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4.2b

OUTCOMES OF THE SECOND ROUND OF GONANO CO-CREATION WORKSHOPS

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1. INTRODUCTION

This report presents the design and outcomes of the second round of stakeholder workshops organised in the Netherlands, the Czech Republic and Spain as part of the European project GoNano (Governing Nanotechnologies through Societal Engagement).[1] Building on the findings from the earlier stages of the project, the workshops aimed to raise awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies.

1.1 OVERALL OBJECTIVES OF GONANO: ENABLING CO-CREATION

The GoNano project is built on the assumption that several types of knowledge are needed to define sustainability, acceptability, and desirability of nanotechnologies. To test this hypothesis, GoNano explores opportunities and barriers for co-creation in different thematic areas (Health, Food and Energy), combining face-to-face citizen engagement, stakeholder workshops and online consultations (see Figure 1).

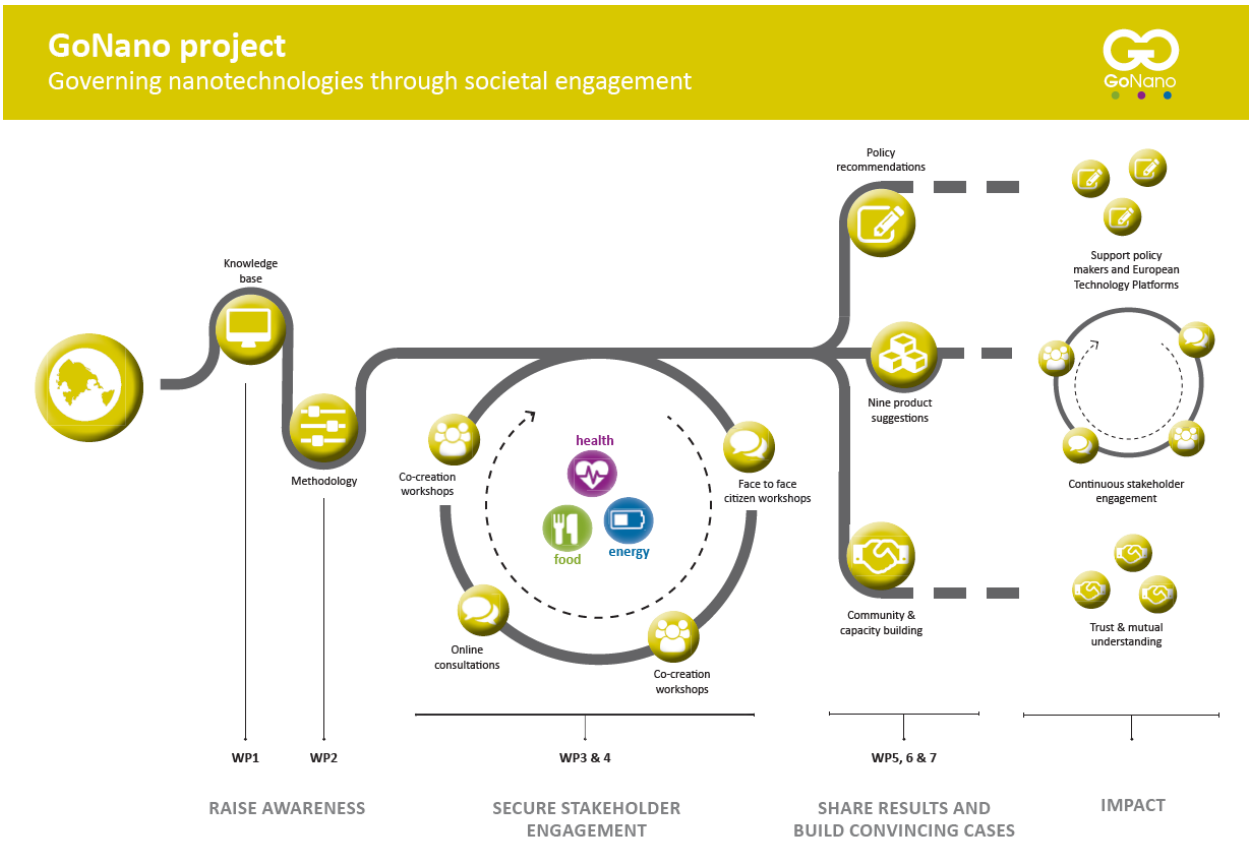

Figure 1 - Overall design of the GoNano project

[1] The partners organising the workshops in the respective countries are: the University of Twente (UT) in the Netherlands, the Technology Centre of the Czech Academy of Sciences (TC CAS) in the Czech Republic, and the Royal Melbourne Institute of Technology (RMIT) in Spain. The lead partner on the coordination of the stakeholder workshops is De Proeffabriek (DPF), a consultancy for responsible innovation based in the Netherlands.

Building on the knowledge base and the methodology developed in earlier stages of the project, GoNano has established an iterative process to integrate societal considerations in nanotechnologies: in a series of citizen workshops, citizens expressed their wishes and concerns with respect to each of the application areas. In a series of stakeholder workshops, stakeholders subsequently explored ways to take these wishes and concerns into account in nanotechnology research and innovation.

The three pilot partners organised a series of face-to-face citizen workshops in the Netherlands, the Czech Republic and Spain in October/November 2018 (see the briefing report[2] for further information on the outcomes of the citizen workshops). The first stakeholder workshops were held in February and March 2019. The University of Twente (UT) organised three workshops in the thematic area of nanotechnologies and health in the Netherlands: the first workshop on 12 February focused on diabetes, the second workshop on 5 March looked at sensors, and the third workshop on 7 March discussed health policy. The Technology Centre of the Czech Academy of Sciences (TC CAS) organised a fourth workshop on nanotechnologies in food in Prague on 28 February. A fifth workshop on nanotechnologies and energy was held by the European Office of the Royal Melbourne Institute of Technology (RMIT), also on 7 March. The aim of the first round of stakeholder workshops was to come up with concrete 'responsive' design suggestions that can be fed back in ongoing research and innovation activities, building on the outcomes of the citizen workshops.[3] The suggestions resulting from the workshops were shared and discussed more widely by way of an online citizen consultation which ran from July to September 2019. The results from the citizen consultation were in turn expected to feed into second round of stakeholder workshops, focusing on the uptake of the responsive design suggestions of the previous round.

1.2 Co-creation workshops with professional stakeholders – the second round

The second round of stakeholder workshops was organised in the pilot countries in October and November 2019 (Table 1). The aim the workshops was to elucidate the preconditions for co-creation, building on the insights gained in the earlier stages of the project.

Location	Partner	Topic	Date	Participants
Enschede (NL)	UT/DPF	Health	7 November 2019	16
Prague (CZ)	TC CAS	Food	22 October 2019	16
Barcelona (ES)	RMIT	Energy	30 October 2019	9

Table 1 – Overview of the second stakeholder workshops

[2] http://gonano-project.eu/wp-content/uploads/2019/02/D3.2-Briefing-report-from-the-citizen-workshops.pdf

[3] Brief summaries and video reports on the workshops are available on the project website:
- For the workshops on health: http://gonano-project.eu/stakeholders-insights-for-research-products-and-policy-on-nanotechnology-and-health/
- For the workshop on food: http://gonano-project.eu/setkani-odborniku-nanotechnologie-a-potraviny/
- For the workshop on energy: http://gonano-project.eu/5181-2/

2. WORKSHOP DESIGN

The first stakeholder workshops provided productive spaces for engagement and mutual learning between a wide range of stakeholders, including researchers, producers, policy makers, civil society and citizens. The workshops succeeded in raising awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to innovation in nanotechnologies. But the workshop findings also pointed to barriers for co-creation:

1. It proved difficult to connect the input from the citizens to the research agendas and concerns of the professional stakeholders;
2. There is a trade-off between inclusiveness and specificity: the decision to treat all stakeholder perspectives on an equal footing for reasons of inclusiveness sometimes came at the cost of a clear action perspective (see D4.2).[4]

The second round of workshops therefore explored how input from citizens can be productively engaged in concrete research and innovation decisions, taking the product suggestions derived from the first workshops and subsequent input from the online consultation as a starting point. The workshops explored how the main actors identified in these product suggestions – the so-called 'problem owners' – could mobilise the considerations of citizens and other stakeholders to co-create more 'socially robust' research and/or product designs.

2.1 WORKSHOP PROGRAMME

Like the first workshops, the programme was structured around the four main pillars of co-creation: exploration, ideation, prototyping and reflection.[5] The *exploration* session aims to present the overall co-creation process in further detail, introduce concrete product suggestions derived from the first stakeholder workshop and input from the citizen consultations, functioning as enabling conditions for further development of the product suggestions. In the *ideation* session, participants join subgroups where each of the product suggestions is presented in further detail. The subgroups discussions are moderated by a table facilitator, who presents statements for discussion. The statements are directed at encouraging an action-oriented perspective to prepare participants for the next session. In the *prototyping* session, participants define a specific action plan in subgroups, defining next steps to integrate societal considerations in the further development of the product suggestions. The concluding *reflection* session aims to consider broader reflective questions about the feasibility of the action plan, the integration of citizen perspectives and the opportunities and barriers of the co-creation process (please see the proposed structure for the workshops in Annex 2 below for further information).

[4] http://gonano-project.eu/working-paper-on-gonano-stakeholder-workshops-now-online/

[5] Due to the different needs of the pilot partners and their stakeholder groups, the project partners agreed on a degree of flexibility in the interpretation of how these steps were to be implemented.

2.2 Expected outcomes

The workshop programme was designed to deliver:

1. The outline of an 'action plan' that sets out how societal input will be organised in the further development of the product suggestions;
2. The formation of a 'community of a practice', consisting of the problem owners, relevant societal stakeholders and facilitating researchers who will support the 'translation' and integration of societal feedback into the product suggestions.

2.3 National reports

The pilot partners drafted national reports on the workshops (based on the template provided in Annex 3). The reports are reproduced in the next section. They aim to present rich descriptions of the events themselves, the characteristics of the participants, the plenary and subgroup discussions, (implicit) group dynamics and tangible outputs (notably completed templates and the initial responses from stakeholders to the messages from citizens and the storyboards) as well as reflections on the workshop objectives (testing the main hypothesis).

3. Workshop National Reports: Organisation and Outcomes

3.1 Report on the second stakeholder workshops in Enschede (NL)

3.1.1 The workshop overall

The second stakeholder workshop in the Netherlands was organized on 7 November, 2019. This workshop focused on two thematic areas in the context of health: 1) the value of data for diabetes technology and 2) involving industry in the development of sensor technology for cancer detection. The workshop took place in the Designlab at the University of Twente (UT) in Enschede. In total, sixteen stakeholders with different backgrounds participated: six researchers, three stakeholders connected to policy making, three representatives from businesses, one person from a civil society organization (CSO) and three citizens who attended both the citizen consultation of GoNano in November 2018 and the first stakeholder workshops in February and March 2019. Seven participants were female (44%), and nine participants were male (56%). The workshop lasted from 11.00 – 15.15h. This time plan was chosen, since a number of stakeholders needed one to two hours of travel time.

The workshop consisted of four phases derived from design thinking methodology: exploration, ideation, prototyping and reflection. During the exploration phase the objectives, methodology and results of the GoNano-project were presented. Additionally, the stakeholders introduced themselves. During the ideation phase, stakeholders were asked to discuss statements that were based on the results of the previous GoNano sessions (the citizen workshop, first stakeholder workshops and online consultation) in a world café setting. These discussions provided input for the prototyping phase. During the prototyping phase, the stakeholders were divided into the two thematic areas and were asked to come up with a plan of action. The workshop ended with a short reflection about the outcomes of the workshop and the GoNano co-creation methodology. During the whole workshop an illustrator was present to visualize the process and outcomes of the different phases. The visualizations are reproduced below.

3.1.1.1 Stakeholders

The second stakeholder workshop followed upon the previous GoNano activities, that is the citizen consultation, the first round of stakeholder workshops on diabetes technology, sensor technology and nanotechnology and policy, and the online citizen consultation. All stakeholders of the first round were invited to ensure consistency between the first and second round of stakeholder workshops and continue discussion of the topics at stake. Nine of them were able and interested to come to the second workshop, seven were interested but unable to attend, one stated he had other priorities and six did not respond to multiple invitations. The organizers also specifically invited key stakeholders of the first round as 'problem owners', taking their needs and interests as key elements of the second workshop. Invitations were sent out to a post-doc researcher working on sensor technology for detecting cancer, representatives of start-ups working on diabetes technologies (artificial pancreas and lab-on-a-chip for detecting diabetes type 2 in an early stage), a professor working on sensor technologies for detecting diabetes type 2, and the head of a research

institute on nanotechnology. In the end, the post-doc researcher and the representative of the start-up working on the artificial pancreas were able and interested in participating in the second workshop. Their participation inspired the main thematic areas of the workshop.

Next to the participants of the first workshop, other, relevant, stakeholders were invited as well. In order to further explore the value of data for the artificial pancreas, as business developer and computer scientists from Vienna, who has developed an algorithm for the artificial pancreas based on data, was invited. He was invited as his artificial pancreas is already in use, while the artificial pancreas based on hardware (as a medical device) is still in its testing phase. Furthermore, a researcher who is specialized in the social aspects of privacy and security of data was invited in order to cover the potential risks of the data collection with health technologies. Additionally, in order to further explore the potential of the research line of the post-doc researcher, a business representative of a company from Czech Republic that support science-driven ventures for novel medical advanced materials was invited as well. Furthermore, a policy maker of the university who is responsible for funding opportunities was invited, to explore the possibility of attracting funds for the post-doc research project.

3.1.1.2 Thematic areas

The workshop was organised around two thematic areas: the value of health data for diabetes technology, and the involvement of industry in (early) research on sensors for the detection of cancer. Both were identified as key areas of interest in the first workshop on sensors and nanotechnology. The purpose of the second workshop was to translate the outcomes of the first workshop into a specific plan of action.

One of the two main themes of the current workshop regarded the value of health data for diabetes technology, and specifically related to the artificial pancreas. This theme was based on the outcomes of the first stakeholder workshop, which was a data management plan for an artificial pancreas based on hardware that is being developed by a start-up. Furthermore, the theme was based on an interview with a representative of a CSO who informed the organizers during a phone interview about an artificial pancreas based on data and algorithms. By bringing together the developers of both the hardware and the software routes with other stakeholders, the aim was to get more insights in the value of data for diabetes technology, and to come to specific product suggestions for the development of the artificial pancreas.

The second theme of the workshop was the involvement of industry in (early) research on sensors for the detection of cancer. In order to further develop fundamental research, funds are needed. However, the funding system often requires involvement of private partners, which are difficult to attract for researchers who work on technologies in an early phase. The theme was based on the research line of a post-doc researcher and on the Sensing-programme. This programme was set-up by Mesa+, the nanotechnology research institute at the UT, aiming at 'integrating modern design concepts with advanced ICT, nanotechnology, social, and humanities sciences realizing Smart Nanobased Sensor solutions in industrial, environmental and medical applications" (University of Twente, 2019).

3.1.2 Exploration

During the exploration phase, the organizers briefly presented the objectives of GoNano. Thereafter the participants were asked to introduce themselves through a game, where they had to explain in one sentence their connection to the workshop. With this game a pleasant atmosphere was created among the stakeholders (see Figure 2). After the game the GoNano methodology was presented together with the results of the sessions that had already been organized (the citizen consultation, the first round of stakeholder workshops and the online consultation). The results were presented by one of the organizers who showed short video clips (see Figure 3) and provided background information. This was followed by an explanation of the two thematic areas in the second stakeholder workshop (see Figure 4). The exploration phase ended with a short outline of the programme of the workshop. The exploration phase was set-up in an efficient and effective way, and this phase lasted 40 minutes. Based on the experiences from the first stakeholder workshops the organizers had learned that the exploration phase should be limited in time in order to have more time for the other phases, where specific steps for research, product, and policy development can be taken.

Figure 2 - Visualization of the exploration session (© Tonke Koppelaar)

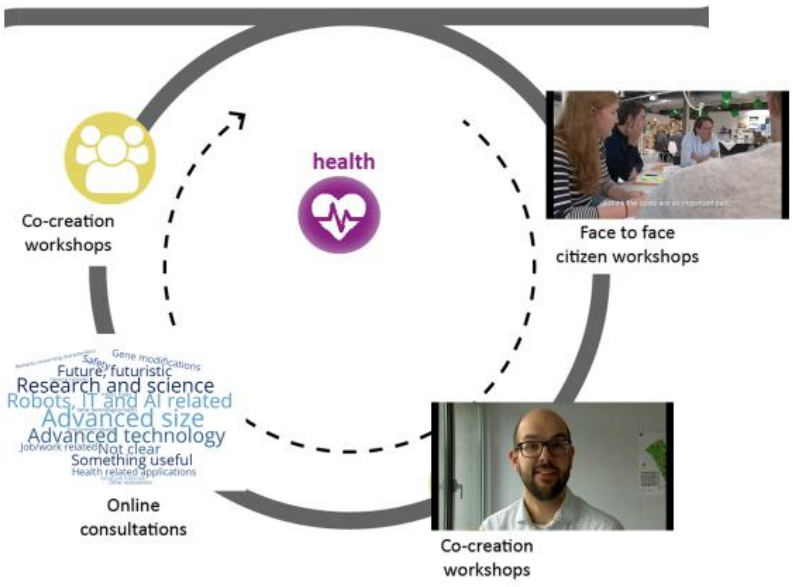

Figure 3 - Slide with short movie clips of the results of the previous co-creation sessions

Figure 4 - Main thematic areas of the workshop: artificial pancreas and sensors

3.1.3 Ideation

The aim of the ideation phase was to give stakeholders the opportunity to reflect upon the main results of the previous sessions of the co-creation methodology, and to generate ideas for the prototyping phase. In order to achieve these aims, a world café method was chosen. World café methodology aims at creating a collaborative dialogue around relevant questions that matter in corporate, government and community settings (World Café Foundations, 2015). Four tables were divided over a room (in a café setting), which all had one central theme and were moderated by trained professionals. Participants could choose their table of interests and discuss the theme with other participants. After 15 minutes, participants were asked to change tables and to discuss another theme with other groups of people. This was repeated in three rounds. The themes were based on the outcomes of the previous sessions of the co-creation methodology. In order to focus the discussion, specific questions or statements were connected to the themes:

1. Co-creation: When I go home, I hope to bring back the following outcomes…
2. Data: Personal health data should be made available if it's in the interest of (public) health
3. Well-being: How can we take well-being into account in the development of health technologies?
4. What are motivators for industry to get involved in research on nanotechnology and health?

Before participants started with the world café sessions, they were asked to shortly reflect upon the questions/statements (5 minutes) individually, and to write down their ideas on a post-it. These post-its were divided into the relevant themes, and provided a starting point for the table discussions. During the ideation phase various relevant conversations evolved about the different thematic areas (see paragraphs below).

3.1.3.1 Co-creation

One of the major aims of the GoNano co-creation process is to add value to product, research and policy development based on societal needs and values. However, as the organizers did not know precisely for which stakeholders the workshop could add value, the question about the preferred outcomes was included in the world café session. The participants had difficulties with answering

this question, but they were able to explain their motivation to attend the workshop. Three types of motivations were mentioned: 1) getting insights in the co-creation process, 2) new perspectives on research and development, 3) bringing in different perspectives to the discussion. Nevertheless, most participants did not have a clear idea what they wanted to get out of the workshop, but were interested in the themes and in meeting with other stakeholders. From this session the organizers learned that stakeholders not necessarily expected great added value. These outcomes could not directly be used as input for the prototyping sessions, but gave insights for the reflection on the co-creation methodology.

Figure 5 - Results table discussion on co-creation (© Tonke Koppelaar)

3.1.3.2 Data

Diagnostic and monitoring devices, such as an artificial pancreas, collect a lot of health data. Based on this data, diagnosis and treatment can be improved on both an individual and societal level (big data analytics), but citizens posed concerns in the citizen consultation and online consultation about the privacy and security of these collected data. In order to start a discussion in the current workshop, participants were presented in the world café session with a statement about sharing personal data for the sake of health. Most stakeholders thought that individuals should have ownership over their data, which corresponds with the outcomes of the citizen consultation.

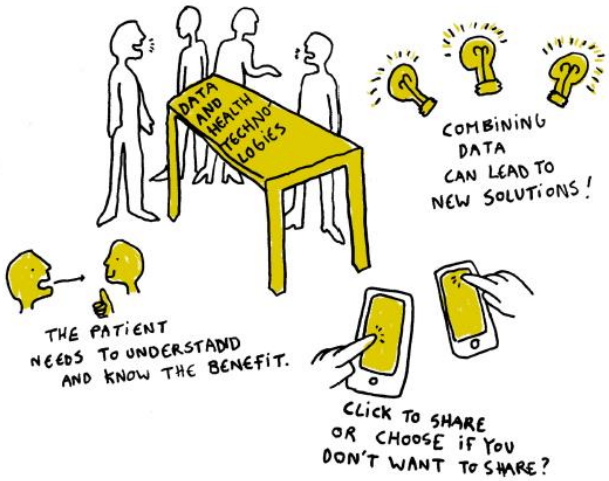

Figure 6 - Results table discussion on data and health technologies (© Tonke Koppelaar)

However, a number stakeholders also emphasized that this was difficult to achieve, as in practice companies (hardware developers or app developers) are often the owner of the collected data. Additionally, they stressed that a large number of people do not have the knowledge or skills to manage their own data, which poses a challenge on individual ownership. Some stakeholders saw benefits in sharing data for the sake of public health, but emphasized that this should be done in a transparent way. The outcomes of this discussion gave interesting insights in stakeholders' opinions on the outcome of the citizen consultation, but it did not provide novel insights for the prototyping session.

3.1.3.3 Well-being

Well-being was chosen as a subject for the world café session, as it was considered to be important in the citizen consultation and online consultation. Some citizens feared that early diagnostic and

monitoring devices would cause continuous awareness of their health, leading to stress. During the world café session, stakeholders agreed that well-being is related to dealing with diseases (and treatments), and that the notion of well-being differs per individual. Health technologies offer a frame of action in this regard, but people differ in their preferred level of control in managing their health and lifestyle. In the context of diabetes, for example, some patients prefer a closed loop device that takes care of their glucose levels and thereby taking away the control or awareness of their health, while others might prefer to have knowledge about their health values and being in control. Stakeholders thought that this is closely related to the level of trust in medical technologies. The discussion gave an interesting reflection on the outcomes of the citizen consultation, and the insights mentioned above were relevant for the prototyping session on data for diabetes technology.

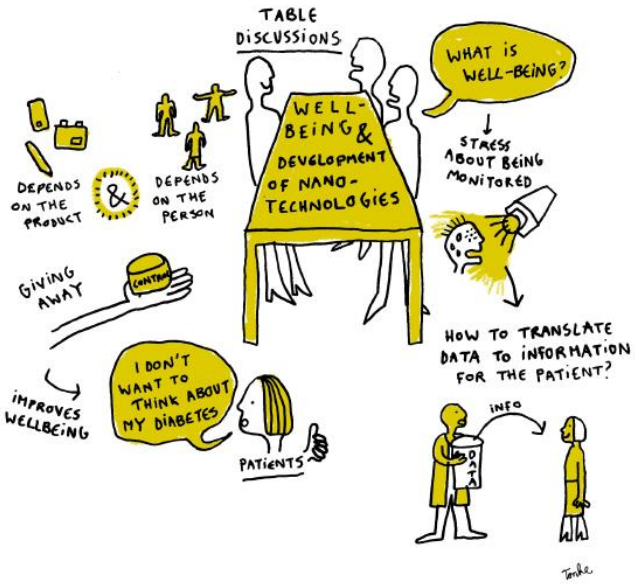

Figure 7 - Results table discussion well-being (© Tonke Koppelaar)

3.1.3.4 Industry-research relation

Based on the first stakeholder workshops, it became clear that researchers working on nanotechnology for health in an early developmental stage (low technological readiness level), have difficulties with involving private partners in their research projects. However, in order to attract funds for further developing their research lines, often the involvement of these partners is needed. In order to get insights from all stakeholders present at the workshop on this theme, this was one of the statements chosen for the table discussion. During the world café session, stakeholders recognized the gap between industry and research. They emphasized that both representatives of industry and researchers should search for shared objectives in order to bridge this gap. Scientists should turn research questions into a business canvas, and industry should turn business questions into research questions. Additionally, scientists could spend much more time in engaging with industrial partners (e.g., through business events, disseminating their results through media outlet), or developing their research into spin-offs and SMEs. Although these insights confirmed the need for attracting industry in research projects, it was difficult to come to specific outcomes that could be used for the prototyping session.

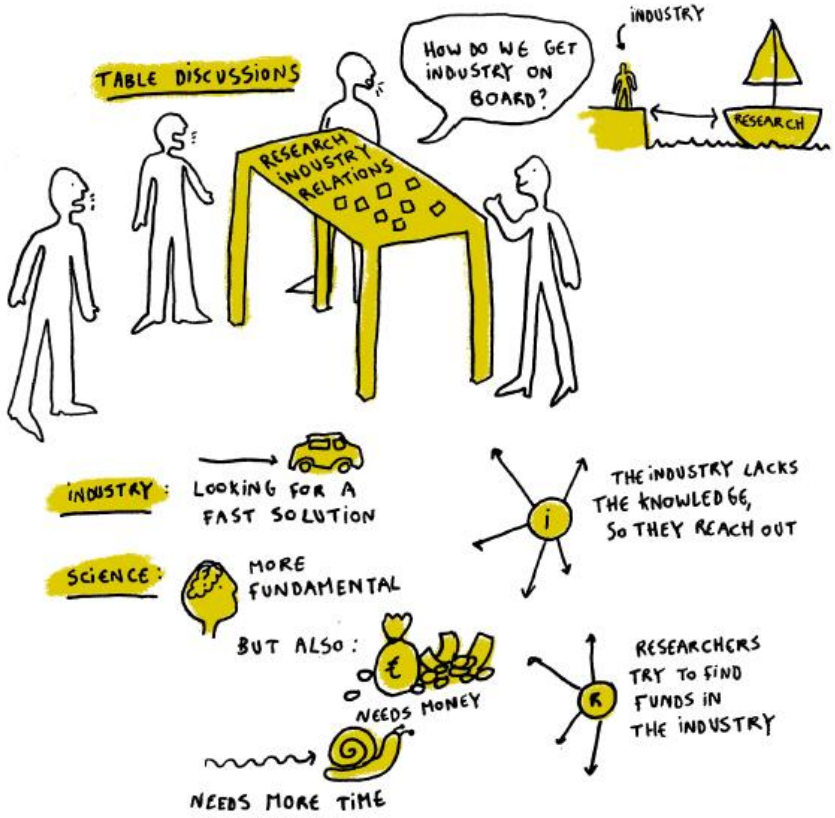

Figure 8 - Results Industry-research relations (© Tonke Koppelaar)

3.1.4 Prototyping

After the lunchbreak the four table moderators briefly presented the outcomes of the ideation session, and participants were divided into two groups connected to the two main themes (tables) based on their area of expertise. As the participants were invited based on their connection to one of the two subject, artificial pancreas and industry research-relations, the organizers decided to divide them in the two group, instead of giving them the freedom to choose the area of interest. The organizers invited stakeholders who had a connection to the theme, in order to make the discussion and co-creation session more focused. During the prototyping phase participants discussed the theme from their own perspective and then were asked to come up with an action plan for the coming years. This phase lasted 90 minutes.

3.1.4.1 Value of data for diabetes technology

The group connected to value of data for diabetes technology was composed of eight stakeholders, including a nano-technology researcher who develops a non-invasive needle for diabetes technology, a social science researcher who focuses on the user perspective of privacy of data, a business developer of a start-up company that develops an artificial pancreas based on hardware, an app developer who develops an open source platform for an artificial pancreas based on health data, a representative of a CSO, a diabetes type 1 patient, a policymaker, and an artist who focuses on science communication. They discussed the importance of health data (glucose values) for

diabetes type 1 patients, and the function of the artificial pancreas in this regard. Participants discussed that even though treatments for diabetes type 1 has been developed, the disease puts a high burden on patients, and there is a need for technological solutions that increase wellbeing of diabetes patients. Interestingly, with the technological solutions that have been developed so far, from the insulin pen, to the insulin pump, to the mobile app that continuously monitors glucose levels, the consciousness of health data has also increased. With the current technologies, much more data is collected and monitored. While this data makes it easier to live with diabetes type 1, it does not relieve the burden of the disease. An important development in this regard is the artificial pancreas that continuously monitors glucose levels and automatically injects insulin when needed, and thereby relieves the burden of the awareness of the disease. A start-up company has developed an artificial pancreas based on a hardware device, and is working on its final CE certification. Although the idea of this technology was developed a decade ago, it takes time to bring a medical device to market.

While the artificial pancreas seems to be the solution for diabetes type 1 patients, during the workshop a number of (potential) issues and suggestions were discussed (see Figure 9). First, participants discussed the system in which the artificial pancreas is being developed. In the current regulatory system it takes a long time to bring a medical technology to market due to tests and certifications, but the software artificial pancreas, an open platform based on algorithms developed by computer scientists, could be on the market right away (the developer was present at the workshop). A number of patients across Europe (including the patient present at the workshop) are already using the software artificial pancreas, but it requires highly technological skills and the patient still needs to act based on the data. Also, the safety of the software artificial pancreas is not guaranteed as there is no regulatory framework for it. Health professionals are therefore reluctant to include the software artificial pancreas in their treatment. At the workshop it was

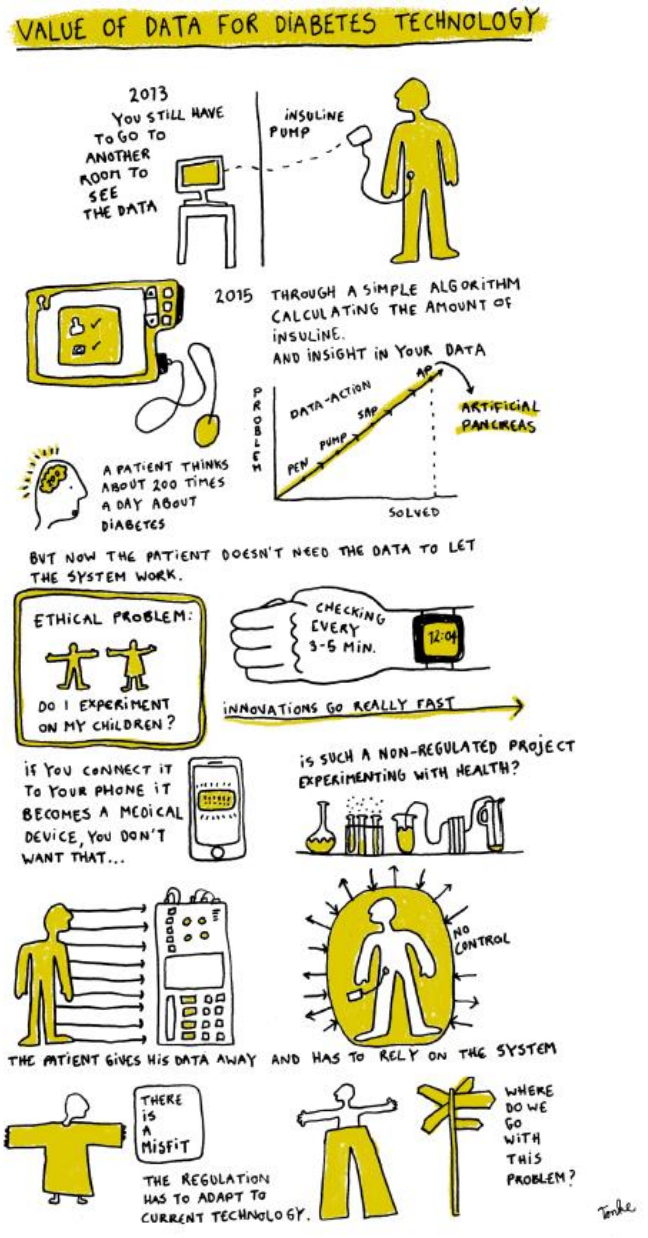

Figure 9 - Prototyping phase value of data for diabetes technology (© Tonke Koppelaar)

concluded that regulations should be adapted to the technology and not the other way around. Furthermore, medical technologies should be distinguished from pharma, and especially in vitro technologies should be easier to bring to market. The policymaker and the representative of the CSO both argued that this was an action for them to take bring back to their organization.

Second, the value of data for diabetes technologies was discussed. Health data can be of value for a number of actors, including: developers of the artificial pancreas to optimize diabetes technologies (e.g., to optimize personalized algorithms that detect the best time to inject insulin); health professionals, to optimize treatment plans; patients, to create better insights in their health; insurance companies, policymakers, and funding organizations, to get insights in the effectiveness of solutions and technologies for diabetes patients. Data of individuals has already been collected in an open platform to optimize the algorithms for the software artificial pancreas. The developers of the hardware AP work on a data management plan (which was the outcome of the first stakeholder workshop of GoNano) in order to make use of different types of data for different purpose.

Third, the user perspective on data was pointed out, which is closely related to well-being of patients and trust in technologies. With the development of diabetes technologies, insight in and the amount of data has increased (see Figure 9). However, this does not automatically lead to more trust in technologies and a better well-being, because the increase of data also leads to a more complex way of dealing with the diabetes in terms the number of actions needed and interpretation of data. The artificial pancreas, which is a closed loop system, might offer the solution for this problem. However, participants argued that for diabetes type 1 patients health (data) has always played an important role in their lives, and a closed loop system that takes away the awareness and control, might lead to a feeling of loss of control. Therefore, patients should be given the opportunity to keep insight in their data when having the artificial pancreas. This suggestions was specifically useful for the business developer of the artificial pancreas.

3.1.4.2 Research industry-relations

The group discussing this theme consisted of seven stakeholders: a junior researcher (post-graduate student) working on sensors for nanotechnology and health, a senior researcher focusing on research on cancer, a senior researcher on design thinking, a policymaker working on research funds, a policy maker working on RRI, a representative of a business consulting firm for start-ups working on nanotechnology and health, and a citizen. Unfortunately, the post-doc researcher who was present at the first stakeholder workshop, had to cancel the workshop last-minute. Instead, she was present via Skype at the beginning of the prototyping session. During this session, the post-doc researcher first explained her research and the difficulties she encountered in involving private partners. This was the same research that was also discussed in the first stakeholder workshop, focusing on the development of sensors for improvement of diagnoses of cancer through monitoring proteins. While the technology might lead to personalized treatment of different types of cancer in the future, the researcher had difficulties with involving private partners in her research as the research is still in an early technological phase. The junior researcher who works on the development of an organ-on-a-chip model for a liver encountered similar problems. During this phase several suggestions and issues were discussed for involving industry in research development (see Figure 10).

First, researchers need to think of a strategy and come up with a 'story' about their research. This should be done in an early phase. They should be able to answer what's in it for the partner, and define potential application areas. The researcher should find common objectives with private partners and frame and explain the technology in such a way that it meets these objectives. They should take into account that they explain their technology in such a way that lay-people can understand it. The 'story' can be directly told to the private partners through networking activities, or the attention of businesses can be attracted via media exposure.

Second, stakeholders mentioned that it is crucial to build relationships with potential partners through networking activities. It is important to find a 'problem-owner', who has an intrinsic motivation in supporting the research activities. Researchers should take into account that these networking activities cost a lot of time and effort, and it is important to not just start with networking around the funding call, but much earlier. Researchers should invest time in building a network and build a reputation around themselves. For junior researchers it might be helpful to use the network (and reputation) of their supervisor or senior researchers.

Third, stakeholders pointed out that it would be helpful to engage potential users in the development of the research in order to detect the demand these users and the solutions the technology can offer. Researchers could explore various user scenarios and should be flexible in the application area of their technology/research.

Fourth, when looking for funding it could be helpful to start with small steps. A Lorentz funding, for example, provides a compensation for costs being made for a workshop that focuses on bringing various actors together connected to a technology. This workshop could be used a starting-point to attract business. In this way, the researcher does not initially asks for resources (funding), but first brings knowledge to the private partners.

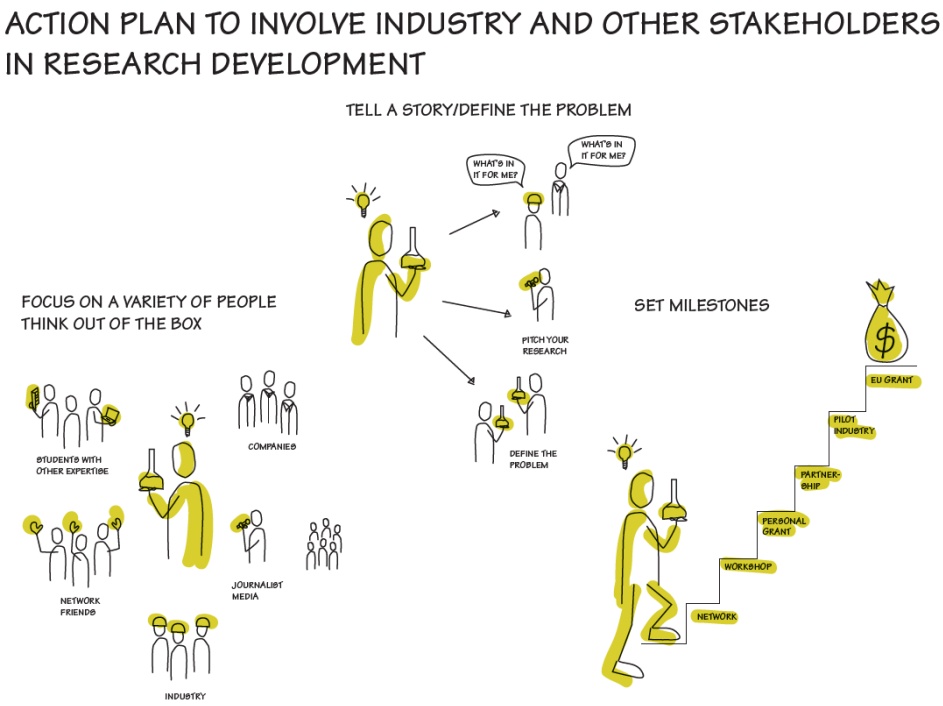

Figure 10 - Prototyping phase research-industry relations (© De Proeffabriek / Hannie van den Bergh)

3.1.5 Reflection

Since the prototyping phase ran 15 minutes over time, there was little time for the reflection phase. In total this phase lasted around 15 minutes. Nevertheless, stakeholders were asked to reflect upon the outcomes and process of the workshop and the GoNano co-creation methodology. Also, at the informal drinks afterwards quite a number of stakeholders stayed and reflected upon the workshop in an informal way. However, the reflections referred mainly to the workshop and less to the whole co-creation methodology.

Most stakeholders thought the workshop was successfully organized and enjoyed getting into contact and networking with other stakeholders. They also saw an added value in hearing perspectives from other stakeholder groups. However, they did not all see the added value of the outcomes of the workshop. One of the stakeholder who was involved in the industry-research table, for example, thought that the discussion and outcomes were rather abstract and was not sure whether it was useful or novel for the researchers. The citizen who was present at this table stated that he had difficulties with engaging in the discussion, as he found the subject of the researcher rather technical and outcomes quite abstract. He stated that he enjoyed the former workshop he engaged in more, which was about policy and nanotechnology, and the outcome was a field lab in an hospital to showcase and test novel nanotechnologies for health. Stakeholders from the other table thought the outcomes were interesting and specific. However, some of them thought the level of knowledge about diabetes (technology) among the stakeholders was too diverse. Some had much more knowledge and were better able to engage in the discussion than others. Also, both the developer of the software AP and the business developer of the AP had a different perspective, and during the (informal) reflection they mentioned they had difficulties with finding agreement. Interestingly, most stakeholders reflected upon the prototyping phases of the workshop, and not on the other phases (exploration and ideation). In general, they thought that 90 minutes was rather short to come to specific and relevant outcomes, and therefore they saw most added value in the meeting other stakeholders and getting novel insights.

3.1.6 Overall assessment of the workshop

Based on the evaluation and reflection of all phases of the workshop, it can be concluded that bringing stakeholders with different backgrounds together leads to relevant discussions and insights for product development and research projects. However, it is difficult to come to specific product suggestions, to get relevant outcomes for all stakeholders, or to find a problem-owner who takes up suggested actions. Below, the reflection the outcomes of the workshop will be discussed first, followed by the procedural findings.

3.1.6.1 Workshop outcomes

The suggestions and insights that were made for the value of data for diabetes technology can be useful for various stakeholders and are well connected to previous outcomes. Based on the discussion it became clear that there is hardly a regulatory framework for data driven technology. Furthermore, for medical devices the regulatory framework might be too strict, resulting in a long

time period before a device can be brought to market. The latter aligns with the outcomes of the first stakeholder workshop on nanotechnology and policy, where different stakeholders came up with the idea for a field lab in hospitals where novel medical devices can be shown and used by the patients. The reason why stakeholders came up with this idea was because they thought it takes too much time to develop and implement medical technologies due to strict regulations. These findings provided input for the policy maker, who is involved in the design of a regulatory (risk governance) framework for nanotechnology. The point about data and well-being with regard to the artificial pancreas provided valuable insights for the business developer of the artificial pancreas. In the citizen consultation, citizens were concerned that monitoring devices would negatively influence their well-being, as it would make them continuously aware of their health data. Interestingly, in this workshop it was discussed that for diabetes type 1 patients, no indication of their health status might potentially also lead to stress. It is therefore important to find the right balance in displaying health data, and to personalize it. This suggestion can be directly applied to the development of the artificial pancreas. Although the business developer thought it was a relevant insight, he stated they were already working on such a function in the artificial pancreas. Furthermore, the organizers expected that bringing together the developer of the software artificial pancreas and the hardware artificial pancreas would lead to interesting outcomes and connect participants. However, their perspectives differed too much regarding the development of diabetes technology, and they had difficulties with getting into agreement.

The discussion on how to involve industry in research on nanotechnology gave interesting insights, but did not lead to novel and specific outcomes. The initial idea was to have the post-doc researcher present as problem-owner, and write an application for a Lorenz workshop with the other stakeholders. However, as the post-doc researcher cancelled last-minute, this was difficult to achieve. Instead of writing a specific application about the research of the post-doc, stakeholders gave more general advice on how to involve industry in research on (nano)technology. Interestingly, most of these suggestions correspond with outcomes of the study of Jansma, Gosselt and De Jong (2017) who studied the communication processes of technological start-ups in the development and implementation of (radical) innovations. These processes include: framing and explaining the technology (problem-oriented to policy makers, solution-oriented to private investors), getting media attention (explaining the technology in an easy understanding and newsworthy way to journalists), networking and collaborating with other parties, and strategically choosing the application area and being flexible in this regard. Furthermore, the outcomes of this workshop were specifically targeted at researchers, and were therefore less relevant for the other stakeholders.

3.1.6.2 Procedural / organisational considerations

The second stakeholder workshop gave interesting insights in opportunities and barriers for co-creation.

First, it was difficult to come to specific product suggestions. In the GoNano-project, the expected outcomes of the co-creation methodology were defined beforehand, namely nine product suggestions (three in each thematic area) based on societal needs and values. Although the term ‘product suggestions’ can be interpreted in different ways, it does give a clear direction of where

the workshop(s) should lead to. However, this might not be the outcome that the stakeholders had aimed for or hoped to achieve. During the organization of the second stakeholder workshop, the organizers were creating the supply, the co-creation methodology, but had to define the demand, creating relevant (product) suggestions for different stakeholder groups, as well. Instead of aiming to create specific product suggestions, the co-creation methodology could be seen as a framework for mutual learning in the development and implementation of nanotechnology, in which different stakeholders along the value chain can learn from each other. However, the question arises whether mutual learning can be regarded as co-creation, or whether it is a requirement for co-creation. Another way to enhance the effectiveness of co-creation, is to first explore the needs of stakeholders, and then design the co-creation methodology. The approach of how to increase the effectiveness of co-creation relates to the aim of co-creation. On the one hand the main aim of co-creation can be to democratize science and technology, and on the other hand the main aim of co-creation can be to add value to science and technology.

Second, related to the first learning point, it proved difficult to engage the same stakeholders from the first stakeholder workshop in the second workshop, including finding 'problem-owners'. For this workshop a date was set in advance, and a number of stakeholders already had other obligations on the specific day. Furthermore, a few stakeholders did not feel the need to attend the second stakeholder workshop, or did not respond on the invitation. Although, every stakeholder was invited a more than 7 weeks in advance, it might be wise to send out invitation even earlier. The strategy of the first stakeholder workshop, with identifying key stakeholders, asking those key participants for other relevant stakeholders, organizing multiple workshops each around one thematic area, and set a date based on the key-stakeholders' schedules, might be a solution as well. For co-creation, this might imply that it is easier to bring together a small group of stakeholder related to one specific theme, than to bring large groups of stakeholders together. However, this set-up gives the organizing actor a lot of power as they bring the stakeholders together, and this limits the opportunities of cross-fertilization between larger groups of stakeholders.

Third, stakeholders did not expect great added value of the workshop, but were interested in the methodology of GoNano and in meeting other stakeholders as part of networking activities. During the breaks of the workshop, stakeholders interacted with each other, and several business cards were exchanged. Interestingly, these interactions did not necessarily take place between stakeholders who were linked to a specific thematic area, but more based on personal interest and organizational backgrounds. This outcome would be an argument to at least have one activity in the co-creation methodology with stakeholders connected to different thematic areas.

3.2 Report on the second stakeholder workshop in Prague (CZ)

3.2.1 The workshop overall

The second stakeholder workshop was held at the Technology Centre of the Czech Academy of Sciences headquarters on 22 October 2019. In what was to be a direct continuation of the previous activities and especially the precedent online consultation, the aim was to create a workshop with a slightly more focused perspective in contrast to the first stakeholder workshop: to (1) re-invite the most interested stakeholders from the previous stakeholder workshop; (2) to re-identify key stakeholders as 'problem owners' according to the product suggestions / research aims that were co-created by citizens and stakeholders.

More specifically, as a lesson learned from the first stakeholder workshop, the overall approach evolved from the aim to cover many various stakeholders to approach involving a lower number of expected participating stakeholders: firstly, potential key stakeholders were invited via phone and interviews. Selected key stakeholders were identified based on three criteria: (1) their expertise, (2) their own products or research aims that were in accordance with the product suggestions and research aims developed within the GoNano workshops, (3) their interest/willingness to participate. Out of the 4 potential partners identified, only two were willing to come (due to date collision or due to lack of interest). Secondly, e-mail invitations were sent out to over 50 e-mail addresses of stakeholders who were previously involved or aimed to be involved initially. In addition, separate calls and interviews were held with some of these as well.

Key stakeholders that were selected were representatives of fundamental research in chemistry and technology and nano-business. The research partner was involved in a project that was specifically connected to a smart food packaging solution. However, due to ongoing legal procedures connected with certifications, the partner was unable to share exact information about the research. Nevertheless, this was not an obstacle when it came to an active participation and further discussions about the product suggestions suggested by citizens and stakeholders during the first stakeholder workshop; the second key stakeholder was a representative of a business involved in producing nanofilters used to filter beverages, that was invited and involved in the during the first phase of the project, but since the workshop had its aim to be more focused, it made sense to try to re-involve him as the partner was one of the few that had the food product already used "in the field".

Other stakeholders were identified in such a way that their activities would be in line with the product suggestions and research aims developed throughout the citizen and stakeholder consultations and the product suggestions and research aims of the key stakeholders. The aim was to cover these activities from all points of view, including state authorities, businesses, researchers and NGOs.

This effort seemed rather successful as one of the workshop´s guests included a successful case of business active in packaging, as the company would only use glass bottles to supply the market with its specific products. Other guests included well-known companies producing biodegradable biopolymers and packaging systems; a representative of the Ministry of Agriculture; the chief researcher of the Department of food preservation of the University of Chemistry and Technology

in Prague; and two representatives of a Food bank – an institution engaged in collecting food for further re-use.

During an online consultation, 37% of the previously involved stakeholders were re-involved in the process.[6] However, the number of previously engaged at the venue was somehow lower: of overall 16 participants, only 3 were present for the second time, as this would account for nearly 19%. When it comes to the factual attendance/registration ratio – compared with the previous stakeholder workshop, only two registered participants were missing.

Gender composition of participants was equal *(f = 8)*, and bigger differences of the gender composition were only apparent in the case of the novel foods application group, which was comprised mostly of female participants. The expertise was divided by researchers *(5 attendees)*, non-governmental organizations *(4 attendees)*, businesses *(4 attendees)*, state representatives and the media.

3.2.2 Session A: Exploration

In the first session, participants were divided into three subgroups based on their interest. This would mean the groups would not have equal number of the participants at the table. Participants re-introduced themselves, were asked shortly about their current ongoing projects and primarily discussed the issues connected with the results from the online consultation and previous phases of the GoNano project. These results were firstly summed up in an initial presentation given by the GoNano facilitators and later handed in in form of hand-outs.

3.2.2.1 Novel foods

Participants in the novel foods group discussed mostly two types of presented outputs that mostly responded to the increased need for safety discussion raised by the respondents of the online consultation: (1) safety aspects and the possibilities of the (nano)analysis of food content in general, and (2) the idea of creating a "superfood" which would be suited for a specific group of customers – e.g. diabetes patients. The participants´ group composed of a representative of the Ministry of Agriculture, researchers from the University of Chemistry and Technology in Prague, and a representative of a Food Bank (NGO).

The representative of the Ministry of Agriculture explained the current legal frame for the safety of food products, which is binding for all the manufactured nanoparticles in use. Accordingly, producers should explicitly declare if the specific product contains nanomaterials. If a company aims to use such content in food, then it is needed to provide the authorities with referential material. And for this matter – from the point of view of state authorities – the essential is to examine the food with technologies such as electronic microscope. Participants also pointed out that in the Czech Republic there is still an institution missing that would oversee and test all the products in food on the nanoparticles´ presence – that is due to a lack of accessibility to technology that would enable to examine the samples. However, participants added that this is the case for all

[6] For further information, please see the D3.3: Results of the online consultation.

the EU countries, as all the member states at this point miss the possibility to compare the products and measurements.

The representative of the food bank subsequently asked if there is an example of novel food being already in use. An example – titanium dioxide – was given by another participant which is being used in chewing gums and which may be banned soon. Other examples are homogenized particles of fat which are being used by companies such as Nestlé. However, other participant added that nanotechnology is currently sometimes being only proclaimed to be used because of it´s popularity, and in fact natural substances of food are being sometimes labeled as special substances "manufactured" in nano-dimension. One of the other stakeholders remarked that adding a certain substance still seems to be more useful when compared to designing and producing a special "superfood" product from scratch.

Figure 11 - Novel foods exploration

Other participants added, that when talking about "superfoods", there is an already existing example: a food called *"Mana"* which consists of perfectly balanced nutrients. However, this is not provided by the nanostructure which is in fact not at all required to serve its proper functioning. The opposite seems to be the case as such a product would have higher costs and would be much more complicated to develop than through traditional processes.

Moreover, the question of adding a certain nano-substance seems to be rather complicated as there are many types of allergies towards various allergens. Participants suggested that human bodies may have problems with accepting such substances, and moreover, if such substances – and especially complex superfoods (nano or non-nano) – would be regularly used, it could lead to recipients having problems with digestion of non-superfoods in some time. This is, according to one

of the participants, supported by the experience of specific groups such as soldiers or mountain climbers.

3.2.2.2 Nanofilters

The nanofilters group was composed of representatives from industry: a well-known company producing filters for cleaning water and air pollution from already used materials; and another key business figure producing filters for the purpose of cleaning food products and especially beverages. As the third representative of the smallest of the groups, a representative of the Czech membrane platform was present.

Figure 12 - Nanofilters exploration

Participants agreed on the general points stressed by the results of the online consultations – they concurred with the suggestion that nanofilters are the safest application of nanotechnology in food. Participants also agreed on the point that nanofilters do not seem as harmful when compared with the other application areas (notably novel foods) and expressed their understanding that increased quality of water, air and food does not spark many controversies. Present stakeholders also strongly agreed with the perceived importance of increased water quality, air quality and food quality originally suggested by the citizens.

One business representative remarked that the company tries to avoid using the term "nanoparticles" as this term seems to spark negative connotations and fears of the public. Instead, the company tries to emphasize that they produce filters out of specific *nanofibers*. When speaking of direct feedback on the online consultation, the representative claimed that the company often

receives positive feedback on producing filters that helps to increase the quality of health of the users and potential users of their products. At the same time representatives stressed that any public feedback is beneficial, and the two companies remarked that they are interested in the outputs.

3.2.2.3 Smart food packages

The group discussing smart food packages initially responded to two of the suggestions from the previous stakeholder workshop – (1) Smart food packaging for vegetables and fruits and (2) smart food packaging for meat products. The group was composed of two representatives of the University of Chemistry and Technology in Prague: the Department of Biochemistry and Microbiology and the Department of the Food conservation. The key partner – from the first department – was at the time directly involved in producing antimicrobial-layered packages and issues connected with what happens with nanomaterials at the end of the life-cycle. The other research partner was studying active and "intelligent" packaging systems with *nanosensors*. Business was once again represented by the same well-known company as in the case of the nanofilters group: a member of a team developing PHA polymers out of frying oil. The fourth participant represented a company working in the field of re-usable glass packaging systems. Other partners included an NGO with a representative from the food bank interested in packaging systems from the point of view of effectiveness and optimization when it comes to donated food products and their long-term conservation – minimizing food waste. The last participant of the group was a representative from the Ministry of Agriculture who was interested mainly in safety and prolonged shelf-life of the food.

The initial discussion concerned the already used packaging systems. The food bank described how sophisticated the treatment of fruits and vegetables in their food conserving activities must be – often manipulation is required. Pieces must be removed from the plastic bags and put into cardboard boxes because of the possible fast contamination by the rotten pieces contained in the packages. One of the other participants added that just one of the major companies working in food delivery uses around 350.000 of these cardboard boxes per day, just to be able to transport the goods. Discussion therefore quite quickly steered into the topic of where the highest volume of the waste actually comes from – supplying chains and packaging systems used *before* the "final presentation" of a product to a potential customer.

The discussion later came back to the packaging systems for fruits and vegetables, the representative of the Department of Food Conservation added that "historically" there were and are packaging systems already in use – a simple small tray with a plastic foil which contained a modified atmosphere, and that this kind of package could be just slightly adapted: containing integrated sensors sensing the possible contamination of the food. The participant also added that the trends in packaging are nowadays defined by thinning. And that thinning also has its consequences to a more successful degradability. A professor from the Department of Biochemistry and Microbiology remarked that biodegradable packages can serve the opposite as initially required – they can lead to creation of new waste, with examples of microplastics and nanoparticles of silver. They ended up with a rhetorical question: how to treat these particles after their dissolvement?

The representatives of the University of Chemistry and Technology then came back to reusable packaging systems. However, they later added that sanitation of reusable packaging system can be somewhat dangerous as well, and that the "popularity" of certain materials, such as glass, PET or carton packages often changes based on public opinion rather than its properties.

Figure 13 - Smart food packages exploration.

3.2.3 Session B: Ideation

The ideation phase further intensified the discussions in the groups. From the initial feedback on the online consultation results and product suggestions, the debates dived into further details given by the expertise of the respective stakeholders, which further problematized the results, notably *the safety aspects* (in the case of novel foods) or the *technological aspects* themselves (in the case of smart food packages):

3.2.3.1 Novel foods

Participants perceived the different shapes of nanoparticles and considered their spontaneous combinations as risky (and unstable) as this could lead to health risks since these particles can negatively interact with human cells. According to the participants, it is also unknown whether particles on nano and macro level might interact with each other. During the production of nanoparticles novel microparticles might emerge.

One of the participants noted that one has limited control over the particles on an example: During the homogenization of fat there are processes leading to reduction of the size of these particles into nano-parameters. These nanoparticles then emerge spontaneously. Others emerge through contact with air. Moreover, if there would be a sum of these particles in emulsion, it is not clear if these should also be labelled as manufactured nanoparticles.

If the particles would be capsulated, they could go through the digestive tract and work in the intestines. This could be beneficial e.g. for people with lactose intolerance. Other participant remarked that nowadays – thanks to nanotechnology – it is possible to lower the content of fat or sugar. The final product could be for example a *"porous sugar"* that would lead to lowering the content of desired substances (this could be used also for fat or salt particles) in food products. However, the capsule itself would need to be safe. The producer should therefore also describe the methods of the production of the nanoparticles – in a similar way to GMOs, incl. the material used.

Figure 14 - Novel foods ideation.

However, apart from the given specific examples, participants were rather uncertain and unoptimistic about the wider use of nanotechnology in food, especially in a foreseeable future such as 5 years. And the doubts were the strongest especially for products that would be solely based on nanotechnology such as superfoods as depicted by the citizen during the citizen consultation (Hebáková & Pour, Bitsch, 2019).

3.2.3.2 Nanofilters

The representatives agreed that when it comes to filters, using nanofiber fabrics had enormously increased their effectiveness. The quality of filters is currently guaranteed by private certification systems: there are several private institutions, e.g. laboratories with attestations with respect to European norms that offer their services on a commercial base, however, the clear negative consequence is that price plays a very important role. Currently in the Czech Republic there is not an institution that would a approve or certify nanotechnology products.

Representatives of companies at the same time claim that there are no particles being released from the materials both during their use and their disposal. Experts at the table thought that none of these particles would imply serious health risks.

One of the companies already tests filtering system for warm water in one of the hospitals as it can be a serious source of bacterial infections. The representatives see new directions mostly in increasing the capacity of these facilities and in application adjustments given by the demand on the market. The other company works with wine filtering which aim to "collect" yeast cells so the

wine would not ferment any further. Similar processes apply to the filtration of beer as well. One of the other important applications are the filtration of oils and getting rid of the waste which is a result of the squeezing processes during wine production.

Participants further discussed topics related to nano-waste management. Firstly, stakeholder discussed the degradability of nanofilters in form of fabric, which participants agreed, are quite easy to degrade and that these could – according to the businesses – be disposed of through the conventional ways without risks.[7] Secondly, the participants discussed nano-sized waste in general. Some experts proposed, that in situations where there is a significant amount of nano-sized waste, it could be useful to transform this waste into solid state and to dispose of it through conventional ways: combustion or dumping. In special cases the waste could be labelled and treated as dangerous waste – e.g. in the case of materials used in health care.

When it comes to the disposal of the already used filters themselves there is still plenty of space to improve according to the businesses. On a positive note some of the filters are degradable, and when it comes to nanofilters made of nanofibers in form of a fabric, this these could be disposed of through the conventional ways, at least according to the businesses.

3.2.3.3 Smart food packages

Some participants claimed that efforts should concentrate on changing the mindset of customers: not every product needs to be wrapped in plastic. According to the experts, there are only 2 types of food which are essential to pack: meat and some types of cheese. From the point of view of vegetables packing, it is useful to pack broccoli or celery, however in this case the package has to be active. On the more general note, there should be a communication change towards the customers that they are also responsible for consuming in a responsible way. An important question when it comes to waste is the export to the developing countries. Returnable packages are financially demanding – they require to re-clean the package. And there is another waste to get rid of – leachate out of the printings, ink etc. Therefore, it would be also more effective to use transparent packages with no added colors (does not have to be solely PET).

"The aim should be not to use ideal materials, but to use the least harmful ones."

The similarity of the public debates about GMO and NANO from the Stakeholder workshop 1 was also discussed. Some experts added that these two debates are actually not as similar as one would primarily tell: GMO exist and are used in the specific cases for some time already (experts mentioned the artificial insulin as the first used GMO). On the contrary, NANO debate seems to be still quite "foresighty" and vague as it depicts many scenarios but only a few real-life applications.

[7] Although this seems to be in contradiction with some of the researchers´ findings that warn of nanofibers as well (Zumwalde, 2013).

When it comes to cooperation between subjects, an example of already working and successful cooperation is an accredited laboratory for packages – in this laboratory packaging system are being tested concerning their proper functioning; including the applications of the nanoparticles. Experts involved agreed that the cooperation is useful and that it provides everyone with the possibility to find common solutions. For one of the departments of the University of Chemistry and Technology it is important to answer the needs of the customers by the development itself.

Figure 15 - Smart food packages ideation.

Safety was thoroughly discussed. Changing the functional characteristics of food products might raise fears that the nanoparticles – once dissolved – would contaminate the food chain.

"At this point the health consequences are unknown."

The topic of degradability was also thoroughly discussed. According to one of the studies quoted by the business representatives, more than 50% of the PLA does not degrade sufficiently. And there are new emerging problems even if it would: there is a missing infrastructure that could be potentially used for recycling such materials on the European level, as the self-degradable materials would contaminate the composts with plastics or other materials. One of the businesses mentioned the PLA as being unsuitable for the current market demands for the packaging solutions. However, the researchers from the University of Chemistry and Technology did not agree with these claims, as there are many other possible substances to produce packages from (e.g. cellulose or starch). Some participants therefore stressed the utility to focus on topics such as circular economy, and to support the efforts to prevent waste to be produced in the first place.

3.2.4 Session C: Prototyping

The prototyping session aimed to come up with action plans of the product suggestions which would describe the actions to be taken concerning the activities of the given stakeholder – this worked out differently throughout the different application areas. In the case of novel foods, there is indeed a sort action plan guiding the new nanotechnology production and how these novel ideas should be treated. In the case of smart food packages, it seems that both aims were achieved: there was a crystalized idea of a product that indeed is worth of developing/continuing to develop, and a vague action plan on what and who should act in the further development in general.

3.2.4.1 Novel foods

The discussion in the novel foods group continued within the safety/regulation aspect detail. The representative of the Ministry of Agriculture claimed, that there is a legislation frame existing, but at the same time there are missing methods that would be applicable in all the EU countries. Therefore the inquiry if nanomaterial is present is quite demanding from the technical point of view. The technology of the food production is still evolving and therefore it is difficult to effectively test the products. The research centers on the European level are well equipped to study the presence of nanomaterials in food. However, it is still not possible to do so on the mass scale.

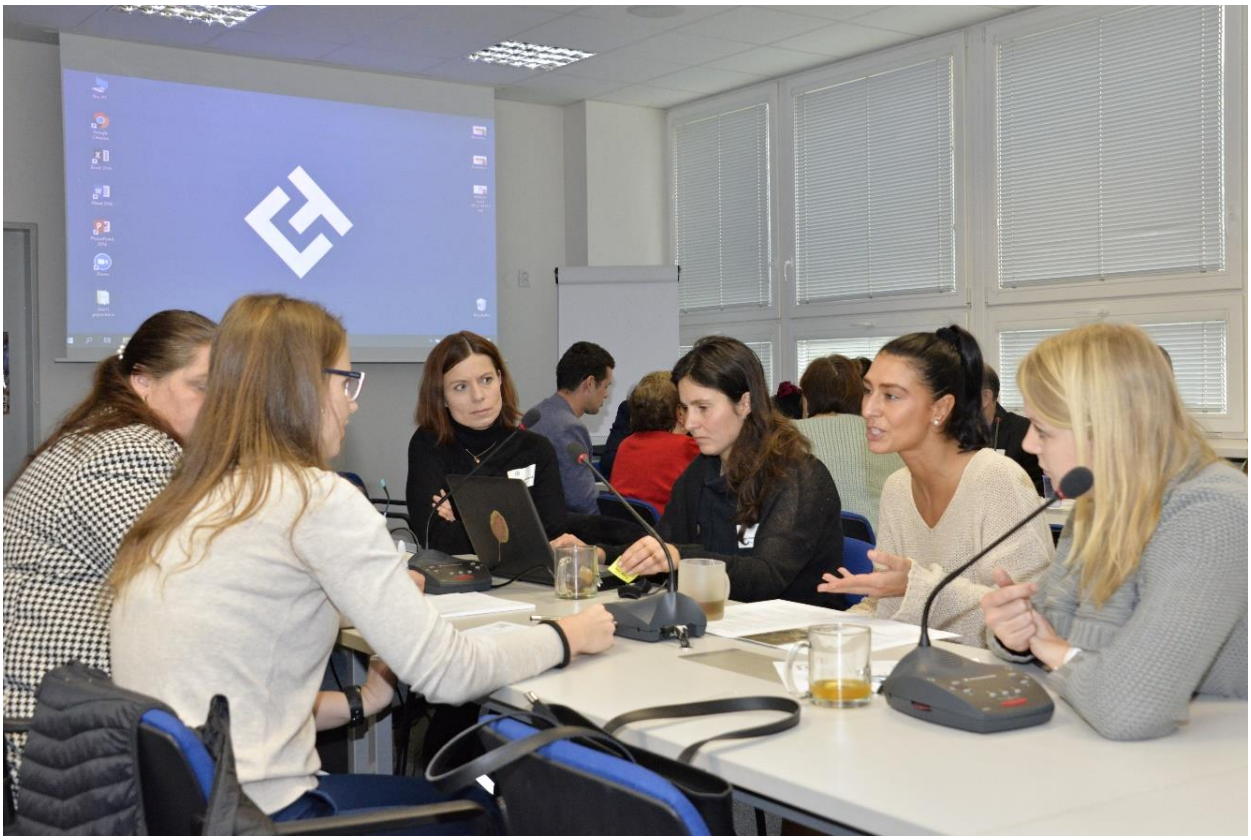

Figure 16 - Novel foods prototyping.

The important recommendation is that the representatives of the companies should cooperate with the state authorities in the phase when they plan to put the products on the market. In such cases, it is possible to decide if a product is safe before it is being produced on the mass scale. This would also give the producer first information on how difficult it will be to approve such product. Safe approaches to apply new technologies however already exist and are e.g. summed in the methodical guide: *Safe-by-Design.*

Participants continued with claims that the current development is not fully under control of the producers as well. E.g. nanoparticles, that can prolong the shelf-life of the food products can under certain conditions evaporate and lose its potentially desired effects. From the regulation point of view, nanoparticles could be by definition *"a helping technological substance"* (e.g. in a form of nano-capsule) and not a food product itself.

If the nanomaterial would only change the taste of the food product, then it would have a different approval process and different legislation frame, then if it has a specific function. Which form? That would also set the legislation frame. In normal circumstances, there is already a European Commission procedure that usually lasts for two years and which is lead by European agency for the safety of food (EFSA). However, it does not work as a control mechanism institute. They approve processes, compare the empirical/scientific evidence and let the other laboratories control the food.

Contrary to Germany or France, in the Czech Republic there is no control institute that would analyze if a product indeed contains nanoforms, if that is labelled as such. Paradoxically, Czech companies could be somewhat disadvantaged compared to companies in the EU, since the customer protection in the Czech Republic is stricter.

3.2.4.2 Nanofilters

In the Nanofilters group, the need to develop filters for cleaning industrial waters was stressed as one of the most important application areas. One of the companies that already produces advanced filtering systems using nanotechnology however claimed that it is still very difficult to come up with filtering systems with such technical parameters and construction characteristics that would be suitable for such high volume and high pressure of water. Later it was once again remarked that water contains many already liquid contaminants that would have to be filtered by other ways including using specific enzymes or the reverse osmosis. In other words – many of the current issues (raised by citizens during the citizen consultation) with cleaning water are not easily solvable through Nanotechnology.

Figure 17 - Nanofilters prototyping.

During the last session participants touched upon the topics of expectations people hold when it comes to Nanotechnology. The public have ideas that for example cleaning of waste water or disposing of the contaminants of medicine or washing powders should all be solved by filtration and through Nanotechnology. However, the representant of the Czech membrane platform claimed that for these problems, nano-filters are not suitable and that one would have to use different methods which are at this point financially demanding and at the same time not so effective.

3.2.4.3 Smart food packages

During the last session, the participants in the Smart food packages group discussed topics such as regulation and certification system. Should there be some authority stepping in to decide on the simplification of the certification systems? For the bioplastics there is not a unified standardization

system, as there are yet many certificates. Currently at the EU level *N1321* is being used. However, it is being often criticized by businesses. The more general reason can be that – according to one of the participants – such regulations are being set for the ideal conditions and not the real-life situations the packaging systems are exposed to.

One of the business representatives described an example of how the regulation and certification works for the company: The certification companies provide the client with a certificate that it is possible to use the given "filter" in food application. This certificate is valid for three years, after the three years, company has to renew the certificate according to the new legislation. Filters have to fulfil criteria that are both connected to the "cleanness" of the substance and at the same time to preserve the taste of it. When it comes to filtration, there is no risk of contamination of the food chain – and that is given by the shape of the "nanoparticles" which are in this case nanofibres.[8] When it comes to nanoparticles themselves, the risks of the contamination indeed exist – at least according to the experts. One of the representatives of the business made a remark that nowadays it is studied how the nanoparticles accumulate in the kidneys and that effective regulation means to standardize all kinds of nanoparticles, and to determine, from what size they can be contained in the food products.

The last point was about communication and possible future cooperation. All of the experts agreed that the public feedback is welcomed and that especially cooperation with researchers and further standardization of the contents that the companies also use would be appreciated.

3.2.5 Session D: Reflection

For the **novel foods** group discussion, it seemed that the crucial points of the discussion concerned the subjectively perceived (un)safety of such products, as was hinted by the results of the online consultation (Pour, Hebáková & Vančurová, 2019). Participants confirmed the utility of the possible use of nano-capsules and some of the additives. On the other hand, they also doubted the real benefits such products would bring: *"Super food products"* already exist and they do not require any nanoparticles or nanotechnology as a method involved. And if they do, some of the participants even claimed that for such purposes, it would be more beneficial to use packaging systems and their modifications rather than modifications of the food products themselves.

The other parts of the discussion were mainly dealing with regulations. This brought a sort of an action plan or a guide for the companies on how to proceed with the authorities when it comes to regulation: companies were encouraged to discuss their ideas in the early phases of their development on the national level, so the authorities would be able to understand the use of nanotechnology in the product and therefore would not have to invest in strong control mechanisms, which are at this point very difficult to put into effect on the whole EU level. The representative of the Ministry of Agriculture also praised the workshop for providing a space

[8] Businesses repeatedly claimed that nanofibers, and especially the ones developed through the specific technology processes often used by Czech companies, lead to less risks of the contamination of both nature and human body than other applications of nanotechnology.

to exchange mutual experience with the companies, as it seemed that it is not very often that authorities and companies would discuss such topic together.

For the **nanofilters** it seemed that the group discussions were the most consensual ones: participants agreed on the utility of the public input and their explicitly expressed need for clean water, air and food. Representatives of the businesses stressed the importance of the distinction between the nanoparticles, nanofibers and other shapes of nanotechnology. These participants claimed that the structures used in the filtering mechanisms usually don't bear any special risks for human health and that especially nanoparticles – not nanofibers – are being perceived quite negatively by the public. This was to a certain extent also supported by the results of the Online consultation. Another important question was the management of the filter waste – participants agreed that the waste should be treated in an accumulated form/size that would enable the waste to be disposed of through conventional ways.

Figure 18 - One of the discussions of the day.

The **smart food packages** group mainly reflected on the popularity of the packaging system product suggestions for (1) fruits and vegetables and the (2) packaging system for meat. Some of the researchers suggested that designing a package should be automatically connected to solutions on how the package will dissolve/will be treated at the end of its life-cycle. It was mainly agreed that smart food packaging system would be useful especially for perishable foods such as meat. Technically it would have to be made through two layers – one inner antimicrobial nano-layer and one outer layer covering the product).

However, such ideas float around for 10 to 20 years and yet further development is still a question. That can be given by the complications with its potential waste: One of the business representatives doubted the possible use of the PLA polymers as a material that would be able to biodegrade and to protect the food products as well. Packaging system would therefore have to be used from different substances - different packaging material.

Biodegradability was further highly problematized. Using degradable plastics would mean to take care about the waste disposal – such materials could not be composted because of the possible proliferation of the nanoparticles into the compost and its further possible contamination. This would lead to newly emerged problems on how to treat such materials.

Quite interestingly, even the representatives of the business in the field concluded that it would be perhaps more useful to take part in activities which are connected to circular economics and prevention of waste – as these solutions seem to be more effective, would cause less new emerging problems and would not cost any additional resources.

3.2.6 Overall assessment of the workshop

When talking about the organization of the workshop, we can conclude that facilitators perceived an improvement especially when it comes to the fulfillment of the expectations of the stakeholders. This can be due to several factors: (1) closer alignment of the participants´ activities with the product suggestions/research of the GoNano project; (2) more tangible results derived from the previous work of citizens and stakeholders during the previous co-creation steps; (3) more easily understandable results of the online consultation with their specific outcomes in form of subjectively perceived (un)safety of product suggestions and their desirability; (4) shortened programme of the day. If we were to reflect on the outcomes of the three application groups separately, it is essential to point out that the groups were composed quite differently:

The **novel foods** group was dominated by the partner from the Ministry of Agriculture – the concentration on the topics of safety and regulation can therefore be given by both (1) the dominating expertise of the key participant, (2) by the results of the online consultation with these products being subjectively perceived as the most (un)safe. However, this can be to a certain extent given by the composition of the group being mostly dominated by female participants, as that could lead to more safety-related discussion overall (Toumey, 2012).

Nanofilters seem to be the application area which is of all the three the one that sparks the least controversies – given by facilitators´ experience, the results of both workshops were again the least specific from all the three application areas. One should consider that (1) the interest in the topic (and the numbers of the stakeholder present) at the place was somewhat lower than in the other two groups despite the involvement of a key stakeholder providing the examples from the food application sphere, (2) also the results of the discussions from the Stakeholder workshop 1 seemed to be rather more nonspecific and connected to many fields and possible applications. That can be simply given by the fact that the nanofilter applications are the ones that are being used and (re)developed for some time already.

The **smart food packages** group was dominated mostly by researchers, and there was a noticeable tension between researchers and business. The overall results however point to the fact that of all the three application areas, the smart food packages area seem to attract many potential ideas, and some of these are possible to develop. However, at the same time it is not clear what would be the true benefits of such solutions given by the current ongoing discussions about the waste and circular economies in the EU countries.

One of the important lessons learned by the facilitators is that – given by the personal experience – it seems that some stakeholders in the field tend to have quite focused perspective, which is sometimes in direct contrast with the expected creativity and the expected results in form of concrete product suggestions. It seems much more understandable – based on a few meetings during a year – to expect a critical elaboration and problematizing of already existing suggestions with no expected problem owning of the issues in *sensu stricto*. Worth considering is the change of approach to a more minimalistic co-creation process involving various stakeholders to already ongoing projects and providing them with the essential citizens´ perspective. Finally, participants – as experts in the nanotechnology field – themselves claimed that proposed nanotechnology solutions should be clearly justified by the potential benefits (and risks) they pose. They claimed that many proposed ideas and products discussed do not essentially need nanotechnology to be produced, and especially pointed out that the product development should stick with the least complicated processes, minding the overall context of a specific product and its application.

To conclude, one of the main benefits of the workshop indeed seemed to be the appreciation of the importance of the multi-stakeholder and citizen perspective. With the substantial results of the online consultation, this was easily done. All in all, the second stakeholder workshop was an event meeting expectation of many of the stakeholders involved, encouraging them to consider more perspectives and to stimulate further cooperation between various actors.

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3.3 Report on the second stakeholder workshop in Barcelona (ES)

3.3.1 The workshop overall

The "*GoNano-Harvestore workshop on autonomous wireless sensor nodes for the future Internet of Things*" took place at the Catalonia Institute for Energy Research, in Barcelona, Spain, on the 30th of October 2019. There were 9 participating stakeholders, including 1 from industry and 8 researchers from universities or research centres, but from different fields.[9] A more diverse group of stakeholders had been targeted and successfully recruited, but stakeholders from other areas (i.e. design, CSO, and local government) cancelled at the last moment, citing other commitments or unforeseen circumstances, or did not show up without further explanation. This was a major disappointment as stakeholder diversity was something that we specifically wanted to improve upon from the first stakeholder workshop, held in March 2019.[10] Of the 9 participants, 2 were postdoctoral researchers, 1 was a doctoral student and the remaining 6 were senior research staff and group leaders. Three of the group had participated in the first stakeholder workshop, which provided continuity of the co-creation process. Another aspect of the group make-up was the balance between researchers directly involved in the Harvestore project[11] – 4 people – and those not involved – 5 people. The group was not so well-balanced with respect to gender, with only 2 females to 7 males; however, no steps were taken in the recruitment process to counter this as the focus was primarily on stakeholder diversity.

The process for recruiting participants for the second stakeholder workshop began with those who participated in the first stakeholder workshop and was then broadened to include other individuals and organisations who had been contacted during the previous phases of the GoNano project. The initial invitation focussed on recruiting stakeholders working within one of the areas of interest produced as an output of the first stakeholder workshop: i) Materials for smart sensors and devices; ii) Piezoelectric (and triboelectric) materials and devices; iii) Educating the public on renewable energy; iv) Public policy and the energy transition. Of the 50+ stakeholders contacted, 17 responded positively, proposing projects in the relevant areas or expressing their desire for further involvement in the co-creative process. Deeper discussions with the respondents identified a principle investigator from a local research centre (IREC)[12] who recognised the potential value that the co-creative process could bring to one of their projects called Harvestore. This project aims to develop materials and devices with applications as wireless sensor nodes (WSN) for the future Internet of Things (IoT), which matched well with two of the outputs previously identified: i) Materials for smart sensors and devices; ii) Piezoelectric (and triboelectric) materials and devices. Recruitment then entered a further iteration, this time centring the workshop proposal on co-creating within the context of the Harvestore project (i.e. new WSNs for IoT). In summary, a diverse group of stakeholders covering research, industry, design, CSO, and local government were

[9] Research fields represented included materials chemistry, materials engineering, physics, microelectronics, materials science, microfabrication, electronic engineering, building engineering, architecture, synthetic chemistry, theoretical and computational nanoscience.

[10] Report from the first stakeholder workshops, D4.2. http://gonano-project.eu/working-paper-on-gonano-stakeholder-workshops-now-online/

[11] http://www.harvestore.eu/

[12] http://www.irec.cat/en/

recruited but unfortunately only those from research and industry participated in the second stakeholder workshop.

On the day of the workshop, the participants were welcomed by the workshop facilitator and the outline and aims of the workshop were explained to them in the introductory presentation. The workshop was organised in four sessions – *Exploration, Ideation, Prototyping,* and *Reflection* – which are described in the following sections of this report.

3.3.2 Session A: Exploration

This first session was dedicated to introducing the two EU projects, GoNano and Harvestore. The presentation of the GoNano project centred around explaining the project, its themes, its objectives, and the outcomes from the previous activities – in particular, the results of the online public consultation.[13] Participants' reactions and responses to the online consultation showed genuine interest in the results shared with them despite not agreeing with all the findings. For example, participants commented on the public's expectations of researchers:

"Some of the outcomes of the consultation demonstrate the need to improve research dissemination, as citizens are expecting from researchers some objectives/roles which are not (mainly) theirs and instead belong to other stakeholders (e.g. policy makers)."

"Citizens seem to put the burden of safety on researchers, but this is something that we don't consider as often."

[participants' comments from post workshop evaluation survey]

Another point the participants picked up on was the clear polarisation of the public's understanding of nanotechnology, where the two largest groups of responses[14] indicated either a very clear understanding of the term or little to no understanding of the term.

The second part of the session focussed on the Harvestore project and bringing up to speed those participants not familiar with the project or the technology it is developing. A principle investigator from the project presented contextual and background information, and offered a vision of what type of device could potentially be realised by the end of the project. They see a gap at the low-power end of the energy network where an autonomous WSN could be deployed, thus reducing the reliance on Li-ion batteries.

The presentations were immediately followed by an open discussion, prompted by two leading questions: *Who do you think benefits from this technology? Who do you think is negatively affected by this technology?*

One participant pointed out that the project is mostly about materials development and not focussed on the overall device manufacturing, so companies in the IoT sector that do manufacture and sell such devices stand to benefit directly, whereas the benefits to the whole of society will be

[13] Results of the online consultation, D3.3. http://gonano-project.eu/results-online-citizen-consultation-d3-3/
[14] Respondents were answering the question from the online questionnaire – *What comes to your mind first when you hear the word "Nanotechnology"?*

less direct. For example, replacing devices reliant on Li-ion batteries with Harvestore devices would be good for the environment as the materials being used (mostly silicon and metal oxides) are more abundant than lithium.

Figure 19 - Image taken during the presentation of the Harvestore project.

A comment was also made about how the project is not creating the demand for new power solutions, but is reacting to it by offering new solutions to an existing societal need: replacing batteries with more environmentally friendly energy harvesting and storage devices to allow sustainable growth of IoT sector. One could also argue about the *need* for IoT devices in society; however, outside of that context, there is still an obvious benefit for adopting more sustainable technologies for the provision and management of energy. There was a realisation in the group that getting society to change behaviour is difficult and that society may need to downgrade its expectations of power demand from devices because of restrictions driven by environmental considerations and not so much by the technical limitations.

"Researchers have a responsibility to adapt to policies and societal and environmental needs. The issue of data ownership will need to be addressed if we want solutions to be accepted and sustainable."

[Workshop participant's comment during *exploration* session]

Another topic raised during the discussion was that of data ownership and data privacy in the area of IoT. One participant asked the somewhat rhetorical question *"Do we even have privacy today? We already lack privacy through prevalence of social media."* An attempt was made to defend this circumstance by pointing out that the decision to relinquish control of our data is a conscious choice we make; however, this was rebutted by the argument that as a technology becomes more embedded in our lives, it becomes harder to reject, and so the freedom to choose is restricted. Another participant also pointed out that personalisation of services with data encryption could be

'safer' than data protection methods in use today. E.g. replacement of passwords with biometrics. Despite one participant pointing out that data privacy may not be such an important issue, as not all applications of WSNs and IoT will be in the public sector but more in the industrial space, the point was made that companies will still want to protect the data being recorded and transmitted in such networks. Questions over the power requirements for data encryption were then raised; for example, are these taken into consideration in Harvestore device designs? Apparently, these needs are being considered and met by the project's approach, as was stated by a member of the Harvestore project.

The discussion on data privacy ended with an anecdote shared by one of the participants about the misuse of data: A company that was selling an electric toothbrush and accompanying mobile application capable of monitoring the length of time users spent brushing their teeth for 'health advice purposes' then sold this information to a peer-to-peer ridesharing company, so they could anticipate when the users were likely to be leaving the house and would be more likely to be looking for transport options. Note that the factual accuracy of this example has not been verified.

The battery research community was considered to be a group that could be negatively affected by the development of the Harvestore technology, as it has the potential to replace battery technology in certain applications. This was initially said in jest, but competition among researchers, technology developers, and producers is a very real concern and one that should be considered during the development of a technology or product; therefore, it is part of the impact. A more diplomatic and possibly realistic vision of this competition between technologies was offered through the suggestion that it is more likely that the Harvestore devices will be used to extend the lifetime of batteries rather than replacing them.

Finally, when considering the inclusivity of the technology being developed within the Harvestore project, there was an admission that it is not wholly inclusive and that its deployment may be restricted to wealthier countries only. However, despite this admission of exclusivity, the group were quite comfortable in accepting this without really criticising it in anyway. This is one area where a broader stakeholder base would almost certainly have affected the discussion.

3.3.3 Session B: Ideation

This session was designed to explore an exercise in ideation that could be useful for both citizen and stakeholder engagement. The participants were first asked to identify (verbally as a group) the key parameters to consider in the design of an ideal WSN. The participants came up with several parameters, e.g.:

Size, cost, device lifetime, storage capacity, safety, material, reliability, range, functionality and capability to interconnect (signal/energy format). An interesting observation here is that a few of these parameters were previously identified during the citizen workshop as important things to consider in the development of products related to nanotechnology in energy, namely, the cost, device lifetime and storage capacity. The group were also asked to identify (by individual brainstorm) a number of things that could be measured or detected. Again, the group came up with several suggestions, e.g.:

- Temperature, location, position, humidity, movement (vibration), height, light, pressure, airflow, noise, acceleration, speed, electromagnetism, shape, texture, mechanical stress,

corrosion, voltage, current, conductivity, environment/ atmosphere (in body, virus, ions, gas).

Finally, the group were asked to suggest how and where WSNs could be applied in a simple network, without considering technical or economic restraints. The ideas offered by the group covered a broad range, with some being relevant/irrelevant or realistic/unrealistic, e.g.:

- Measure happiness; health monitor (tricorder from Star Trek); determine hours of sleep; fatigue sensor; personalised environment sensor; sense empty spaces – how to escape from crowds; traffic monitor; measure corrosion; status of volcanoes; crop control; violence (physical and psychological).

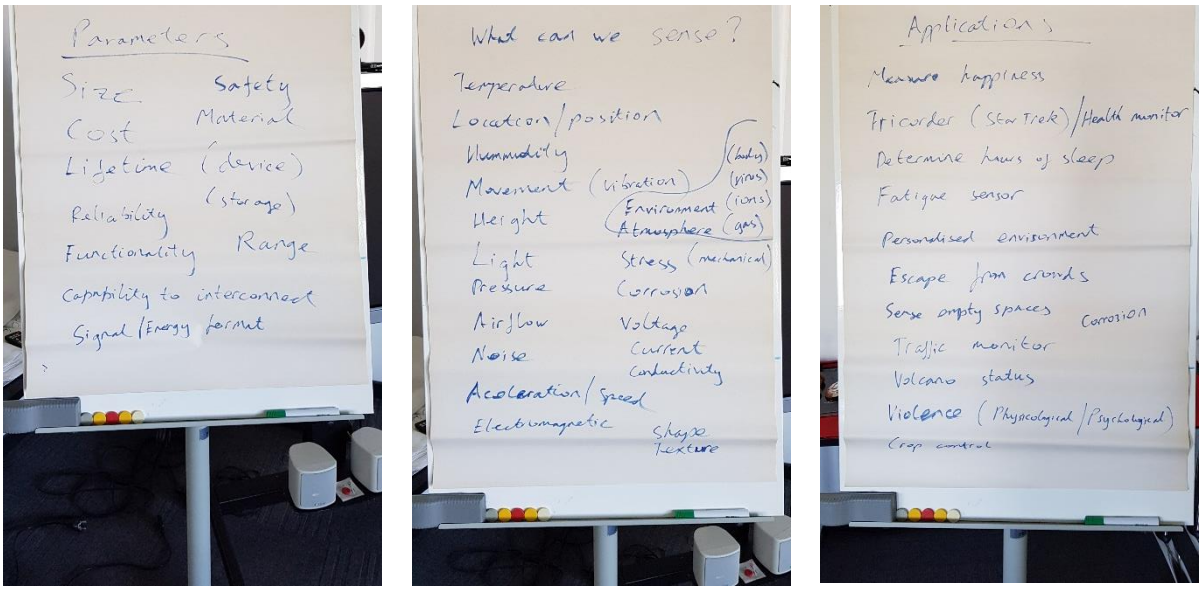

Figure 20 - Images of participants' suggestions from the Ideation session.

The first two exercises worked very well, and the suggestions provided by the group were in line with the facilitator's expectations. Where things deviated from expectations were in the final exercise: Participants were expected to return suggestions more in line with those given in the second exercise, e.g. a temperature sensor for an inaccessible pipeline, or a corrosion sensor for oil rigs, etc. Although some of the suggestions were along these lines, others were more abstract. This was possibly due to the facilitator's instruction to be creative and think freely. While this is not a negative outcome, it was somewhat unexpected given that the group were all researchers, who may be considered to be relatively more conservative than the general public.

"… the public can offer wild ideas that researchers may not, although we got some wild ideas today."

[Workshop participant's comment during *reflection* session]

3.3.4 Session C: Prototyping

The prototyping phase was where the group was asked to elaborate on the suggested applications by associating them to the parameters discussed in the ideation session. The objective was to

demonstrate how relatively high levels of design detail, which is useful for technology developers, could be devised through this group activity. The participants were divided into two smaller groups and asked to choose one of the application areas. The first disappointment arose when both groups chose the same application area; however, to influence their decision would have gone beyond the role of the facilitator. The second disappointment then came in the form of the specific application area chosen, which was one of the least implementable options – the health monitor (i.e. the tricorder from Star Trek). This decision to select a more abstract application made it much harder for the groups to envisage the device and converge on parameter settings. The completed templates from this session are shown in Figures 21 and 22, and are summarised below. The two groups were instructed to set the range for the parameter, although a suggestion was already included in the template, and then to individually indicate their opinion of the optimum parameter setting for a WSN device in the selected application area (in this instance, the health monitor).

Group 1 Summary. Health Monitor.

Material: biocompatible (silicon, zirconia, …), light, flexible, cheap, abundant, environmentally friendly.

Cost per unit: under 100€

Device lifetime: more than 10 years

Size: less than 1 cm

Colour: customisable or not important

Wireless range: greater than 1 m

Charge duration: greater than 1 day

Q. Who would benefit from this (directly/indirectly)? A. Everyone from developed countries.

Q. Who would be negatively affected (directly/indirectly) by this? A. Everyone from developed countries (but for different reasons).

Q. Are there any societal or environmental barriers that would limit the use of this technology for this purpose? A. Privacy barrier.

A positive point to note is that both groups managed to complete the activity, just not to the full effect that was expected. It was hoped that the groups would have had enough time to complete the activity for at least two application areas. However, this was not achieved, in part due to overrunning in previous sessions and in part due to the participants taking longer than expected to understand and complete the exercise. It is our feeling that with enough time to repeat this exercise, and with a wider variety of stakeholders, valuable insights could be gathered and really influence the decisions being made in the Harvestore project. Those workshop participants involved in Harvestore agreed with this conclusion and are considering how this may be implemented in the following phases of the project, as evidenced by the discussions in the Reflection session.

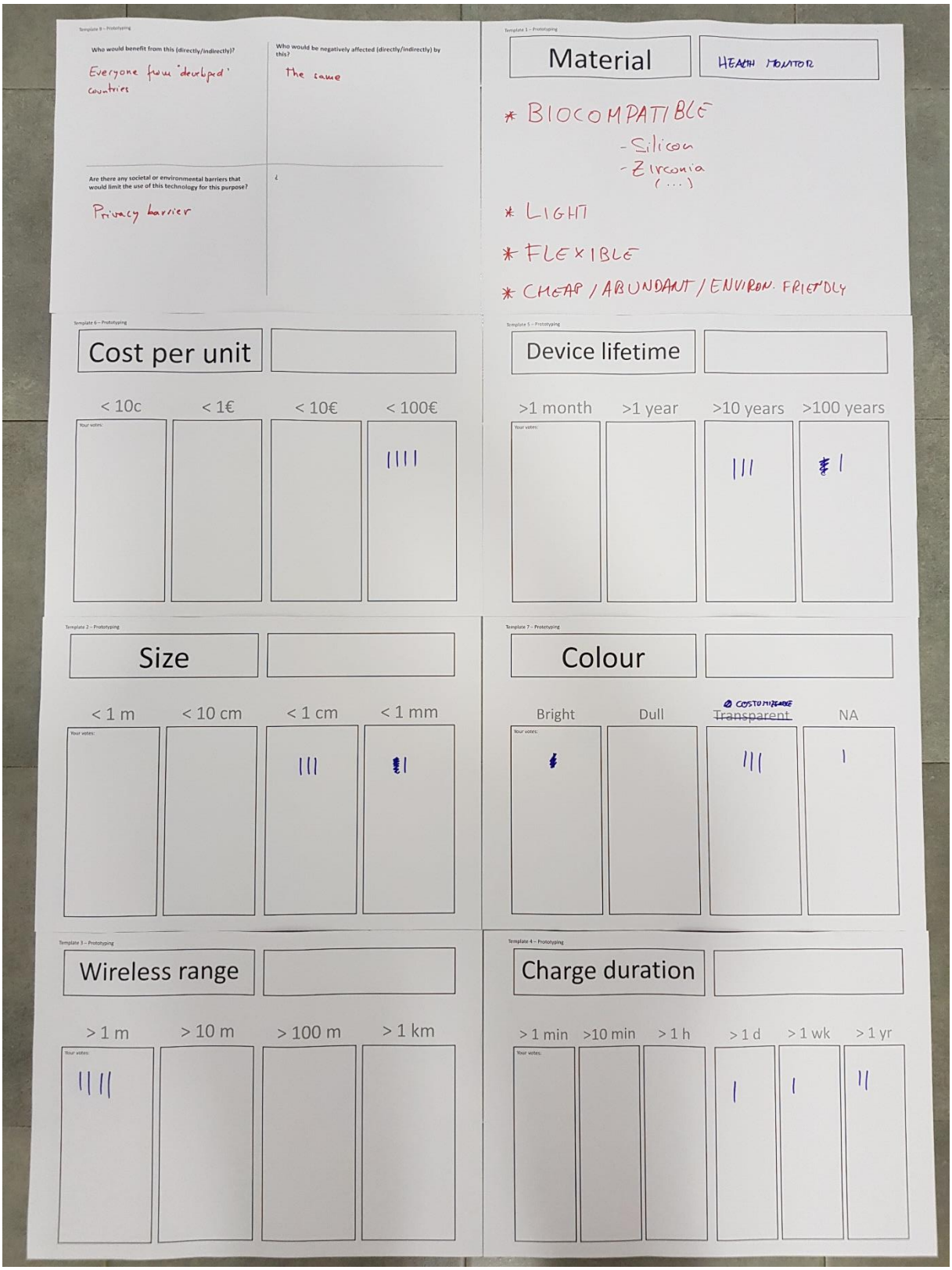

Figure 21 - Completed template from Group 1 for the discussion and selection of device parameters during the Prototyping session.

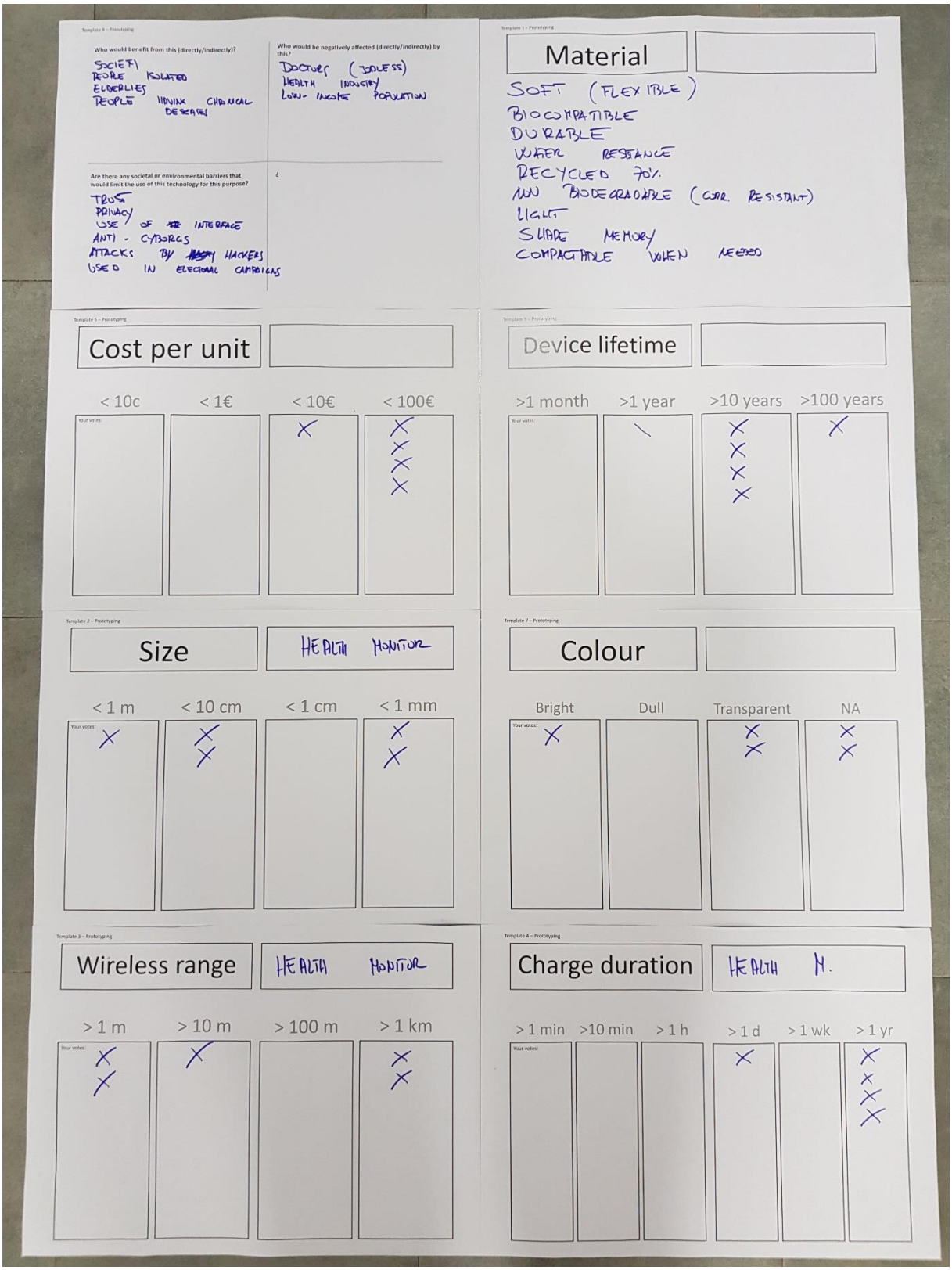

Figure 22 - Completed template from Group 2 for the discussion and selection of device parameters during the Prototyping session.

Group 2 Summary. Health Monitor.

Material: biocompatible, soft, flexible, water-resistant, 70% recycled, light, non-biodegradable (corrosion resistant), shape memory, compactable when needed.

Cost per unit: under 100€

Device lifetime: more than 10 years

Size: no consensus

Colour: bright, transparent or not important

Wireless range: no consensus

Charge duration: greater than 1 year

Q. Who would benefit from this (directly/indirectly)? A. Society, people who are isolated, elderly people, people with chronic diseases.

Q. Who would be negatively affected (directly/indirectly) by this? A. Doctors (lose jobs), health industry, low-income populations.

Q. Are there any societal or environmental barriers that would limit the use of this technology for this purpose? A. Trust. Privacy. Use of interface. Anti-cyborgs. Attacks by hackers. Use in electoral campaigns.

3.3.5 Session D: Reflection

The final session of the day was an opportunity for the group to reflect on the morning's activities through a structured discussion. The participants' answers to the questions they were asked are summarised below.

Has thinking about this technology in this way added value to the Harvestore project? If so, how?

"Yes, we have increased the scope for potential device applications through the discussions. It offers a possible method to seek and receive feedback from society so that the technology outputs are more appealing."

"Data privacy issues are an area not previously considered in the scope of the project but perhaps should be."

Would it be worthwhile to do these ideation and prototyping activities with the general public? Why?

"Yes, the public can offer wild ideas that researchers may not, although we got some wild ideas today."

"Yes, it would be a good way to find out what their concerns were about the technology."

"It could help the public understand how research is being done and what steps are being taken to resolve certain problems."

"These exercises would be useful, especially if combined with opportunities to be involved in later stages of development like prototyping and testing."

Would it be worthwhile to do these ideation and prototyping activities with other stakeholder groups? If so, which ones and why?

"Yes, it would be good to interact with engineers, IT security experts, companies, etc."

"Yes, it would be good to involve policy makers in these early stages of R&I as it is pre-emptive, allowing decisions to be taken and legislation developed before the technology is out there."

"Policy makers should perhaps not be so much involved in the co-creation process but at least be aware of it, i.e. publics and stakeholders define needs and policy makers react to them via legislation."

"Companies, but would need more focus on technical aspects."

"Co-creation works better if all types of stakeholders are involved."

This session also included an evaluation questionnaire, which all participants completed. The results of this are covered in Annex 1 of this report.

3.3.6 Overall assessment of the workshop

We feel the workshop was successful in achieving its specific aim, which was *to elucidate the preconditions for co-creation, building on the insights gained in the first round of workshops*. A much-changed approach was taken in both the planning and implementation of the second workshop in comparison to the first. This changed approach was motivated through a desire to avoid the problems identified in the first round of workshops and apply these learnings to achieve the overall

aim of the workshops, which was *to test the hypothesis that the productive integration of societal considerations can add value to research and innovation decisions*.

The first workshop engaged a group of stakeholders on the theme of nanotechnology in energy applications and tried to ideate new research lines stemming from societal needs and values previously identified from the citizen workshop.[15] Those discussions and ideas were found to be quite speculative and generic, and whilst there was genuine interest and enthusiasm, the broader topics and the lack of problem owners reduced the utility of the feedback for the participants' own research. Identifying the problem owner (on this occasion, the Harvestore project researchers) before this workshop provided a platform around which to build a focussed discussion, whereby the comments of the participants were of direct relevance to the project and the ongoing and envisaged research within it. This resulted in feedback that was of greater value to those most capable of incorporating it in future research and innovation actions within the field.

"[I can use the suggestions of today's workshop to] expand the range of potential sensing applications for my research."

[participant's comment from post workshop evaluation survey]

There were clear aspirations to engage more with all types of stakeholders and to consider broader societal issues related to WSNs and IoT (see section 5). However, the full impact of this workshop and the GoNano co-creation process will be determined by the decisions made in the Harvestore project from this point forward. For example, the researchers may: debate the issue of data management and data privacy in the context of the project at future project meetings; decide to avoid using certain materials in their prototypes due to the implications that their toxicity, natural abundance, cost, etc. may have at larger scales; incorporate the workshop methodology in future stakeholder engagement activities. While there is little evidence as yet to support a tangible impact on, or added value to, the Harvestore project, there are encouraging signs that such results are within reach and could still be obtained in the final phase of the GoNano project.

[15] Report from the citizen workshop, D3.2. http://gonano-project.eu/citizen-needs-and-values-in-relation-to-nanotechnology-in-food-energy-and-health/

4. Reflection on the workshop findings

The national reports complement the findings from the earlier stages of the GoNano co-creation process. They point to new opportunities for enabling co-creation between different stakeholders, but also suggest new barriers.

The results from the evaluation questionnaire indicate that participants highly appreciated the events in all three pilot countries. They were even more positive about the quality of the second round of workshops compared to the first: on average, they scored the quality of the group discussion 4.8 on a 5-point scale (for further information, please see the evaluation results in Annex 1). Participants were positive about acquiring new information, fresh ideas and new perspectives on research and innovation. Many agreed that the early consideration of societal needs and values can add value to innovation in nanotechnologies.

That said, participants also expressed some doubt about the future impact of the workshops. It points to a difficulty experienced throughout the co-creation process: the difficulty of translating general insights on the relevance of societal considerations into concrete actions.

The workshops show how bringing stakeholders with different backgrounds together leads to relevant discussions and insights for product development and research projects. The relevance of this finding should not be underestimated. The productive integration of societal considerations in research and innovation will depend on mutual learning between stakeholders, on the shared realisation that broader societal perspectives *matter*. So the workshops succeeded in realising this important objective.

However, the GoNano project also aimed to take these insights one step further: to derive concrete product suggestions from the interactions. This proved to be quite a challenge. The second round of workshops already succeeded better in raising the interests of the participants than the first round, by focusing on concrete solutions to actual problems. But even here, the translation from an interesting discussion to concrete actions proved difficult.

One important finding is that it is simply very hard to identify the concrete interests of all participants in a co-creation event, let alone drilling down to the point where the participants can meaningfully exchange possible contributions towards addressing those particular interests in a way that leads to concrete follow-up. The pilot partners have spent considerable efforts in the preparation of the national workshops, and while they even successfully identified the interests of participants, the translation of those findings in activities proved one step too far in this setting. In retrospect, the bar that the consortium set itself in the Description of Action (DoA) – not only to elucidate the societal values that different stakeholders bring to bear on nanotechnology research and innovation, but also to translate these into concrete product suggestions – may have been too high.

First of all, the pilot partners were 'outsiders' to the research projects at hand: they had to identify relevant contacts who were willing to voluntarily commit to the process (contacts which also had to tick all predefined boxes of the DoA: focused on the right topic area, being at the right stage of innovation (concrete enough to be discussed, but malleable enough to be redesigned), in the right country, and representing a balanced mix of stakeholders with the right distribution in terms of gender, education levels and backgrounds). Subsequently, they had to determine relevant inroads

for societal considerations based on discussions with these contacts. Then, they had to identify the 'right' societal stakeholders, again ticking the right boxes – and all on a voluntary basis. And then they had to determine which sorts of conversations would lead the stakeholders to discuss relevant societal considerations, while a the same time integrating the perspectives of citizens expressed in earlier stages of the project. And finally, these discussion not only had to lead to enhanced mutual understanding, but also generate concrete product suggestions that somehow addressed the needs and values of citizens. None of this is self-evident. Given all these boundary requirements, the mere fact that all participants have rated the workshops so positively should be considered a major achievement.

Looking back on the overall project design, it seems that the sheer number of conditions, expectations and boundary requirements made it difficult to achieve all objectives. Co-creation clearly can address multiple objectives: it can be used as a tool to 'open up' research trajectories, inviting multiple stakeholders who would normally not be included in research decision making, and exploring how their views might be more productively integrated in research and innovation trajectories. Another possible aim of co-creation is to 'add value' to ongoing research trajectories, by inviting feedback from specific stakeholders (prospective users for example) on particular research decisions, and seeing how this feedback might improve the research outcome (by making it more efficient, cheaper, or more acceptable, for instance). Both approaches are valid and promising. However, the GoNano experience suggests that perhaps it is too much to expect both objectives to be addressed *simultaneously.* As D4.2 also noted, the desire to 'add value' to concrete research lines may come at the cost of 'opening up' research and innovation: it requires specific stakeholders, with a *stake* in the developments (as opposed to stakeholders who are more broadly representative of the variety of views and opinions). Also, it requires a focus on one specific application, and a dedicated 'problem owner' (rather than general discussion about a technological field). As such, it maintains power asymmetries between the enactor (the researcher or engineer as the 'primary' actor) and broader stakeholders (as 'passive contributors').

Clearly, these requirements are at odds with the 'democratisation' of research and innovation, which seeks to address existing power asymmetries, shifting the prerogative away from the primary actors towards a more balanced decision-making structure. However, the GoNano workshops point out that it is excessively difficult to realise these objectives *and* drill down to the level of concrete product suggestions at the same time.

To be sure, there may be instances of win-win situations: the Harvestore-example from the workshops in Spain is a case in point. If the interactions between the Harvestore research consortium and external stakeholders at the second round of workshops lead to changes in the design of the final product, that is a case where these focussed discussions have added value for the research consortium (as it improves the research design), and where the design becomes more responsive to societal inputs identified through the more generic discussions of the previous steps in the co-creation process. But to get to that point, an executive decision had to be made by the pilot partner, that this is the relevant project around which to engage, and these are the design considerations that are up for discussion.

The specific nature of the intervention plays a role here: as a European project, the GoNano project necessarily has its own dynamics. Important parameters are already fixed in the Description of Action: one needs to stick to the objectives, procedures and timelines laid out beforehand. As a result, the process can be geared towards the specific interests of the participants only up to a

point. In the case of the artificial pancreas for example, the topic of data management was considered highly relevant by the entrepreneurs, but given that the business had other urgent priorities, it was difficult for them. If the opportunity to organise a session on this topic would have arrived a year later, it might have been much easier for the entrepreneurs to commit to the event and organise concrete follow-up. But that is not always a viable option in the context of a European project.

Similarly, for the collaboration with the Harvestore project in the Spanish workshop, which showed great potential to relate the considerations from societal stakeholders directly to the ongoing research decisions being made in the research. But given that several key participants cancelled at the final moment, it did not realise this potential at the actual event.

To conclude, the workshops did provide important insights into the requirements for co-creation in nanotechnologies, highlighting both opportunities and constraints for co-creation.

ANNEX 1 – RESULTS OF THE EVALUATION QUESTIONNAIRE OF THE SECOND STAKEHOLDER WORKSHOPS

At the end of the second round of stakeholder workshops, a questionnaire was handed out to every participant. This questionnaire is part of a larger evaluation measurement, aiming to evaluate the whole co-creation methodology of GoNano, by measuring two key performance indicators:

1. Co-creation process: respondents' attitudes towards the workshop and the co-creation process in general;
2. Outcomes of the co-creation process: respondents' perceptions of the outcomes of the co-creation process in general, and the product suggestions in particular.

In total, 28 stakeholders completed the questionnaire: eleven participants (69% of the stakeholders who participated) from the Netherlands, nine (100% of the stakeholders who participated) from Spain, and eight (53% of the stakeholders who participated) from the Czech Republic. The constructs that were used in this questionnaire were similar to those used in the questionnaire after the first workshops:

Key performance indicators	**Construct**	**Questions that were asked in the questionnaire**
Co-creation process	Quality of group discussion	I felt comfortable and at ease to voice my opinions during the process.
		All participants were respectful to one another.
		The moderators did a good job in ensuring a constructive and fair process during the discussions.
	Relevance of outcomes online consultation	The outcomes of the online consultation make sense to me
		I can relate these outcomes to my own work
		Today's discussions will help me to consider these outcomes in the future
	Early consideration of social needs and values	It makes sense to consider values and concerns of other stakeholders, such as citizens, at early stages of nanotechnology research
		It could inspire new or unexpected developments
		It is an informative exercise, but with little impact on the products that will reach the market
Outcomes co-creation	Quality of overall output	I am satisfied with the overall quality of the output of the workshop
		Despite different opinions we were able to reach to consensus

	Total	The Netherlands	Czech Republic	Spain
	N = 28	N = 11	N = 8	N = 9
*Co-creation process**				
Quality of group discussion	4.82 (0.32)	4.76 (0.37)	4.79 (0.22)	4.93 (0.22)
Relevance of citizens' messages	3.83 (0.57)	3.78 (0.34)	3.95 (0.41)	3.91 (0.41)
Early consideration of societal needs and values	3.77 (0.55)	4.33 (0.50)	3.48 (0.54)	4.00 (0.54)
*Outcomes co-creation**				
Quality overall output	4.27 (0.59)	4.27 (0.55)	3.95 (0.45)	4.52 (0.41)
Outcomes product suggestions				
Relevance		3.80 (0.63)	4.38 (0.74)	4.29 (0.76)
Novelty		3.00 (0.67)	3.86 (0.69)	4.14 (0.69)
Feasibility		3.90 (0.74)	3.71 (0.76)	3.57 (1.13)

		I am convinced that the suggestions formulated today will serve as relevant input for the upcoming workshops
	Outcomes product suggestions (question level)	Relevant
		Novel
		Feasible

Table 1 – Mean scores and standard deviations on constructs

*Scores are on a five-point Likert-scale

1.1 Co-creation process

To measure the stakeholders' perspectives on the co-creation process, participants were asked to provide their views on the quality of discussions during the stakeholder workshop and the quality of the overall output of the workshop.

Participants were very positive about the quality of the group discussion, as this was scored on average with a 4.82 (SD = 0.32) on a 5-point Likert-scale. All of them (100%) agreed or strongly agreed that the group discussions were of good quality. Participants also regarded on average the relevance of the outcomes of the online consultation as positive (M=3.83, SD 0.57) with 40% of the participants who agreed or strongly agreed with the relevance of the online consultation. A similar pattern was shown for participants views that early consideration of societal needs and values can add value to innovation in nanotechnologies (M = 3.77; SD = 0.55).

Due to the small sample size no statistical comparisons between the countries are possible. However, comparing average scores, no large differences between the participants from the three countries were found. In the open question about the added value of considering needs and values

of stakeholders and citizens in the development of nanotechnologies, comparable views between the participants in the three countries were found. In all three countries, positive remarks were made about the new dimension and new information that had been included to research and innovation, but also less positive remarks were given regarding the limited impact of the workshop and doubts about the role of industry. With regard to the comments on the outcomes of the online consultation, several Dutch and Spanish participants indicated that it gave interesting insights in societal values. Czech participants were more reluctant regarding the added societal value.

1.2 Outcomes product suggestions

More than 70% of the participants were positive about the quality of the output of the workshops (M = 4.27; SD = 0.59).

In the three countries, a large number of stakeholders answered the open question how they could use the output of the workshop in their own area of expertise. Stakeholders in the Netherlands thought the workshop added value, because it generated new ideas, it gave more insights in challenges of researchers and their mind set, it gave insights in the patient's perspective in the development of medical technologies, and it helped developing smart interventions to stimulate the development of the artificial pancreas. In the Czech Republic, stakeholders thought that the workshop led to ideas for further research progress, that it enriched traditional perspectives with new knowledge and information, and that it stimulated valuable debates with other stakeholders. In the Spain, participants thought the workshop helped tuning the messages of dissemination, and increased understanding of how early engagement could help with the development of technologies, the workshop also gave them a practical idea of how specific types of research and product development have an impact on society.

Regarding the action plans (product suggestions) that were formulated as outcome of the workshops, the participants in the Netherlands were positive about the feasibility and relevance of the action plans, but were less convinced of their novelty (see Table 1). In their explanation of the scores of the product suggestions, participants thought the topics discussed were relevant, the action plan focused on societal needs, and provided practical guidelines. However, some participants also mentioned that the content in the action plan was not really new to them.

In the Czech Republic, participants were most positive about the relevance, novelty, and feasibility of the workshop. Two participants commented to the evaluation of the product suggestions. One thought that outcomes were not very useful as nanotechnology is only applicable in the far future. Another thought that the outcomes are certainly relevant when it comes to the improvement of the environment.

In Spain participants seemed to be especially positive about the relevance and novelty of the outcomes of the workshop, and to a lesser extent, but also positive about the feasibility. However, only two participants provided comments in open question regarding the evaluation of the product suggestions. One participant thought that the ideas were important, but not feasible in the near future. Another participant thought that the workshop helped to further develop the design and idea of a product based on societal needs.

1.3 Conclusion

Overall, a majority of the participants in all three pilot countries who filled in the questionnaire were positive about the workshop, the co-creation process and the outcomes of the product suggestions. Due to the small sample size, comparisons between the evaluation of the participants in the Netherlands, the Czech Republic and Spain were made based on the average numbers and no statistical comparison was applied. In all, the participants views' from the three countries aligned mostly with each other. Interestingly, participants were on average even more positive about the quality of the workshop and the quality of the output of this workshop than the first workshop. Also, relatively more participants gave an answer to the open questions in this evaluation than in the evaluation of the first workshop, and these comments gave more insights in the respondents' perceptions. However, the sample size was much larger in the first workshop (N = 63) than in this workshop (N = 28).

ANNEX 2 – PROPOSED STRUCTURE FOR THE SECOND ROUND OF GONANO STAKEHOLDER WORKSHOPS

This document suggests a common structure for the second round of GoNano stakeholder workshops, to be organised in October/November 2019 by pilot partners UT, TC CAS and RMIT as part of Task 4.2. This proposed structure is based on the suggested programmes from pilot partners, the assessment of the first stakeholder workshops (see deliverable D4.2) and recent online exchanges between partners in WP4. It aims to bring together common programme features proposed by partners and successful elements from the previous round of stakeholder workshops (while allowing pilot partners to tweak their programs according to their national and thematic needs and interests). This common structure is meant to facilitate assessment of the workshop outcomes in Task 4.3 and 4.4 and possibly allow for cross-country comparisons.

Objectives

The overall aim of the stakeholder workshops is to test the hypothesis that the productive integration of societal considerations can add value to research and innovation decisions. The specific aim of the second round of workshops is to elucidate the preconditions for co-creation, building on the insights gained in the first round of workshops.

The results of the first round of stakeholder workshops suggest that – at least in some cases – the workshops succeeded in raising awareness with stakeholders that the early consideration of the needs and values of citizens and societal stakeholders can add value to research and innovation in nanotechnologies. But the workshop findings also suggested barriers for co-creation:

1. It proved difficult to connect the input from the citizens to the research agendas and concerns of the professional stakeholders;
2. There is a trade-off between inclusiveness and specificity: the decision to treat all stakeholder perspectives on an equal footing for reasons of inclusiveness sometimes came at the cost of a clear action perspective (see D4.2)

The upcoming stakeholder workshops will seek to address these challenges by considering in further detail how input from citizens can be productively engaged in concrete research and innovation decisions. It will do so by taking product suggestions derived from the first workshops as a starting point, and exploring how the main actors identified in the product suggestions (as 'problem owners') could mobilise the considerations of citizens and other stakeholders to co-create more 'socially robust' research and/or product designs.

Expected outcomes

The co-creation process steps in these workshops should ideally lead to:

1. The outline of an 'action plan' that sets out how societal input will be organised in the further development of the product suggestions;

2. The formation of a 'community of a practice', consisting of the problem owners, relevant societal stakeholders and facilitating researchers who will support the 'translation' and integration of societal feedback into the product suggestions.

D4.2 suggests that the definition of concrete product suggestions in a half-day workshop proved to be too optimistic. This is why the second round of workshops focuses on more realistic, focused outputs and looks towards continued interactions after the workshop.

Participants

The workshop objectives and expected outcomes imply that the workshops bring together participants that can advance the ideas for the product suggestions. Ideally, the group should be composed of a mix of key partners from the first workshops, including the 'problem owners' (to ensure that the original idea is clearly represented) and newcomers (additional partners that are needed to realise the product suggestions).

Programme

Like the first workshops, the programme will be structured around the four main pillars of co-creation: exploration, ideation, prototyping and reflection.

General introduction

(plenary session, 30 min or so)

Before moving to the co-creation process, there should be a general introduction that:

- Sets out the overall aims of the GoNano project and the specific objectives of this workshop;
- Brings any newcomers up to speed on the results of the co-creation process so far;
- Provides an explanation of the workshop structure based on the objectives and lessons learned, and indicates the expected outcomes:
    - An 'action plan' for integrating societal perspectives in the product suggestions (that should ideally express a win-win situation that simultaneously addresses a specific problem of the problem owner and integrates the considerations of societal stakeholders);
    - The establishment of a 'community of practice' that continues to work on the action pan after the workshop;
    - Insights into the 'business case' for co-creation: the added value of societal considerations for research and innovation
    - Preconditions / opportunities and barriers for addressing societal considerations in research and innovation more generally.

Session A: Exploration

(plenary session, 45 min or so)

The exploration session will first present the overall co-creation process in further detail, including the findings of the first stakeholder workshop. Subsequently, it will introduce concrete product suggestions derived from the first stakeholder workshop and subsequent input from the citizen consultation (*depending on the level of concreteness achieved in the first workshop, this can be the literal product suggestions from the workshop, or new suggestions derived from those discussions*).

It will give brief presentations of these suggestions (in the shape of a video, prototype or elevator pitch) to ensure continuity between the discussions of the first workshop, the citizen consultation process and the second stakeholder workshop.

This session should also discuss the results from the citizen consultations [addressing 'the diversity of citizen perspectives']. These results need to be 'translated' and presented in a way that participants can both understand and address them at the micro-level of research and innovation decisions *(they could be presented as statements to be discussed in the World Cafe discussions, see below)*. The considerations of citizens should function as boundary conditions for the further development of the product suggestions. They should remain visible throughout the session, for instance as posters on the wall, and play an explicit role in the discussions.

> *The first workshops were too optimistic in assuming that participants would be able to understand and appreciate the values and challenges of citizens based on very short summaries. In fact, participants had difficulty to relate the design suggestions to the wishes and concerns expressed in the citizen workshop. It was also not self-evident how these prescriptions apply to the micro-level of research and innovation decisions. A more focused approach is needed to integrate the wishes and concerns of citizens into the discussion.*

Session B: Ideation

(World Cafe, 60 min or so)

Participants join subgroups where each of the product suggestions is presented in further detail. The subgroups discussions are moderated by a table facilitator, who presents statements for discussion. The statements are directed at encouraging an action-oriented perspective, so participants get prepared for the subsequent prototyping session. After 15 minutes, participants are invited to move to another table (but the 'problem owner' stays at the same table). At the end of the hour, they have discussed all product suggestions, and are invited to join the product suggestions of their interest for the next session (prototyping).

Participants can thus choose their group, but there have to procedural selection criteria to ensure multidisciplinarity (e.g.: "there can be only one researcher in each group...").

[The ideation and prototyping session could make use of a dialogue platform to facilitate the co-creation process. Nicklas (DBT) will prepare an overview of how different platforms, including EngageSuite, could be used to address different co-creation needs, such as enabling the discussion

between stakeholders in the workshops, facilitating the emergence of a community of practice, and monitoring the dialogue between participants during and after the workshops.]

Session C: Prototyping

(subgroup work, 90 min or so)

In this session, participants will define a specific action plan in subgroups. The action plan should describe specific steps to integrate societal considerations in the further development of the product suggestions.

(For instance:

- Defining a plan on how to gather specific insights from users that help a product developer to include user considerations: what would you like to know from users? How will it affect your design? How could this be researched? Who needs to do what?
- Writing a proposal for funding of a co-creation community of practice: Who should be part of such a community of practice? What should be its remit? How will it facilitate co-reation?)

In the first workshops, the action plans did not always make clear who/which stakeholder should undertake action and what steps should be taken. The action plans for the second stakeholder workshops should clearly identify actions for the participants involved.

Session D: Reflection

(plenary session, 60 min or so)

This closing session should enable reflection on different levels:

1. What did we learn from the co-creation session?
    a. What do you think about the action plan that was created in your session? Which elements are feasible / realistic / credible, and which aren't?
    b. What will be the next steps based on this plan? Who will take action, when and how?
    c. How were considerations from the citizens consultation and the previous workshops integrated in the action plan?
2. What did we learn with respect to the overall GoNano objectives?
    a. Do you think the co-creation process has added value? If so, what is it? If not, why not?
    b. Under what circumstances would you actively involve citizens and/or stakeholders in your own work?
    c. With whom would you seek collaboration, and how would you involve them?

ANNEX 3 – TEMPLATE FOR NATIONAL REPORTS ON THE SECOND STAKEHOLDER WORKSHOPS

The national reports from UT, RMIT and TC CAS on the second stakeholder workshops will provide input to D4.4, which aims to integrate all insights and lessons learned from WP1-4. To provide answers to the main evaluative questions outlined in the current draft of D4.4, the national reports should provide rich descriptions of the events themselves, the characteristics of the participants, the plenary and subgroup discussions, (implicit) group dynamics and tangible outputs (notably the initial responses from stakeholders to the messages from citizens and the storyboards) as well as reflections on the workshop objectives (testing the main hypothesis) and on the question of inclusivity. The questions below may offer a 'template' to help the pilot partners to collect and report on these outputs (please answer all questions below in as much detail as possible).

Table facilitators and rapporteurs should be informed about these expected outcomes in advance, so they know what to look for and what to document during the meeting – if the 'raw data' required below isn't captured during the meeting, it will be lost forever!

1) The workshop overall

When and where was the workshop held?

…

Who attended? Composition of the group: background, expertise, etc. Did everyone come, or did people cancel?

…

Do you think group composition (gender, but also age, socio-economic background, etc.) has influenced the discussion? In what ways?

…

2) Session A: Exploration

How did you think this session went, overall?

…

How did participants respond to the proposed product suggestions? If possible, please include photos or PowerPoint-slides of the suggestions.

…

How did the participants integrate the results from the citizens consultations?

Please use quotes, pictures of post-its as supporting evidence.

…

3) Session B: Ideation

How did you think this session went, overall?

…

Which subgroups were formed? How did the subgroup discussions go? What responses were received to the statements? How did the 'problem owner' respond?

Please add pictures of the subgroups, of drawings, telling quotes you overheard.

…

4) Session C: Prototyping

How do you think this session went, overall?

…

What action plans did the groups create? How did the discussions go? Was there a discussion/disagreement about the final output ideas within the group members?

Please include pictures of the group discussions (noting relevant quotes if possible) and the resulting action plan.

…

How did the different participants respond to the assignment? Was there enthusiasm, engagement, detachment, disappointment? Did a 'community of practice' emerge?

…

5) Session D: Reflection

How did participants respond to the action plans? Please include supporting evidence of the discussion: pictures from presentations, quotes, a description of the atmosphere, etc.

…

Did you detect a sense of 'ownership' during the presentations? In other words, were they proud of what they came up with and do you think participants are keen to follow up on the action plans? Do they think their action plan is achievable?

…

How did participants reflect on the overall hypothesis? Did they think it makes sense to include the considerations of citizens' in their work, and in research and innovation generally? Is it possible to do this in their daily practices? Did they think they *succeeded* in creating responsive design suggestions?

Do you think participants were generally receptive to the general idea of responsiveness/'opening up' research decision making?

…

6) Overall assessment of the workshop

How do you assess the workshop, overall? Are you happy with the way things went? Are you happy with the outcomes? Were there unsatisfied expectations from the participants and/or organization?

…

Judging by the explicit (and implicit) reactions during the day, do you think stakeholders see the relevance of considering citizen perspectives and multi-stakeholder engagement? Do you think there were differences in attitude before and after the workshop? (in other words, did the workshop make the participants more or less 'responsive' to citizens' perspectives?) Do you think the participants would participate again in such a workshop?

…

What did you do different from the first stakeholder workshop and (how) did that change the outcome/overall workshop process? If you could do the workshop all over again, what would you do differently? What would you keep the same? (think of group composition, overall approach, duration, location, specific work forms, outputs, etc.)

…