INSPIRE

Business Model Innovation Workshop

Summary report

Brussels, 23 November 2017

TNO innovation for life

ZLC MIT GLOBAL SCALE NETWORK
TALENT HUB FOR SUPPLY CHAIN

PNO

1. Introduction

This document presents a summary of the activities and insights obtained during a workshop within the framework of the INSPIRE project held in Brussels on November 23th, 2017. The objective of the workshop was to bring together people from the industry, research and academia within the SPIRE network, in order to carry out a business model innovation exercise around four existing business models further introduced in Section 3. The workshop was divided in two parts. First, after a brief introduction of the INSPIRE project itself, participants engaged in a survey focused on the offshoring/ backshoring decisions of firms in process industry. Second, the business modelling exercise was performed in four parallel sessions for four different business model archetypes. The business modelling exercise was designed for allowing the participants redesign of the value chain and discussing the required technologies and related flexibilities to those business models. Our goal with this report is to share our findings with a group of members of the SPIRE community in order to receive further feedback to be taken into account in the design of novel business models for flexible and sustainable manufacturing in process industry.

2. Survey results

This section presents the results of the survey carried out during the first part of the INSPIRE business model innovation workshop. The participants were asked several multiple choice questions and the responses were immediately projected on screens using the tool "TurningPoint" from TNO. The objective was to learn more about the offshoring/ backshoring decisions based on the feedback from participants within the SPIRE network, and make sure that the novel business models to be developed later in the INSPIRE project are calibrated to reduce offshoring and encourage backshoring decisions. The survey was structured around ten questions and was introduced to the participants by Cagri Gurbuz from ZLC. Figures below (1 to 10) show the results obtained. Questions are based on the research performed in Kinkel and Maloca (2009), ERM (2016) and Barbieri et al. (2017).

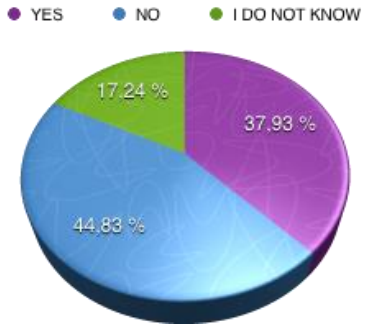

Figure 1. Has your company already carried out an offshoring process?

Figure 2. Has your company already carried out a backshoring process?

The term **offshoring**, also known as delocalization or outsourcing, can be defined as the "*closing or scaling down of a firm's activities in the home market following the shifting of part of the production chain abroad*" (European Commission, 2005). According to this definition, the majority of the participants (almost 45%) have indicated that their companies did not engage in offshoring, while approximately 38 % of the participants (see Figure 1) represented companies that have performed an offshoring process. Interestingly, 17% of the participants did not know whether their companies performed offshoring/backshoring, which might mean that these decisions are not transparent in all situations. On the other hand, regarding the term

backshoring, defined as "*the act of reintroducing domestic manufacturing to a country*" (Oak, 2010), results show (Figure 2) that the majority of participants (61.54%) considered their companies haven't carried out a backshoring process. This is consistent with the previous question where there is a majority of companies that have not offshored its production. Unfortunately, these responses largely limit the usability of the following questions, as many had no direct experience with the situation.

The rest of the survey was focused on the backshoring decision as the main focus of the INSPIRE project is to explore novel business models to bring back manufacturing jobs back to Europe in process industry. The survey included questions around the following elements, which are the main determinants of the backshoring decision:

(1) External Environment.
(2) External Costs.
(3) Customer Related Issues.
(4) Risks.
(5) Supply Chain Management.
(6) Internal Environment.
(7) Managerial mistake.

External environment includes those elements outside the company which influence the backshoring decision: (i) access to skill and knowledge, defined as the possibility to hire trained personnel; (ii) different types of external costs; (iii) customer related issues; (iv) innovation; (v) risk; and (vi) elements related to the supply chain management (excluding costs). According to the opinion of the participants (see Figure 3), the main drivers of the offshoring process related to the external environment are the access to skill and knowledge (30 %), cost (20 %), customer related issues and innovation (both 15 %).

Figure 3. If the backshoring decision was due to the external environment, which one of the following factors may have been the major driver?

According to the participants, the main drivers of the backshoring process due to the ***External costs*** in order of decreasing importance are (Figure 4): logistics costs/ freight costs (26.67 %), increased home country productivity (20 %), labor costs/energy costs/home labor market flexibility/national subsidies for relocation (each 13 %). On the other hand, cost related to raw material supply, payment terms and custom duties are found as irrelevant in the decision.

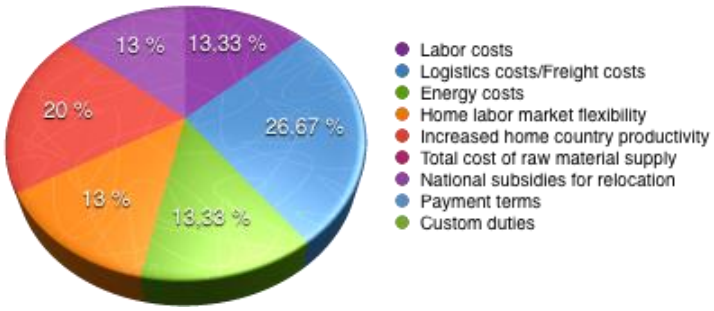

Figure 4. If the backshoring decision was due to external costs, which one of the following costs was the most important?

On the other hand, according to the results obtained (Figure 5), **customer related issues** as drivers of the backshoring decision are mainly due to the "made in effect" (37.50 %), where customers have a better perception of those products manufactured in Europe, mainly in terms of quality (31.25 %), the need to increase the satisfaction of customers (18.75 %), and the reduction of the host market size (13 %).

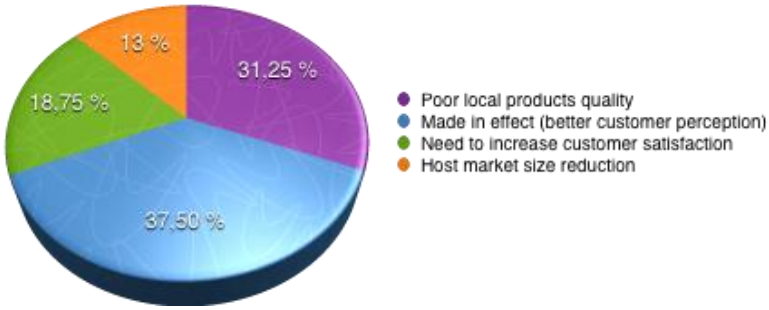

Figure 5. If the backshoring decision was due to customer related issues, which one of the following issues was the most important?

Risks are also considered in the backshoring process (Figure 6). The participants considered that the most important risk is the volatility and uncertainty of the global supply chain (66.67 %), followed by the intercultural criticalities (20 %). However, currency risk and demand volatility affect equally (6.67 %) the decision. Political social risk has not been considered by the participants.

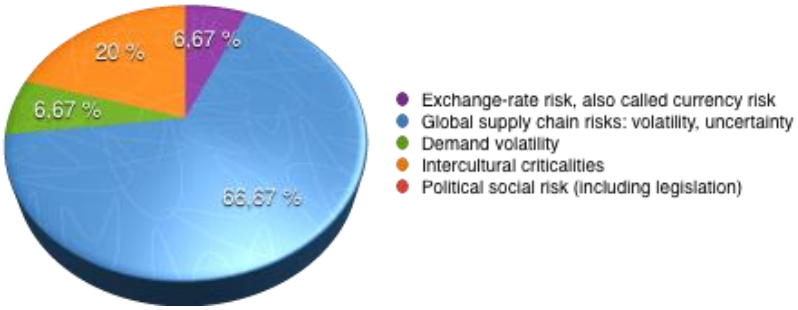

Figure 6. If the backshoring decision was due to risks, which one of the following risks was the most important?

Supply chain management as driver of the backshoring process (Figure 7) is mainly affected by the impact of the production and delivery time of the product (45.45 %). In addition, the lack of infrastructure in the host country was selected by the 27 % of the participants. Other factors identified with a minor importance and that affect equally the decision are related to the raw material in terms of closeness to the supplier, availability and size (9 %). Nevertheless, purchase order rigidity and termination of earlier supplier relationships have not been identified as relevant by the participants.

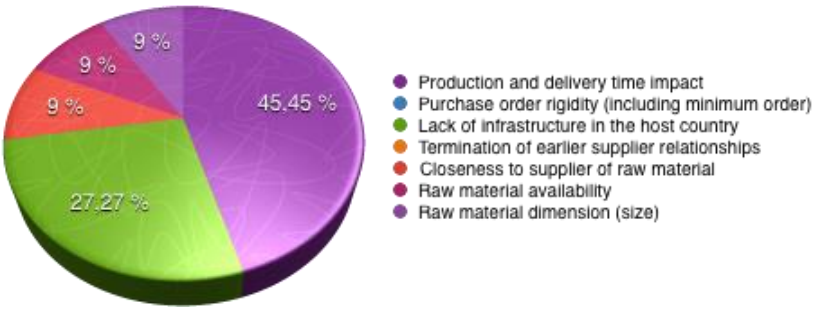

Figure 7. If the backshoring decision was due to supply chain management, which one of the following factors was the most important?

Internal environment include those elements within the company which influence the backshoring decision (Figure 8): (i) Access to physical resources, which includes spatial flexibility which is determined by different parameters and "reflects which operations can be performed where, at what scale, at which performance level and in which timeframe" (INSPIRE, 2017); (ii) different types of internal costs; (iii) customer related element; (iv) loss of innovation potential; (v) Managerial/ Entrepreneurial elements, among others. According to the participants, the major driver in this group is the loss of innovation potential (43 % of the votes). Spatial flexibility (28.57 %) and internal costs (14.29 %) have been also identified with less significance. Managerial/ Entrepreneurial elements have not been considered by the participants.

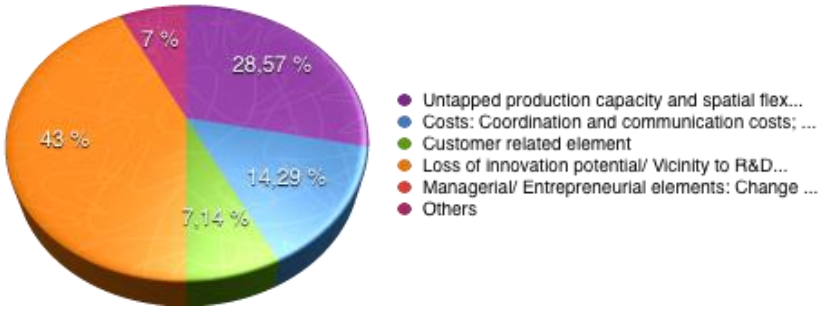

Figure 8. If the backshoring decision was due to the internal environment, which one of the following factors may have been the major driver?

Managerial mistake refers to the errors that the management could make/ has made when deciding an offshoring process. Some of them include: (i) the miscalculation of the actual cost in the production process or the accounting of new accounting methods, e.g., total cost of ownership; (ii) lack of knowledge on host country, e.g. cultural background, infrastructure, regulations; (iii) a study has not been carried out when choosing the location; (iv) the decision was based on an opportunism that has not been sustained in time. Participants considered the major driver due to a managerial mistake is the lack of knowledge on host country (45.45%), and the opportunism (27%). The other factors have been identified as equally important in the decision although less determinant.

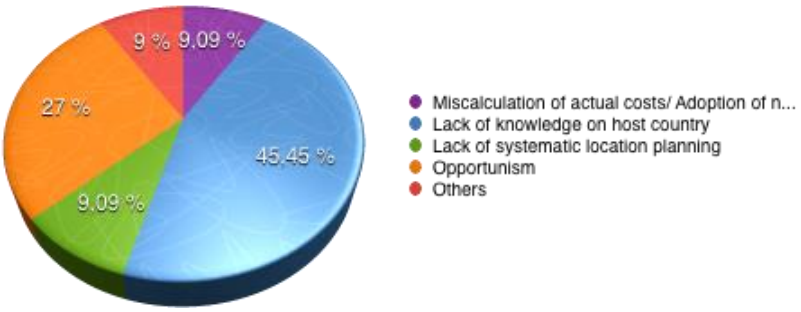

Figure 9. If the backshoring decision was due to a managerial mistake, which one of the following factors may have been the major driver?

Finally, participants were asked to identify the most important driver for backshoring. Results (Figure 10) are as follows: knowledge/ skills on host/ home country (33.33 %), Innovation/ Risk/ Supply chain management (20%), costs (6.67%). The following factors were not considered by the participants as important: systematic location planning, customers, access to physical resources and spatial flexibility, and Managerial/ Entrepreneurial elements.

Figure 10. Which one of the following factors is the most important driver for backshoring?

The information obtained from the survey will be used in the remaining tasks of the INSPIRE project, while designing new business models. The feedback from the workshop points to the fact that the availability of skilled labour, know-how, innovation potential, existence of physical/financial/information infrastructure, the perception of higher quality goods produced in Europe, and the flexibility are the strengths of the process industry in Europe. Therefore, the innovative business models need to take advantage of such capabilities and promote supply chain management strategies creating flexible systems to maintain jobs in or bring them back to Europe. As expected, global supply chain risks (volatility and uncertainty) and costs are major drivers for backshoring decisions, and therefore deserve special attention. This input is invaluable in terms of designing innovative business models that would ensure the competitiveness of the European process industry in the next decade. A summary of the highest response for each question and the percentage is provided in Table 1.

Question	Highest response	Score
If the backshoring decision was due to the external environment, which one of the following factors may have been the major driver?	Access to skill and knowledge: lack of skilled workers	30 %
If the backshoring decision was due to external costs, which one of the following costs was the most important?	Logistics costs/ freight costs	26,67 %
If the backshoring decision was due to customer related issues, which one of the following issues was the most important?	Made in effect (better customer perception)	37,50 %
If the backshoring decision was due to risks, which one of the following risks was the most important?	Global supply chain risks: volatility, uncertainty	66,67 %
If the backshoring decision was due to supply chain management, which one of the following factors was the most important?	Production and delivery time impact	45,45 %
If the backshoring decision was due to the internal environment, which one of the following factors may have been the major driver?	Untapped production capacity and spatial flexibility	28,57 %
If the backshoring decision was due to a managerial mistake, which one of the following factors may have been the major driver?	Lack of knowledge on host country	45,45 %
Which one of the following factors is the most important driver for backshoring?	Knowledge/skills on host/ home country	33,33 %

Table 1: Summary of highest responses in backshoring decision

3. Business Model Game

This section summarizes the main insights generated during the second part of the INSPIRE business model innovation workshop held in Brussels on November, 23th, 2017. The participants were given the task of redesigning the value chain and discussing the required technologies and related flexibilities in four parallel sessions during the workshop. The business model innovation exercise in each parallel session was designed for a particular business case (real life problem) focusing on a business model archetype as defined in the work package 1 of the INSPIRE project. Specifically, the participants worked on the following Business Cases (BC) and business model archetypes during the parallel sessions:

(1) Decentralised or modular production (DM): **BC1**- Small scale ammonia.
(2) Mass- customization: **BC2**- Fashion sector in Europe.
(3) Servitisation of the process industry: **BC3**- Chemical leasing.
(4) Reuse and sustainability: **BC4**- Critical Raw Materials (CRM).

Detailed descriptions of each parallel session and the related discussions are provided in Annexes 1 to 4. The participants were split into two major groups. One subgroup of the participants were encouraged to contemplate major challenges/barriers and opportunities that each business model archetype would have for the specific business case in each session, while redesigning the value chain. The redesign was based on proposing types of flexibility and technologies identified in [INSPIRE D2.1]. The other subgroup was charged to observe and provide feedback to the design based on a number of different evaluation aspects (e.g. sustainability, economic viability, reshoring opportunity). This assignment of roles helped to improve the resulting design. For more information about the structure of this game, please get in touch with the consortium via info@inspire-eu-project.eu.

In what follows, we present the general findings/insights from the discussions (detailed discussions for each session are in Annexes 1-4), along with the comments participants made in regards to the technologies required and flexibilities created with the potential deployment of the business model.

A number of challenges were identified for all business models. To name a few, for instance, in **BC1** (small scale ammonia) main challenge seems to be the high dependence on natural gas. Natural gas causes a large CO_2 footprint and fluctuation in the price of ammonia, which is an element of vital importance for world food supply. Main challenges for mass-customization in the fashion sector in Europe in **BC2** originate from the need for a more flexible, efficient, and sustainable production system, which is responsive to changes in demand and capable to quickly gain market share. The inclusion of Small and Medium Enterprises (SMEs) and the length of the value chain emerged as important elements to consider for the mass customization model in **BC2**.

The servitization model for the chemical leasing business case (**BC3**) introduces new roles for two main players (*supplier* and *user*). In the new value chain configuration, the supplier becomes responsible for not just for the supply of the chemicals but also for additional services (e.g., application of the chemical and recovery after use) and the user pays for the "service" provided. The definition of "service" seems to be a major challenge for this business case, where the scope identification and the guarantees regarding potential "gains" for both players constitute major barriers against successful deployment of the servitization model.

The main challenge for the reuse model in the "critical raw materials" business case (**BC4**) is related to the location of the source of these materials, predominantly in non-EU countries, and its use in manufacturing several daily-life products. Furthermore, global markets are relatively unstable and prices tend to fluctuate.

The biggest challenge is to create low cost recovery technologies and the necessary conditions for investments in collection, treatment and re-use to be able to re-use of critical raw materials in end-of life products.

In addition to the main barriers, how different flexibilities are affected and technologies required in the four business cases were also discussed. Table 2 below shows a summary of flexibilities of the following six types: (1) Location, (2) Capacity, (3) Product, (4) Feedstock, (5) Innovation, and (6) Energy. Similarities across business cases are related to the location flexibility, the need to be close to the customer/ user, the necessity to increase the resilience of the SC for **BC2** and **BC4**, and the reuse of materials in **BC3** and **BC4**.

	BC1	**BC2**	**BC3**	**BC4**
	Decentralized or modular	Mass Customization	Servitization	Reuse and sustainability
	Small scale ammonia	Fashion sector in Europe	Chemical leasing	Critical Raw Materials (CRM)
Location flexibility	Close to the customer to reduce outbound transport, related emissions and storage risks.	Move the production process closer to customers to reduce times and transports.	Supplier close to the user for the stronger relationship to work	---
Capacity flexibility	Scaling down the large production process.	Increase the resilience of the SC to face fluctuating demand.	As a result of better knowledge of the user needs. Better use of the existing capacity.	Increase the resilience of the SC in light of fluctuating availability of CRMs.
Product flexibility	To meet changing demands for fertilizer.	Facilitate the customization capability.	---	Eco-design strategy and extension of the life cycle.
Feedstock flexibility	Different demands may require different amounts of feedstock.	---	Linked with the reuse of chemicals.	Use of recycled CRMs with different characteristics.
Innovation flexibility	---	Proposal of innovative products and use of new materials and features.	Supplier would better know the “needs” of the user, and co-innovate new products.	Track resources and facilitate the use of secondary materials.
Energy flexibility	Use of local renewable energy instead of gas natural.	---	---	---

Table 2: Flexibilities

In regards to the technologies required, Information and Communication Technologies (ICTs) have been identified as relevant technologies in all business cases. Specifically, ICTs in **BC1** are related to remote control and systems to ensure the continuous operation of the plant. **BC2** uses big data for the identification of the fashion trends and the creation of new business opportunities. **BC3** depends on the information infrastructure and the capabilities to monitor/measure service, and **BC4** points out the internet of things (cloud based platforms) for identifying the availability and location of critical raw materials. In addition, 3D printing technology has been identified as relevant in **BC1** and **BC2**. Sustainability and recycling technologies are also relevant technologies that have been recognized in all business cases with exception of **BC1**.

Some insights that emerged as a result of the discussion during the game were structured around four factors (see Table 3 below): (1) Sustainability, (2) Efficiency, (3) EU reshoring, and (4) Resilience. Sustainability arises in the discussion as a consequence of the current trend towards a circular economy, and is based in the re-use and recycling of materials. Efficiency in the discussion is mostly referred to the reduction of costs (e.g., transportation, production) although some changes are necessary (e.g. new equipment), and some questions arise linked with the obtaining of the funding. On the other hand, EU

reshoring is generally related to a change in the production (e.g. from big producers to local ones, supplier close to the user). Last but not least, resilience is highly dependent on the interdependencies between the actors of the SC.

	BC1	BC2	BC3	BC4
	Decentralized or modular	Mass Customization	Servitization	Reuse and sustainability
	Small scale ammonia	Fashion sector in Europe	Chemical leasing	Critical Raw Materials (CRM)
Sustainability	Waste available at the farmer location.	---	Less amount of chemicals and "reuse" possibilities.	Look at environmental, economic and social sustainability.
Efficiency	Producing locally reduces transport costs. Funding of the equipment?	To reduce production costs of small batches and increase capability to answer customer demands on time.	"Better" use of chemicals.	To reduce production costs of waste.
EU reshoring	Change from big producers to local ones. Shift from central producer to equipment provider.	Managing production locally in the assembly phase will enable to improve responsiveness to customer and increase quality.	The *supplier* needs to be"closer" the *user* to provide the "service".	Balance between risks and costs, affordability of new technologies and market uptake.
Resilience	How to adapt changes in demand when the ownership of the plant lies downstream in the SC?	---	Closer relationship between the supplier and the user.	SC partners are highly interdependent. Systemic approach as a "security" for investors.

Table 3: Insights from the discussion process

The session also involved the redesign of the value chain in the four business cases. New elements were added and can be seen in Annexes 1 to 4 in detail for each business case.

The feedback received from the participants via this workshop along with the learning experience regarding the opportunities and critical issues towards more flexible and sustainable value chains will be used in the INSPIRE project for the proposal of novel and innovative business solutions. The following section of this report includes the detailed discussions for each parallel session.

References

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ANNEX 1. Decentralised or modular production (DM). Business Case: Small Scale Ammonia.

OUTLINE

1. General description break-out session
2. Business Model redesign
3. Comments/reflections on the business model innovation process
4. Learning experiences for the business model
5. Overall evaluation of the BM Game

1. General description break-out session

1.1. Introduction

The group consisted of 10 persons, representing several research institutes, consultancy, European association.

The game has been explained by Frank Berkers from TNO, and the group divided in 2 sub-groups, techies/flexies and assessees.

1.2. Explanation of the Supply Chain (SC) challenges

Niels Jansen from TNO gave a description of the current supply chain of ammonia production for fertilizers in Europe, and its challenges. The current SC was drawn on the Canvas game and the white board (see Figure 1).

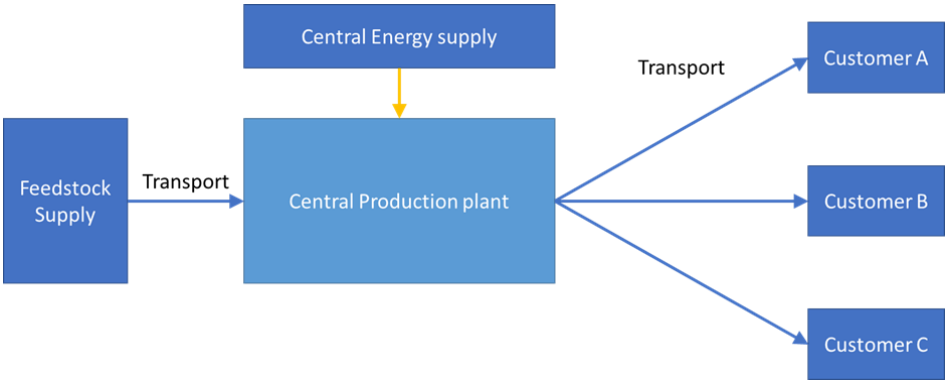

Figure 1. Current Supply Chain: central production of ammonia/fertilizers.

Several challenges exist in this supply chain. Natural gas is used for production of ammonia. This induces a large CO2 footprint for the process and introduces fluctuation in the ammonia price. In agriculture, especially certainty about the price of ammonia (used in fertilizers) is important. Furthermore, natural gas (in NL/EU) will be phased out on long term which creates uncertainty about the feasibility of ammonia production from natural gas in the EU. Due to the depencency on natural gas, new sites are mainly built where this feedstock has a steady and cheap supply. Ammonia production is mainly dominated by China. India, Russia and the US are the next major producers (USGS, 2017). A growth in demand for fertiliser is expected because of world population growth. Ammonia is of vital importance for world food supply.

In the current SC, ammonia is produced centrally and transported to distributed customers. In remote areas these transport costs are significant. Sustainability of products is seen more and more as value added (e.g. biomethanol; possibly on longer term also green H2 and ammonia).

2. Business Model redesign

The sub-groups each discussed separately for 15 minutes to 1) select relevant technologies for this case (from the already pre-selected technologies for this Business Model Archetype, Re-use and sustainability), 2) the applicable or required flexibilities, 3) relation to the assessment criteria.

Each group already wrote down motivations for selection on their cards. Subsequently the **flexies and techies started redesigning the supply chain**, starting by introducing the following

Flexibility cards (and written down thoughts):

- *Location flexibility:* Locate the production process close to the customer to reduce transport, related emissions and storage risks. This flexibility also contributes to fit the process to the needs of local customers. A new idea is to introduce a mobile production plant which moves from customer to customer.
- *Capacity flexibility:* Capacity flexibility is introduced for scaling down the large production process in order to align this with the needs of local customers.
- *Product flexibility:* The specific demands for fertilizer may change for different customers. Introducing local product flexibility can meet these demands.
- *Feedstock flexibility:* With product flexibility, feedstock flexibility for fertilizer production follows as different demands may require different (amounts) of feedstock.
- *Energy flexibility:* Energy flexibility can be used by changing the production process such that local renewable energy can be used instead of natural gas. This way cheap energy can be used (e.g. wind and sun at peak production) and the production can be scaled to the energy supply.

Technology cluster cards added were:

- **Modularity:** Introduce local production using skid based designs.
- **Continuous processing and process intensification:** Continuous processing was viewed as a crucial technology for localized production of fertilizers. It enables smaller dimensions of production plants and a higher yield. Challenges in this cluster are the capital investment in the plants (this should be low to allow gradual upscaling across the EU) and related the question if economies of scale for small plants production can be reached by manufacturers.
- **Equipment manufacturing:** In order to make the business model feasible, optimal small reactors should be designed which are cheap and easy to use. This technology is not mature yet. As a possibility 3D printing can be considered. Questions also arised: Is it sensible to have small production units with enough safety and reasonable production costs? Is it possible?
- **Electrification:** Electrification of the local process enables the use of local renewable energy sources and thus reduces the CO_2 footprint. It also introduces flexibility in which energy source is used (biogas, tidal, wind, solar).
- **ICT:** Remote control and ICT systems to ensure continuous operation of the plant must be available. The farmer itself will not be able to run the plant.
- **Plasma technology for fertiliser production:** Using plasma technology to produce fertilizers at the farmer site. This technology directly addresses the main challenges of this case by reducing the footprint in fertilizer production (CH_4 and CO_2), reduces supply risks and contributes to electrification of the process. (*This was added using a wildcard.*)

Supply chain elements were added:

1. **Small scale production** of the ammonia/fertilizer at farmer location.

2. **Decentral energy generation** as feedstock for the local production.
3. **Remote control** to facilitate the farmer in using the plant.
4. **Central feedstock** of catalyst, nitrogen (from air) and fertilizer components
5. Rotating **customers** which each in turn make use of the production plant.
6. **Transport** to move the plant between customers.
7. **Energy storage** either to store H_2/NH_3 for later use or store energy.

Follow the **assessees,** who introduced the following cards and considerations:

- **Sustainability:** At the farmer location probably also waste (manure) is available for use as biogas or energy source with low CO_2 footprint. Local and mobile production reduces the footprint of the process.
- **Efficiency:** Producing locally reduces transport costs. Consider reaching local farmers and realizing a cost decrease. Important open question is the funding of the equipment.
- **EU reshoring:** The proposed supply chain will contribute to increase local business opportunities and jobs. Change from big producers outside Europe to local ones.
- **Resilience:** A key question arises on how to adapt to changes in demand (what if a customer stops using fertilizer) when the ownership of the plant lies downstream in the supply chain (possibly at the customer).

Figure 2. Assessment in progress.

Additional supply chain elements were added:

8. **Equipment Manufacturer** that makes the moveable equipment can be owner of the plants and lease these to the customers. The main challenge is to create a (as much as possible) standardized process to produce and facilitate this concept.
9. **Customer** that cooperates as partly owner of the equipment, together with other customers and the manufacturer.

This followed to a next assessment point:

- **Resilience:** The major players in the ecosystem change. Instead of collaboration between large ammonia suppliers and equipment manufacturers, now competition between them emerges. The

new providers will have to contribute to and introduce the new technology. Financial stability is a key barrier for this new model.

Lastly another wildcard was added:

- **Policy:** Can policy be used as an incentive to move towards this business model? This is an open question.

End result of the supply chain:

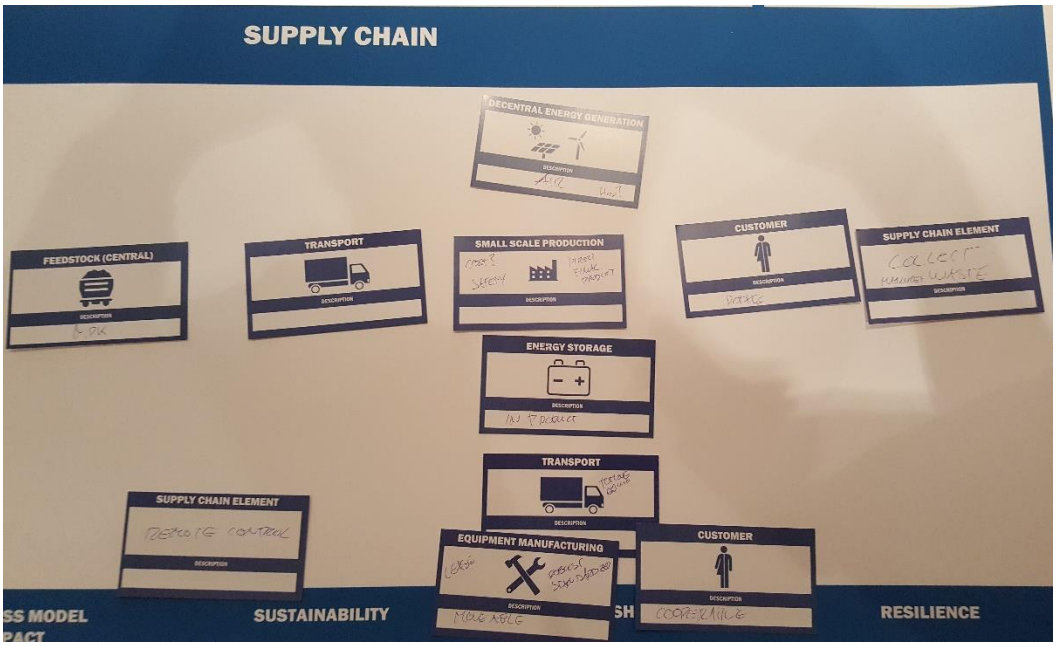

Figure 1. Resulting supply chain.

3. Comments/ reflections on the business model innovation process

Overall the exercise proved to be very useful to involve all group participants and capture their thoughts. The division in groups (tech+flex for creativity and assessees for constructively criticizing) works fine and stimulates interactions between the group members. The general discussion between groups also was a stimulating and inspiring task which led to new insights on the business model.

A clear presentation of the supply chain and its challenges is essential for the game to work.

4. Learning experiences for the business model

The most important value added for the Business Model innovation work in INSPIRE were:

- Addition of the idea of location flexibility where different customers use the same plant which is moved locally from customer to customer. Through this concept investment costs can be shared among customers or cooperatives.
- Introduction of product and feedstock flexibility based on the specific needs of the customer for product specifications. Also the addition of new ideas for local feedstock and energy generation (such as biogas).

The main challenge for this business model is to create incentives for actually incorporating this business model. In the discussion it came to table that the large producers will not have incentives to shift to small scale production. It was made clear that the concept implies a shift from producer to equipment provider

and that this model could be phased in gradually farmer by farmer, requiring less capital at once. Therefore concepts with ownership at the equipment manufacturer was introduced, possibly in combination with policy incentives. This is an important consideration in developing this case further in the INSPIRE project.

5. Overall evaluation of the BM Game

The results of the feedback forms showed the lowest scores on enabling participants to redesign their own business model and the understanding of potential for EU-reshoring. Very positive results were given on the use of a canvas and the different cards, also using a case added practical relevance to the workshop. Lastly the workshop also was perceived as *inspire*ing.

Using the Business Model Game in other settings it will be useful to emphasise the use of the method to redesign the model of the participants' own business ideas (e.g. at in-company sessions). Multiple participants indicated their interest in using the game format for use. For more information about the structure of this game, please get in touch with the consortium via info@inspire-eu-project.eu.

INSPIRE and Frank Berkers and Niels Jansen of TNO thank the participants for their useful discussions and inputs.

ANNEX 2. Mass-customization. Business Case: Fashion sector in Europe.

OUTLINE

1. General description break-out session
2. Business Model redesign
3. Comments/reflections on the business model innovation process
4. Learning experiences for the business model
5. Overall evaluation of the BM Game

1. General description break-out session

1.1. Introduction

The group consisted of 6 persons, representing large companies (e.g., Procter&Gamble, Solvay, ThyssenKrupp), consultancy and European industrial association.

The game has been explained, and the group started working according to the instructions.

1.2. Explanation of the Supply Chain (SC) challenges

Rosanna Fornasiero from CNR gave a description of the current supply chain of the Fashion sector in Europe, and its challenges linked to customization. The current steps in the supply chain have been explained and shown to the audience emphasizing which are the most important nodes and their role in the chain.

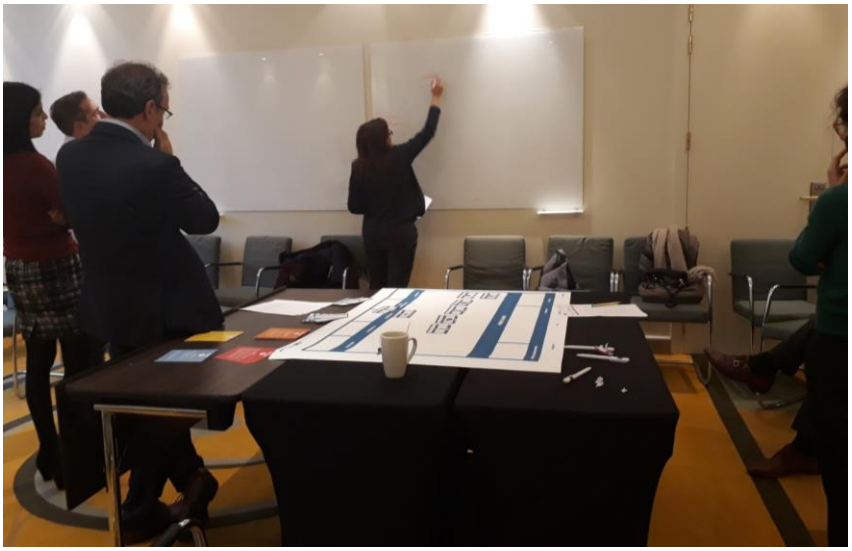

Figure 1. Business case introduction

The current supply chains was drawn on the white board as (see Figure 2):

Chemical companies → leather tanneries → components producers using plastics and compounds →assembling process →distribution → market

The challenges of the SC are the following:

- Production needs to be **more flexible** as the MC allows having different and innovative products, as well as an easiness for development of new products in virtually any location.

- Manufacturing needs to become **efficient and sustainable** as the design for new products will be made on computers before final printing (in the case of 3D printing), saving raw materials and reducing the amount of waste. In the case of other MC types, manufacturing will rely heavily on the supply chain (SC) configuration in the sense of selling a larger variety of the products using the same SC structure and standard modules and components.
- A minimization in the **time to market**, as product customization and new product development will happen faster.
- Minimized **response time to changes in demand as** result of understanding and providing the exact customized solution to the customer needs.
- Inclusion of **SMEs opportunities** will be a result of more variety of products, allowing these SMEs to become part of the conversation.

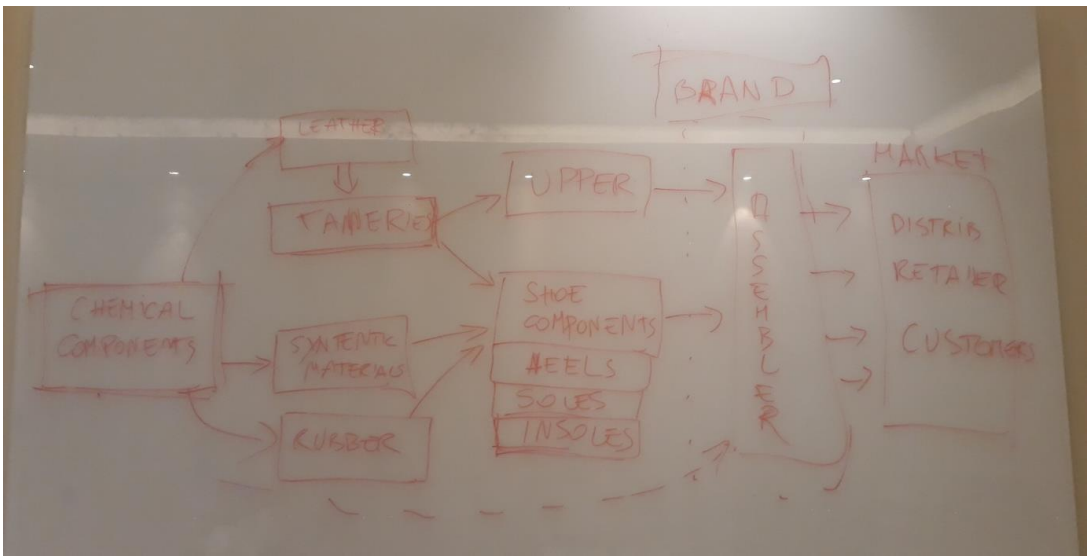

Figure 2. Current SC: fashion sector in Europe

2. Business Model redesign

The group discussed to 1) select relevant technologies for this case (from the already pre-selected technologies for this Business Model Archetype, customisation), 2) the applicable or required flexibilities, 3) relation to the assessment criteria.

The technologies already identified in the BC and proposed to the audience were confirmed:

- **Design and configuration**: product configuration tool enable customer to select and customize its own product according to specific need. Virtual reality offers the possibility to increase customer experience in the try-on and purchase process. Smart materials give the opportunity of apply specific treatments and functionalize products.
- **Supply chain management:** tools supporting to support process monitoring with suppliers, loading and sharing orders, price negotiation of materials and components. Market information through consumers, retailers and designers interactions have to be integrated and analysed to identify customer preferences and its modification.
- **Sustainability**: materials end of live is a challenging issue in customization and solutions have to be find to approach dismissal and recycle of custom products.

- **Equipment manufacturing**: Additive manufacturing is essential in order to achieve customization of components. 3D printing technologies are available on the market but need to be refined and optimized in order to provide the necessary responsiveness.
- **ICT**: Internet of things -> in particular structured big data to create new business opportunities and satisfy the evolving specific customer needs in Europe, identity fashion trends.

Two Supply chain elements (wildcards) were added:

10. **Flexibility of the whole network**
11. **Length of the network** > to monitor how many steps products have to undergo in the network

Follow the flexies, who introduced the following flex cards:

- **Product flexibility** -> to facilitate the capability to customize (strategy of product configuration necessary), leverage on the sharing economy and individualized production
- **Innovation flexibility** -> need to be able to propose with a high frequency innovative product models / product configuration possibilities to the customers and to -> facilitate the use of new materials /new product features
- **Capacity flexibility** -> to increase the resilience of the supply chain in light of risk of fluctuating demand.
- **Location Flexibility** -> move the production process closer to customers to reduce times and transports. The customization of components as soles and lasts can be offered through shared service centres addressing different companies.

Follow the assesses, who introduced the following cards and considerations:

- **Efficiency of the supply chain**: essential to reduce production costs of small batches and increase capability to answer on time to customer needs
- **Business Model Impact**: companies should rethink not only the supply chain but the value chain and how to redistribute the value along the network.
- **EU reshoring**: managing locally production, and in particular the assembly phase, will enable to improve responsiveness to customer and increase quality. This is enabled by new technologies which can automatize the process.

The following considerations were added on post-its:

- MC represents a quite new paradigm for process industry and related implications have to be still deepened. It's important to understand how the customization influences the relationship among chemical and manufacturing companies, in particular for what concerns smart textiles and plastic materials for 3D printing of soles.
- Customization affects especially combination level and for footwear sector nowadays is most in the downstream value chain.
- A relevant element to consider is the length of the value chain.

The final result can be seen in Figure 3.

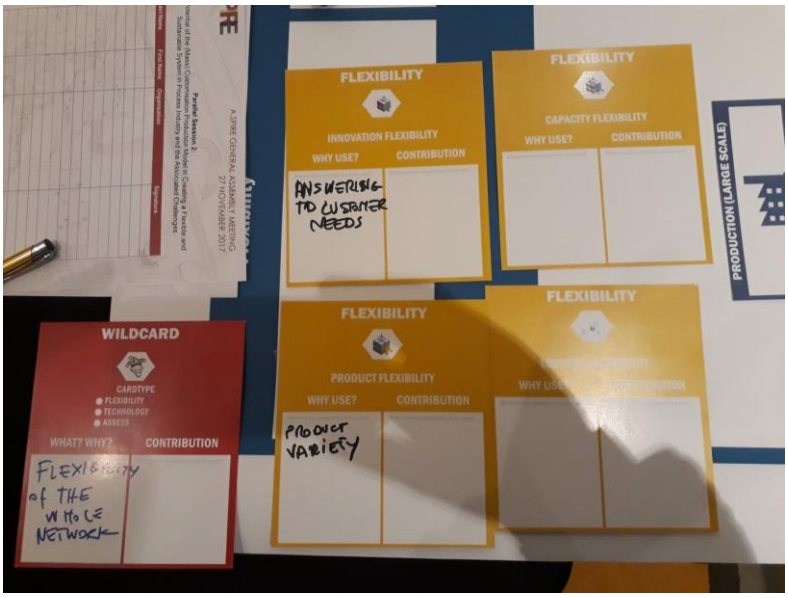

Figure 3. Final result.

3. Comments/ reflections on the business model innovation process

In conclusion, the game revealed to be useful to involve all participants and capture their thoughts and reflections. Even if with a small number of participants the group works fine and stimulates interactions between its members, interesting discussions on the business model and on how it can affect the link between process and discrete manufacturing arisen. The time for the game is quite short.

A clear presentation of the supply chain and its challenges is essential for the game to work.

4. Learning experiences for the business model

The most important value added for the Business Model innovation work in INSPIRE were:

- Highlight that companies have to rethink not only the supply chain but the value chain and how to redistribute the value along the network.
- Suggestion to focus also on length of the network in order to monitor how many steps products have to undergo along the whole supply network.

5. Overall evaluation of the BM Game

The game with the canvas model helped participants actively engage in the redesign of the value chain and evaluate the challenges/opportunities. Creative and critical thinking was made possible by the assignment of different roles (techies, flexies, assesees) for detailed evaluation of the business model archetype for a specific business case.

INSPIRE and Rosanna Fornasiero (CNR) and Andrea Zangiacomi (CNR) wish to extend their gratitude to the participants for their useful discussions and inputs.

ANNEX 3. Servitisation of the process industry. Business Case: Chemical leasing.

OUTLINE

1. General description break-out session
2. Business Model redesign
3. Comments/reflections on the business model innovation process
4. Learning experiences for the business model
5. Overall evaluation of the BM Game

1. General description break-out session

1.1. Introduction

The group consisted of 9 persons, representing research institutes, large companies, consultancy firms and European industrial association.

The game has been explained by Luk Aerts from PNO, and the group started working according to the instructions. The group has been divided into three: flexies (to evaluate how the business model archetype relates to five types of flexibilities), techies (to see what technologies would be required for the deployment of this model), and assessies (to redesign the supply chain based on the impact it would have on a number of objectives, two of which are the creation of flexible and sustainable supply chains).

1.2. Explanation of the Supply Chain (SC) challenges

Cagri Gurbuz from ZLC gave a description of the current supply chain for the business case of "chemical leasing". First, the "as-is" supply chain has been described, with two main players: *supplier* and *user*. In this "as-is" supply chain configuration, the *supplier* is only responsible for the "supply of chemicals" and the *user* is responsible for the application of the chemical in its operations as well as its disposal. The relationship between these two entities is transaction-based, where the *user* pays the *supplier* for the quantity purchased.

The current supply chain was drawn on the white board (see Figure 1).

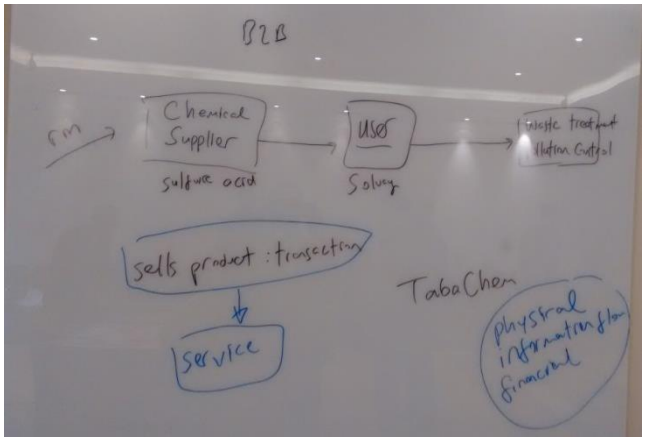

Figure 1. Current Supply Chain: chemical leasing.

Once the current business setting is defined, the business model archetype of "servitization" has been introduced to the participants. The participants were basically told that in the new supply chain configuration, the *supplier* would be responsible not only for the supply of the chemicals, but also the "application of the chemical" in the operations at the *user*'s facilities as well as "recover" as much chemical

after use to be able to reuse it in the future (e.g., TaBaChem example was provided to concretize the idea). The moderators (Cagri Gurbuz, ZLC and Luk Aerts, PNO) intentionally kept the "scope" of the new relationship (e.g., product/user/service oritented Product Service Systems) between the *supplier* and the *user* open, to see how deep a relationship the participants would favour. The participants were told that the user would no longer own the chemicals, and the payment to the supplier would be based on the "service" provided by the supplier rather than the quantity of chemicals purchased.

Some examples of the deployment of the "servitization" business model in the process industry (as well as manufacturing) have been briefly discussed with the participants, to raise awareness that this particular model has been already in use in some industries (including process industry). Some challenges in relation to the switch from the "transaction based" to the "long-term relationship where the *supplier* provides "service instead of just the product" were mentioned to stimulate the participants to engage in detailed discussions.

- Quite a few challenges need to be overcome for the successful deployment of this business model. Some of these challenges that were mentioned before the participants start the game in order to encourage thorough analysis of the business case, without giving out too much detail, were as follows:
- The "scope" of the services that the supplier could provide: e.g., would the supplier only be responsible of the application of the particular chemical at user's facility, or also take care of the waste generated?
- The "payment": when would the user pay for the services, and how this payment should be related to the "service" and "quantity of chemicals" used? How would the supplier determine the price to charge, with the additional services?
- Supply chain configuration: would there be new players in the supply chain, or would some entities be disintermediated (e.g., waste collector)?

More challenges that came up during the discussions when the participants played the game would be mentioned later in this report. Figure 2 was drawn by some participants that later proved useful to discuss opportunities/challenges/changes this business model would introduce.

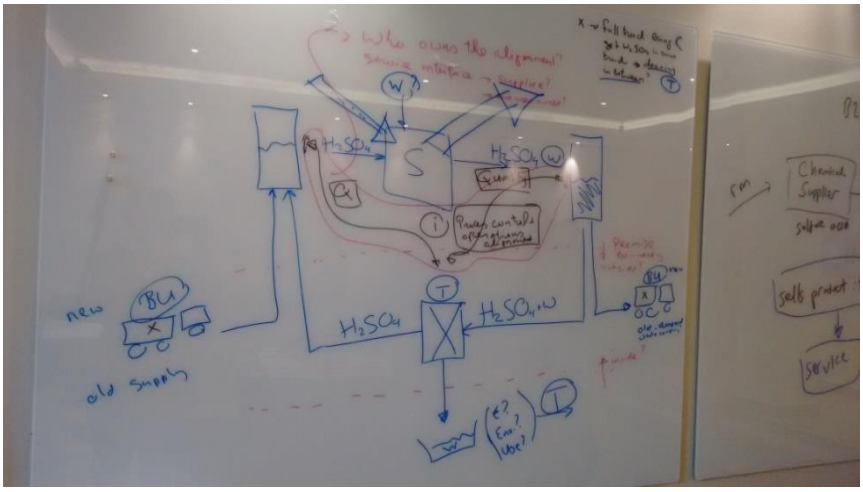

Figure 2. Chemical leasing scheme.

2. Business Model redesign

The sub-groups each discussed separately for 15 minutes to: (1) select relevant technologies for this case (from the already pre-selected technologies for this Business Model Archetype, "Servitization", (2) the related flexibilities, and (3) relation to the assessment criteria.

We had the following observations during the discussion of flexibilities and technologies:

Flexibility cards (and written down thoughts):

- *Location flexibility:* Participants mentioned that for such a relationship to work (servitization) the supplier needs to be in close proximity to the user, as it requires a much more involved long-term relationship.
- *Capacity flexibility:* Capacity flexibility is introduced as a result of better knowledge of the needs of the user (that the supplier knows how much chemical the user would need and when much better with the servitization model). Besides, the amount of chemicals used would be less as a result of "better use of chemicals" by the supplier and the "lack of promotions from the supplier leading to volume discounts and more sales with the traditional transaction-based system). Therefore, the supplier would be able to use the existing capacity better.
- *Innovation flexibility:* The participants mentioned that through the stronger relationship between the supplier and the user, the supplier would better know the "needs" of the user, and therefore co-innovate new products tailored to the requirements of the user and be more responsive to changes in such requirements.
- *Feedstock flexibility:* As the business model involves taking back the chemicals after use for reusing them later, it contributes positively to the "feedstock" flexibility (as a second source of raw material).

A few technology clusters were identified:

- **Equipment manufacturing:** New equipment for the collection of waste and reuse of the chemicals by the supplier. Also, the technologies required for proper measurement of the "service" which ultimately determines the payment to be made to the supplier by the user.
- **ICT:** Smooth communication between the supplier and the user depends on the information infrastructure. Also needed for the proper quality control of the process.
- **Technologies for waste treatment and reuse:** The supplier needs to develop capabilities to collect waste, recycle, and feed the chemicals back to the production.

After the discussion within sub-groups, the participants started redesigning the supply chain as a group. Figure 3 gives an overall idea of the players and relationships in the value chain proposed by the participants.

Supply chain elements were added:

1. **Reverse feedback loop**: from the *user*'s facility back to the *supplier*'s production facility
2. **Mining of virgin raw material**
3. **New equipment providers**: for the "collection/pre-treatment/reuse" of chemicals
4. **Facilitator**: a new entity in the supply chain who would encourage the deployment of this model, monitor progress, make audits for measuring the "service" performance/quality (e.g., neutral third party, a non-profit organization/association)
5. **Energy supplier**: a new energy supplier at the user's facility for the *supplier*, and a new contract maybe

6. **Waste collector**: who would collect and treat the waste (may be a company working with the supplier)
7. **Enforcement agencies**: that the *supplier* and/or the *user* might have to "report to"
8. **A new entity**: part of the "*supplier*'s" organization responsible for the application of chemicals at the *user*'s facility, procurement decisions, etc.

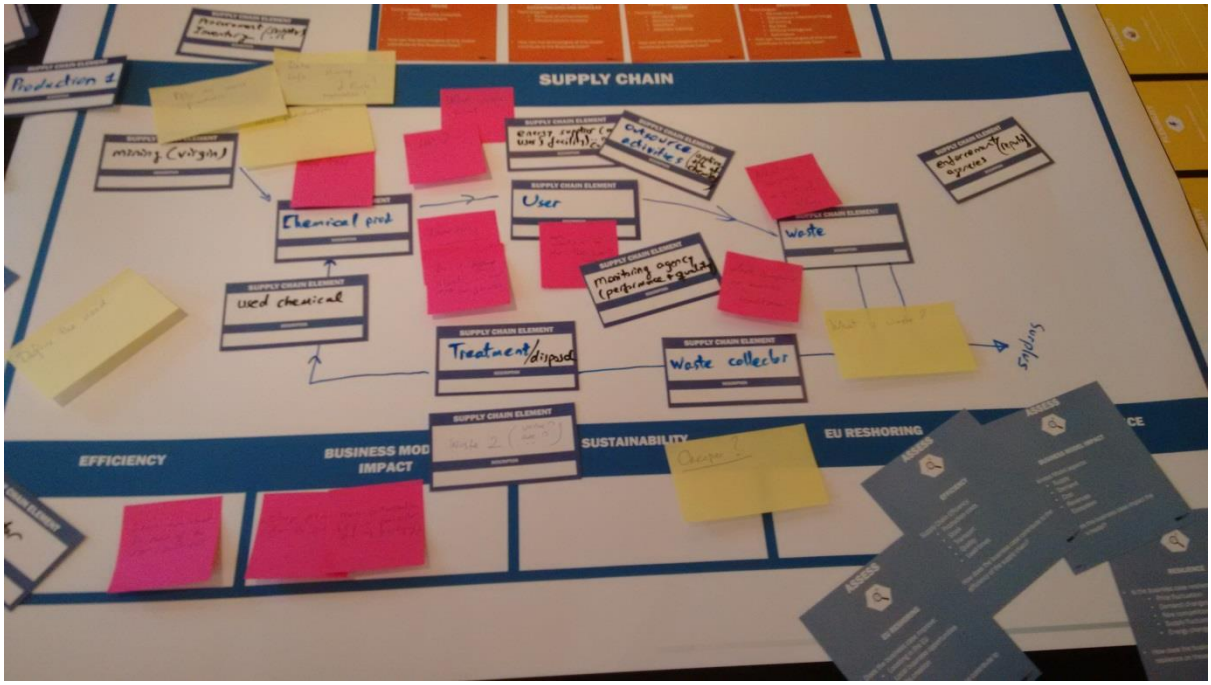

Figure 3. Redesign of the SC

The discussions regarding the impact of this business model on the supply chain yielded the following general insights:

- **Sustainability:** Because of less amount of chemicals used and the "reuse" possibilities, servitization was deemed to have positive contribution to the sustainability
- **Efficiency:** As a result of "better" use of chemicals by the supplier, the process becomes more efficient at the user (less chemicals used to achieve the same output). Besides, the user would be able to focus on "core" activities, and leading to improved performance in general. The "product+service" would also be better customized because of deeper knowledge of the needs of the *user* by the *supplier*, and the closer/stronger relationship between the two entities. Ensuring quality and the liability issues were mentioned that might impact efficiency negatively (because of the additional work created and the stress).
- **EU reshoring:** Although not very clear, the general tendency was that this business model archetype would help bring jobs back to Europe as the supplier needs to "closer" to the user to be able to provide the "service"
- **Resilience:** The supply chain becomes more resilient as a result of the closer relationship between the supplier and the user, as well as the increased feedstock flexibility (securing raw materials due to reuse). However, participants also raised the issue that the impact on resilience could also be negative for the user if this model increases the dependency on the supplier (i.e., if it becomes prohibitively costly for the user to switch to a new supplier).

3. Comments/ reflections on the business model innovation process

Dividing the team into subgroups (flexies, techies, and assesses) led to fruitful discussions among group members, and critical thinking. The moderators were able to observe the thought process and discussions, which led to the identification of some opportunities and challenges that were new to the moderators. This exercise helped the INSPIRE team greatly to receive the feedback from industry, research institutes, and associations to evaluate the "applicability" of such business model.

A clear presentation of the supply chain and its challenges is essential for the game to work.

4. Learning experiences for the business model

The participants identified opportunities and also raised critical issues that would determine whether the servitization business model archetype would actually lead to more flexible and sustainable value chains, some of which are briefly summarized below.

- **Opportunity for more sustainable value chain**: Less chemicals used as the *supplier* is supposed to be more efficient and the business model does not encourage larger amounts of chemicals purchased (the *user* no longer has incentives to purchase more through volume discounts). However, some participants raised the issue of "less production" of such chemicals, and therefore the risk of some producers (*suppliers*) going out of business in general.
- **Opportunity for more sustainable value chain:** Because of taking back the chemicals and reusing them, the environmental impact would be reduced.
- **Opportunities for new players:** Equipment providers for waste collection/treatment and reuse might find business opportunities. Facilitators (monitoring agencies, ICT providers, auditors) might also have new business opportunities for ensuring the smooth deployment of this business model (e.g., quality control, monitoring service and payments, etc.).
- **Opportunity to create better products/services and customization**: *Supplier* obtains more information about the use of the chemical, potential quality issues/problems in production and therefore works with the *user* to improve the design of the product and the service. *Supplier* can provide customized services with this business models.
- **Opportunity for the user to focus on core business activities and reduce capital intensive spending**: Because of the servitization, the supplier will take care of the application of chemicals, and therefore helping the user to divert the capacity originally dedicated to the application of chemicals to core business activities. Moreover, the participants mentioned that the user might end up reducing the investments because of "not owning" certain assets (e.g., chemicals, equipment to apply those, etc.), which would increase financial flexibility.
- **Risk of increased dependency**: The *user* may become highly dependent on the *supplier* because of the stronger relationship, and in case things do not go as planned, serious problems can emerge.
- **Overall reduction in the production quantities of chemicals**: Some participants raised the issue of less chemicals produced in general, which might lead to some suppliers going bankrupt.
- **Quality and liability**: The additional task of ensuring the quality as a result of the application of chemicals by the supplier was mentioned as a risk. Liability, especially considering the application of potentially hazardous chemicals, may prove to be an important challenge in case unexpected adverse events occur during application of chemicals. Who would be responsible in such situations

remains a barrier against the deployment of this model. Contracts clearly identifying the responsible party are necessary.

- **Information related risks**: "Knowledge leakage" was mentioned as a risk. The user losing its competitive advantage as the supplier becomes more knowledgeable in user's operations was also mentioned as a related risk ("information is power"). One participant gave an example from the "steel industry", that a similar business model led to the creation of "competitors" as the suppliers became more knowledgeable.
- **IP issues**: Intellectual property rights were also another important factor to consider, raised by a number of participants. It was argued that this business model cannot be deployed with partners that do not have proper IP practices in place.
- **The economic gains and the sharing of such gains**: It was not clear to some participants how the *supplier* or *user* would increase their profits with this business model. Participants were especially sceptical about the *supplier*'s incentives, as less amount of chemicals would be sold under this business model. Other participants mentioned that the *supplier* would charge "premium" for the service and will have more business with the *user*, and therefore increase its profits. However, the "premium" to be charged remains a difficult factor to determine as it depends on the "nature/scope of the service".
- **Waste collection**: Some participants raised the issue that the "waste collector" in the original/traditional system might be hurt because of this new business model (risk of being disintermediated because of reuse). How the waste would be collected and recycled was mentioned as a challenge to be faced. One particular solution was the *supplier* working closely with such waste collectors to close the cycle, and therefore not eliminate such players from the chain.
- **Outsourcing**: This business model was perceived as the *user* outsourcing some activities to the *supplier*. Risks/advantages associated with "outsourcing" were discussed.
- **Additional tasks for the supplier**: The *supplier* needs to develop capabilities to apply chemicals at the *user*'s facilities, to have employees located at the *user*'s facilities to carry out such tasks, monitor quality, take back chemicals, etc. This may prove to be quite a challenge for small *suppliers* with limited resources.

5. Overall evaluation of the BM Game

The participants' feedback regarding the game showed that the canvas model and the associated cards stimulated engagement and active processing of the information provided by the moderator. The assignment of different roles (techies, flexies, assesees) fostered critical thinking and led to a focused analysis of different aspects.

Most participants thought that their understanding of the application of this business model and the impact on business resilience improved after the workshop. The "business case example" helped understand the "practical concerns" for the deployment of this model in a real life setting. One participant pointed out that moderators could have limited the discussion to a specific form of the servitization model, rather than leaving the "scope" open. Besides, the connection to the EU-reshoring, however, was not very clear to most participants. These will be taken into account in the future workshops to come.

Overall, the feedback was positive and the workshop was perceived to be inspiring. INSPIRE and Cagri Gurbuz (ZLC) and Luk Aerts (PNO) wish to extend their gratitude to the participants for their useful discussions and inputs.

ANNEX 4. Reuse and sustainability. Business Case: Critical Raw Materials.

OUTLINE

1. General description break-out session
2. Business Model redesign
3. Comments/reflections on the business model innovation process
4. Learning experiences for the business model
5. Overall evaluation of the BM Game

1. General description break-out session

1.1. Introduction

The group consisted of 12 persons, representing several research institutes, consultancy, European association.

The game has been explained, and the group divided in 3 sub-groups, techies, flexies and assesses.

1.2. Explanation of the Supply Chain (SC) challenges

Nader Akil from PNO gave a description of the current supply chain of Critical Raw materials in Europe, and its challenges.

Figure 1. Session performance.

The current supply chains was drawn on the white board as:

Mining -> Refining -> (various) applications -> end-of-life products -> landfill or Back to Asia for metal recovery

The main challenge for this supply chain, and put in front of the participants, is the fact that an EU selected list of Critical Raw materials is crucial for several innovative products, and EU industries. Such materials include rare earth materials as well as other rare materials, which are predominantly controlled by non-EU countries, sometimes in geopolitically less stable regions in the world. These materials are essential to be able to produce a wide range of important products and innovations such as magnets (e.g. for electric) cars

and windmills as well as different consumer electronics products such as air-condition, loudspeakers, hard disk drivers, and so on.

As producer of these products Europe depends for a large part on import of these materials, which global markets are relatively unstable and prices have shown the potential to fluctuate dramatically. A solution would be to re-use critical raw materials which are abundantly available (compared to their concentration in natural sources, such as ore) in end-of-life products such as cars and electronics waste.

Technologies are coming available to make this possible and make Europe less dependent on import of CRMs. The challenge for this business model is to create low cost recovery technologies and the conditions for investors to invest in collection, treatment and re-use.

2. Business Model redesign

The sub-groups each discussed separately for 15 minutes to 1) select relevant technologies for this case (from the already pre-selected technologies for this Business Model Archetype, Re-use and sustainability), 2) the applicable or required flexibilities, and 3) relation to the assessment criteria.

Each group already wrote down motivations for selection on their cards. Subsequently the **techies started redesigning the supply chain**, introducing the following value chain cards (and written down thoughts:

1. Collection systems/marking (small scale)
2. Separation -> automated disassembly
3. Recovery (to replace virgin materials)

Technology cluster cards added were:

- **Recycling** -> use markers to improve collection and sorting + recycling (and bio-degradability) by design to improve the separation process and avoid EoL CRM in landfill
- **Reuse, Longer Lifetime** -> traceability of materials, in order to know where a certain (critical raw) material is in the product as well as in the supply chain + when and under which conditions it will be available for re-use or recycle
- **Sustainability** -> eco-design/design for recycling, efficient solvent recovery and increase efficiency (again: re-use by design)
- **ICT** -> Internet of things -> electronic passport (tagging each material/application) connect materials passport and tagging to could base platforms to identify where CRM are available in Europe

Supply chain elements were added:

4. **Applications** with material passport tags
5. **Feedstock** (different qualities)

Follow the flexies, who introduced the following flex cards:

- **Product flexibility** -> to facilitate the recovery of CRMs and its re-use in products (strategy of eco-design for easy disassembly, and extension of the life cycle), leverage on the sharing economy
- **Innovation flexibility** -> need to be able to track resources in the supply chain/market and know where CRMs are -> facilitate the use of secondary materials in Europe
- **Feedstock flexibility** -> to be able to use recycled CRMs with different characteristics/quality

- **Capacity flexibility** -> to increase the resilience of the supply chain in light of risk of fluctuating availability of CRMs

Supply chain element was added:

6. **Consumer** -> create awareness and behavioural change to enable collection of CRM containing products (e.g. consumer electronics)

Follow the assesses, who introduced the following cards and considerations:

- **Efficiency of the supply chain** -> essential to reduce production costs of waste a part of the circular economy and increase availability of CRMs (adding recovered end-of-life CRMs to available virgin imported CRMs)
- **Sustainability** -> need to look at environmental, economic and social sustainability i.e. CRM re-use can reduce environmental impact, reduce OPEX but also important to enhance the public image of mining and refining of CRMs (currently not always positive)
- **Business Model Impact** -> Re-use can lead to reduced supply risks, new companies/businesses in the supply chain (e.g. collectors, pre-treatment etc) as well as reduced fluctuation of prices, standards/certification (e.g. for materials passports are deemed necessary for making this new business model work)
- **Resilience** -> supply chain partners are highly interdependent: need to take a systemic approach, combining public authorities e.g. (smart) cities to create local CRM re-use eco-systems, that stimulate consumer awareness, end-of-life collection, managing standards/certification systems for material passports which can be used on cloud-based platforms that map CRM material flows, location and availability as well as facilitation of collection and separation of CRMs in a cost-efficient and effective manner. A systemic approach can also function as a “security” for investors that a local, region or larger geographic marker for CRM re-use will be present and there to stay (investors security)
- **EU reshoring** -> will depend on the balance between risks and costs, affordability of new technologies and market uptake.

An additional supply chain element was added:

7. **Mining** -> opportunities to do mining in Europe serves multiple purposes 1) there may be undiscovered EU deposits that can increase locally mined CRMs reducing dependence of Europe on importing CRMs, 2) mining often has large amounts of tailings (CRM rich waste) which currently are not exploited, mining in Europe may be a stimulance and a local market for investors in the development of new recovery technologies (additional market) -> need to improve the image of mining in Europe

The following considerations were added on post its:

- Need to create a new sustainable resilient investment environment by systemic support (compare Industrial Symbiosis initiative and environment in Kalundborg)
- Multistakeholder governance needs to be integrated in the value chain (e.g. through smart cities), to create incentives and regulation as well as a governance structure that favours a secure investment environment
- Such an environment would also function to support mission oriented innovation

The final result can be seen in Figure 2.

Figure 2. Final result.

3. Comments/ reflections on the business model innovation process

Overall the exercise proved to be very useful to involve all group participants and capture their thoughts. The division in groups works fine and stimulates vivd interactions between the group members.

The time for the game is on the short side.

Involvement of more industry and especially business representatives in combination with research oriented representatives would be favourable.

A clear presentation of the supply chain and its challenges is essential for the game to work.

4. Learning experiences for the business model

The most important value added for the Business Model innovation work in INSPIRE were:

- Suggestions to focus on material passports/tagging in combination with Internet of Things solutions (cloud based platforms) to track and trace CRM material flows and location in products and supply chain, with the aim to increase efficiency and cost effectiveness of the overall business model (key challenge of this business model archetype)
- Suggestion to focus on a systemic approach in Europe, to create a resilient supply chain by multistakeholder governance of a CRM re-use value chain, including public bodies that need to foster secure and predictable market for investors in Europe by creating the right environment, e.g. through standardisation/certification of materials passports and to enable cross-border re-use of materials currently considered as waste.

5. Overall evaluation of the BM Game

The game with the canvas model helped participants actively engage in the redesign of the value chain and evaluate the challenges/opportunities. Creative and critical thinking was made possible by the assignment of

different roles (techies, flexies, assesees) for detailed evaluation of the business model archetype for a specific business case.

INSPIRE and Nader Akil (PNO) and Ron WeerdMeester (PNO) wish to extend their gratitude to the participants for their useful discussions and inputs.