GLOBAL LOGISTIC CLUSTER: THE FUTURE SUPPLY CHAIN WITHOUT HUMAN INTERFERENCE

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Abstract

Globalization has dramatically changed the competitiveness environment. In the past, the competitiveness environment used to be more stable and did not require the supply chain to be resilient. The disturbances have caused the supply chain to increase costs and lead-time. Moreover, the consumer trend for high quality products, with minimal costs and just on times limits the competiveness of the supply chain. The majority of research recommends to implemented logistic clusters to minimize these negative effects and maintain competiveness; however the research does not consider the management part of the logistic clusters. The authors indicate that a concept of cyber-physical systems can be used to limit the trade-offs in the logistic cluster management. The main finding is that these technologies enables the supply chain to gather information, process it and utilize the information by using innovative technologies such as autonomous vehicles. The developed methodology based on these trends can be used to implement a global logistic cluster without human interference. The created methodology could minimize the trade-offs in the supply chain, which are necessary with the current understandement of supply chain management.

Keywords

Supply chain, logistic cluster, industry 4.0, self-driven vehicles, innovation

JEL Classification: L91, P25, O32

Introduction

History has revealed the need of innovation and technological development. In the past our ancestors gathered herbs, later started growing crops and breed animals. In the 18 century, the industrial revolution began. New types of manufacturing processes appeared which minimized the production costs dramatically. Today due to developed innovative technologies (e.g. internet) it's necessary to change the way of thinking like in the industrial age and to start thinking innovative as it should be common an information age. The rules that worked in the 20 century are not working today, because new concepts developed – Internet, Internet of Things (IoT), autonomous vehicles, e-platforms, robotics etc. These innovative technological developments are heading towards a fully industry 4.0 concept which still is developing and currently is only a scratch of the surface. Many people might argue if technological innovation will really reach higher peaks, however the lessons provided from the history can prove it.

The whole economic cycle is based on expenditures, income, credit and how fast everything is done. Newer production methods, processing types, information flow are increasing the productivity, which directly influences the growth of economy, therefore innovations, which increase productivity are inevitable. The best innovative technology, which made a huge impact to the world's economy is internet. Internet allowed to distribute information much faster and cheaper. The result of that is globalization, which pressure every enterprise is feeling. The internet allowed all people to easily access products and services from around the globe. Companies like Amazon, Uber would have been not possible in the past. Uber is the world's largest taxi company, which owns no vehicles. Facebook is the world popular media owner, which creates no content. Alibaba is the most valuable retailer, which has no inventory. Companies with minimal owned capital are growing rapidly. Currently the competitiveness advantage shifted from cheap production to distribution of services, information and products. Production costs has gone down dramatically in recent years, however the supply chain still needs optimization.

The innovative approach indicates are shift of business models in the industry, however innovative technologies implementation in the supply chain can also cause the industry to adapt to the information based businesses. The necessity to innovate the supply chain can be also recognized from the food industry's case. By 2050 it is estimated that the world population will reach 11 billion people, which the majority of them living in urban regions (Parfitt et al. 2010), (Food and Agriculture Organization 2015). The current supply chain is ineffective and produces a lot of food waste, therefore the current supply chain must be changed. The authors' literature analysis indicates the most influence technologies for the supply chain, which connects information gathering, processing and

utilization concepts is cyber-physical systems. The implementation of these systems together with a global logistic cluster can provide efficacy to the current supply chain. The created methodology recommends forming a global logistic cluster, which management would be controlled through technologies. This approach could change the current supply chain and provide more sustainable supply chain management. Currently many researchers urge to make trade-offs in supply chain management, however by using innovative technologies the trade-offs can be minimized and low costs and low environment impact can be achieved.

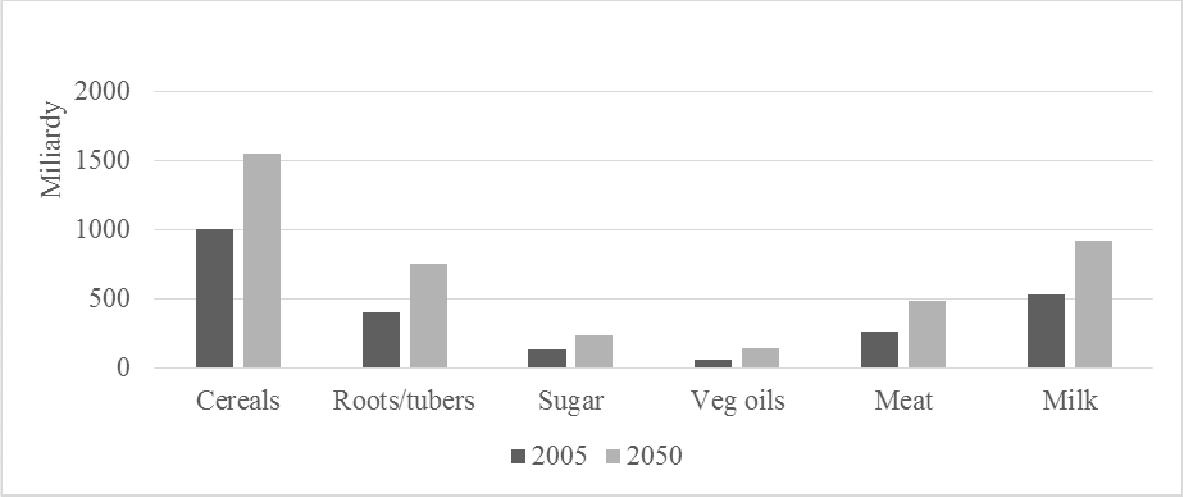
Therefore, the goal of the paper is to develop a methodology for global logistic cluster by using innovative technologies for management aspect. To accomplish this goal several objectives must be accomplished:

1. Identify the problematic areas of the current supply chain;
2. Identify the most influence innovative technologies to the future's supply chain;
3. Model a methodology for a global logistic cluster implementation.

The Necessity to Innovate the Food Supply Chain

One of the key industry's which will face challenges in the future is the food industry. The consumer is demanding for qualitative food, which would be organic and would fit their needs. The obesity problem is rising dramatically, especially in the USA. Unfortunately, the problem is still not solved and in the future, it can get even worse, because of several reasons. Firstly, the world's population is expected to reach nine billion by 2050 (Parfitt et al. 2010), which will increase not only the food demanded but the necessity to reduce lead-time. "As the entire farm to fork cycle is being squeezed to provide short lead times and efficiency, supply chain designs have to rely heavily upon logistics and warehousing functions that provide temperature conditioned transport and storage, and increased use of advanced information and communication technologies. Recent research states that in perishable-product supply chain design, a trade-off should be made between transportation costs, shortage costs, inventory costs, product waste and expected shelf-life losses and quality decay" (Dani 2015).

Figure 1: Food consumption, major commodities (kg/year)



Source: own processing by Food and Agriculture Organization, 2015

Consumers not only need a variety of food, but also organic with as less as possible of chemicals and pesticides. The demand of food demand will increase dramatically (see. figure 1) due to population growth. Currently there a huge problem in the food supply chain, because the lead-time and clarity is not sufficient, therefore there is a lot of waste of food. "Between the farm and the fork, roughly a quarter of food calories are lost or wasted" (World Resources Institute 2013). The lack of infrastructure in many developing countries and poor harvesting/growing techniques are likely to remain major elements in the generation of food waste (Parfitt et al. 2010). Another difficulty that awaits the food industry is urbanization level. Urbanization will continue at an accelerated pace, and about 70 percent of the world's population will be urban (compared to 49 percent today) (Food and Agriculture Organization 2015). The urbanization will cause huge problems to the supply chain. Currently, the urban logistics costs consist of 28%

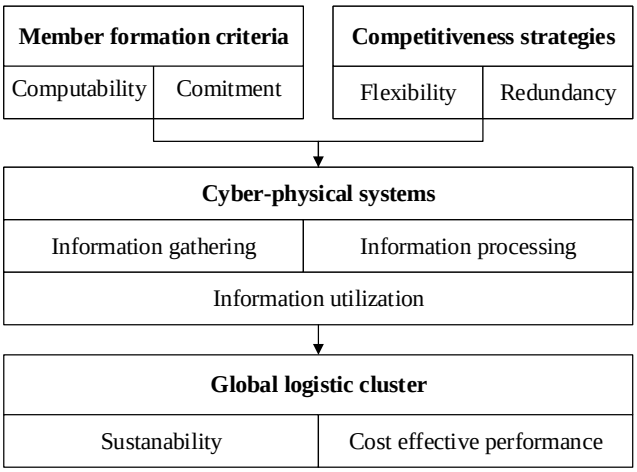
from the total logistic costs, which makes the largest part (Lau 2014). The consumers not only demand for quality and fresh products, but also delivery to their doorstep, because everyone lacks time now. This problem can be solved by promoting the small-scale farmers, which should fulfil the food demand. "Small-scale farmers produce over 70% of the world's food needs (Nations 2015)". These trend will cause the supply chain to be even more complex and increased complexity will limit the supply chain's ability to cope with disturbances. In the future disturbances to the supply chain will increase even more due to decreasing population density and changing climate. Chistopher and Holweg (2011) stated that current supply chain management models emanate from a period of relative stability, and second, that there is considerable evidence that we will experience increasing turbulence in the future (Christopher & Holweg 2011). For the supply chain to be effective in the future collaboration and open data must be promoted, however then many difficulties awaits, which must be solved by using computers and not human interference. Otherwise, it will be impossible to reduce food waste and maintain high quality level. Therefore, it is necessary to promote innovations to secure economic growth and better life quality.

Innovative Technologies Influencing the Supply Chain

In the past enterprises had 1 accountant for 3 people, however today due to technological growth the cost of communication has decreased dramatically. The world's the GDP per capita, which increased approximately 10 times due to technological growth. Innovations in the supply chain has also optimized the whole process of management. Internet of Things allows to gathered transportation information in real time. The gathered information is analysed by using the big data concepts, which allows making micro decisions in the business process, which were not possible in the past. Some people may think that this is already an industry 4.0 concept, however it is only the scratch of the surface what will be possible with a fully autonomous supply chain (pwc 2016). The autonomous vehicles already are being tested as a public transport method to replace taxis, buses etc. (Bloomberg 2016). People can order autonomous vehicles to pick them up and to drive them where needed. This will utilize the roads, vehicles and time even better than traditional transports. A similar situation will be possible with the supply chain. The newly developed autonomous trucks will change the industry, as we know it. Recently an autonomous truck made its first delivery in the USA (Bloomberg n.d.). These all innovative equipment will influence the current supply chain. A concept, which includes information gathering, processing, utilization and management, most, be overviewed in order to model a proper methodology for supply chain management. The concept, which combines all these aspects is called Cyber-physical systems (CPS). This systems combines several functions, which helps to not only connect the physical world to the internet, but also allows for the system based on the processed data make decisions. These functions are integration, sensors, information and data processing, automation and control, networks, actors, adaptability. Firstly, it is important that all the supply chain members can have a certain integration level, which would provide visibility to the chain. This can be achieved through sensors, which can gather information from the whole supply chain. Visibility improves decision-making, however data processing is essential to increase the efficiency of the supply chain. The current technologies focused on decision support systems, however today with automation and control the system it can make decisions instead of human's e.g. autonomous vehicles. For the system to be effective, everything must be connected in to a network with certain actors, which helps to manage and process all the information. Lastly, the system must be adaptability - have the ability to change itself based on previous experience. The CPS concept is being analysed by various institutes around the world. For instance, ehe research for CPS in Europe is multi-dimensional with several European actors - European Union, the Joint Technology initiative (ECSEL) and International Test and Evaluation Association (ITEA). The EU estimated the impact of CPS for economic growth and increase in employment of around 250,000 jobs with more than 100BEuros of additional investment (Commission 2013). It might seem that these systems will remove human interaction in the supply chain, however it is simply a shift of skills. Frazzon et al. (2013) identifies that even though CPS strongly rely on technological advancements, the creativity, flexibility and problem solving competence of human stakeholders is strongly needed for their operation (Frazzon et al. 2013). The CPS concept can also reduce costs in terms of maintenance. Rise of cyber-physical systems (CPSs) and smart, connected equipment paves the way for additional opportunities for the service business among the lifecycle and pivots of traditional maintenance, repair and overhaul (MRO) service business (Herterich et al. 2015). Oborski (2016) also identifies that connection of technical systems, machine tools and manufacturing processes monitoring with advanced information processing seems to be one of the most important areas of near future development. It will play important role in efficient operation and competitiveness of the whole production system. It is also important area of applying in the future CPS that

can radically improve functionally of monitoring systems and reduce the cost of its implementation (Oborski 2016). Trappey et al. stated that CPS is the core technology enabling the transition from Industry 3.0 to Industry 4.0 and is transforming global advanced manufacturing (Trappey et al. 2016). However, for supply chain management this concept must be implemented not in an organization scale, but in a region, or country scale. Tachizawa et al. suggests that smart cities and big data alone have limited capacity of improving supply chain management processes, but, when combined, they can support improvement initiatives (Tachizawa et al. 2015).

Figure 2: Global logistic cluster formation methodology



Source: own processing

To effectively use the cyber-physical systems a logistic cluster should be formed. Fig 2. Identifies the key criteria, which should be considered when formatting a logistic cluster. Firstly, the members for the cluster should be chosen based on computability criteria and commitment. The members should by compatible and should be working in a common industry. In addition, they should decide on a proper commitment level, which is necessary for a useful logistic cluster formation. Mainly, there are too approaches to have competitiveness advantage for a supply chain. The supply chain can be flexibility, have an ability to quickly adapt to changes in the chain or have redundancy, anticipate and be prepared to deal with upcoming disturbances. The management of the cluster and the best combination of these approaches can be obtained through cyber-physical systems. Then the logistic cluster can maintain sustainability and cost effective performance, which would lead to a long-term competitiveness advantage.

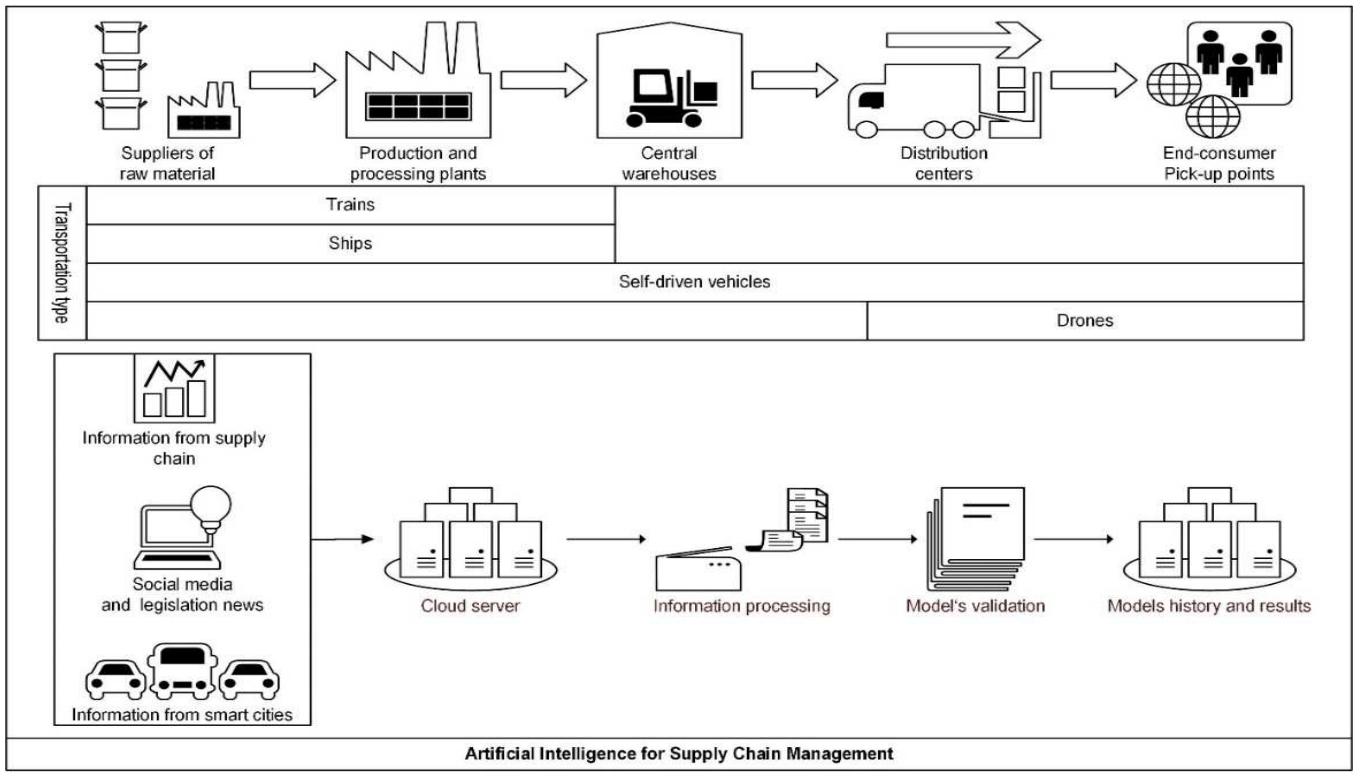
Implementation Possibilities of the Global Logistic Cluster

The benefits of collaboration and logistic cluster formation has been widely researched. Nie and Sun (2015) identified that search costs are an extremely important factor in the formation of industrial clusters that can give rise to industrial clusters in certain industries (Nie & Sun 2015). Industries located in a strong cluster register higher employment and patenting growth. Regional industry growth also increases with the strength of related clusters in the region and with the strength of similar clusters in adjacent regions. We also find evidence of the complementarity between employment and innovation performance in regional clusters: both the initial employment and patenting strength of a cluster have a separate positive effect on the employment and patenting growth of the constituent industries. Finally, we find that new regional industries emerge where there is a strong cluster (Delgado et al. 2014). Buxmann et al (2008) identified that the centralized coordination scenarios usually lead to superior results compared with different decentralized approaches in the field of procurement planning and distribution planning (Buxmann et al. 2008). Lee et al (2014) results show that collaboration visibility positively influences overall supply chain performance, as measured by operational performance (Lee et al. 2014). However, only a limited amount of research amplified the management aspect of collaboration.

To successfully implement the innovative technologies in the current supply chain a world-wide logistic cluster should be implemented. The main idea is to share information between the members of the cluster, to process it and to utilize the information by using self-driven vehicles. To accomplish this multiple warehouses should be development in the continent, between which self-driven vehicles would

drive continuously. By gaining enough members, the trucks should always be full by gathering partial freight. Later, from the central warehouse the cargo would be distributed across the region, which smaller trucks or drones. However, the practical implementation possibilities of this approach has many limitations.

Figure 3: Global logistic cluster methodology



Source: own processing

Imagine a possibility that a large number of enterprises can communicate together through a platform, place orders, which would be picked up with autonomous vehicles, they would be delivered to consolidation centres and then distributed around the region. Small quantities would be delivered with drones, while larger ones with smaller autonomous vehicles. In addition, computers would do all of this – artificial intelligence (see fig. 3). The process of human thinking still needs to be reproduced by the computer, however even today there are super computers developed, which shows tendencies towards a full artificial intelligence. Watson is a super computer, which can describe and answer complex questions, which are creative and has a hidden meaning. The computer system was specifically developed to answer questions on the quiz show Jeopardy!. In 2011, Watson competed on Jeopardy! Against former winners Brad Rutter and Ken Jennings. Watson received the first place prize of $1 million (IBM 2012). Imagine similar computers like Watson can make business decisions instead of people. Can a fully autonomous supply chain without human interference be a reality in the future? I would say that defiantly, and that it is a necessity to do so, there are various sources to prove it (DHL Trend Research 2014). However, there are many limitations in the practical implementation of the fully autonomous supply chain concept.

The current technological level still has limitations, which must be addressed. Autonomous vehicles must communicate with everything around them, to do so extremely short information transmission time are necessary for trucks to communicate together when they meet each other in a crossroad. Elon Musk is planning to launch satellites which would cover the whole globe with Wi-Fi, therefore these limits are only temporary (The Guardian 2016). Many cities infrastructure lacks the concept of smart cities. Internet of things concept has developed dramatically, however it still lacks adaption to current infrastructure. The smart cities concept allows to optimize energy efficient, but also provide useful information to such kind of distribution systems, however they still lack a lot of capital and restructuration. However, many cities are starting to see the potential and change their environment to fit the need of the upcoming industry. E.g. Singapore, USA, Netherlands. Artificial intelligence based business decision making involves a lot of risk and is

not guaranteed. Business decision-making process is complex and it is even harder to reproduce the process with artificial intelligence, however there is already a lot of computerized processes, which enables real-time business decision making. However, a fully autonomous supply chain still lacks the correct level of artificial intelligence. The combination of information gathering, processing and utilization is just developing. The next difficulty when infrastructure, data and algorithms will be available will be a difficulty to combine everything together. Currently the cyber-physical system concept is being used in the production area, however the supply chain still is under development. The biggest problem would be to store every information in a server and based on that information an artificial intelligence should learn and teach itself how to make better decisions. The data can be gathered and algorithms are available which could start making decisions, unfortunate the storage devices must still be developed, to maintain all the data that could be generated through the supply chain. The government still lacks policy related to open data. For this kind of model to work data must be available from everything and to everyone. However, people has mind-set that you need to compete and not share information. However, speaking about optimization possibilities it is necessary to share information in order to fully utilize the autonomous vehicles. Currently a lot of trucks must stop and rest, which does not increase the efficiency of the supply chain. Moreover, regarding the food supply chain, during this time the pollution to the environment is also increase, because the refrigerator must run all the time. A discussion is also about the safety of autonomous vehicles. Who will be responsible after accident? How can we limit the potential danger of the vehicles? What kind of problems can we face with hackers? Lastly, there will be a lot of social and economic change, when the whole industry 4.0 concept will be implemented in the economy. Development of autonomous technologies will lead to many social and economic difficulties. A lot of people usually faces change in a negative way. Because they feel secure and think why should I change? However, these kind of technology development will destroy a lot of working positions which currently may seem impossible to live without. E.g. accountant, expeditors etc. (Bureau of Labour 2015). However, technological innovation is not a bad thing. Many opportunities arise due to the change and people simply need to change their habits, skills and mind-set. Those who will adapt to the changes will thrive and other might wait too long, but it is necessary to understand that is better to dig a well before the water runs out. Due to technologies, fewer and fewer people can generate the same value as hundreds of people in the past. The result of that is growing economy and growing unemployment rates.

Conclusion

The current supply chain management strategies has been conducted based on previous experience. Previously, the business environment did not change so drastically and there were no problems dealing with disturbances. However, now the changed in competiveness environment and customer trend for high quality services, just on time with minimal costs drastically changed the current supply chain. The authors identified that innovative technologies development can limit the negative effect of the competitiveness environment. The importance of logistic cluster has been widely researched in the past, however the management aspect was not amplified as much as needed today. The authors of the paper determined the main technologies, which must be adapted in the management process of logistic cluster. By using cyber-physical systems for the management of logistic cluster long-term competitiveness advantage can be achieved. These findings are requiring to conduct future research which would provide new strategies for supply chain management. From one side the authors promote the necessity to make trade-offs in the supply chain management, however due to innovative technologies this is not necessary. Innovative technologies can help gather real-time information and increase visibility of the supply chain. Decision support systems were used in the past, which consisted of information processing possibilities. The main identified novelty and new aspect, which was not possible in the past, is information utilization possibilities due to self-driven vehicles in the supply chain. The identification of these trends must be addressed in future research by conducting a supply chain simulation to determine the necessary combination levels of logistic cluster and innovative technologies usage. Moreover, the negative aspects should be addressed in future research such as social, unemployment and so on.

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