. Height, cross section of the air passages and also place and the number of openings are the main factors which affect the ventilation performance of a wind catcher structure **Montazeri, 2011[1].** Natural ventilation has been a fundamental approach to the design of low energy buildings and it is well known that in low-rise buildings this is mainly achieved by wind-driven air flow through windows and openings. Purposefully designed and positioned openings are able to draw in and expel air. A wind catcher or wind tower is a single device to facilitate the supply and extract of air. They have been used in the Middle East countries for centuries to produce natural ventilation and passive cooling in buildings. **Yuehong et al, 2008 [2].** A wind-catcher functions as a solar chimney in an environment with no significant wind or available water. A solar chimney, which creates a pressure gradient, is a vertical duct or passage employing solar energy to heat up the air. Thus, the air rises through the passage as a result of convection. This convection of heated air is able to improve the natural ventilation of buildings and create passive cooling and natural ventilation. **Tavakolinia, 2011[3].**
Earth to air heat exchanger (EAHE) as Indirect Ground Air Cooling systems mainly depend on the high thermal capacity of the soil allows the temperature below a specific depth to remain constant throughout the year; a temperature that is near the annual average ambient temperature. In summer, the soil would act as a heat sink because the ambient temperature is higher than the ground temperature, whereas in winter the earth serves as a heat source. **Alanezi, 2012[4]** . Earth–air heat exchangers are one of the fastest growing applications of renewable energy in the world, with an annual increase in the number of installations with 10% in about 30 countries over the last 10 years. *Bisoniya et al, 2013 [5].*
It is widely perceived that the indoor comfort of buildings is accomplished at the expense of increased energy consumption due to active cooling utilization; passive cooling contributes to reducing or eliminating this expense. Buildings can be cooled by passive schemes through heat discharge to natural heat sinks such as the ambient air, sky and soil. The appropriateness of any passive cooling system not only depends on the indoor conditions but also on the building type and the site microclimate. **Alanezi, 2012[4]**

2. Passive cooling techniques in energy efficient building of hot arid areas
Incorporate solar passive techniques in a building design to minimize load on conventional systems (heating, cooling, ventilation and lighting) Passive systems provide thermal and visual comfort by using natural energy sources and sinks e.g. solar radiation, outside air, sky, wet surfaces, vegetation, internal gains etc. Energy flows in these systems are by natural means such as by radiation, conduction, convection with minimal or no use of mechanical means. The solar passive systems thus, vary from one climate to the other e.g. in a cold climate an architects' aim would be design a building in such a way that solar gains are maximized, but in a hot climate his primary aim would be to reduce solar gains, maximize natural ventilation and so on**, Majumdar [6]**

Employing natural or passive cooling system can be an alternative way to maintain a cool house or reduce air-conditioning load. A passive cooling system employs non-mechanical procedures to maintain suitable indoor temperature. Ingenuity of ancient

architectures has showed how a rational use of traditional passive techniques, along with a smart design, was involved in having desired summer comfort without a need to pursue mechanical cooling systems. Recently, there is much inclination toward these systems, especially due to economic and environmental reasons. **Maerefat & Haghighi, 2010 [7].**

Passive heating and cooling systems are known for their advantage of consuming no or very less energy as compared to active heating and cooling systems. **Bansal *et al*, 2012 [8].** The passive cooling of buildings is broadly categorized under three sections (i). Heat prevention /reduction,(Reduce heat gains) (ii).Thermal moderation(Modify heat gains) and (iii). Heat Dissipation(Remove internal heat). The various methods adopted for each of these, are further classified **Geetha & Velraj,2012 [9],** And given in Fig. 1.
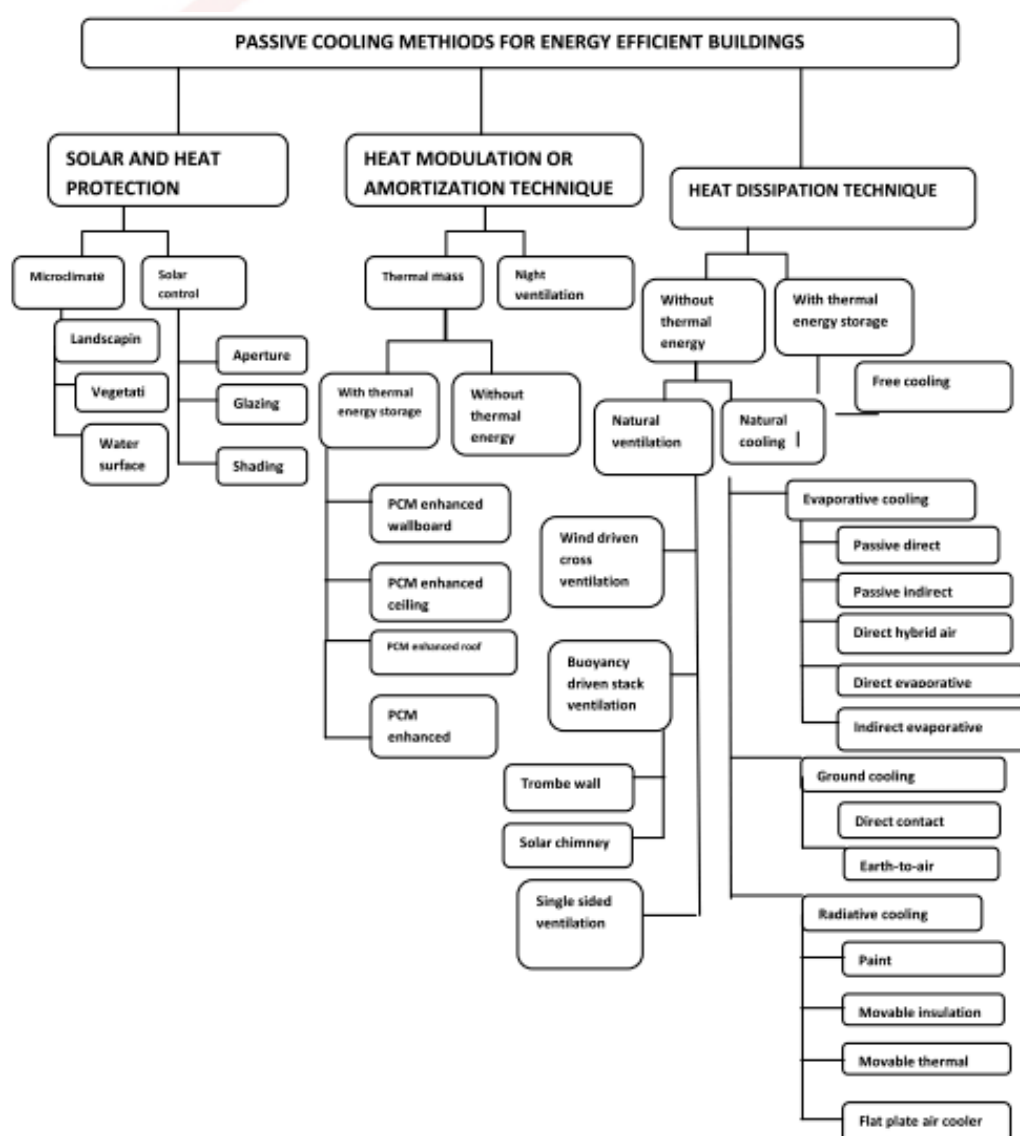
Figure 1: Classification of passive cooling methods in energy efficient buildings.
Geetha & Velraj, 2012[9]

The concept of Wind catcher is normally a tall structure with the height from 5 to 33 m mounted over the building roof. With taller tower capturing winds at higher speeds

and with less dust. **Dehghan *et al* , 2013[10]**.The number of directions in which Wind catcher face is different; therefore these towers are often classified to the number of their openings. One-sided, two-sided, four-sided (triangular cross section) and six-sided (hexagonal cross section) Fig. 2 shows several old Wind catcher with different number of openings. **Montazeri *et al*, 2008[11]**
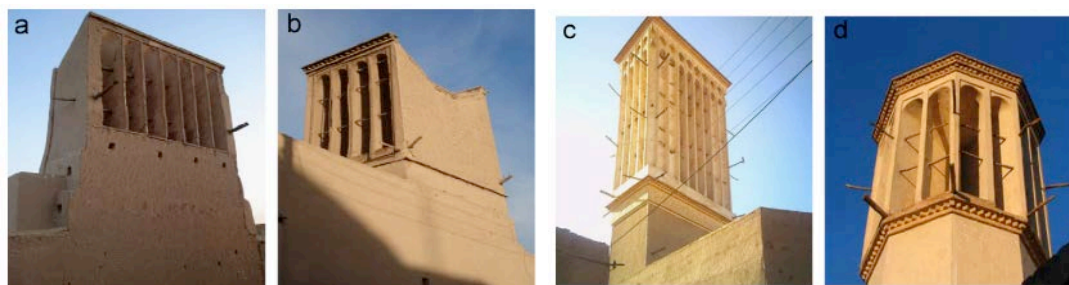

Figure 2: Several old Wind catcher with different number of openings,
(a) one-sided(b) two-sided (c) four-sided and (d) octahedral- wind catchers.
Montazeri *et al*, 2008[11]

The concept of ground cooling is based on heat dissipation from a building to the ground, which during the cooling season has a temperature lower than the outdoor air. This dissipation can be achieved either by direct contact of a significant section of the building envelope with the ground, or by injecting air that has been previously circulated underground into the building by means of earth-to-air heat exchangers. **Geetha & Velraj, 2012[9].** The earth temperature fluctuation reduces with depth and almost dies down at about 4 m. The temperature at this depth approximately equals annual average ambient temperature, as shown in Fig. 3. **Samuel *et al*, 2013[12]**
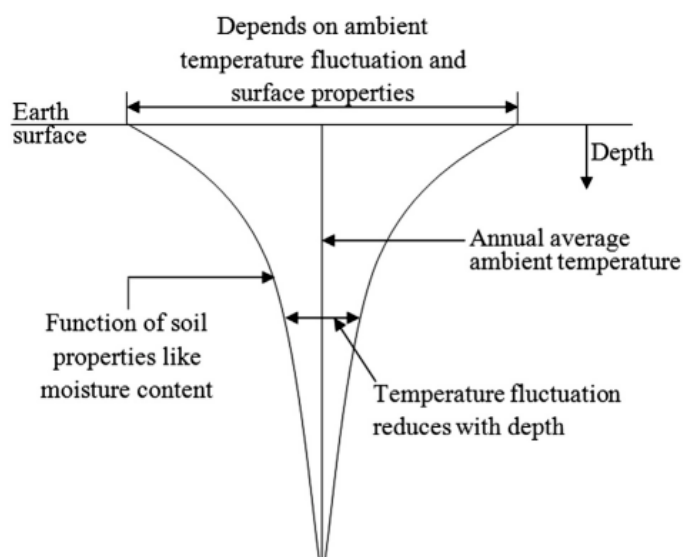

Figure 3: Earth temperature fluctuation with depth. **Samuel *et al*, 2013[12]**

A solar chimney on the other hand, is a good configuration to implement natural ventilation in buildings where solar energy is available. **Maerefat & Haghighi, 2010 [13],** An appropriate design of a solar chimney for cooling includes providing an air gap in a south facade or in the roof of the building that causes stack effect exists

between the solar chimney and the inlet of the building. The stack effect operates between the high temperature and high pressure developed in the solar chimney and the low pressure and low temperature at the inlet. If the openings are provided at the inlet of the building and at the outlet of the solar chimney, air will enter into the building due to the difference of air densities and pressure gradient and move through the building before exit from the outlet of the solar chimney. **Chungloo & Limmeechokchai, 2007 [14].**

3. Wind catcher earth air tunnel: a tool for passive cooling for the suggested renewable energy efficient home for new cites in Egypt

Passive cooling is being employed as a low-energy consuming technique to remove undesirable interior heat from a building in the hot seasons. There are numerous ways to promote this cooling technique, and in the present study the use of Wind catcher together with earth to air heat exchanger (EAHE) and solar chimney (SC) is introduced. As this study aim is to design energy efficient home with maximum possible renewable energy utilizations at early stage of planning of new societies in Egyptian desert, therefore, a prototype house for single-family detached houses of 240 m^2 in two floors, each floor of $120m^2$ - as shown in Figs. 4 &5. the proposed prototype is making use of the maximum possible utilization of the available renewable energies resources with high efficiency technologies of the house is sited - as shown in Figs. 6 &7. This suggested prototype house is design for new single-family detached houses for Egyptian new cities which consider as a key for Egypt future in the habitation of people in new towns.

under ground floor plan   Ground floor plan   First floor plan

Figure 4: Suggested prototype house for single-family detached houses planes and perspectives

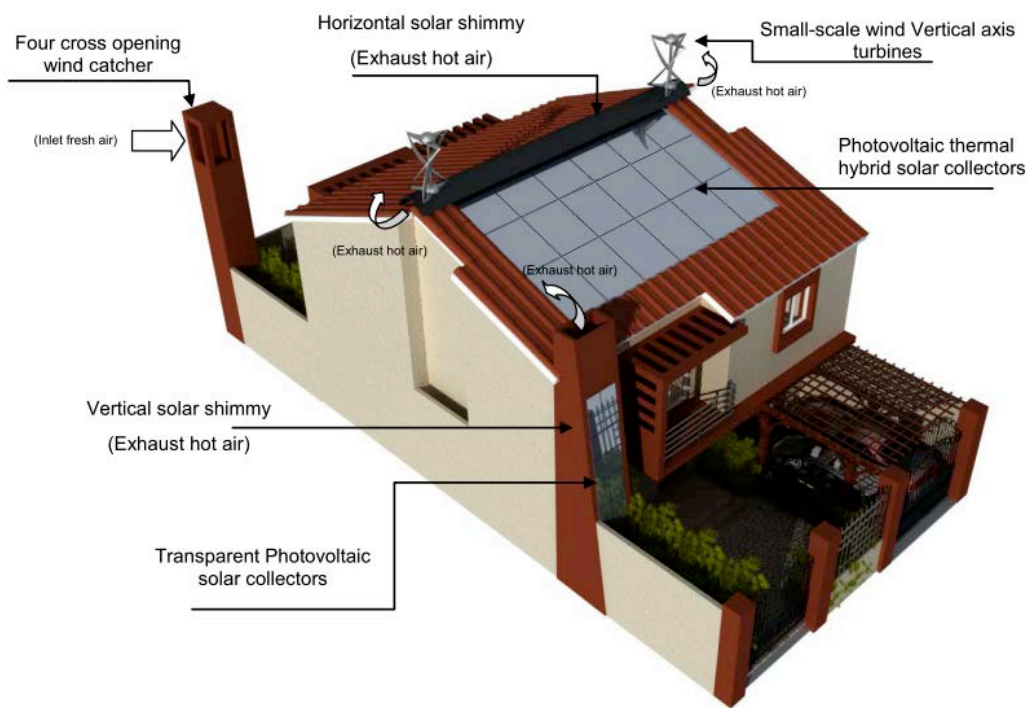**Figure 5:** Suggested layout for prototype house mass plane and perspectives.

Figure 6: Renewable energy technologies used in suggested prototype smart house
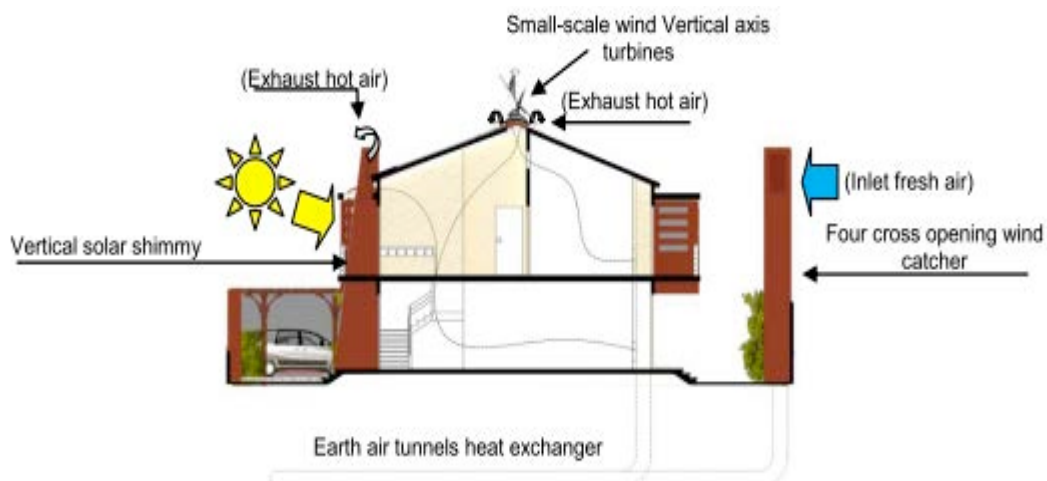
Figure 7: Suggested prototype smart house cross section.

In the suggested house, is proposed to use four cross opening wind catcher Earth air tunnels as a source for fresh air cooling supply, also a horizontal and vertical solar shimmy collector for hot air exhaust as shown in figures 8, 9&10.
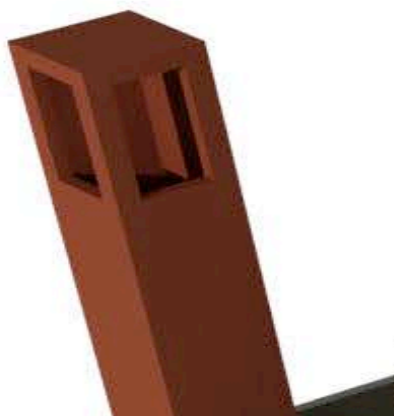

Figure 8: four cross opening wind catcher for the Suggested prototype house.

Figure 9: horizontal solar shimmy for the Suggested prototype house.

Figure 10: vertical solar shimmy for the Suggested prototype house.

The opening face of a wind-catcher is away from prevailing wind. When wind blows over this wind-catcher, it creates lower air pressure on the windward side. Since the air pressure inside the building is higher than the outside, the tendency of higher pressure air traveling to the lower pressure region causes the air to be drawn upwards. The wind-catchers using this method are usually combined with an underground earth cooling tunnels. In Figure7, the hot air is drawn down into the tunnels and is cooled by coming into contact with the cold earth. The cold soil helps the air become even cooler. This cool air is then drawn upward through the tunnel and ventilates the entire building.

The solar-chimney component can be integrated with an underground earth tunnel. If the incoming air goes through an underground pipe, the cooling effects can be significantly increased. Fig.7. shows that when the solar chimney warms up by solar radiation, while the warmed air is trying to escape through the solar-chimney duct, it will replaced by cooled air coming from the wind catcher through the underground tunnel.

Also using hybrid Photovoltaic thermal solar collectors as a source for electric power and Solar thermal energies is shown in fig. 11.The electricity flows into an inverter for use in the building or export to the grid as per a standard PV configuration. The temperature is regulated via a control sensor and the coolant is transferred using a pump to a heat exchanger which heats water in a storage tank for use in the hot water, heating and optional cooling systems. The system provides hot water for any kind of usage such as sanitary use, domestic applications (such as dish and clothes washing) and any other required usage. The heating output can be used for room heating and cooling as well as pool heating and other heating equipment

Moreover, it's proposed using Small-scale wind Vertical axis turbines, as a source for electric power also. Small-scale wind Vertical axis turbines are particularly suited to urban situations and to being integrated into buildings. Presently, there are several versions of vertical axis machines available in the market. It is suggested to use the most common vertical axis machine is the helical turbine as seen at the Earth Centre

as shown in fig. 12, Doncaster. In that instance it is mounted on a tower but it can also be side-hung on a building. This technology can generate power from 1 kW to megawatt capacity.

Figure 11: Photovoltaic thermal hybrid solar collectors

Figure 12: Small-scale wind Vertical axis turbines for the Suggested prototype house

The house required power is obtained from two sources through a smart meter used in the smart house energy management system; the power grid and the proposed electric supplier using renewable energy technologies systems mentioned before. The solar cell and small-scale wind vertical axis turbines energy is stored in battery system and then inverted to AC power form. The battery can be charged from the solar cell whenever the sun is shining, after the battery reach its full capacity during the day time, the system can supply the generated electric power to the public grid through the smart meter. The suggested home will obtain the electric power from the public grid during the off-peak hours if needed through the smart meter.

To calculate the annual energy performance of the suggested prototype house, ENER-WIN Software for building energy analyses had been used for simulation **ENER-WIN [15]**. ENER-WIN is categorized in the following steps, as shown in Fig. 14.

a. First run the program and select the building type as a residential building from the interface window.

b. Select the city for the weather data generation taken Asyut city Egypt as a case study.

c. Draw the building geometry for the ground floor plane.

d. Draw the building geometry for the first floor plane.
e. Define each zone in the plane through the zone processing window.
f. Define each zone description by defining each zone envelope materials cataloging and user profile cataloging; it can be taken as in table 1. The building envelope materials used in this prototype is used as the building material available in the market with low price and used by the contractor in the location of the taken new Asyut city Egypt which used as a case study.
g. Energy summations as Execute the simulation with selected HVAC systems or evaluating passively heated and cooled buildings (no HVAC).
h. System simulations and saving the output results.

Table 1: Building description printed from the run

```
*** PROJECT: Project Name                          LOCATION: Asyut (ES), EGYPT
PLAN: Preliminary           TYPE: Residential      Weather Year: 2013       Date of Run:
**************************************************************************************

                          MATERIAL DESCRIPTIONS CATALOG:
-------------------------------------------------------------------------------------
MATL                                      U-        SOLAR        TIME    DECREMENT
 ID    NAME                            FACTOR   ABSORPTIVITY    LAG      FACTOR
-------------------------------------------------------------------------------------
  1    insulation wood frame w/ wd siding    .454      0.30        1.0      0.0
  2    Brick veneer, insulation stud wall    .454      0.75        3.0      0.0
  8    Roof w/ 6"(15 cm) fiber insulation dark color  .284  0.8   2.0      0.0
  9    Heavy wt conc. roof w/ rigid insulation .397    0.8        3.0      0.0
 14    Slab-on-grade, un insulated           .568      0.0         3.0      0.0
 15    Slab-on-grade, insulated              .284      0.0         4.0      0.0
**************************************************************************************

                          WINDOW DESCRIPTIONS CATALOG:
-------------------------------------------------------------------------------------
WINDOW                                    U-       SOLAR HT.             DAYLIGHT
 ID    NAME                            FACTOR    GN. COEF.   EMISSIVITY   TRANS.
-------------------------------------------------------------------------------------
  1    1/4" (6mm) clear plate            6.416     0.83        0.84        0.87
**************************************************************************************
```

The orientation of buildings would be determined partly by the sun and partly by the wind. The best orientation of this prototype for the annual energy performance using the conventional systems without any passive cooling techniques is northwest as shown in Fig.13., though we have run the programme for this prototype in this orientation direction to decrease the energy usage for this prototype using the passive cooling techniques.
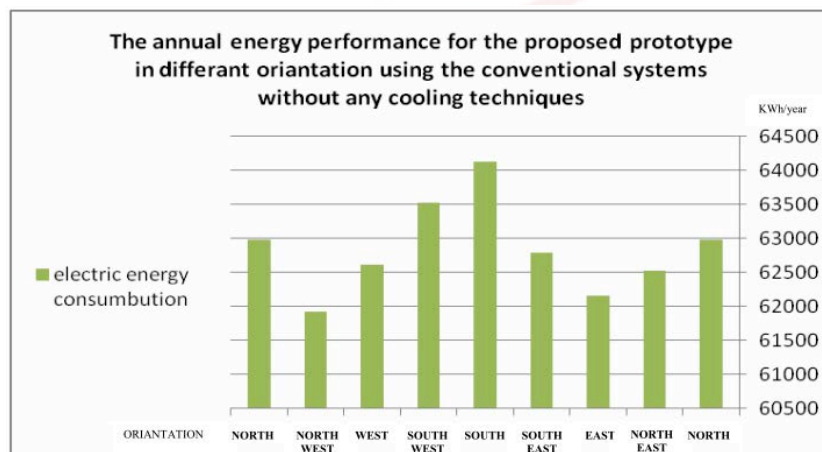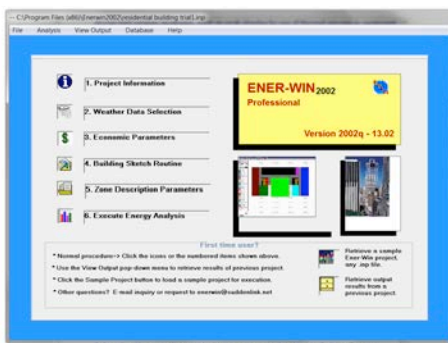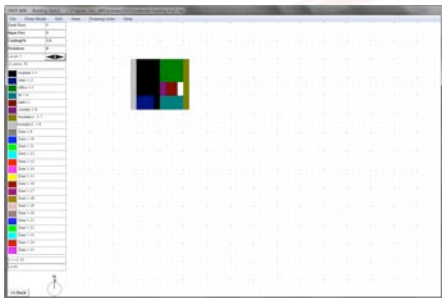

Figure 13: The annual energy performance for the proposed prototype in different orientation using the conventional systems without any cooling techniques
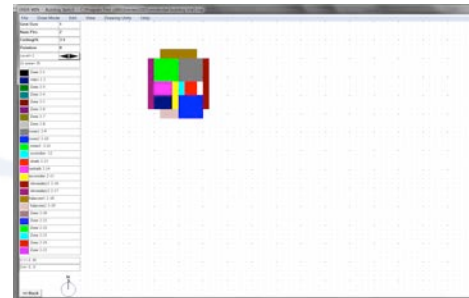.

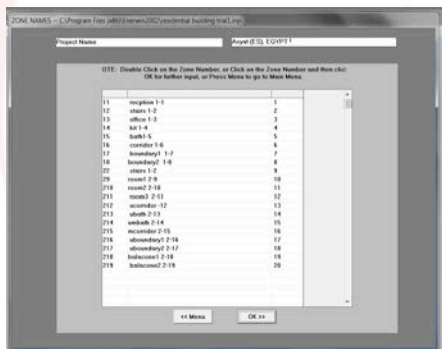a. ENER-WIN Software interface

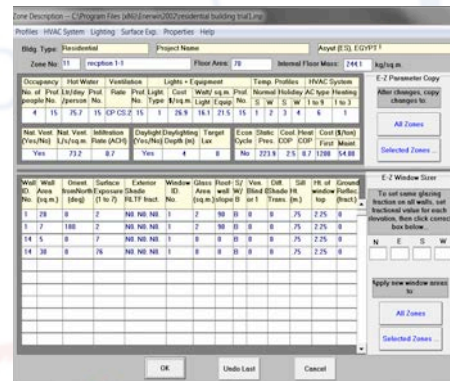b. weather data generation

c. Building geometry processing for ground floor

d. Building geometry processing for first floor

e. Zone processing

f. Zone description

g. Execute the simulation with HVAC or passive

h. Load calculations and system simulations

Figure 14: ENER-WIN Software for building energy analyses.

Using ENER-WIN Software for building temperature and relative humidity analyses, the obtained results by using the active energy HVAC system can be described in The
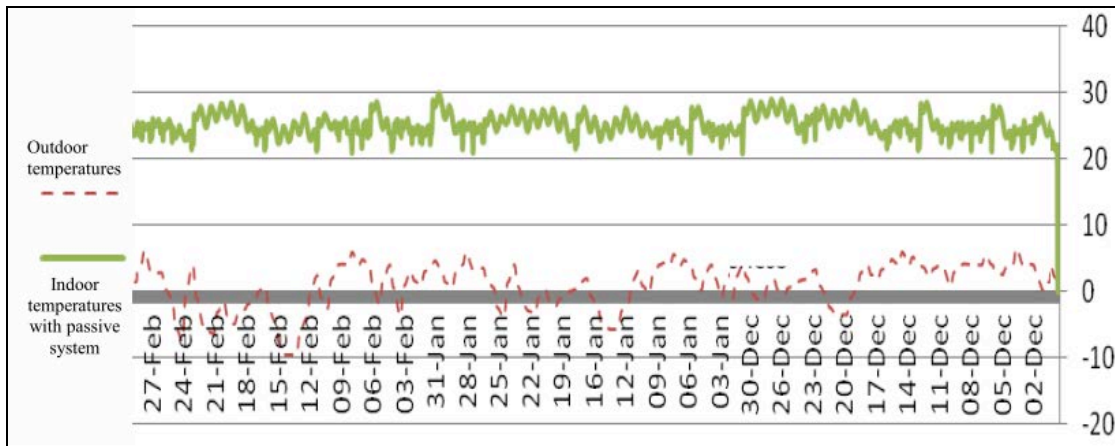
hourly deference between the outdoor temperatures, and the indoor temperature for reception area with use of passive system (without HVAC) in t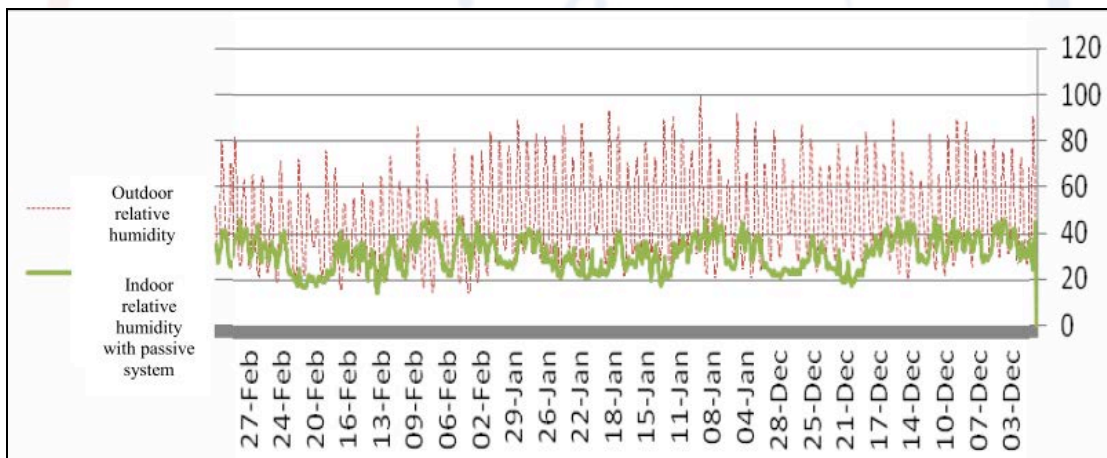he cold season (December, January & February) are shown in Fig. 15. Also The hourly deference between of the outdoor relative humidity and indoor relative humidity for the most important indoor zones as reception area with use of passive system (without HVAC) in the cold season (December, January & February) shown in Fig.16.

Figure 15: The hourly deference between the outdoor temperatures, and the indoor temperature for reception area with use of passive system (without HVAC) in the cold season (December, January & February)

Figure 16: The hourly deference between of the outdoor relative humidity and indoor relative humidity for the most important indoor zones as reception area with use of passive system (without HVAC) in the cold season (December, January & February)

The hourly deference between the outdoor temperatures, and the indoor temperature for reception area with use of passive system (without HVAC) in the hot season (June, July & august) are shown in Figs. 17. Also The hourly deference between of the outdoor relative humidity and indoor relative humidity for the most important indoor zones as reception area with use of passive system (without HVAC) in the hot season (June, July & august) shown in Figs.18.
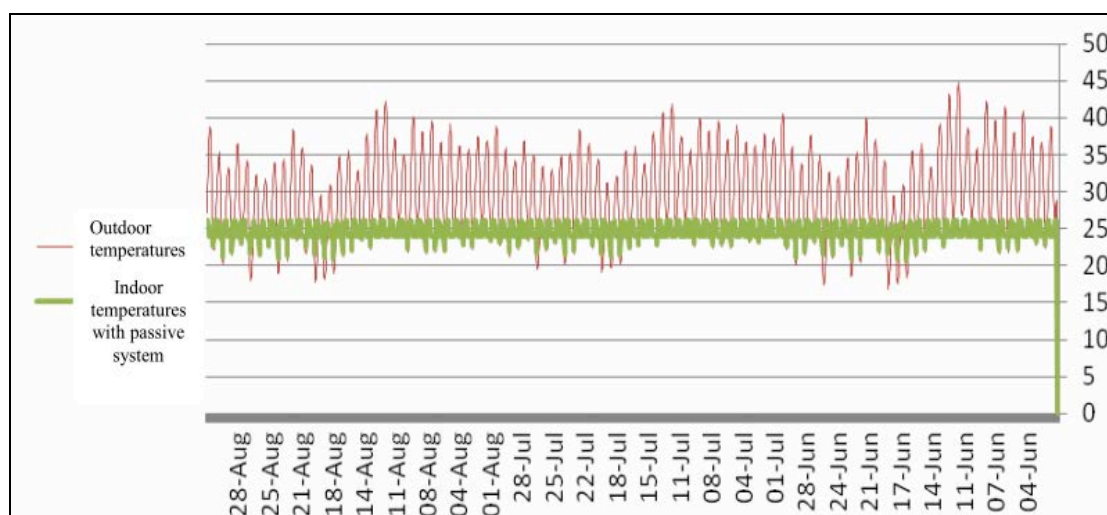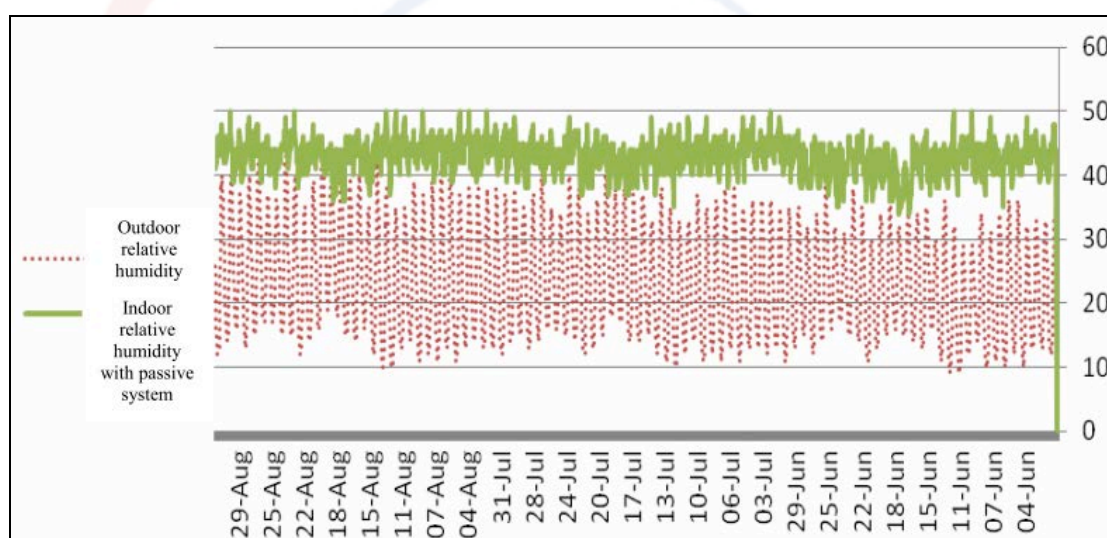
Figure 17: The hourly deference between the outdoor temperatures, and the indoor temperature for reception area with use of passive system (without HVAC) in the hot season (June, July & august).

Figure 18: The hourly deference between of the outdoor relative humidity and indoor relative humidity for the most important indoor zones as reception area with use of passive system (without HVAC) in the hot season (June, July & august).

The obtained results by using ENER-WIN Software for building energy analyses using the active energy HVAC system are shown in Figs. 19, 20 & 21. From these figures clearly seen that the total electric energy consumed was 40283.5 KWh/year with peak electric energy demand = 167.5 KWh/year, also required peak heating power is 11.185 kw at 14 Feb. at 7 am, while the peak cooling power is 18.28 kw at 11 Jun. at 6 pm. As illustrated in Fig.19, the maximum need of electric energy occurs in July, corresponding to the maximum cooling load in the same month, whoever this load could be reduced by using passive cooling technology such as underground earth cooling system which will lead to minimize the consumption of electric energy required for the cooling.

The maximum use of space heating energy occurs in Jan, as shown in Fig. 19, to overcome this load can be done by using a passive heating technology as P V/ thermal

hybrid solar collectors to decrease both the electric energy needed and heating load . Therefore, the electric energy consumption can be decreased in the cooling energy demand in the hot season (June, July & august), and heating energy demand in the cold season (December, January & February) through using the renewable energy resources on the site with appropriate efficient technologies.
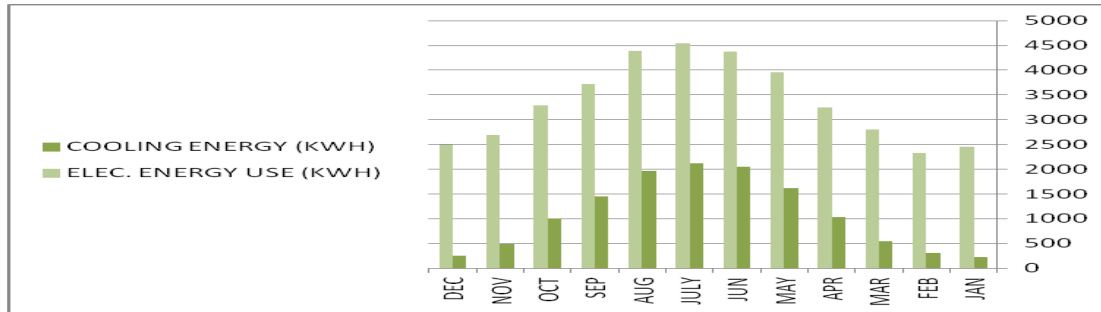

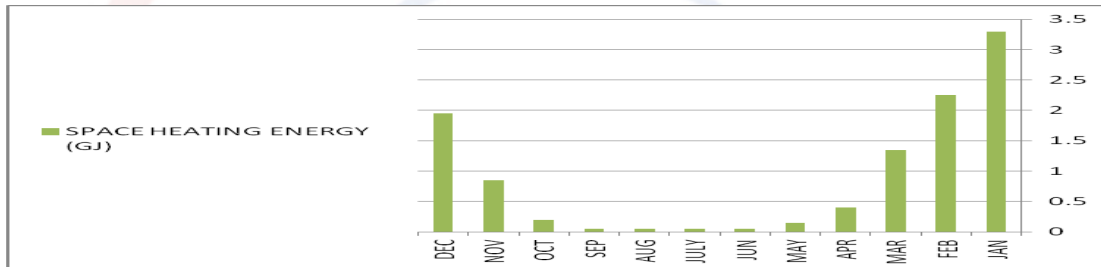**Figure 19:** Monthly electric energy and Monthly Cooling energy consumed by the active energy system.

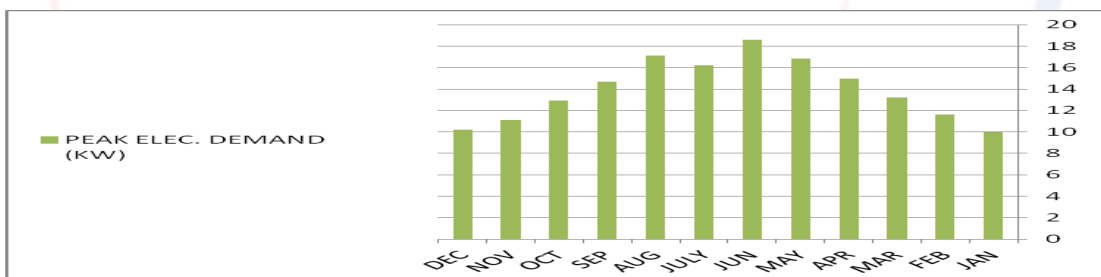**Figure 20:** Monthly space heating energy consumed by the active energy system.

Figure 21: Monthly peak electric energy demand by the active energy system.

Also the results show that using the smart passive energy techniques, show that the total electric energy consumption is 32509 KWh/year. Correspondence to total peak electric energy demand = 120.3 KWh/year, as shown in Figs.22 & 23.
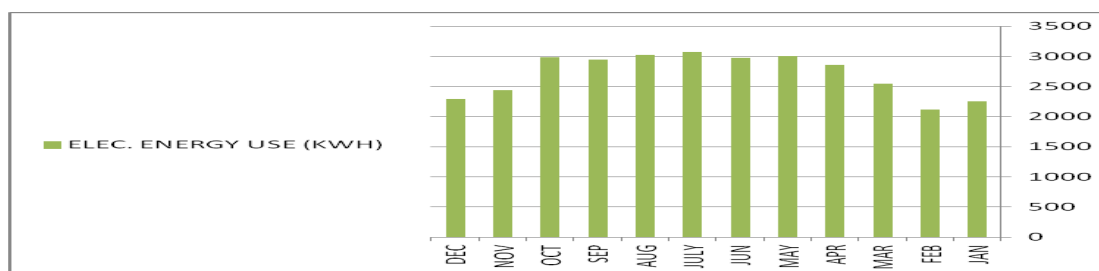
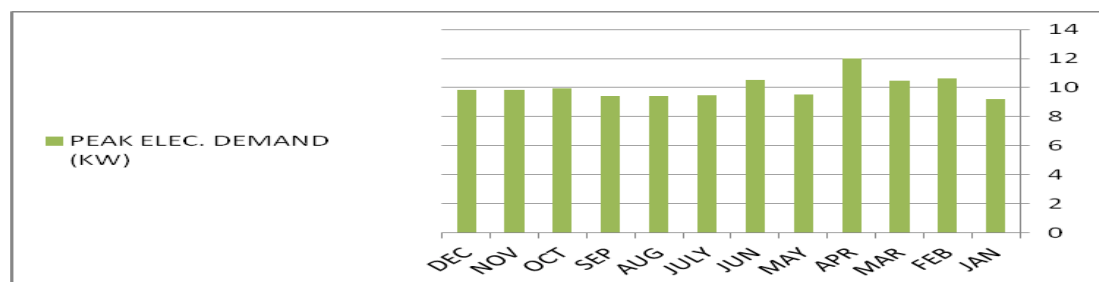**Figure 22:** Monthly electric energy consumed by the passive energy system.

Figure 23: Monthly peak electric energy demand by the passive energy system.

4. Conclusions.

This study presents a wind catcher earth air tunnel system as a tool for passive cooling for a suggested renewable energy efficient home for new cites in Egypt. The proposed design for an energy efficient smart home with renewable energy utilizations in Egyptian desert new cities as compared with conventional design homes can be can be consider as a key for Egypt future in the habitation of people in new towns.

This proposed prototype home is designed for a single-family detached house with area of 240 m2 in two floors; each floor has 120 m2, which the efficient renewable energy technologies planned to provide such home by electricity, heat and supply of cold air need in summer times as following:

Electric and Heat supply: This by using hybrid photovoltaic thermal solar collectors as a source for both electric power and solar thermal energies.While the PV module generates electrical power, in combined with a small-scale vertical axis wind turbines, as a source for electric power. For output heat generated use, a heat exchanger is used to heat water in a storage tank for the use of domestic hot water, home heating in winter and optional solar driven cooling systems in summer.

Cold Air Supply: This by using a combined four cross opening wind catcher with earth air tunnels as a source for fresh cold air supply, assisted by a horizontal and vertical solar shimmy collector for sucking the hot air from the home to be exhausted.

The use of wind catcher earth air tunnel system as a tool for passive cooling could help to reach the thermal comfort conditions inside the prototype house in summer hot seasons, also in winter cold seasons. The results obtained from building energy analyses using the active energy HVAC system, the total electric energy consumed was 40283.5 KWh/year with peak electric energy demand = 167.5 KWh/year, also required peak heating power is 11.185 kw at 14 Feb. at 7 am, while the peak cooling power is 18.28 kw at 11 Jun. at 6 pm. However, using the smart passive energy techniques, show that the total electric energy consumption is 32509 KWh/year.

Correspondence to total peak electric energy demand = 120.3 KWh/year. This means that the prototype house could be efficient and save about 20% of the home energy bill.

In case of the renewable resources are not sufficient or exceed the needs, the suggested house is equipped by both multiplexer for both renewable power resources and grid power as well as a smart meter for the house energy management. This type of power combination will result in reducing the consumer electrical bill and better manage the peak loads by the electrical utilities.

Acknowledgement

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Maximum Power Point Tracker Based on Perturb and Observe Algorithm for Photovoltaic Energy System under Egyptian Conditions

Ali. M. Eltamaly, King Saud University, Saudi Arabia
Hegazy Rezk, Minia University, Egypt

Abstract
In this paper, a maximum power point tracker (MPPT) based on perturb and observe algorithm for photovoltaic (PV) energy system is introduced. MPPT is a dc to dc converter that regulates the output power to ensure an optimum value of the PV module voltage to extract the maximum power from PV module. The main objective of this paper is to study the effect of operating the PV system at maximum power point under Egyptian conditions. The overall system is modeled by using MATLAB/Simulink program. The output power and energy from PV system in case of using MPPT based on perturb and observe algorithm are compared to those obtained by the system without MPPT. Results show that, the PV system with MPPT increases the efficiency of energy production harvested from PV.

Keywords: Photovoltaic Energy System, MPPT, Perturb and Observe and Boost Converter

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I. Introduction

Renewable energy generation has experienced consistent growth in the last two decades, motivated by the concerns of climate change and high oil prices, and supported by renewable energy legislation and incentives. Solar photovoltaic (PV) is one of the fastest growing energy technologies, with an average annual growth of about 40% in the past decade [1]. Today PV electricity generation has a considerable contribution among other renewable energy sources. At least 28.4 GW of PV systems have been installed in the world last year [2]. At least, 110 TWh will be produced in 2013 by PV systems already installed [2], which represents about 0.5% of the electricity demand of the planet, some countries have reached rapidly significant percentages. These 110 TWh represent the annual consumption of countries such as the Netherlands or Egypt. Many European countries planned to install several big PV power stations in the desert of North Africa which will increase the generation from PV considerably. Despite the technological advances and governmental incentives, the cost of energy produced by grid connected PV energy systems is still relatively high and cannot compete yet with traditional wholesale electricity prices. This motivates the research for creating not only improved solar modules but also more efficient power converters which increase the generated energy from PV systems which can be translated to considerable cost reduction.

Most of Arabian countries have shining sun all the year for example Egypt enjoys excellent solar radiation; the annual global solar radiation is between 1900 and 2600 kW h/m^2 per day from north to south respectively [3]. Solar energy, especially PV energy system generates electricity from sunlight collected by solar modules. PV energy systems are particularly suitable for supplying electrical power to load in many rural remote areas, which have no access to electric utility. Unfortunately, the actual energy conversion efficiency of PV module is rather low. So to overcome this problem and to get the maximum possible efficiency, a maximum power point tracker (MPPT) is used [3,4].

The output power from PV module varies with atmospheric conditions like solar radiation level and temperature as well as their output voltage and current. There is an optimum value for the PV terminal voltage for each radiation and temperature. This optimum value is called the maximum power point (MPP) at this condition. It is crucial to operate the PV energy system near the MPP to improve PV energy system conversion efficiency. MPPT algorithms are usually implemented in the power electronic interface between the PV module and an energy storage device or load for this purpose [5].

MPPT methods are used to track the voltage V_{mpp} or current I_{mpp} at which a PV module delivers a maximum power under a given radiation and temperature. The commonly used MPPT methods are fractional open circuit voltage, fractional short circuit current, Perturb and Observe P&O and Incremental conductance MPPT methods. The P&O and incremental conductance methods are widely used in PV applications due to the ease of implementation [6,7]. The fractional open-circuit voltage method is based on determining a constant value which gives the relationship between MPP voltage and open-circuit voltage to find the optimal operating point. On the other hand, relationship between the MPP voltage and radiation might not be same for different solar cell technologies. It is impossible to determine the optimum voltage by using only one linear function of the open-circuit voltage. Due to that reasons, this

tracking method might fail to determine the optimum voltage during fast changing irradiance conditions especially in fractional open-circuit voltage [8].

In recent years, research has been done on improving the capabilities of MPPT algorithms, partly driven by the availability of more powerful control circuitry. However, even a quite simple P&O algorithm can give sufficient accuracy and response speed to assess the power output of PV modules [6]. This tracking method based on the fact that, on the voltage-power characteristic, on the left of the MPP the variation of the power against voltage $dP/dV > 0$, while on the right, $dP/dV < 0$ as shown in Fig. 1. If the operating voltage of the PV array is perturbed in a given direction and $dP/dV > 0$, it is known that the perturbation moved the array's operating point toward the MPP. The P&O algorithm would then continue to perturb the PV module voltage in the same direction. If $dP/dV < 0$, then the change in operating point moved the PV array away from the MPP, and the P&O algorithm reverses the direction of the perturbation [2].
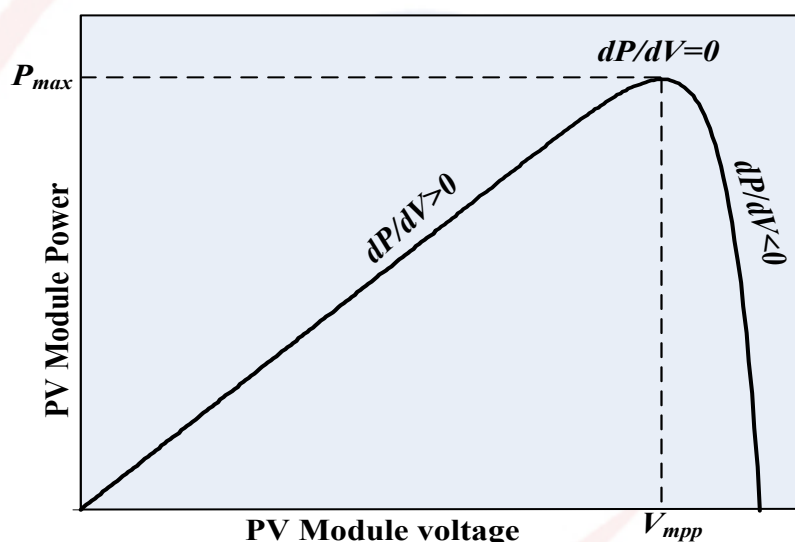

Fig. 1 PV module power -voltage characteristics

Ii. Model of the Proposed System
The simulation of the proposed system has been carried out using MPPT based on P&O method. MPPT P&O technique attempts to find the PV voltage that result in the maximum power point V_{mpp}. Simulation of the proposed system has been implemented using MATLAB/Simulink program; the simulation of the proposed system contains sub models that explained in the following sections:

A. PV cell characteristics
Photovoltaic cell generates electricity from the solar radiation. PV module works under the phenomenon of photoelectric effect, where it directly converts sunlight into electricity. Solar cells are connected in series and parallel to step up the voltage and current of PV module respectively. Solar cell will produce dc voltage when it is exposed to sunlight. Fig. 2 shows the equivalent circuit model for a PV module. Solar cell can be regarded as a non-linear current source. Its generated current depends on the characteristic of material, irradiation and cell temperature. Equations (1), (2) and (3) describe the I-V characteristics of the PV model [10-13].
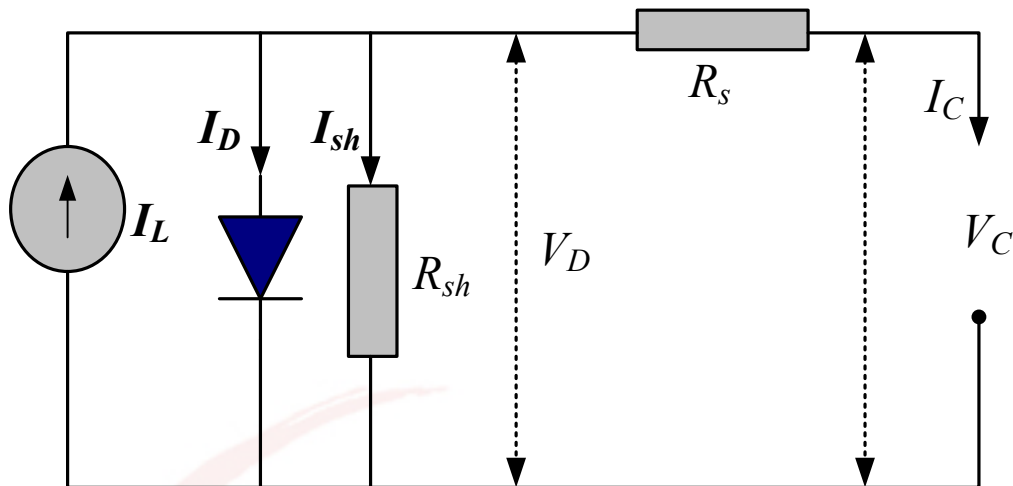
Fig. 3 Equivalent circuit of PV module

$$I_C = I_L - I_D - I_{sh} \tag{1}$$

$$\text{where } V_t = \frac{AKT_c}{q} \text{ , } I_D = I_o \left\{ \exp\left(\frac{V_D}{V_t}\right) - 1 \right\} \tag{2}$$

$$I_L = R \left[I_{L,ref} + \mu_{I,SC} \left(T_c - T_{c,ref} \right) \right] \tag{3}$$

Where:

I_C Cell current (A).

I_L Light generated current (A).

I_o Reverse saturation Current.

q Charge of electron = 1.6 x 10^{-19} (coulomb)

K Boltzmann constant (j/K).

A Ideality factor.

V_t Thermal voltage.

R_s Cell series resistance (ohms).

R_{sh} Cell shunt resistance (ohms).

$\mu_{I,SC}$ Temperature coefficient of the short circuit current $A/°C$.

T_c PV cell temperature

$T_{c,ref}$ Reference Temperature $25°C$

LA361K51S PV module is chosen to be used in MATLAB simulation model. The module is made of 36 multi-crystalline silicon solar cells in series and provides 51 W of nominal maximum power [14]. Table 1 shows the LA361K51S PV module electrical specifications. Fig.3 shows the Simulink model of PV module. Typically, fixed (non adjustable) PV arrays should be tilted toward south by angle equal to the latitude of the array's location to capture the most year round solar energy. If the PV array is mounted with a tilt angle equal to the site latitude, it's perpendicular to the sun twice a year (on each equinox date) and very close to perpendicular for the weeks before and after the equinox; this makes the array perpendicular to the sun's position in the sky for the greatest number of hours throughout the year [10]. The hourly radiations on the horizontal and on the tilted surface by angle equal 22.46° southward

are shown in Fig. 4. These data which are used in simulation are from realistic hourly data of the EL- Owainate city of the Arab Republic of Egypt as a case study.

Figs. 5 and 6 show the P-V and V-I characteristics of the tilted PV module for various time from 8:00 AM to 5:00 PM at April 15th.
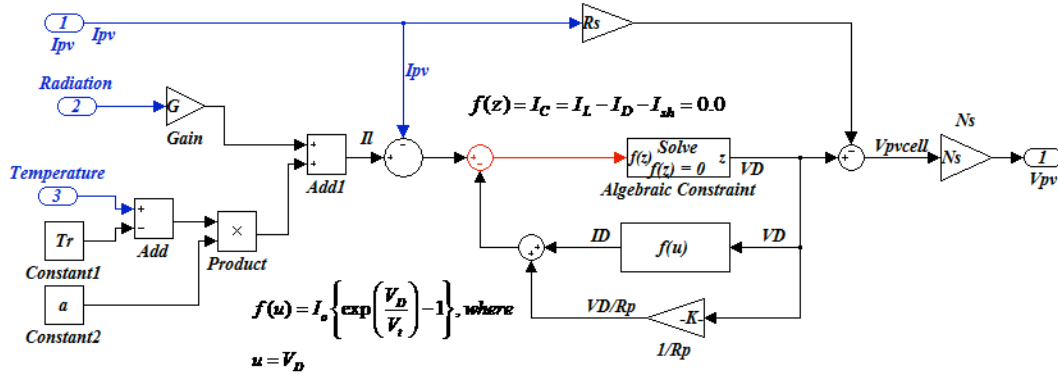
Fig.3 MATLAB Simulink model of PV module

The algebraic constraint block shown in Fig. 3 constrains the input signal $f(z)$ to zero and outputs an algebraic state z. The block outputs the value that produces a zero at the input. The output must affect the input through a direct feedback path, that is, the feedback path contains only blocks with direct feed through [16].

Table .1 Electrical characteristics data of PV module [14]

Characteristics	Specification
Maximum power	51 W
Short circuit current	3.25 A
Open circuit voltage	21.2 V
Current at MPP	3.02 A
Voltage at MPP	16.9 V

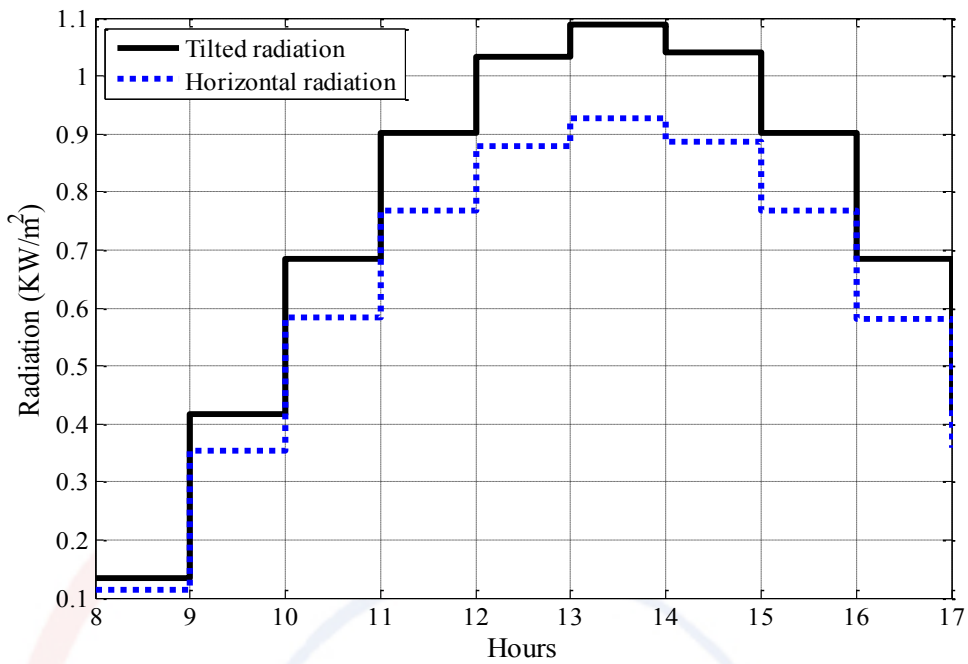**Fig. 4** Average daily hourly radiation in EL- Owainate, Egypt for April 15th

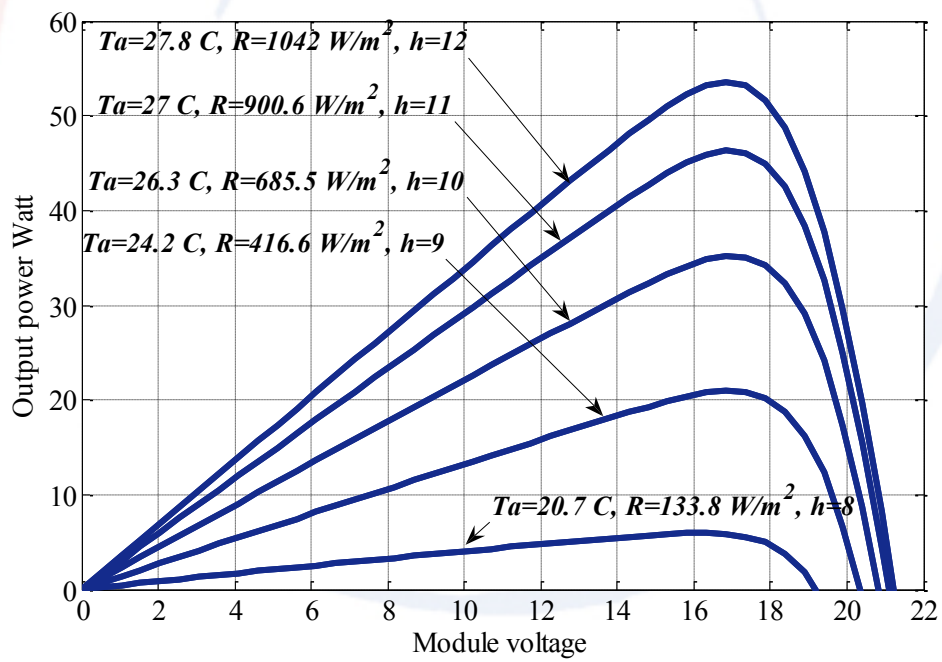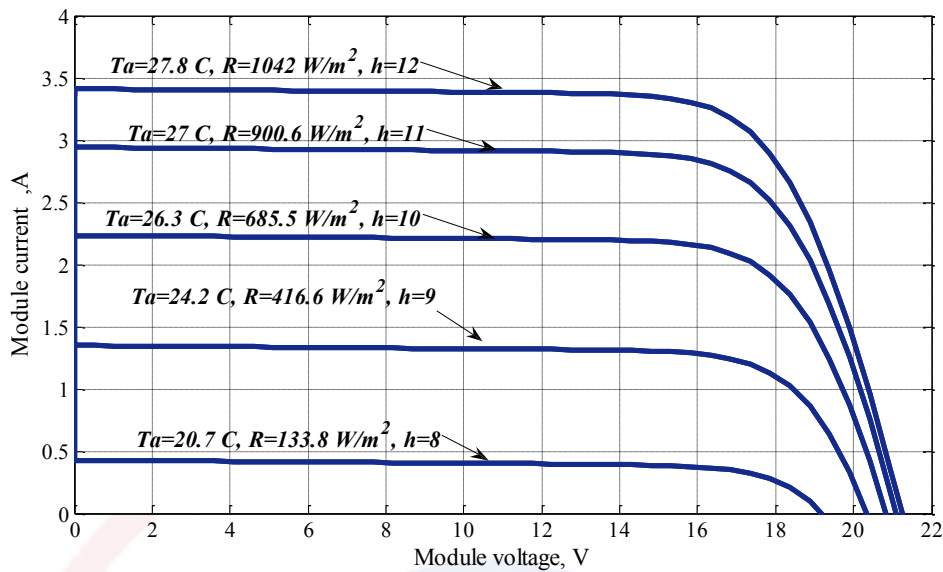**Fig. 5** P-V characteristics using LA361K51S Solar Cells Module at April 15th

Fig. 6 I-V characteristics using LA361K51S solar cells module for April 15th

B. Mathematical model of boost converter

The input to dc-dc converter is connected to PV array and its output is connected to battery storage. Fig.7 shows the Simulink of mathematical model of boost converter [15]. The inputs of this model are the output voltage and current of PV array. The voltage transfer function of boost converter is written as shown in the following equation:

$$V_i = V_b (1 - D) \qquad (4)$$

Where,

V_i The terminal voltage of PV array,

V_b The battery voltage.

D Duty cycle.

Fig.7 Simulink model of the boost converter
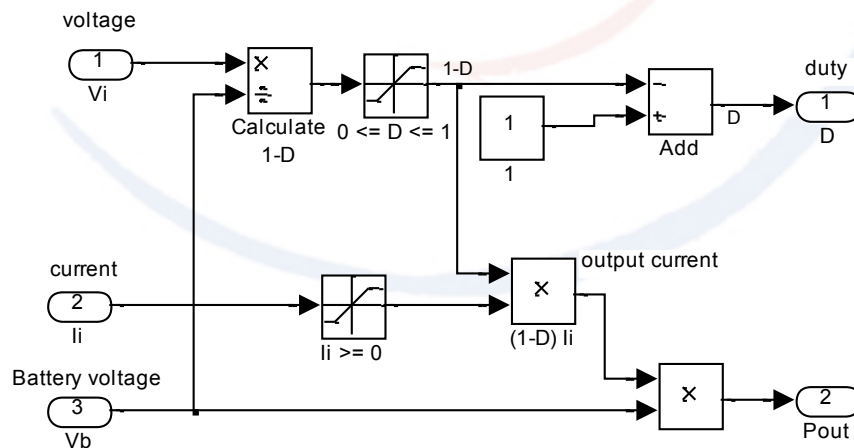
C. Perturb and Observe MPPT algorithm

P&O MPPTs can be implemented with perturbations in the PV module current or PV module voltage reference signal. For the latter case, the PV voltage reference signal is varied as a function of the sign of the perturbation and output power variation in the previous interval. The proposed algorithm which used in this study will track V_{mpp}.

However, it tracks directly the maximum possible power P_{max} that can be extracted from the PV. The flowchart of the proposed MPPT method is shown in Fig. 8. After one perturb operation the current power is calculated and compared with previous value to determine the change of power ΔP ($P - P_{\text{old}}$). If $\Delta P > 0$, then the operation continues in the same direction of perturbation. Otherwise the operation reveres the perturbation direction [8-9].

III. Simulation Results

The simulation of the proposed system has been implemented using MATLAB /Simulink program as shown in Fig. 9. The simulation is carried out with the realistic hourly data of the EL-Owainate city of The Arab Republic of Egypt as a case study for various times from 8:00 AM to 5:00 PM at April 15th for the purpose of study the effect of operating of PV system with MPPT on the output power and energy. Output power and energy from PV system are shown in Figs.10 and 11. It is clear from these figures that the output power and energy from PV module in case of using P&O MPPT are greater than output power and energy in case of using constant PV output voltage.

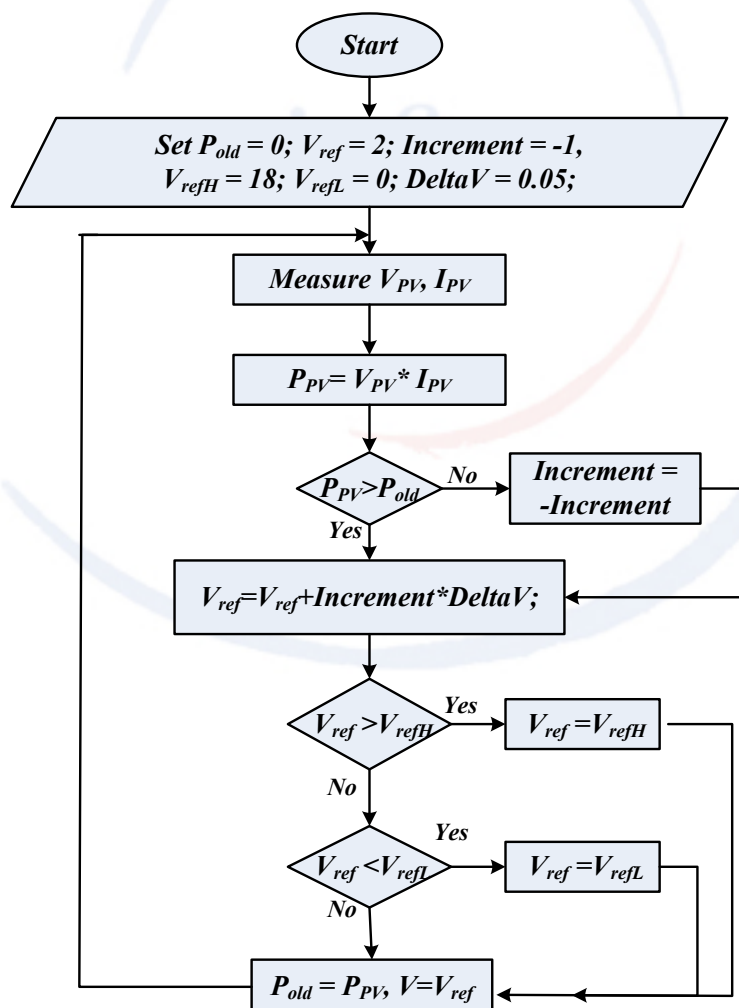**Fig. 8** Flowchart of the proposed P&O MPPT algorithm
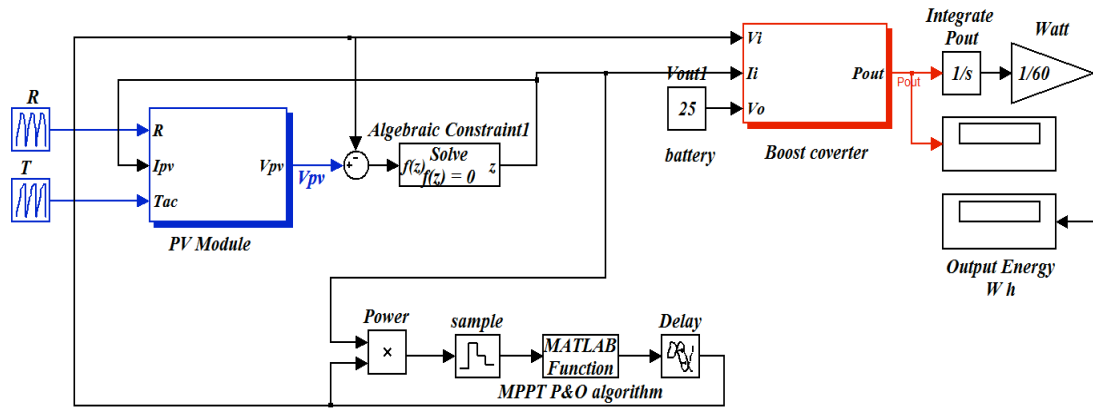
Fig. 9 MATLAB Simulink Modeling of Maximum Power Point Tracker based on P&O algorithm

The function of the algebraic constraint1 block in Fig.9 is solving for I_{pv} that result V_{pv} to convert the current input PV model shown in Fig. 3 to voltage input of PV model.
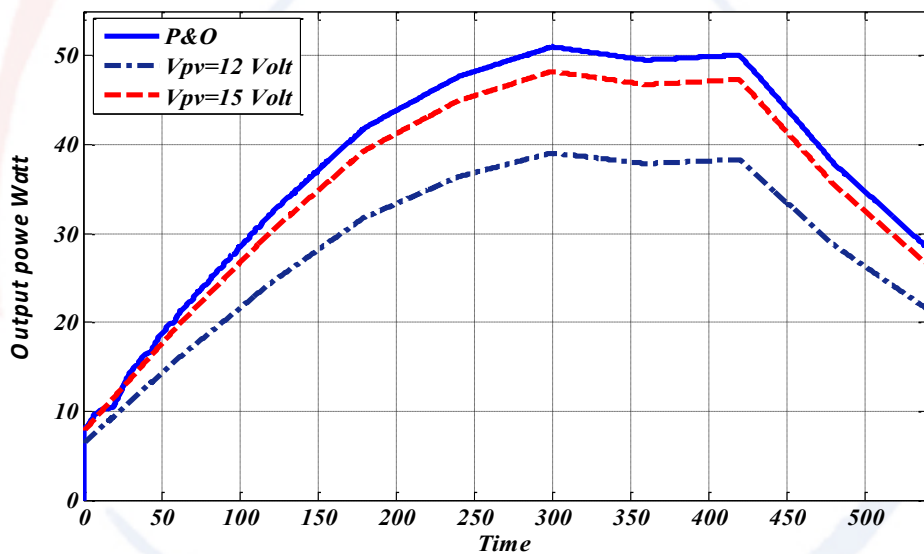
Fig. 10 The output power from PV system with and without using MPPT
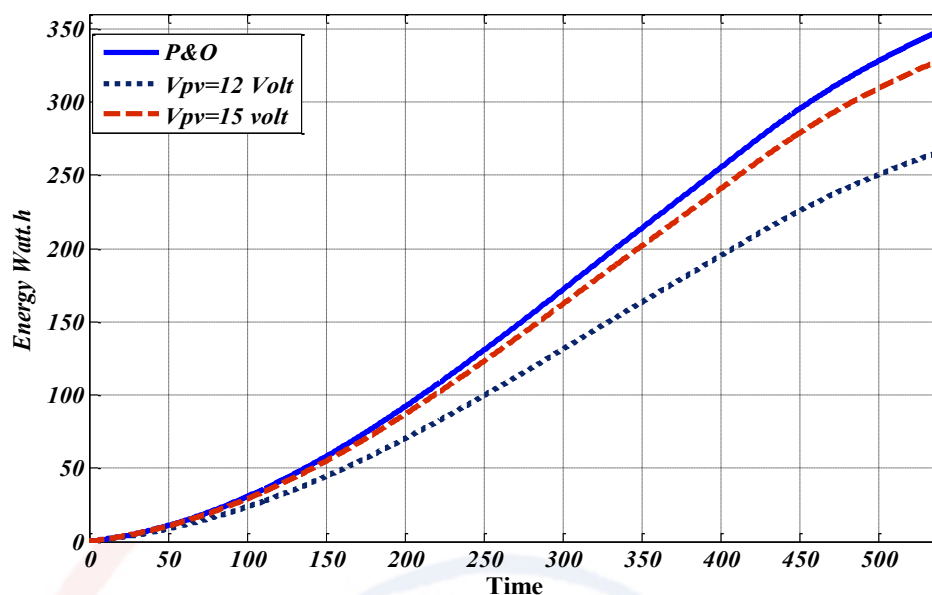
Fig. 11 The output energy from PV system with and without using MPPT

IV. Conclusion

The output generated power from the PV module is changing with the operating voltage of the PV Module for each value of radiation and temperature. There is a maximum power point, MPP at certain voltage of the PV cells. Maximum power point tracker, MPPT is used to track this point. Simulation results reveals that, operation at MPP increases the energy output from one tilted PV module for one day on April from 8^{am} to 3^{pm} from 266 Wh at 12 V PV constant terminal voltage and 329 Wh at 15 V PV constant terminal voltage to 349 Wh with using the proposed technique, i.e the energy increased by 31 % and 6.1% respectively. This increased in the output energy from PV proves the superiority of the proposed algorithm which can be translated to considerable cost reduction of the generated kWh.

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Effect of Fuel Type on the Life Cycle of Egyptian Cement Industry: Environmental Impact Assessment Approach

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Abstract
Life cycle assessment (LCA) is a useful tool for assessing the environmental impacts of a system, product or service. Cleaner production and pollution prevention opportunities for the cement sector include: 1) use of alternate fuels in cement kilns; 2) NOX reduction; 3) reduction of dust emissions; 4) reuse of bypass dust; and 5) treatment of hazardous waste. Nowadays, Egypt faced energy scarcity inducing political, social and environmental factors putting pressure on the cement industries to obtain their energy from coal instead of the natural gas, solar and mazzut. Therefore, this paper focuses on assessing the environmental impacts of cement producing facilities in Egypt with regard to their environmental compliance if coal is used compared to other sources by using the LCA tool. A comparative analysis among various fuel types of typical cement plant in Egypt is conducted. Results show that the decision of replacing the existing used fuels in cement industry by coal will carry an additional burden on the environment approximately by 20%. Based on a midpoint method, the global warming potential and respiratory inorganics recorded highly negative impacts of 20% and 25% respectively when using the coal compared with other fuels type. Referring to the endpoint method, the damages to human health (DALY) is dominated when using the coal with a relative contribution of 30%. This increased adverse expected damage must be faced from the Egyptian Environmental Affairs Agency (EEAA) by the limitation and constrains of how to control the output emissions from the plant chimney.

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1. Introduction

There are many different procedures and tools used to perform an Environmental Performance Evaluation (EPE) of a material or product such as; the Environmental Indicator Systems (EPIs), the Environmental Management Accounting (EMA), the Environmental Management Systems (EMSs), which performed by *Asdrubali et al.* [1] Furthermore, *Flavin* [2] added the Eco-labeling and Environmental Impact Assessment (EIA) in the EPE.

The study will focus on EIA approach which includes many tools; one of them is the named life cycle assessment (LCA) and life cycle energy analysis (LCEA). [3] LCEA is an approach includes all energy inputs to a product are accounted for, not only direct energy inputs during manufacture, but also all energy inputs needed to produce components, materials and services needed for the manufacturing process. [4] Also life cycle carbon analysis (LCCA) is an increasingly hot topic internationally and domestically associated with certain stages of the life cycle of buildings. Finally, life cycle cost analysis (LCCA) of buildings has been carried out by several researchers. [5] LCCA is a method for assessing the total cost of facility ownership; it takes into account all costs of acquiring, owning, and disposing of a building or building system. [6] This study focuses on the LCA tool. [10]

Omar et al. [8] defined LCA is "a technique for assessing the environmental aspects and potential impacts associated with a product, by: (1) compiling an inventory of relevant inputs and outputs of a product system; (2) evaluating the potential environmental impacts; and (3) interpreting the results of the inventory analysis and impact assessment phases. [9] In literature on life-cycle impact assessment two approaches are proposed; the midpoint and endpoint method. So far, there is no consensus in the research community which assessment method is preferable. Since both methods have their merits and limitations both approaches might be jointly used to provide better insight in environmental impact. [7]

Regarding to the LCA of the cement industry, *Huntzinger et al.* [12] describes that the production of cement involves the consumption of large quantities of raw materials, energy, and heat. Cement production also results in the release of a significant amount of solid waste materials and gaseous emissions. The manufacturing process is very complex, involving a large number of materials (with varying material properties), pyro-processing techniques (e.g., wet and dry kiln, preheating, recirculation), and fuel sources (e.g., coal, fuel oil, natural gas, tires, hazardous wastes, petroleum coke). Thus, inventory analyses and complete LCAs can be quite complicated [13].

Therefore, the authors used the LCA tool to assess the environmental impacts of the alternative fuel types in the cement manufacturing process. This paper presents the results of analyzing the environmental impact assessment of the cement producing facilities in Egypt using SimaPro V8.1. The analysis includes the four phases of LCA, namely; goal and scope definition, life cycle inventory, life cycle impact analysis, interpretation of the results, these phases are defined by EN ISO 14040 [19] and EN ISO 14044 [20].

2. Cement manufacturing in Egypt

The Egyptian cement industry increased in size and capacity during the last 30 years. In 1975 the Egyptian Cement Industry was comprised of four factories, which produced 4 Million tons/year. Now there are 16 factories, which produce 46 Million tons cement/year.[14] The government continues to support the expansion of the cement industry because of rapidly increasing demands for cement; consequently, they have approved the construction of an additional six cement factories in 2006-2007 and another 8 factories in 2010.[15] The satellite image in Fig. (1) shows the locations of the 16 cement factories in Egypt.

Fig. 1 Cement factories in Egypt are highlighted with red indicators.

2.1. Cement Production in Egypt

The Egyptian cement industry increased in size and capacity during the last 30 years. In 1975 the Egyptian Cement Industry comprised four factories, which produced 4 million tons/year. Now there are 16 factories, producing 46 million tons/year of clinker primarily from dry kilns with only a small amount from 7 wet kilns in 3 companies. Egypt's production is estimated to be 1.5% of the world production (year 2008). Table (1) shows the production & energy consumption of each of the Egyptian cement producing companies. [14]

Table 1 Cement company's clinker production and energy consumption in Egypt.

No.	Company	Line Clinker	Production
1	Amreya cement (Cimpor group)	Kiln 1, Kiln 2	1,900,483
2	Amreya cimpor (Cimpor group)	Kiln 1	1,352,098
3	Sinai cement (Gray)	Kiln 1, Kiln 2	3,350,221
4	Bani suef cement	Kiln 1	1,573,844
5	Alexandria cement (TITAN)	Kiln 1	1,500,005
6	Misr Qina	Production line	1,859.730
7	National cement	Kiln 1 (wet), Kiln 2 (wet), Kiln 3, Kiln 4	3,031.951
8	Suez cement (Suez plant) (Italcementi group)	Kiln 1, Kiln 2	2,100,710
9	Suez cement (Kattameya plant) (Italcementi group)	Kiln 1	845,810
10	Suez Cement (Torah plant) (Italcementi group)	Kiln 5, Kiln 7, Kiln 8, Kiln 9	2,474,412
No.	**Company**	**Line Clinker**	**Production**
11	Helwan (Italcementi group)	Dry Kiln 1 (plant 2), Dry Kiln 2 (plant 2), wet Kiln 2(plant 1), wet Kiln 3(plant 1),wet Kiln 5(plant 1), wet Kiln 6 (plant 1), wet Kiln 1(plant 3), wet Kiln 2(plant 3)	4,009.340
12	El Minia (Italcementi group)	Kiln 1	287,666
13	El Arabeya cement	Kiln 1	2,030,428
14	CEMEX (Assiut cement)	Kiln 1, Kiln 2, Kiln 3	4,706,112
15	Lavarge Cement	Kiln 1, Kiln 2, Kiln 3, Kiln 4, Kiln 5	8,295,478
16	Misr bani suef (TITAN)	Kiln 1	1,573,844
Total			40,892,132

2.2. Cement manufacturing process

Raw materials should be mixed precisely to manufacture the cement. [16] The cement clinker requires appropriate amount of compositions of the elements calcium, silicon, aluminum and iron. All these raw materials together with the fuel as an energy consumption must be combined to form the typical clinker composition.[17] Fig. (2) shows a comprehensive cement manufacturing process.
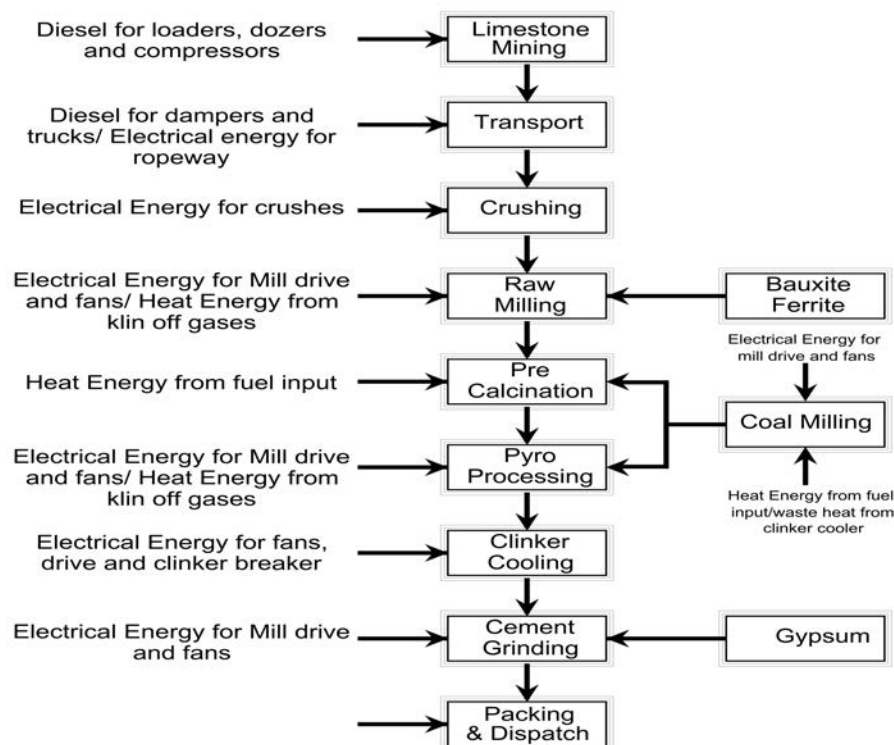
Fig. 2 The life cycle of the cement production
(raw material and the consumed Energy)

2.3. The Environmental Status of Cement Companies in Egypt

In 1994, the Egyptian Environmental Affairs Agency (EEAA) issued the Egyptian Environmental Protection Law number (4) and their executive regulation was issued for protection of the Egyptian environment. Limits for dust emissions from cement plants were 300 mg/m^3 for plants established before 1995, 200mg/m^3 for plants installed after 1995 and before issuance of the new amendments and 100 mg/m^3 for new plants. Nitrogen oxides (NO$_x$) and Sulfur oxides (SO$_x$) emission limits were set at 300 mg/m^3 and 4000 mg/m^3 respectively. Following ratification of Law 9 for the environment in 2009 the Ministry of State for Environmental Affairs and the EEAA developed new air emission standards, which are expected to be ratified by Parliament towards the end of 2010. The new standards for cement plant's dust emissions will thereby be more in line with international standards with 100 mg/ m^3 for old plants and 50 mg/ m^3 for new plants, SO$_x$ is 400 mg/ m^3 and 600 mg/ m^3 for NO$_x$. [14]

2.4. Cement Process Emissions

Cement is made from a mixture of calcium carbonate (generally limestone), silica, iron oxide and alumina. A high temperature kiln fuelled by natural gas or heavy fuel oil heats the raw materials to a partial melt at 1450º C, transforming them chemically and physically into clinker. Clinker is then ground with gypsum, flue ash and/or sand to make cement. Figure (3) shows the main sources of pollutants from cement production using the dry process. [14]
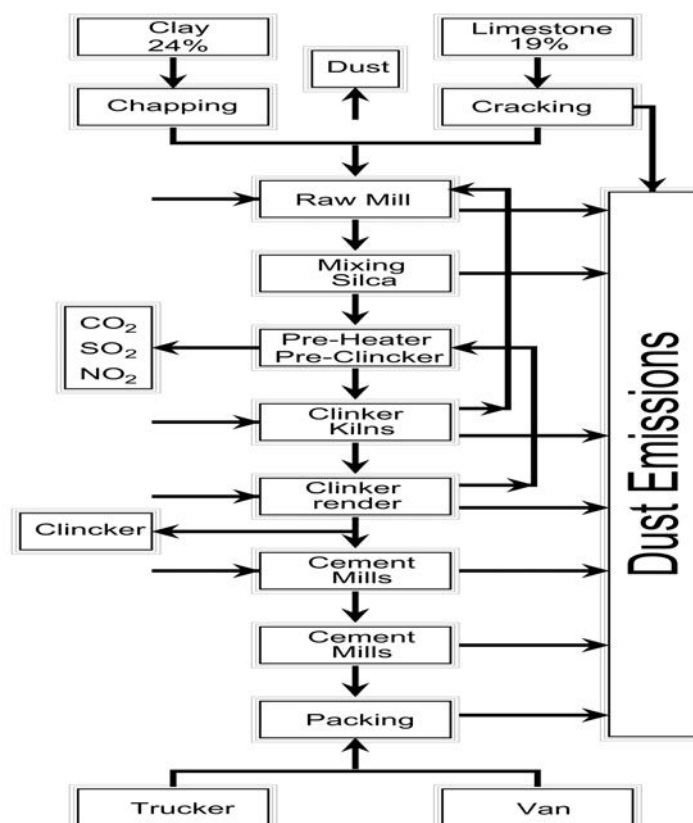
Fig. 3 Pollutions from Cement manufacturing - dry process

2.5. Cement plants in Egypt (case study)

The main components in the manufacture of cement are not different from the factory to another but differ in the amounts of these materials in factories, these material are lime stone,(Adobe Clay) sand ,slagand g gypsum, which called raw materials. Referring to the other materials such as energy and resources, consist of mazzut, natural gas, solar (diesel), water and electricity. Eventually, the emissions from the cement manufacturing are include dust emissions and gasses emissions (CO, SO_2 and NO_2).

2.6. The collected data form cement factories

To the best of the authors knowledge and from previous authors literature which published in [18], Egypt suffered from shortage of life cycle inventory database, thus, the researchers suggest collected the (input-output) database of Egyptian plant from the field visits. Table (2) shows the collected data during field visits & survey of the cement plants.

Table 2 Cement manufacturing data which collected from Egyptian cement plant

Consumption of raw materials By ton/year	Lime Stone	5978720
	Clay	528719
	Sand	0
	Slag/Iron Ore	624946
	Gypsum	207410
Consumptions	Electrical (MwH/Year)	641526
	Natural Gas (Ton/Year)	0
	Mazut (Ton/Year)	399790
	Solar (Diesel) (Ton/Year)	7984325
Emissions Mg/m^3	Dust	23648
	CO	512.48
	SO$_2$	25.27
	NO$_2$	130.69

•   Solar (diesel) used in transportation of the materials in each stage by heavy trucks and the excavators in the raw material excavation stage.

•   Natural Gas and Mazzut used in mechanical machines and other used Electrical power. (Which shown in figure (2)).

3. Assess the environmental impacts of cement industry

SimaPro V8.1 was used in the analysis of the two types of cement industry plant using the above inventory databases. SimaPro is a dedicated LCA software tool for undertaking LCA studies according to EN ISO 14040 [19] and EN ISO 14044 [20].

3.1. Goal and Scope

The main objective of this study is to contribute to the Environmental Impact Assessment of the cement industry in Egypt, by means of the adaptation of the LCA methodological process, in order to ease the stakeholders, decision makers and building material manufacturers, through the knowledge of the environmental impacts caused by technologies, procedures or materials used in cement industry. Therefore, a comparison has been performed between two different systems of the same cement plant in Egypt; regarding to the alternate fuel types. One of them is using electricity, natural gas, solar and mazzut as energy consumption and the second is a hypothetical plant operating using electricity and coal. Purpose of this study is for academic only but the outcomes and conclusions will be beneficial for Egyptian cement industry so as to tackle with environmental impacts and energy consumption. To make a fair comparison between the two systems, all of the inputs of life cycle inventory database are the same quantities in the two case studies in Egypt, because the second case study is still under development and thus it is hypothetical, taking into account, the minimal error rates of the results between the two Egyptian cement plants. Referring to the scope of the study focuses on the consumed fuels in these process; raw material acquisition, processing, and product manufacturing which are shown in Fig. (2). As for the functional unit; as cement industry is a manufacturer industry all the data collection and calculations in this study have been converted to be for 1 Kg basis.

3.2. Life Cycle Inventory database

Involves data collection and calculation procedures to quantify relevant inputs and outputs of a product system, such as; raw material from mines: lime stone, gypsum,

clay, slag/ iron ore and Additions, Water use, Diesel use and Emissions; Dust emissions, Particulate matter emissions, gaseous emissions and heavy metals emissions. This study used the inventory data which collected from Egyptian cement plant as a case study and any missing data will take it from literature review, international papers, assumptions and Ecoinvent V.3 Database.

3.3. LCA Impact Assessment

The use of impact categories gives the ability to compare the environmental impacts of the different options. Characterization factors, or equivalency factors, describe the relative impact of the different environmental flows (ISO 2006). [21] A larger characterization factor means a larger impact for that flow. Characterization factors are multiplied by each of the environmental flows to convert all them into an equivalent amount of the category indicator. The category indicator is the flow that is usually associated with that particular impact category (CO_2 for global warming) [22] Table (3) describes the environmental impact categories which required for LCI inventory which involved in SimaPro V. 8.1; this study used the IMPACT 2002+ category to assess the environmental impacts from cement industry in Egypt.

Table 3 Sources for characterization factors and damage units of IMPACT 2002+(version Q2.2) [23]

[source]	Midpoint category	Midpoint reference substance	Damage category	Damage unit	Normalized damage unit
[a]	Human toxicity (carcinogens + non-carcinogens)	kg Chloroethylene into air-eq	Human health		
[b]	Respiratory (inorganics)	kg PM 2.5 into air-eq	Human health	DALY	Point
[b]	Ionizing radiations	Bq Carbon-14 into air-eq	Human health		
[b]	Ozone layer depletion	kg CFC-11 into air-eq	Human health		
[b]	Photochemical oxidation (= Respiratory (organics) for human health)	kg Ethylene into air-eq	Human health		
			Ecosystem quality	n/a	n/a
[a]	Aquatic eco-toxicity	kg Triethylene glycol into water-eq	Ecosystem quality		
[a]	Terrestrial ecotoxicity	kg Triethylene glycol into soil-eq	Ecosystem quality	PDF·m^2·y	Point
[b]	Terrestrial acidification/nutrificati	kg SO^2 into air-eq	Ecosystem quality		

[source]	Midpoint category	Midpoint reference substance	Damage category	Damage unit	Normalized damage unit
[c]	on Aquatic acidi-fication	kg SO^2 into air-eq	Ecosystem quality		
[c]	Aquatic eu-trophication	kg PO43- into water -eq	Ecosystem quality		
[b]	Land occupa-tion	m^2 Organic ara-ble land-eq · y	Ecosystem quality		
	Water turbined	inventory in m^3	Ecosystem quality		
[IPCC]	Global warm-ing	kg CO^2 into air-eq	Climate change (life sup-port sys-tem)	kg CO_2 into air-eq	Point
[d]	Non-renewable en-ergy	MJ or kg Crude oil-eq (860 kg/m^3)	Resources		
[b]	Mineral ex-traction	MJ or kg Iron-eq (in ore)	Resources	MJ	Point
	Water with-drawal	inventory in m^3	n/a		
	Water con-sumption	inventory in m^3	Human health Ecosystem quality Resources		

[a]IMPACT 2002, [b]Eco-indicator 99, [c]CML 2002, [d] Ecoinvent, [IPCC] (IPCC AR5 Report), and [USEPA] (EPA). DALY= Disability-Adjusted Life Years; PDF= Potentially Disappeared Fraction of species; -eq= equivalents; y= year.

In LCA-type models, two main methods in describing impacts can be distinguished [7]: the first is at the level of midpoint impacts, covering issues such as climate change, abiotic resource depletion and others. The second include the study used the endpoint impacts, covering issues such as [1]:

•   Human health damage, expressed as the number of years of human life lost or in suffering from disease, which expressed in Disability Adjusted Life Years (DALY).

•   Quality of ecosystems, expressed as the loss of living species in a certain area over a time.

•   Natural resources, expressed as the surplus of energy necessary for further ex-tracting minerals and fossil fuels.

3.4. Result, Discussion and Interpretation

It should be highlighted that the assembly of cement industry links to the processes, which describe the materials, production, transport and energy processes that are needed to produce the reference flow of 1 KG cement defined in section 2.6.

At this stage the basic model of the cement production cycle is built by creating the unit processes identified in section 2.6 and interconnecting them into an assembly network through "known outputs to technosphere (products and co-products)". A list with the processes used in the model is provided in Fig. (2), whereas the model networks of the two cases created are shown in Fig. (4). In this case the classification into categories was based on the unit, with which the product output is defined.
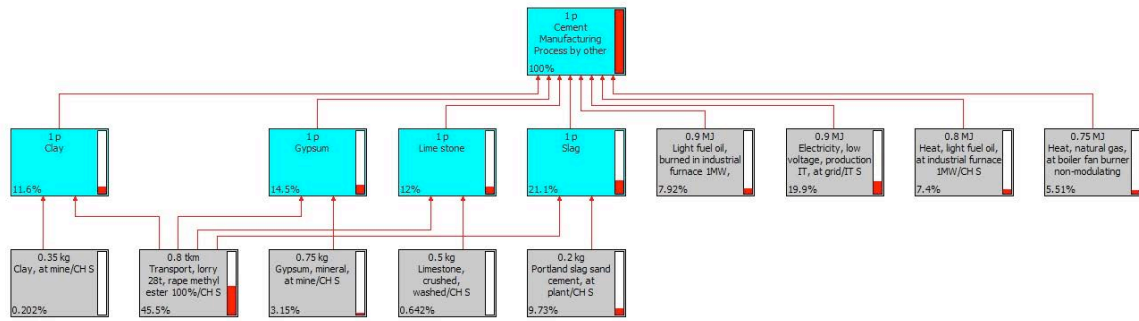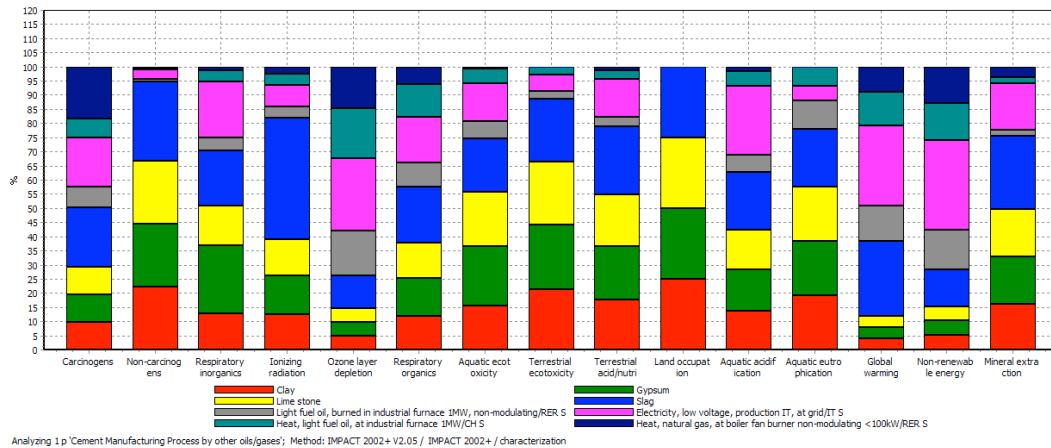

(a) Energy consumption in cement industry plant based on electricity, natural gas, solar and mazzut as Energy sources.
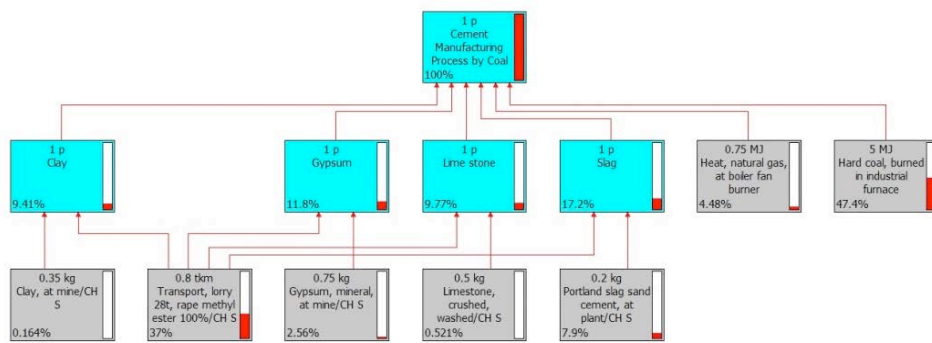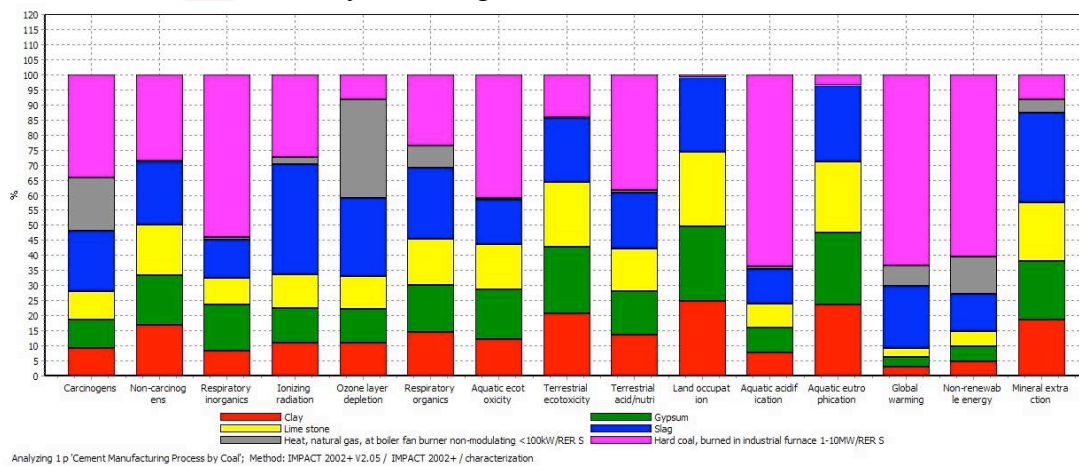

(b) Energy consumption in cement industry plant based on electricity and coal as Energy sources.

Fig. (4) The network flow diagram of the two cases studies based on SimaPro.

Figure (5) presents the relative impacts produced by each energy sources in each phase of the Egyptian cement plant. It is observed that the respiratory organics, aquatic acidification, global warming (climate change) and the non-renewable energy have higher impact than the ordinary process by 35, 60, 35 and 35% respectively. Consequently, the main high bad effect resulting from the use of coal is the SO_2 compound that is produced from the plant chimney during the oven stage. To get rid from the SO_2 emissions we should use the technology which used in the European plant such as the scrubbers which removes, or "scrubs," the SO_2 emissions from the exhaust of coal-fired kiln.

Analyzing 1 p 'Cement Manufacturing Process by other oils/gases'; Method: IMPACT 2002+ V2.05 / IMPACT 2002+ / characterization

(a) The life cycle impact assessment of the Egyptian Cement Plant by using electricity, natural gas, solar and mazzut.

Analyzing 1 p 'Cement Manufacturing Process by Coal'; Method: IMPACT 2002+ V2.05 / IMPACT 2002+ / characterization

(b) The life cycle impact assessment of the Egyptian Cement Plant by using electricity and coal.

Fig. (5) Environmental impact assessment of the two Egyptian cement plants

Figure (6) shows the comparison of Life Cycle Environmental Impact between the two analyzed case studies, based on the Midpoint method; the overall impact of coal is higher. The main contributing categories to this higher impact are global warming potential and respiratory inorganics (see Table 3 the identification of these impacts in the IMPACT 2002+ category) where they represent 20% and 25% from the overall 100% impact respectively. This mainly attributed to the difference of the chemical composition of the coal and the other fuels which are used in the oven process. Furthermore, using coal in the cement plant has high adverse environmental impacts by 20% in total (60 Ecopoint), this percentage is not ineffective, we can reducing it by using European technology such as the scrubbers and reach to the ordinary case.
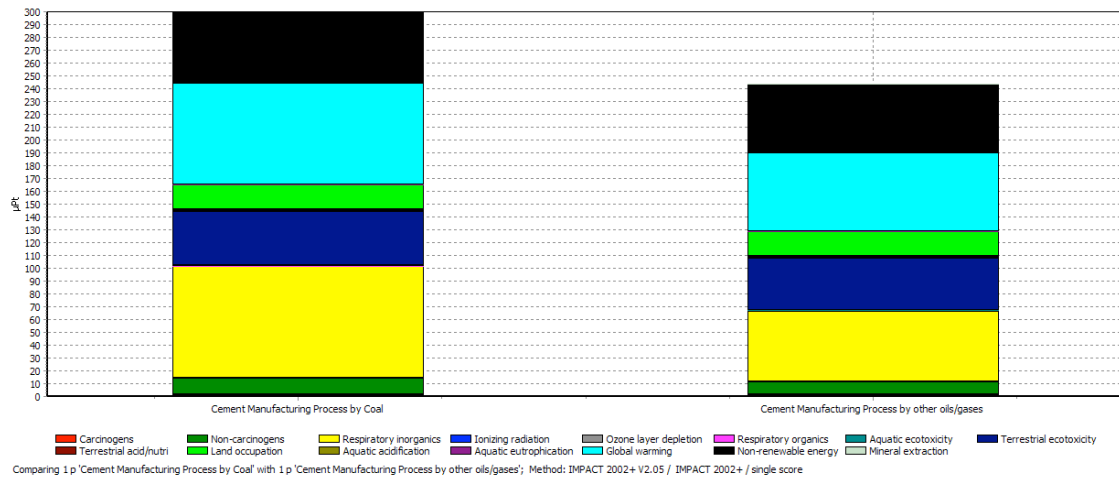
Fig. (6) The comparison of Environmental Impact Categories of the two Egyptian cement plant (Midpoint Method)

On the other hand, the damage assessment (been mentioned in the section 3.3) based on the endpoint method indicates that both of the human health damage (DALY) and climate change damages are higher in case of using coal in cement industry as clear from Figure (7). Their relative contributions are 30% and 25% respectively.

Fig. (7) The damage assessment of the two Egyptian cement plants (Endpoint Method)

4. Conclusion

This paper compares the environmental impacts of a typical cement industry in Egypt considering different sources of energy compared to coal. Discussion of results revealed that using coal in cement industry produce 20% adverse environmental impact (global worming) and 25% respiratory inorganics compared to other sources based on the midpoint impact method. From the endpoint method point of view, the expected damages are higher in both of the human health damage (DALY) and climate change categories where their relative contribution are 30% and 25% respectively if cement is used coal compared to other sources. However, the adverse environmental impacts of coal can be minimized by activating the environmental laws through the Egyptian Environmental Affairs Agency (EEAA) and encouraging cement industry to utilize new technologies through set of incentive policies and using the European technology such as the scrubbers.

5. Recommendations

The authors highlight the following suggestions which if implemented might be highly contributed in reducing the environmental impacts associated with coal-based-cement industry:

•   Developing national policy to systemize supply on long term basis for consistent quality waste derived fuel.

•   The difference of the coal chemical composition which used has a significant environmental impact positively and negatively.

•   Clean coal technology is a collection of technologies being developed to mitigate the environmental impact of coal burning such as the scrubbers, must have an important role in Egyptian cement plants.

•   Encouraging production of low energy cement and incentivizing the use of wastes as raw materials / fuels.

•   Using sustainable fuels and raw materials to reduce the environmental impact from the quarrying and the grinding process.

•   Developing and applying comprehensive norms for cement industry (covering all pollutants, when coal and/or alternate fuels are used.)

•   Involving reliable and acceptable LCA for cement industries as well other industry based on   Egyptian conditions and encouraging cement plants to take up LCA studies voluntarily for continual improvement

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