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SVILUPPO SOSTENIBILE
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NUOVE TECNOLOGIE
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GOVERNANCE
Guidelines for the implementation of workforce planning (WFP) in project-driven environments

i Focus

Manutenzione e valvole per impianti industriali

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Guidelines for the implementation of workforce planning (WFP) in project-driven environments

A core activity of human resource management, facing the huge challenge of matching the staffing needs in terms of right amount of skilled workers at the right moment, so as to make the whole organization able to deliver a project within a scope, on time, and budget

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"Workforce planning (WFP) has become a crucial part of the governance of project-oriented organizations and is considered critical for driving critical resource management decisions

The main goal of using Workforce Planning (WFP) is to identify the potential gap between workforce capacity (WFC) and workforce demand (WFD), in order to plan training, recruiting, [3] promotions, and lay-offs. Therefore, a proper WFP should entail workforce capacity and workforce demand evaluation, together with a viable course of action to address any shortage or surplus identified between demand and supply. In this perspective, the WFP has become a crucial part of the project-oriented companies' governance and it has been deemed fundamental to drive critical decisions on resource management. This paper aims to present the key principles in terms of process steps, operative methods, input data, actors and tools of the WFP, going through its main components (WFD and WFC). Additionally, it attempts at depicting high-level guidelines that are generally valid for project-driven companies, with the ambition to strengthen standardization and sharing of knowledge. The information presented is the result of a combination of academic literature review, based on fifty-two articles published from 1980 to 2021 in scientific journals, and an empirical study led by the IPMA (International Project Management Association) and ANIMP (Associazione Nazionale di Impiantistica industriale), involving representatives of ten project-based companies of different size and belonging to different sectors (EPC, Components, Package, and Services).

Workforce Demand (WFD)

The Workforce Demand evaluation (WFD) is a prediction of the evolution of the required workforce, exploiting a "What-If" scenario to get insight into the business policies' influence on the future personnel structure. Thus, the main goal of the WFD study is to estimate present and future workforce requirements to execute a project [3]. As mentioned by Huang [4], the total demand must be in form of "projects" skill requirements [man-hours per skill or job-role]. The overall workforce demand should be composed of: the demand for future projects, the demand for the projects in execution, the demand of the work backlogs, and the demand coming from possible trend changes. Each project should be also defined by size, duration, and arrival time (if new) [4].
Concerning the operative calculation of the demanded workforce for future projects, the literature proposes four main methods considered highly compatible with project-driven contexts because strictly related to the single project.

1. The *Labor Multiplier (LM)* approach assumes that in each project type, the projects will have the same level of labor requirements per unit of project expenditure, and will follow standard patterns [5]. Based on the past projects' labor deployment per skill and their expenditure, the number of laborers for each trade/job role in form of [man-days/€] for individual type of project can be derived. For example, a company producing two products, "Tank" and "Burner", might calculate, based on the past data, that for every 100.000€ of expenditure in the design phase of a project classified as "Tank", 150 hours of employees with designing skills and 100 hours of employees with analysis skills will be required. Furthermore, for every 100.000€ of expenditure in the construction phase of a project classified as "Tank" type, 100 hours of welding skills will be needed. This method is recommended to all organizations, especially small to medium size companies, due to its need for data coming from only a few past projects, its simplicity, and its acceptable accuracy. On the other hand, it requires to be constantly updated alongside the technological and methodological improvements.

2. The *Linear Regression (LR)* model is a time series forecasting method that identifies historical patterns in past data to extrapolate future trends. The cost of the project and the type of the project are good predictors of future manpower requirements. As a consequence, once the costs and labor deployments per skill or job role (e.g., drawing and welding) from at least 30 completed projects of the same type have been collected, it is possible to estimate the future labor hours per skill, knowing the expected cost of the future project. Excel allows to show, as an option of the scatter plot (fig.1), the linear trend relationship between project cost and labor for each skill, together with the mathematical equation which rules it. In the case of low R^2 (max 1), the use of this method is not recommended.

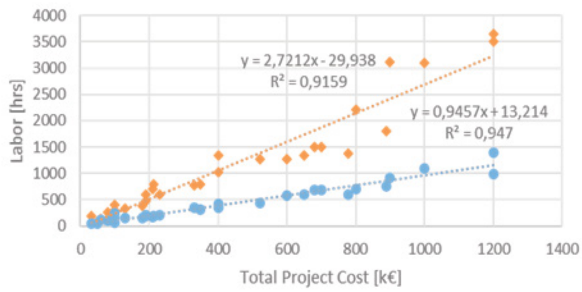

Fig. 1 Regression Analysis example over two skills

By exploiting the equations in fig.1 and assuming a x future project expenditure, the workforce hours demanded per skill can be foreseen. The presented model is suitable for medium to big size project-oriented companies, able to provide a relevant sample of past projects not too distant in time (old projects might have recurred to different techniques and methods).

3. The *Ad hoc Simulator (SimMan) (SIM)* is a tool developed and presented by Huang [4]. It assumes that each incoming project belongs to one of the pre-specified sets of "project types" and as such should be defined in size (the total man-hours required) and duration (the amount of calendar time required to be completed). A project type is specified by the proportion of different required skills (based on historical data). For example, knowing that a project of the "Tank" type requires 20% of the total hours expected to be covered by employees with drawing competencies, and knowing that its size could be 2.000 hours, the workforce with drawing skills required for the project's duration will amount to 400 hours. The project type and its size can be considered valid alternative predictors of the project's demand. Labor Multiplier, Linear Regression and Ad hoc Simulator are the best candidates for the static quantitative evaluation of the workforce demand. However, in order to include the dynamic changes which are likely to modify the project's expectations, the researchers focused on System Dynamics (SD).

> **"This study aims to investigate current knowledge on WFP by aiming at the recognition of its key characteristics, in order to build a high-level guideline that is generally considered valid in project-oriented organizations**

4. System Dynamics (SD) is an objective-oriented methodology able to introduce cause-and-effect relations between system variables by using causal loop diagrams [6]. It allows the exploration of how project changes affect the project variables responsible for the definition of the workforce demand, promoting the "What-If" scenario simulation. Assuming the division of a construction project into three phases, design, construction, and test, where each ge-

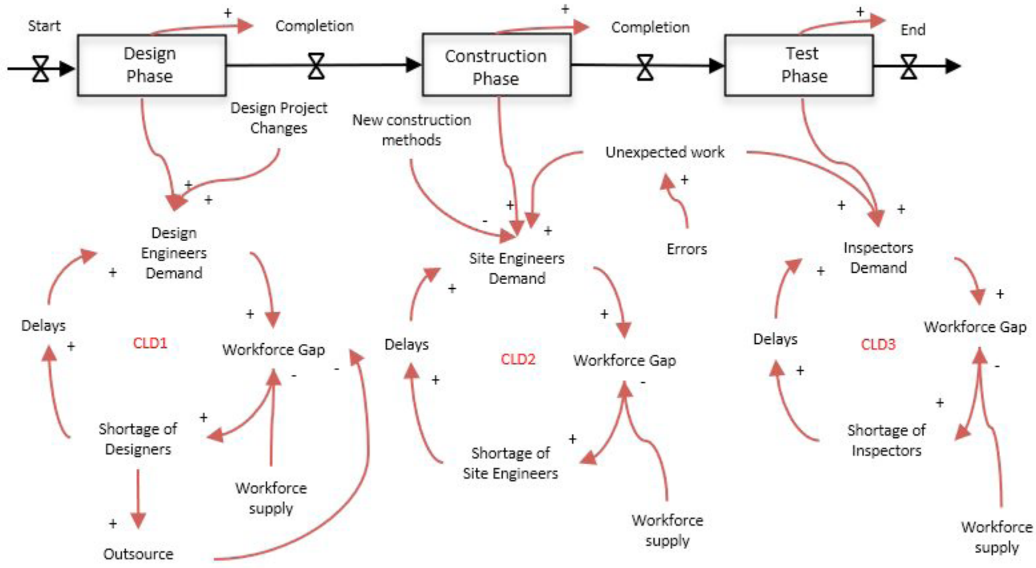

Fig. 2 System Dynamics example of a three phases project requiring three job roles workforce

nerates a manpower demand for job roles (quantified by the previous models), a series of causal loop diagrams are used to investigate the impact of changes (fig.2). What if design modifications are introduced? They generate an increase in designers' demand (+), with a consequent increase in the workforce gap and with ensuing possible shortages and phase completion delays. What if more efficient construction methods are introduced? What if unexpected errors are found? This model must be coupled with one of the previous quantitative ones to guarantee the highest level of accuracy while embracing the dynamic nature of the projects.
With regard to the data sources, numerically-wise, a company should make use of historical data from past projects, and of current data (expected information about the new projects and current projects' workload) from the internal database. Qualitatively-wise, organizations can capitalize on the internal staff's experience (such as the one of a Project Engineer) and on surveys or questionnaires filled out by either internal or external experts. An organization should leverage the combination of data-driven approaches and human expertise.
With respect to the actors involved in the workforce demand evaluation process, the interviewed workgroup suggested different owners of the process steps. The current workforce demand, including the work backlogs, should be communicated by the responsible of the project and reviewed by the head of the department. The manpower demand generated by future projects should be evaluated by the commercial department and the operative direction, and reviewed by the head of the department as well. This proposal might undergo modifications depending on the size and the sector of the company.

Workforce Capacity (WFC)

The workforce capacity evaluation is a prediction of the evolution of the available workforce, exploiting a "What-if" scenario to get insight into the influence of

"To address this issue, companies have independently developed internal procedures based on their sector, size and skills, obtaining heterogeneous results

business policies on the future personnel's structure. Thus, the main goal of the WFC analysis is to provision the available amount of staff with a certain skill at a particular time [3]. A proper workforce supply evaluation must rely on a detailed and updated personnel profiles' database, reporting each employee's main attributes such as age, grades, salary, experience, skills/job role. Once the population is defined, the analysis must consider internal mobility (employees' movements within the same department, among different departments, promotions, trainings, holidays, and illnesses), external mobility (resignations, retirements, attritions) and recruits. At any time, the organization should be able to communicate how many hours per skill or job role are available.
With respect to the operative calculation of the available manpower per skill or job role, the literature presents the following five methods, that are suitable for project-oriented organizations.

1. The *Stock and Flow* models (S&F) illustrate the population distribution as stocks and movements between stocks as flows [3]. In every period of time, it is possible to determine the number of workers in the stock and to monitor their movements into the stock (recruitments, promotions) and out the stock (promotions to another stock and wastage). Since the project's demand is in form of skill requirements [man-hours per skill or job role], it might be convenient to interrogate the system about the number of employees available per skill or job role. A solution could be to group the population by skill and experience. Figure

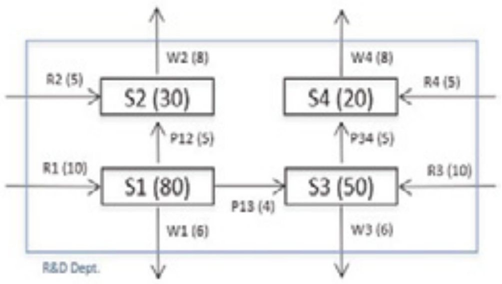

Fig. 3 An example of the Stock & Flow representation

3 shows an example of a possible representation of an R&D department, where employees are grouped into Junior Designers (Stock1), Senior Designers (S2), Junior Analysts (S3) and Senior Analysts (S4). Their recruitment (R), promotion and transfer (P) and wastage (W) are monitored along the whole planning period of interest.
This check must be extended to all the planning periods, in order to have an accurate time by time overview of the capacity distributed by skill. The present model can be used by any kind of organization, however, it does not allow any forecast about the probable future workforce supply.

2. The *Markov model (MM)* is a time series approach, able to predict the distribution of personnel. It represents an upgrade of the Stock and Flow model, upon which is built. The Markov Model assumes that the employees grouped in the same stock or class have the same probability to move to another class (the characteristic by which employees are grouped should be the main driver of the employees' flows). This means, for example, that all the junior designers have the same probability to be promoted, to be recruited, to undergo a training courseor to leave the organization. By looking at the past years' flows, the transition's probabilities are computed, allowing future flows and the total distribution of employees per class at any time (*t*) to be forecast [7]. As mentioned by Safarishahrbijari [3], the Markov model presents the following limits: it is not able to interact with the environment, it is not capable of incorporating feedbacks in the system, it is based on past data, therefore assuming that past trends will continue. In addition, it requires a wide amount of data, which makes it suitable for large organizations only.

3. Besides what has already been stated, the *Ad hoc Simulator (SimMan)* [4] suggests indicating the maximum number of jobs and training courses that an employee is allowed to take at the same time.

4. Through the *Qualitative models*, such as questionnaires and surveys, the future available supply can be outlined without numerical or mathematical methods. They are powerful instruments in case of absence of past data, like in case of the creation of a new department for developing new projects. This technique is suitable for any kind of organization, and it is complementary to numerical methods.

5. When it comes to the workforce capacity's side, System Dynamics (SD) is still the main way to embrace the dynamic nature of a project. Starting from a system representation by means of the Stock and Flow model, it is possible to depict all the cause-effect connections between system variables. In figure 4, a System Dynamics example is applied to a supply system composed of three stocks (Trainees, Junior Designers and Senior Designers). What if the recruitment rate of Junior Designers increases? What if the training completion rate increases? Is the supply still able to meet the demand?
With regard to data sources, numerically-wise, a company should count on historical and current data from the personnel's master database. It is strongly recommended to keep the personnel's profiles detailed and updated. Qualitatively-wise, the organization should tap into the internal staff's experience (such as the Project Engineer's), and into surveys or questionnaires filled out by either internal or external experts.
Concerning the actors involved in the workforce capacity evaluation process, the interviewed workgroup and the literature agreed about the responsibility of the Human Resource Department over the management of the personnel's data and the personnel's distribution inside and outside the organization. This information is valid for all companies, regardless of their size and sector.

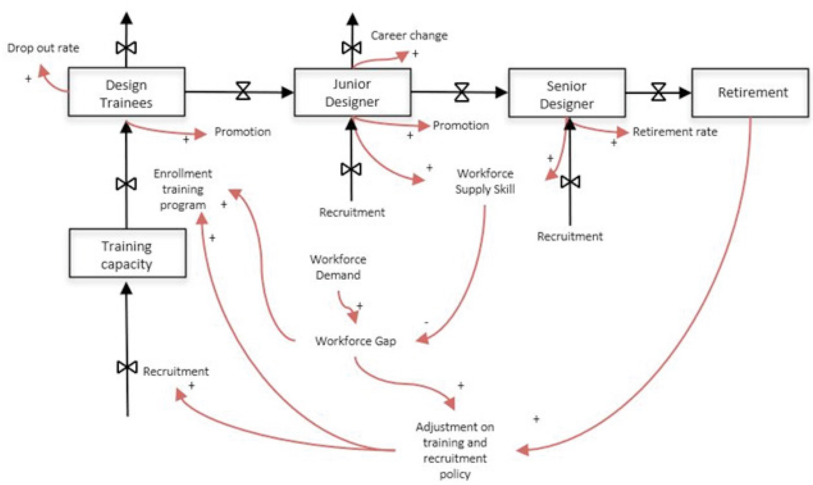

Fig. 4 System Dynamics Model of a three classes system (based on Singh, 2016)

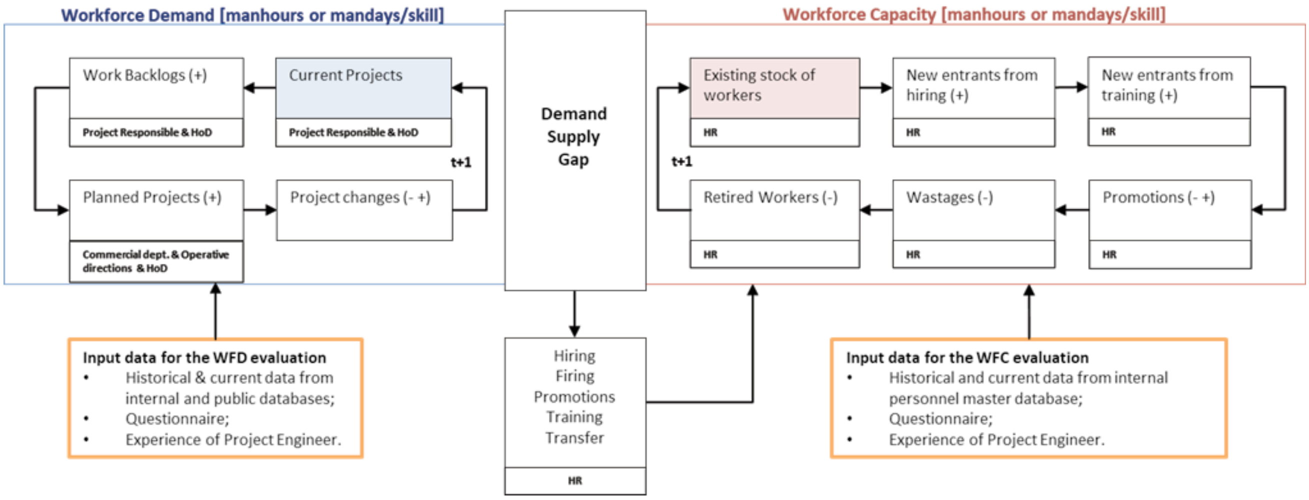

Fig. 5 High-level Workforce Planning Process

Gap Optimization

Once the demand side and the capacity side are defined, the ultimate goal of the process is to highlight possible shortages or surpluses between the demanded manpower and the available manpower per skill or job role, and to eliminate the gap by recruiting employees from the external environment, by transferring them within the organization, or through promotions, trainings and dismissals.
The Optimal Control Model, Ad hoc Simulator, and the Fuzzy Model are based on the objective linear programming technique, and therefore can compute the best combination of employees with a certain skill, at every planning period, to be hired, dismissed, transferred, promoted and trained, in order to meet the demand's requirements and minimize the operational cost. The objective function can be solved by the Excel "Solver".

Workforce Planning (WFP)

In light of what has been outlined about the Workforce Planning sections (WFD, WFC), the overall WFP process must guarantee the following key features: dynamism (ability to follow the project's changes), iterativity & interactivity (including feedbacks), being based on What-If scenario (ability to simulate different situations with different inputs), continuity (ability to adjust the staff at each time), discretion in time (planning periods), being data-driven and cost-effective. A generally valid high-level process depicting input data, process steps, and owners has been created (fig. 5). The overall workforce planning should be monthly mastered, controlled and led by the Human Resources department (t=1). Every month, workforce demand and workforce capacity should be evaluated, compared and balanced. Regarding the tools to manage the process, Excel could be a starting point, but not only, useful to collect and handle data regardless of size and sector. However, a big to medium size company should aim at implementing ad-hoc tools. With reference to the latter, SAP BPC, Microsoft Azure, Decisyon and Oracle appear to be suitable platforms on which custom solutions can be designed.

Conclusions

This paper shows the key features of the Workforce Planning and its main sections (WFD and WFC), advising high-level guidelines in terms of recommended process steps, operative models, input data, owners, reports' frequency and tools. The presented features are believed to be generally applicable to project-driven companies, yet of course to be fully understood and individually deployed.

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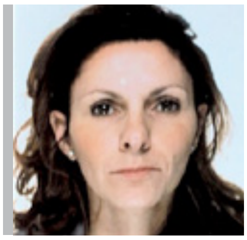

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Linee guida pratiche per l'implementazione della pianificazione della forza lavoro in ambienti guidati da progetti

La pianificazione della forza lavoro – workforce planning (WFP) – è diventata una parte cruciale della governance delle organizzazioni orientate al progetto ed è considerata fondamentale per guidare decisioni critiche sulla gestione delle risorse. Per affrontare tale tematica, le aziende hanno sviluppato autonomamente procedure interne in base al proprio settore, dimensione e competenze, ottenendo risultati eterogenei. Questo studio ha lo scopo di indagare le attuali conoscenze sul WFP puntando al riconoscimento delle sue caratteristiche chiave, e di costruire su quest'ultime una linea guida di alto livello tale da essere considerata generalmente valida in organizzazioni orientate al progetto.