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INDUSTRY 4.0 CONCEPTION

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Abstract: The growing market globalization, increasing global competition, and more complex products results in application of new technologies, methods and business processes. Fast changing market environment and fluctuating customer demands require efficient operation of logistical processes. In this study the logistical tendencies and challenges are introduced with reasons and driving forces. The essence of Industry 4.0 conception is also introduced.
Keywords: market environment, customer demands, logistical processes, Industry 4.0 conception

INTRODUCTION

Logistics is a common word nowadays, since it is an essential component in supply chains and also in the competition of the economic operators.

There are several existing definitions for logistics. Logistics is the planning, organizing and coordinating of the flow of materials, information, energy, money and values inside a logistic system. Beyond the realization of these processes logistics is also an interdisciplinary discipline that synthesizes and utilizes the state-of-art knowledge and methods of several disciplines connected to logistics in order to realize a given logistical task.

Therefore, the goal of logistics is to provide things in adequate quality and quantity at a given destination, in an appropriate time, from an appropriate origin, with an appropriate method and equipment, and with an appropriate minimal cost.

The quality and availability of the offered services by the logistics sector are of capital importance for the economical growth and for increasing employment potentials.

Globalization, enhanced competition in the global market, more complex products with shorter lifecycle and fluctuating customer demands gave rise to new technologies, business processes and the application of global supply chains. Therefore, the logistic sector is currently meeting and will meet in the future new practical challenges, and the fast respond to them is the key of success for the economic operators.

INTRODUCTION OF THE EUROPEAN LOGISTICS SECTOR: INFLUENCING FACTORS AND CHALLENGES

The logistical performance of the European Union is nearly 1,000 billion Euro (Fig. 1.). The logistic sector is in constant growth. The Western-European countries are the leading countries, while Hungary is dropped behind with its 4.9 billion Euro (which is 0.5 % of the total European performance). The Hungarian logistical sector gives 6 % of the GDP of Hungary, while in case of Western-European countries it reaches up to 10-13 %. Therefore – as emerges from the statistics – it can be concluded that an efficient logistical sector in a country strongly promotes a successful economy.

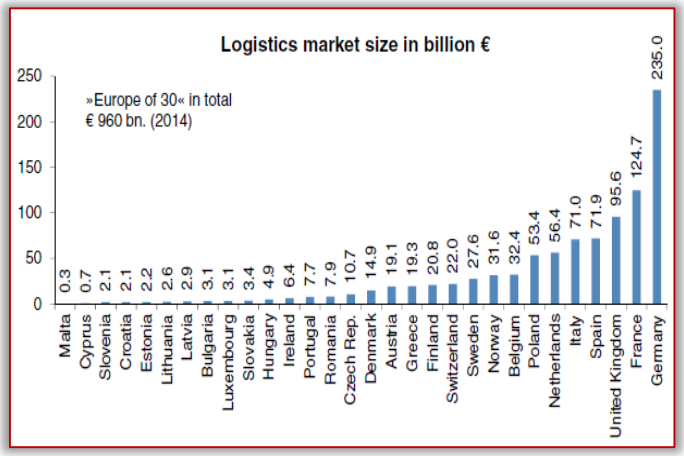

Figure 1. Top 30 countries of Europe in terms of the performance of their logistic sector
Source: Fraunhofer Institute [1]

Furthermore it is clear that the logistic sector of Hungary has to meet high standards because our geographical location and our economical-cultural role as a joint of East and West Europe would provide significant opportunities in this sector.
According to a study of Fraunhofer Institute from 2015 mostly 10 driving forces listed in Table 1 influence the logistic sector of Europe [1].

Table 1. 10 main driving forces that influence the logistic sector

DRIVING FORCES	
1. Globalization	Drivers which can be hardly influenced
2. Demographic development	
3. Sustainability	
4. State intervention	
5. Rising risk	
6. Professionalization – efficiency	Drivers which can be adopted for successful business options
7. Focusing on core competencies – effectiveness	
8. Service oriented	
9. Innovative technologies	
10. Faster ticking clocks	

According to an international survey executed by Jones Lang LaSalle from [2] companies working in the logistic sector defined their main challenges for the next five years with the 13 points:
Reduction of supply chain costs, changing customer demands, increasing volume of e-commerce, improvement of relations between supply chains, reduction of stock level, sensitivity and flexibility of supply chains, sustainability, application of new technologies, intermodality, cooperation in transport activities, reverse logistics, new transport corridors, increasing of global purchase.

INDUSTRY 4.0 CONCEPTION

The tendencies of the 21st century – such as the s life-cycles of products are shorter while consumers demand more complex, unique products in larger quantities – poses many challenges to the production.
There are many sings that show that the current practices in the utilization of resources is not sustainable, which will limit the production.
The industrial sector is going through a paradigm shift, which will change the production drastically. The traditional centrally controlled and monitored processes will be replaced by decentralized control, which is built on the self-regulating ability of products and workpieces that communicate with each other.
The essence of Industry 4.0 conception is the introduction of network-linked intelligent systems, which realize self-regulating production: people, machines, equipments and products will communicate to one another.
This paradigm shift includes the conception of Industry 4.0, which is widely used in Europe, especially in Germany. The name of the conception forecasts the upcoming 4th industrial revolution**,** because according to the theory of the conception the 1st industrial revolution introduced automation, the 2nd mass production, the 3rd is the utilization of robots. Industry 4.0 will bring intelligent production robots.
The goal of the conception is to make flexible, custom production economical, and to use resources efficiently. It requires each equipment that takes part in the production to communicate with one another. The organization of information flow is executed by a central production control system.
Products control their own production, since to communicate with unique product codes with the machines and equipments, which means virtual and actual reality merges together during the production. The scheduling of the production will be also controlled by the communicating products. Factories will be self-regulating and optimize their own operation.

THE 5 MAIN COMPONENTS OF NETWORKED PRODUCTION

The 5 main elements of the networked production can be defined by the following [4]:

Digital workpieces

The dimensions, quality requirements and the order of technological processing is given for the digital workpieces.

Intelligent machine

Intelligent machines communicate simultaneously with the production control system and the workpiece under processing, so that the machine coordinates, control and optimize itself.

Vertical network connection

When processing the unique specifications given by the customer for the product to be manufactured the production control system forwards the digital workpiece created by automated rules to the equipments. The products control their own manufacturing process, since they communicate with the equipments, devices and the other workpieces about the conditions of the production.

Horizontal network connection

The communication is realized not only within one factory, but also in the whole supply chain; between the suppliers, manufacturers and service providers. The main purpose is to enhance the efficiency of production and to utilize the resources in a more economical way.

Smart workpiece

The product to be manufactured senses the production environment with internal sensors and controls and monitors its own production process in order to meet the production standards, since it is able to communicate with the equipments as well as the components already incorporated and to be incorporated.

The production technology of Industry 4.0 is not a technology from the far-away future. In July 2015 the Changing Precision Technology (Dongguan, China) became the first factory where only robots work. Each labour process is executed by machines: the production is done my computer operated robots, the transport is implemented by self-driven vehicles, even the storage process is completely automatic. Furthermore, although not fully, but many companies apply some of the innovative technologies listed in section 2.3.

THE FRAMEWORK OF INDUSTRY 4.0 CONCEPTION, RELEVANT TECHNOLOGIES

The importance of production arranged in global network is that the manufacturing process can flexibly adapt to the unique costumer demands, to the activity of the other parties of the supply chain and to the rapidly changing economic environment.

The term Industry 4.0 is getting global recognition and the survey of PWC [5] from 2016 defines three main areas, where it affects the corporate world:

- integration and digitalization of horizontal and vertical value chains,
- digitalization of products and services,
- the formation of digital business model and costumer relations.

The connected new technologies are shown in Fig. 2.

Figure 2. The main technologies of Industry 4.0 [6]

The cyber-physical production systems (CPPS) [4]

Cyber-physical production systems are online networks of equipments that connect IT technology and mechanic or electronic accessories, which are able to communicate on a network.

Intelligent machines are sharing information continuously about the current stock levels, problems, errors or the changes in demands/orders. The processes and deadlines are controlled in order to increase efficiency and to optimize lead times.

Sensors and controlling accessories allows the machines to keep contact with the factories, networks and people. Intelligent production robots are organic parts of the system, they communicate with the production control system and the workpiece to be processed, so that they are able to optimize the whole manufacturing process and realize system-wide optimization of resources.

Machine-to-machine Communication (M2M)

Machine-to-machine (M2M) communication is essential in cyber-physical systems, since it allows that the devices connected to the network initiate and actuate communication without human intervention or help. For example robots working on a production line can provide each other the necessary components, or stop the whole line in case of errors.

Artificial intelligence (AI)

Artificial Intelligence (AI) is the ability of machines to learn and think logically. With the help of AI machines can perform more complex task, which were unknown by them before not only by programs written by people, but also independently, 'consciously'.

Horizontal and vertical system integration

Products communicate with the production machines and the other workpieces as well to operate their own manufacturing. Furthermore, communication is realized not only within one factory, but also in a whole chain, between each party, such as suppliers, producers and service providers.

Internet of Things (IoT)

Machine to machine communication requires the existence of an information channel, which is called the Internet of Things (IoT). This term is applied for different, identified objects and their internet-like network. Actually IoT is a network connection and data exchange of objects, equipments, vehicles, buildings or other incorporated electronic devices. With the aid of IoT the objects not only percept their environment but also allowed to regulate it, so that the devices can be used more efficiently and economically.

Big data

Systems operating as an intelligent network requires huge, almost unmanageable amount of information. This gigantic data set is called 'big data'. The collection, storage, transport, maintenance and analysis of this data also requires lots of work.

Cloud services, cyber security

The essence of the operation of cloud-based services is to store data of softwares on a distant device, so called 'cloud' instead of local data storage. These stored information can be accessed by any given place and device with internet connection. This raises questions about the examination of access permission, safety of the distantly stored data, or in other words 'cyber security'.

Virtual reality, simulation

Actual and virtual reality merge together throughout the production. Virtuality plays an important role in

this conception both in design and production. The simulation of processes is essential during product design, production planning, and in case of material flow and stocking processes, or in modeling unexpected events and their effects.

According to experts there is 20-30% growth potential in intelligent production networks, and the companies that refuse to follow the development and modernization will fall behind in the global competition. In the near future companies will become digital corporations, which will allow them to realize custom production with maximum efficiency according to the costumers' demands. The prior condition for this is to allow every equipment, device, workpiece to communicate with each other. Although in the near future human resource will still remain the key and essential factor in production.

CONCLUSION

Globalization, changing economic environment and customers' demands and the ever increasing competition in the market emerged the need for new manufacturing technologies and business processes. These changes constantly confront the practice of logistic with new challenges. This study describes the global logistic tendencies and changes of the main production and logistic processes, as well as the driving forces and reasons behind them.

The industrial sector is going through a paradigm shift, which will change the production drastically. The traditional centrally controlled and monitored processes will be replaced by decentralized control, which is built on the self-regulating ability of products and workpieces that communicate with each other. The essence of Industry 4.0 conception is the introduction of network-linked intelligent systems, which realize self-regulating production: people, machines, equipments and products will communicate to one another.

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