Challenges for the supply chains of the future

(NEXT-NET) The Next Generation Technologies for networked Europe project aims to put in place a cross-sectoral and cross-technological initiative at European level to increase integration between production and distribution proposing research and innovation priorities for the future of supply chains (SCs).

Main results consist of:

- Creating a European network reaching a critical mass of relevant stakeholders from the process industry, manufacturing, logistics and distribution
- Identifying future industrial scenarios based on the analysis of trends and their impact on supply chains
- Developing a European Strategic Research Agenda and action plan for the Supply Chains in 2030

The project is based on a top-down and bottom-up approach by involving different stakeholders. Companies from the process industry, discrete manufacturing, distribution and logistics, ICT providers, and consumers will be involved.

NEXT-NET is grounded on the analysis of the status of implementation of most important European and national roadmaps, the identification of the most promising enabling technologies for the future industrial scenarios to develop the research and innovation priorities, and on workshops (focus groups, brainstorming sessions etc.) with experts and stakeholders from more than four supply chains across Europe.

NEXT-NET has developed and assessed future industry-specific supply chain scenarios, which are shaped by various socio-economic, political and technological megatrends. The projection about the future state of factors affecting the design and operations of global SCs will reveal what challenges and opportunities will arise. This publication focuses on the identification of challenges that will face supply chains in future scenarios.

Some studies are already available in literature analysing specific challenges, but most of the time they focus on some specific application or domain. Sustainable logistics and supply chains are the engine for a more competitive and unified European market. To be able to comply with market demands, logistics must be highly efficient, reliable, safe, secure, environmentally friendly and cost-effective. Some key aspects include (Clausen U., 2016):

- better utilisation of existing infrastructures
- in Europe, increases in infrastructure capacity cannot always be (cost-effectively) facilitated by physical infrastructure expansion
- anticipated shortages in manpower required for physically demanding tasks

In addition, some challenges are related to the adequacy of measures to minimise advanced logistics negative effects and include (Clausen et al., 2016): (1) reduction of the environmental impacts (e.g. carbon footprint, noise, un-safety and inadequate land use), (2) reduction of the demand for non-renewable resources, (3) improvement of external safety and labour conditions. Furthermore, the creation of megacities and people getting older suppose the appearance of challenges for society and the corporate world linked to risk behaviour, mobility and certainly consumer behaviour. With regard to logistics, it is linked to the need to organise warehouses, transport operations and other workplace environments. Megacities have been identified as a trend within the social dimension in Next-Net project.

The major challenges for manufacturing companies are "aligning corporate strategy with the right organizational model and matching that strategy to targeted customer segments— by size, footprint, vertical category and market. Leading logistics providers excel at understanding key customers' needs and purchasing behaviours—and they know that understanding is a key ingredient to build a solid strategy and defining the most efficient commercial approach and offerings"[1].

1 https://www.bain.com/insights/challenges-and-winning-models-in-logistics

Figure 1. NextNet Project

Identification of challenges in future scenarios

NEXT-NET identified challenges in future scenarios taking advantage of information regarding future projections already developed during the project, including six macro scenarios with specific features and technologies.

Optimistic	aSPIRANT	Inventory levels dimension includes low and constant levels of inventory
	PrOCEEDINg	Low and personalised inventory, higher stocks
Intermediate	oFFsET	High inventory levels, multi-level inventory, and shortage of some materials
	DiThER	Low levels of inventory, higher stocks
Pessimistics	UNEasE	High inventory levels
	ENDANGEr	High inventory levels, low levels of inventory based on demand, avoid the use of scarce resources in production to stock

Table 1. Definition of the six future macro scenarios proposed by NEXT-NET

The methodology used for the identification of challenges for supply chains consists of two stages:

(1) Identification of challenges based on the six macro-scenarios defined in the project. The identification of challenges is based on technological challenges and gaps from each scenario.

Figure 2. Technological challenges and gaps identified for all future scenario.

Different dimensions were considered when performing the challenges identification.

Figure 3. Dimensions of the challenges

During the first stage of the analysis, it has been observed that whether a certain trend creates a challenge or not very much depends on 'what supply chain actor' one looks at. Future scenarios leading to more 'local sourcing' due to protectionism might create a 'challenge' for 'buyers' of raw materials/products as there are few suppliers (only local) to choose from. This, however, might be an 'opportunity' for 'local suppliers' in the sense that they now would have more power (e.g. can charge higher prices) and even develop local networks. Consequently, for all the actors within a supply chain to survive in different future scenarios, a holistic view needs to be taken and win-win solutions for all actors in the supply chain need to be designed.

(2) Identification of challenges with input from industry stakeholders through a dedicated workshop. The workshop with stakeholders enabled the list to be consolidated and to challenges to be specified taking into consideration the point of view of different actors in the supply chains (buyer, supplier, policymaker, and facilitator).

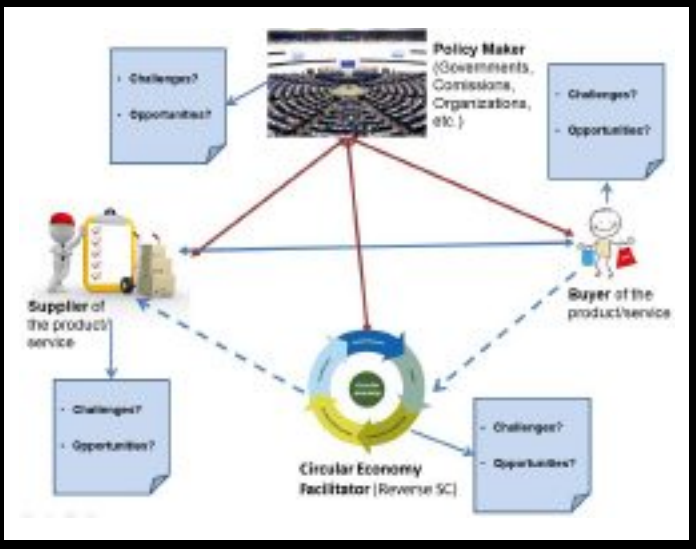

Figure 4. Interrelation within the stakeholders of the SC

The results and insights generated by the workshop resulted in the identification of the challenges along the six scenarios. The most common challenges:

- From the point of view of the supplier, the main challenge is how to be competitive to gain share market. One possible strategy is through differentiation, e.g. through technology or the use of new materials (linked to challenges #5 and 6).
- The main challenges for the buyer are the adaptation to new business models according to technology (linked to challenge #1). In addition, the existence of policies that promote sustainability.
- For the policymaker it is challenging to establish the suitable environmental laws, making use of the proper channels to share the information (linked to challenge #11).
- The facilitator faces the legislative pressure on the final disposal of goods. Different technologies can bring a detriment to the use of human labour thus driving to a loss of employment. In addition, digitalisation (in different levels) can be used for the circular economy coordination to create new jobs. This supposes a challenge due to data protection issues (linked to challenge #5).

The identification of SC specific challenges from macro-scenarios resulted in an initial list of 65 challenges, identified from all the scenarios. It is interesting to underline that in several cases firms end up facing similar challenges in very distinct future scenarios. Therefore, certain challenges are quite important regardless of how the future looks and businesses need to come up with sound strategies mitigating risks stemming from such challenges. Most probably, 'proactive' strategies must be designed for these as the likelihood of these scenarios being realised is significant. Contingency planning or a mix of proactive and contingency planning might be the appropriate choice for some other challenges that only appear in rare situations.

After their identification, challenges were aggregated according to cluster-specific topics in order to restrict the number to a reasonable amount and to help the process of identifying research needs.

Technological challenges have been also identified in the project regarding 18 enabling technologies: Autonomous transport systems, Robots, Cloud based computer systems, Internet of things, Distributed ledger/blockchain, Artificial intelligence, Data science, Mobile and wearable devices, Communication infrastructure, Identification technologies, Location technologies, Visual computing, Additive manufacturing, Energy infrastructure, Alternative propulsion system, Renewable energy technologies for production and storage, Smart materials, Nanotechnology. These challenges are transversally linked to the other challenges previously considered due to their interrelation with some specific aspects addressed in each of the clusters identified.

A careful analysis of the reasons why these challenges are relevant leads to the observation that while some are related to technology or infrastructure, some others could solely be due to behavioural or legal issues, and so on. In certain cases, even though the actors within a specific supply chain can effectively and efficiently share information (i.e. ICT is sufficiently developed and the systems

		Technological Challenges												
		TCH#1: Tech. maturity	TCH#2: Improvement energy systems	TCH#3: Costs	TCH#4: Acceptance and awareness	TCH#5: Lack of standardisation	TCH#6: Safety for users	TCH#7: Security	TCH#8: Scarce interoperability and difficulties in integration	TCH#9: Need for specialised workforce	TCH#10: Limited production/scalability	TCH#11: Limited reliability	TCH#12: Accuracy	TCH#13: Feedstock supply
Enabling Technologies	Autonomous Transport Systems	•	•		•	•	•	•	•					
	Robots	•	•	•	•	•	•	•						
	Cloud based Computer Systems	•		•				•	•		•	•		
	Internet of Things (IoT)	•		•	•	•	•	•	•			•	•	
	Distributed Ledger/Blockchain	•	•		•	•		•			•			
	Artificial Intelligence (AI)	•		•	•	•		•		•			•	
	Data Science	•						•		•		•		
	Mobile and Wearable Devices	•	•		•			•			•		•	
	Communication Infrastructure	•						•				•		
	Identification Technologies	•		•		•							•	
	Location Technologies	•	•	•		•		•			•		•	
	Visual Computing	•	•		•	•	•	•		•	•		•	
	Additive Manufacturing	•				•		•				•		
	Energy Infrastructure	•	•			•		•						
	Alternative Propulsion Systems	•		•		•			•					•
	Renewable Energy Technologies for Production and Storage	•		•	•						•	•		
	Smart Materials	•		•	•					•				•
	Nanotechnology	•					•			•	•			

Table 2. Mapping of technological challenges on specific technologies

enabling efficient data/information transfer is well established), they end up withholding critical information from their supply chain partners. This could be due to several reasons such as conflicting incentives, no legal requirement for such reporting or information sharing, the fear of releasing confidential information, or the risk of letting competition get their hands on such information (or even create own competition). It is important to know what the main underlying reason behind a challenge is so that corrective actions can be taken to attack the root cause of the problem and avoid spending resources (time and capital) on the wrong issues.

	Definition	B	O	L	F
CH #1	Developing new collaborations SC models	•	•		•
CH #2	Resource management for a circular economy	•	•	•	
CH #3	Sourcing complexity management	•	•	•	
CH #4	Developing "leaner" and more flexible SC		•		
CH #5	Promoting efficient and sustainable logistics in urban environment		•		
CH #6	Facing changes in SC due to personalised shipment		•		
CH #7	Organising SC for variable and custom demand	•	•		
CH #8	Ensuring quality along the SC		•		
CH #9	Identifying talents in SC	•			
CH #10	Energy and emissions management	•			
CH #11	IT Integration and interoperability	•	•		•
CH #12	Managing IP protection issues	•		•	
CH #13	Dealing with digital-driven issues		•	•	
CH #14	Human perspective in digital transformation	•			
CH #15	Coping with digitalisation and globalisation in finance	•			•
CH #16	Addressing problems and limitations of regulatory framework	•		•	
CH #17	Facing outsourcing complexity	•	•		
CH #18	Managing omnichannel SC and multimodality		•		
CH #19	Managing complex or increased information flow		•	•	
CH #20	Dealing with industry concentration and competition		•	•	
CH #21	Managing risk and disruption	•	•		
CH #22	Facing inventory and shipping problems		•		
CH #23	Policies			•	

Table 3. Main challenges for the SC of the future identified in NEXT-NET

A classification of the challenges into operational, behavioural, technological, financial, and legal issues was performed, but it is necessary to take into consideration that many of those challenges have a combination of different issues (even all of them) that are interlinked. Operational and technological challenges are rather straightforward as they become obvious immediately, but we also added the impact of human decision making and interactions (behavioural), the policymaker's impact on how global supply chains function (legal), and the difficulties associated with setting up a business or the ultimate goal of any business, which is making money (financial) challenges. In what follows, a brief discussion of these challenges within the aforementioned categories:

Behavioural issues: In decentralised systems where each entity in the supply chain strives for optimising its own objectives (e.g. maximising profits) in isolation without considering the impact of own decisions on the performance of the rest of the partners, it is known that the system efficiency (of the whole chain) deteriorates. In general, it is quite difficult to change such behaviour and make people adopt a holistic view of the supply chain rather than their own firm/ business unit in isolation. Initiatives to increase coordination and collaboration among supply chain partners are not always successful because of the lack of willingness to share information, coordinate actions, and collaborate when necessary, even if it is technically possible.

Operational issues: Longer and more complex/global supply chains with different technical and information infrastructures make supply chain management even more difficult. Most of the challenges, besides the political ones and other specific cases, have an operational component in it. Significant research in improving the quality of such decisions must be carried out to be effectively and efficiently combat such challenges.

Legal issues: Regardless of whether a supply chain is local or global, there are certain legal obligations that each supply chain actor must comply with. Apparently, this becomes a herculean task for firms that do business with supply chain partners the world over. There are different and at times conflicting regulations in different parts of the world, and companies that are present globally need to develop effective strategies to ensure compliance. These challenges limit the options supply chain professionals have and determine the boundaries in which they can do business.

Financial issues: A lot is happening recently in the field of supply chain finance that has the potential to change the way business manages the financial flows. Chief among these are the new sources of income (e.g. crowdfunding), new forms of payments and currencies (e.g. cashless payments and cryptocurrencies), technology enabling financial flow integration and settlements. As most of these developments are fairly recent, new research needs to be carried out to identify proper mechanisms/models to finance SMEs as well as big players (e.g. reverse factoring, crowdfunding, platforms enabling the allocation of costs/benefits through smart payments and smooth financial transactions), explore the impact of new currencies on global trade agreements, use of new technologies for financial flow integration and emergence of fintech providers (e.g., blockchain).

Conclusions

It was observed that in several cases firms end up facing similar challenges in very distinct future scenarios. For this reason, after the workshop, a list of clustered challenges was created merging in a reasoned way the long list initially collected.

Major technological gaps and challenges to enabling technologies were identified, the most commong of which being a lack of maturity of technology or underdevelopment of technology, data security and intellectual property threats, and lack of standardisation for the use of technology.

The workshop carried out with industry and academic participants served to validate the results obtained during the first stage of the methodology.

In a complementary manner, based on the categories, different research needs should be put in place. For instance, behavioural challenges will be linked to the definition of models understanding human reaction, collaboration, trust-building mechanisms, etc.

Operational challenges will be linked to the recommendations that technology-driven research needs improved flexibility, and resilience should be the focus. Legal challenges will need to be related to research need where regionally or globally sound regulations are in place.

During the analysis, not only operational but also political and systemic challenges have emerged with the need to define a shared mapping of the supply chains, their structure and the definition of a level of competitiveness.

Reference

Clausen U., De Bock, J., and Lu, M. (2016). Logistics Trends, Challenges, and Needs for Further Research and Innovation. In: Lu, M., and De Bock, J.(eds.). *Sustainable Logistics and Supply Chains. Innovations and Integral Approaches.*

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SUMMARY

The NEXT-NET project creates a cross-sectoral and cross-technological initiative at European level to increase integration between production and distribution proposing research and innovation priorities for the future of supply chains.

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