REORGANIZATION OF THE LOGISTIC PROCESSES IN ACCORDANCE WITH THE REQUIREMENTS OF "INDUSTRY 4.0"

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Abstract: The article analyzes the essence, condition and functioning of the existing logistics system. The aim of the publication is to examine approaches to structural changes that must be made in the logistics system to bring it to the requirements of Industry 4.0. These are segmented and holistic approach and choice for their application, and also the coming change in the pyramid of organization and automation of these processes. Discussed are other approaches to the reorganization of these processes.

Keywords: INDUSTRY 4.0, LOGISTICS PROCESSES, CYBER-PHYSICAL SYSTEM

1. Introduction

The development of information technologies in all spheres of economic life forms the concept of coming changes in industrial activities. The logistics as an integral part of total industrial development, is also subject to these laws. The adoption of this concept as a basis for securing enterprise development determines the particular importance of logistics processes as a necessary resource for development and increasing the competitiveness and efficiency of the products. This is a development that impose a dominated the new technologies that are built on the information base and creating a market for information and knowledge [2,4,9]. It is characterized as requiring economy by service type and is characterized by increasing attention to the role of services and increasing business orientation towards the client. Increasingly will satisfy the interests of consumers and will form the basic principles of business development in achieving better results. This new production attitude is oriented towards the use of individual solutions for all standard principles and practices. A particularly important feature of these principles is that they act everywhere, as customers are treated not so much as an end user, but as a business partner who participates in the value chain and has the role of the applicant in this contact economy. Basic prerequisite for development of this process is the creation of intelligent manufacturing and alignment of industrial activities with the requirements of Industry 4.0. Particular importance in this process play the logistic subsystems characterized by its specificity of expression and their direct impact on production efficiency [5,6,7].

2. Essence, condition and ways of functioning of the logistics system in the existing production conditions

2.1. Role and place of the logistics system in the production system

The logistics system is relative systematic combination of components, interconnected for implementation of corporate strategy of a particular business organization. The logistics system is designed to perform the following activities: provision of products and services in a given place, in the necessary quantities and assortment with the highest possible degree of preparation for production and personal consumption whit a given dimension of the costs. For logistics systems it is assumed that their nature is characterized also with stages of development (automation of activities), which extend the components of the production system.

Subsystem of the logistics system is part of this system, which allows to solve tasks of the logistics system at a lower level in a separate logistic activities or field of the business organization. The components of the logistics system arranged in certain levels, modes and relationships, form the the logistic subsystems [1].

The logistics system includes management and control of material, financial and information flows from supplier to consumer. In general requirements the logistics system contains the following: purchase and supply of materials; raw materials; storage of products; production; distribution; consumption and others. All they need to be financial and information secured to establish normal functioning of the logistics system viewed as a whole. This means that the material, financial and information flows, or called logistics chains, by their nature can be regarded as subsystems because they are characterized by systematic property. It is customary these are dealt with as:

- Logistical subsystem of material flow;
- Logistical subsystem of financial flows;
- Logistical subsystem information flow.

Typical for this classification definition is that they as subsystems of a one system (logistics) are bound together with certain relationships characterized by systematic structural and logistical security of the enterprise. The system will be in equilibrium when the relationships between these subsystems create conditions for normal functioning of the logistics system, providing logistical support to the production. This means that the relationship between the three types of subsystems will form the optimal relationship between them and those in the service sector. In Figure 1. is shows the structure of the logistics system with its subsystems.

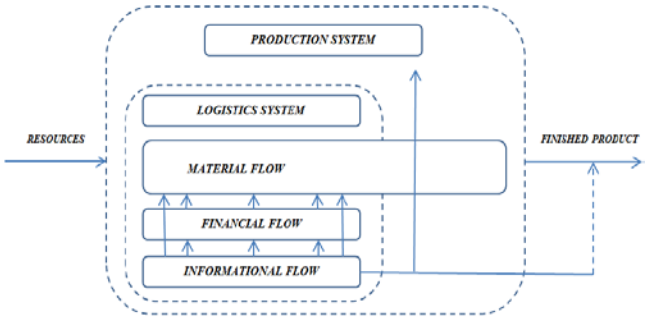

Figure 1. *Structure of the logistics system*

Subsystem material flow - characteristics.

The logistics subsystem material flow is the main or the most important components in the entire logistics system. This is because the material flow is the one, without which it is impossible the course of the production process, and therefore and functioning of the production system. When talking about material flow actually be understood subsystem of material flows, actually be understood subsystem of material flows, which carried movement of main, auxiliary and other material components without which it can not be done any production of products and services.

In fact subsystem of the material flows can be viewed, arranged and analyzed the following key features:

- regarding the site of the enterprise in the logistics chain - in this case differ internal and external flows or inflows and outflows of the enterprise;
- the number of the assortments (nomenclature position) material flows are divided into single and many product. According the assortment, material flows are divided into one- and many assortments. The assortment is divided into groups and types.

- at the level of determination of the flow parameters differ two types of material flow - deterministic and stochastic. Deterministic are fully specified parameters, while stochastic flow parameters are random variables;
- on the basis continuity in the time differ continuous and discrete material flows.

Another important factor is that material flow is not only fundamental, but that it defines volume parametric requirements and the quality of collateral from the other two flows (financial and informational. Therefore, the characteristic features are associated with the materials (supply and storage), processing (basic, specialized and more.), mounting of the product (installation, storage, distribution, etc.). It is most important in terms of formation of competitive advantages in the production of products and their market realization.

Subsystem financial flow

The examination of the financial flow as a subsystem can be considered only in terms of the system requirements. Or to what extent the components of other flows are financially secured for the normal course of the production activity. An essential role in this respect play degree of automation of this process, or opportunities for passing and making on flexible and fast financial operations resulting in a savings of time, money and human resources.

The main objective of financial flows in the logistics system is the continuous provision of financial resources in the required volume and deadlines using the best and most effective sources of funding of the production-logistics system.

Подсистема информационен поток

In modern data structures, that provide electronic processing of information, the considered as logistics subsystem information flow is indeed subsystem of production - information system of the enterprise. In fact, it is one of the necessary elements of the electronic system of the production management and the enterprise as a whole.

Interrelation between logistics subsystems of the physical, financial and information flows and development tendencies

Material and financial operations are always related with the necessary specialized information, and synchronization of material and financial flows in the logistics system can be achieved only if there is sufficient in volume and quality information.

To be operational the logistics systemis necessary to seek optimal of interconnections between the components forming the conditions and the performance requirements of the material, the financial and information flows. They, in turn, create an environment for effective logistics support of production activity, directly and indirectly affect on both the achievement of the main objectives of the firm and on its economic performance.

Well-structured logistics systems create real conditions and opportunities for quick and flexible adaptation of the subsystems to the requirements of the production system and effective production. Many of the industrial companies seeking optimal solutions on this issue started to react quickly, shortening the cycle of material flow through a gradually and selectively removal of several stages.

On the other hand, financial flows, with the new electronic requirements started flexibility to use financial instruments for fast and seamless service to the logistic process in the industrial enterprises. All this, however, is impossible without a well-established and problem oriented to the logistic needs of the production logistics information system. So, the effect of the impact of the logistics system on the effectiveness should be looking apart from in the way of construction of the relationships between subsystems and also in seeking of optimal solutions to the logistics flow process, and it is now a priority of Industry 4.0.

Need for reorganization of the logistics processes

The rapid development of technical progress will increasingly put on the agenda the question with the effectiveness of the logistics system. Industrial enterprises are beginning to experience such need of modern logistics which is directly oriented to the problems of the efficiency and their competitiveness. The implementation of new solutions in organizing the logistics, built on improving the relationship between logistics subsystems (physical, financial and information flows) yet it is still focused on automation of this activity case of centralized management. Still the pyramid of automation is seen as a multi-stage of development, with the highest level of ERP systems, as shown in Fig.2. The time and the production needs require prompt decisions for the reorganization of the logistics processes and align them with the requirements of Industry 4.0.

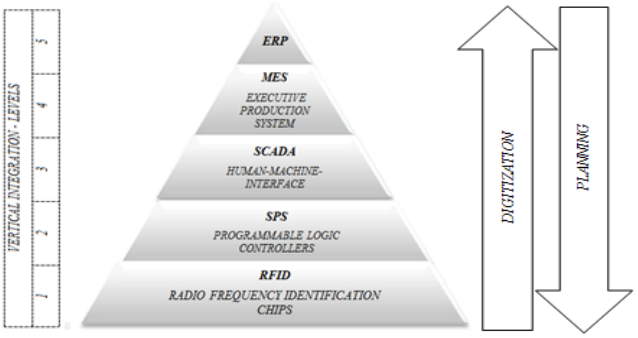

Figure 2. *Pyramid of automation*

3. Nature and basic requirements of Industry 4.0.

The concept "Industry 4.0" is a new industrial philosophy that offers the replacement of the centralized management with decentralized with the construction of intelligent manufacturing systems and "Smart Factories." It includes so-called "Internet of Things" and "Internet of services" that can qualitatively to alter the future production and logistics processes. It is not only a technical challenge, and creating opportunities to new production models and corporate concepts in a networked world.

The main element of this industrial revolution cyber - physical systems (CPS), whereby create networks for self-regulation of spatially distributed production resources. Cyber physical systems include physical objects (mechanical complexes) whit IT systems with hardware and software digital components with mechanical or electronic parts that autonomously communicate with each other. So cyber - physical systems are intelligent systems, which cover hardware and software, and effectively integrated physical components that interact closely with each other, so as to reflect the change in status of the real world.

The most important factors for technical progress are embedded systems and global networks (Internet and data services). Embedded systems already play a central (hidden) role in the lives of us all. More than 98% of all processors produced in the world are used in regulatory, control and monitor functions in devices, distributed in all aspects of daily life. They are road transport, ABS and ESP systems, smart phone communications and information services, in the ordinary household utensils to the industrial production. Embedded systems are the most intelligent central control units at work in the most modern technology products and devices. They operate like processing systems "embedded" within to "connect" with the product for a range of applications. For this "connection" with the outside world are used sensors and actuators, allowing the embedded systems to be becoming more connected to each other online.

Internet of Things, as a cybernetic system aspect are: intelligent machines, built-in self-regulating systems, hardware, software and more. uniquely addressed objects and networks that intelligently interact with each other to achieve a common goal. *Therefore,* Internet of Things describes overall network of embedded systems with household items, manufacturing, infrastructure or equipment via the Internet who have uncontrolled by the people communication of system status and performance of intelligent actions (communication of a component by component).

Internet of services is the ability to "service providers" to offer their services. The Internet is composed of participants in the service, and these are: infrastructure for services, business models and performers themselves of the services. Services are offered and combined into value-added services from different suppliers; they communicate to consumers, since consumers have available to them

through various channels [3]. This development provides a new way of dynamic variations in the distribution of the activities of the individual value chain [10]. It can be assumed that this concept will be transferred from individual factories to entire networks of sites with added value in the future. Factories can be one step ahead and offer special manufacturing technology, not only productions.

Place and role of logistics in the Industry 4.0.

Industry 4.0 requires so-called service-oriented platform of development (intelligent monitoring) of the product, which means that he will be monitored throughout their lifecycle - from concept to recycling it. These intelligent products (Smart Products) have knowledge of their production processes and their future application. They actively support the production processes (when it will be produced, with what parameters, whit what materials should be produced, where it should be delivered, what modifications, etc). In Industry 4.0 logistic support has qualitatively new dimension. Logistics chains will be under constant optimum connection with the manufacture of the product, so that the material, information and financial flows will be components (physical and virtual) of a cyber system, built by both the physical real objects and from the virtual ones operating in optimal levels in the production network system.

This service-oriented platform, including features of Smart Mobility, Smart Logistics and Smart Grid makes it intelligent factory, producing intelligent products, and the intelligent logistics system becomes an important component of future smart production infrastructures.

Characteristic in this development is that IT-support at all hierarchical levels leads to a new trend of an increase in information flows at all levels and gives rise to the need for a new model of industrial information architecture. It should reflect the three dimensions of vertical and horizontal integration. Moves smoothly from a centralized to a decentralized control and levels of automation pyramid began to blur. The planning of the production moved to the level of ERP, Figure 3.

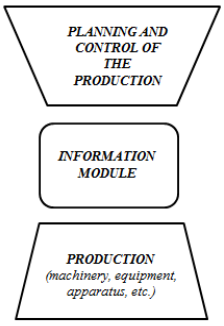

Figure 3. *The passage of some of the automation functions at lower levels*

In order to enable effective to operate in this new environment production-logistics system its necessary its components can be adapted according to requirements of Industry 4.0.

4.Adduction of the logistics system to the requirements of Industry 4.0

Hybrid (segment) approach

Industry 4.0 is a manufacturing revolution in terms of cost and time savings. The intelligent factory production brings many advantages compared to conventional production or it's transition to the future smart factory production. Cyber physical systems require the networking of information, technology and production systems through a domains and hierarchical limits. This requires interoperable communication interfaces and standardized protocols. Moreover, industry products are intelligent because they carry information from its own production in machine-readable form (RFID Chips) in order to coordinate their actions in their own production.

To meet the requirements of real-time communication, cyber-physical systems must meet the requirements for high availability in a longer life cycle, so they must be built with standard IT components. Thus, in order to implement a decentralized collection of data must be continually integrated IT systems - in the best case, including Enterprise Resource Planning (ERP), production management (production system performance, MES), systems to monitoring - supervisory control and data acquisition (SCADA), controllers (SPS) and embedded systems in operative level (vertical integration). All these components as well as the network in the enterprise will be integrated into the horizontal integration. The result can be used data and services for information flows that are crucial for cyber-physical production as a whole.

The conversion of the logistics system in a component of the Cyber-physical system

Figure 4 shows the transition from the existing to cyber-physical systems (including the logistics system).

CYBER PHYSICAL SYSTEMS	***FEATURES***
Embedded systems (appliances, devices and others for regulatory, control and monitor functions)	Coverage of all physical data with sensors. Use of models for work and optimization in real time.
Production facilities Logistics (coordination and management processes)	Using international data and services at all levels. Construction of intelligent systems.
	Evaluation and data storage.
INTERNET SERVICES	Creation of network through digital communication technologies
	Effects of the physical world
	Use of multi module Man-Machine-places (displays, control speech, management of gestures)

Figure 4. *Transition from independent logistics systems to components of the Cyber physical systems*

Usually Cyber physical systems (CPS) include: embedded systems, production, coordination and management processes, as well as Internet services, which by means of sensors physically collect data and interact on physical processes using digital networks connected to each other. Not least here include the logistics systems. They can use globally available data and services, and multi model human-machine interfaces, logistic service and others.

The Cyber-physical systems are open socio-technical systems and allow for the performance of a number of new functions, services and properties. Basically, cyber-physical systems include robots, smart objects and self apparatus. So one of the most important tasks in the design, development and management of cyber-physical systems is the issue of collaboration on cyber-physical systems and people. Issues that are important in the context of this is to identify and model the "situational awareness", human experience of these systems and the environment, but also reflect changes.

The hybrid approach is the most appropriate for now for phased reorganization of logistics processes and bring the system according to needs of industry 4.0.

Forecast (holistic) approach

It is forecast for future full implementation of the principles and requirements of Industry 4.0, which defines a period of 15-20 years.

The logistics system is essentially a subsystem of the Cyber-physical system. The implementation of cyber-physical systems in manufacturing “born” "smart factories." The intelligent fabric products, resources and processes are realized through a cyber-physical systems. Obtaining real-time data for quality, resources and costs provide significant advantages as compared with the classical production systems. The intelligent factory must be built in accordance with sustainable and service-oriented technology and business practices. They are characterized by flexibility, adaptability and self-learning, fault tolerances well as risk management. The high levels of automation become mandatory

standard in the smart factory, which is possible thanks to the flexible network of cyber-physical-production-based systems that automatically monitor the production process. Flexible intelligent manufacturing systems and models that are able to respond in real time allowing internal production and logistics processes are radically optimized. The production advantages are not limited on single time production conditions, but in the ability to optimize through a global network of adaptive and self-production components belonging to more than one operator.

Conclusion

From an analytical study of the role of the logistics system can be summarized the following conclusions:

1. The logistics flows - physical, financial and information, in terms of the orderliness can be seen as subsystems of the logistics system.

2. The nature of the interaction of linkages between the subsystems directly and indirectly affects the physical and virtual nature of the components of the logistics system.

3. The reorganization of logistics processes and adapt them to the requirements of Industry 4.0, essentially becoming logistics in system logistics component that is part of the structure of the Cyber physical system.

4. The system logistic component of cyber-physical system comprises a physical object (material flow) and two virtual object (logistics financial and logistic information).

5. The hybrid approach is the most appropriate for now for phased reorganization of logistics processes and bring the the logistics system according to the requirements of Industry 4.0.

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