ICT IN LOGISTICS: POSSIBILITIES AND THE AREAS OF APPLICATION

Igor Jovanović [a], Aleksandra Čolović [a]

[a] University of Belgrade, Faculty of Transport and Traffic Engineering, Serbia

Abstract: *High market requirements in the realization of trade flows impose a need for more efficient and more effective management of all links of supply chains. The overall connection of logistics subsystems and the exchange of timely and correct information is one of the basic pre-requisite conditions for the development of logistics processes. Thereby, the development of information-communication technologies – ICT, gains a significant notation when it comes to the managing of logistics subsystems. Therefore, in this paper, there will be word about ICT as the key aspect of operational cost decrease and increase in overall production and delivery of goods. Some of the technologies which will be mentioned here include Logistic Information System - LIS, electronic data interchange – EDI, radio frequency identification – RFID, Internet of things, Big Data etc. We will present how these technologies work, how they affect the overall supply chains and what their main benefits are.*

Keywords*: ICT, LIS, RFID, Internet of things, Big data.*

1. INTRODUCTION

In accordance with the market development and the increase in trade flows, the companies require an upgrade in their business subsystems at all levels, which can be achieved with the exchange of timely and high-quality information among all participants in the process. Within supply chains, the exchange of information is one of the key aspects for precise decision making, which increases the importance of the information-communication technologies (ICT). The application of ICT in logistics processes is inevitable, from the development of software and applications for logistics subsystem management – transport, inventory, warehousing, user interaction etc. It is used for managing facilities and outsourcing, to improve customers' satisfaction, developing better supply systems etc. (Obogne and Lidasan 2005). The real time accessibility of information affects the logistics flows realization, provides on-line tracking and gives opportunity of the prompt response to changes and risks when they appear in supply chain. The identification and signing of goods, pallets and vehicles during the realization of logistic flows, allow the businesses to track the goods, while simultaneously increasing significance of RFID technology. However, all those information should be analyzed, processed, stored and then used in the appropriate way, emphasizing importance of data collection and processing technologies, such as Big Data and Internet of Things (IoT). The aim of this paper is to show different ICT already used in logistics and supply chain management, as well as technologies that are developing and are predicted, according to other authors, to become important parts of overall supply chain development in the future.

Remaining of the paper is organized as follows. In the second section we mention Logistics Information System and Electronic Data Interchange as the most common technologies nowadays. Later, we talk about the Big Data for handling excessive amounts of data and finally on Internet of Things, which is still a developing technology.

2. LOGISTICS INFORMATION SYSTEM

The increase in logistics and transportation flows encourages the need for automation and increases the importance of development of Logistics Information Systems (LIS) systems and applications. Logistics information systems allow the interconnection of all participants within a supply chain and create the possibility for efficient management of all logistics processes (Ivanović et al. 2014). LIS usage assumes collection of data from different sources grouping and sorting data in databases, and decision making process based on software tools and systems. Some of the most popular include Customer response system – CRS, Inventory management system – IMS, Transportation management system – TMS, and Warehouse management system – WMS. Another very widespread technology nowadays is Electronic Data Interchange, which is used for supply chain integration – the connection of a company with its customers and suppliers, creating one larger and more complex supply chain.

The realization of logistics flows within a supply chain depends on numerous factors, which are connected with the subsystems and processes, such as warehousing, transportation, materials handling, inventory management, etc., which have significant effect on the costs and profit of a company, as well as provided service level. Therefore, the main role of the mentioned information technologies should be considered as a tool used to smoothen logistics flow realization and make them efficient and cost effective, as it is shown below.

2.1 The application of LIS in warehousing

Within the LIS, great attention is paid to the development of WMS, which is devoted to increasing efficiency of warehouse operations, in this way enhancing one of the key segments of logistics systems. Some of warehousing operations, such as order picking, inventory management etc., have a crucial influence on overall business costs, and therefore, in order to decrease them, require more advanced ways of managing information, processes, technologies and warehouse flows. Since the real word applications comprise different types of warehouse systems, which differ in characteristics and performances, costs of implementation and the goals, regarding to its complexity, following types of software solutions exist: basic WMS, advanced WMS, and complex WMS (Faber et al. 2002). However, the main purpose of WMS is to be able to track the movement, storing and handling goods in warehousing systems, as it is stated in Faber et al. (2002). With the implementation of WMS, better stock management is achieved, along with the better utilization of warehouse capacity and the more efficient realization of warehousing operations. Those improvements are achieved by provision of real time information about the number of SKU's, on the items need to be processed, while giving opportunity of sharing information between all supply chain members. There are numerous best practice examples. In one of the largest retail stores in India, the implementation of the WMS system has brought significant improvement in processes, but in this case, before the WMS implementation. Truck arrival times were unknown and suppliers were forced to wait for up to an hour, before even starting to unload, while the storage space utilization was very low (Rvce et al. 2012). By implementing WMS, there was a chance to improve each of these tasks, by automating the processes and preventing manual data entry, which was one of the main causes of creating mistakes (Rvce et al. 2012).

Similarly, the use of RFID has become more frequent in warehouses. RFID technology allows wireless reading and data transfer, and can be used within a warehouse for identification of

pallets, containers, warehouse zones, picking zones etc. According to the study of Poon et al. (2009), it is firstly required to observe the warehouse system, and then to define which type of RFID device is best to be used. The decision about RFID is made by testing the horizontal and vertical coverage of a reader device. Maximum coverage and performances of a device will be the key to selecting the optimal one. The data collected by RFID devices include quantities and types of SKU's, its storage locations, free space existence, the number of orders determination etc. Another group of RFID devices are related to storage locations, equipment, etc. Based on the results of RFID technology implementation, overall visibility is increased, which further improve operations and the productivity of warehouses (Poon et al. 2009). Chow et al. (2006) analyzed the steps of RFID implementation with the aim of maximizing efficiency and productivity of material handling equipment, so that the operational costs of a warehouse are as low as possible. Findings of their research show that real time information may improve routing decisions related to handling equipment.

2.2 Electronic Data Interchange (EDI)

EDI stands for Electronic Data Interchange, which considers the companies being connected to their suppliers and customers, in order to integrate overall logistics activities. As most companies work within their own network, Intranet, this kind of systems is supposed to interconnect the Intranets of all the companies within a supply chain. The interchange of data in real time would increase the overall productivity of a supply chain, with the companies being able to receive and process correct and timely information, regarding any deliveries, warehousing, stock keeping etc. The EDI framework encompasses all the actors in a supply chain: suppliers of raw materials, producers of intermediate goods, producers of final goods, and finally customers. Internet is a key aspect to keeping an EDI system, since the participants in the supply chain have to have a constant and timely communication amongst each others (Stefansson 2002).

Cloebbecke and Powell (1998) have researched potential cost savings in case of using EDI, and in some cases, they discovered that costs can be reduced by up to 27 billion US dollars per year. However, we have to take into consideration that this paper was published in 1998, which means that most companies were still using only telephone and fax to communicate. The ideal framework for supply chains insisted on interconnection of participants in more ways than simply having EDI installed and functioning. The authors state that a successful information logistics system includes: EDI providing for direct data exchange through electronic submission, Electronic Funds Transfer (EFT), which would simplify payments through data communication networks, activity based costing relating cost information to their sources, article-numbering and bar-coding for identification and addressing of goods and finally databases to store, manage and analyze the collected information efficiently by Cloebbecke and Powell (1998).

Taken that EDI has been a new concept about 20 years ago, a group of researchers has conducted an inquiry in order to show all the benefits of the developing EDI technology, in 2007. The researchers have inquired data from 336 respondents from different companies, regarding the application of EDI system in their company and its respective customers and suppliers, 179 of which have adopted the concept. One of the most important conclusions of the study is that plants would continue to implement EDI systems to connect with their suppliers and customers, for better organization and Supply Chain management. EDI is here mentioned to be one of the most important factors of supply chain integration, especially in B2B sector (Craighead et, al, 2007).

3. BIG DATA

With the increase in the volume of logistics flows, and thereby the activities and processes which need to be controlled within a supply chain in order to realize the logistics flow, companies deal with numerous strategic, tactical and operative decisions that need to be made, and whose quality contributes to the more or less efficient realization of operations within a supply chain. Accordingly, the quantity of data that needs to be analyzed, processed and structured increases considerable. One of the techniques used for analysis, processing and storage of this data is known as Big Data concept. Big Data considers using different kinds of approach and optimization techniques in order to have an insight in overall company business, which further allows the company to improve its operations and processes as is stated by Wang et al. (2016).

There are several studies that consider Big Data application in logistics. Dutta and Bose (2015) have shown the application of Big Data on an example of the company Ramco Cements Limited (RLC), where the collected operational data was expressing stability and firmness of processes in different units of RLC. The data was collected from the ERP system, and was related to users demand, orders, the number of deliveries etc. The study has shown that understanding the business problems, forming a cross-functional team and accepting innovative visualization techniques are crucial for the setting of Big Data. Another study of Tan et al. (2015) was examining SPEC, one of the biggest companies in the eye-glass production industry. Having the goal of making the highest possible profit and becoming more competitive in the market, the company believes that gathering data, both structured and unstructured, is one of the main drivers for achieving it. Therefore, in order to gather and analyze the data in the best possible way, Big Data was used, along with the technique of deduction graphs. The aim of this study was to help in making better decisions regarding to the development of future products, as well as to improve the operations in supply chains.

4. INTERNET OF THINGS

Internet of things (IoT) is a term that considers the idea of interconnecting different objects, "making them smart". This means having different devices connected among each others in such a way that they can share information and coordinate decisions (Al-Faguaha et al. 2015). We can easily notice the possibilities of applying the IoT in logistics with the development of RFID devices for warehousing. With the creation of this idea, a new concept is created, called machine-to-machine (M2M), where machines objects communicate with each others, in order to provide information and coordinate decisions.

As such, Internet of Things consists of five layers: objects layer, object abstraction layer, service management layer, application layer and business layer. Objects layer represents the physical sensors, objects that are interconnected with the purpose of collecting and processing information. Object abstraction layer is a technology used to transfer data from Objects layer to Service management layer. In the case of logistics, especially warehousing, an obvious technology that can be used for data transfer is RFID. Service Management or Middleware (pairing) layer pairs a service with a requester, thus turning data collected by the Object layer into heterogeneous objects, making decisions regarding them in the process. The application layer provides services requested by the customer. Finally, the business (management) layer is there to manage systems activities and services. Apart from that, this layer is created to design, analyze, implement, evaluate, monitor and develop IoT system related elements (Al-Faguaha et al. 2015).

Internet Connected Objects (ICO) are one of the main factors in the development of Internet of Things. Namely, sensor-based information, which is collected through the ICO (the object layer), can collect individual data about consumption and other product activities even within households, which can be transferred to companies in charge of the deliveries and products, in

order to be able to plan and make decisions, according to consumer needs and preferences. This kind of information would directly affect production, especially when it comes to quantities, which would further have effect on stocks, and thus improve stock keeping and warehousing processes. Apart from decreasing costs through timely and correct information, this kind of data collection could have a positive effect on the businesses, especially in tailoring and creating new products, which would also increase the incomes of a business (Scharf et al. 2015).

In order to develop Internet of Things and make it functional, there are six main elements that need to be taken care of: identification, sensing, communication, computation, services and semantics. Identification methods are used to provide clear identity of each object within the network. Sensing considers gathering data from related objects within the network and sending it back to the data warehouse, database or cloud. The collected data is analyzed to take specific actions, based on required services. When it comes to communication within the Internet of Things, it is used to interconnect heterogeneous objects in order to deliver specific smart services as a system. Processing units and software applications represent the "brain" of the IoT. They are used for computation, or, in the logical sense, decision making. There can be four types of services within IoT: identity-related services, information aggregation services, collaborative-aware services and ubiquitous services. Different types of services help create a difference in application of IoT. Finally, semantics is used to extract knowledge by different machines, in order to provide required services (Al-Faguaha et al. 2015).

5. CONCLUSION

From the research, we can definitely say that there are many ways and areas for the application of ICT in logistics. Many technologies have already been implemented, while many are still being developed. The different technologies, are used in business, and everyday life, and also in the logistics subsystems and related activities – transport, warehousing, user interaction etc. As mentioned, the possibility of tracking goods and receiving real time information can be valuable to any supply chain, providing prompt reaction to any potential problem. We have noticed that Logistics Information System (LIS) is one of the most widely used technology, particularly in the form of Warehouse Management System (WMS). Another very common technology nowadays is Electronic Data Interchange. This technology has found its use throughout whole supply chains, since its purpose is to connect all of the participants of a supply chain in order to improve the interchange of timely information, which can directly affect the processes, within all of the companies that belong to the same supply chain.

Big Data is the next technology, slowly becoming popular in modern business. Its point is the collection, storage and interchange of excessive amounts of data, which cannot be easily handled. The main difficulty here is the fact that data can either be structured or not, which is important for processing. Be that as it may, Big Data has found a major application in the business world, and many companies that have used this technology have gained competitive advantage. Finally, Internet of Things, as the last technology mentioned here, can be the most complex in this case, not only due to the complexity of its nature, but also due to the fact that it is still under development, and that it has a widespread use, within and outside of businesses, such as in everyday life. The idea is interconnection of different devices, even within the homes of consumers, in order to give correct information back to the businesses, regarding what should be done with the products. This directly affects production, and thus, obviously all of supply chain. However, this technology is still in development, and thus needs more precise defining and application.

Generally, the ICT is used in logistics already, but there are still more fields, in which it can be applied even further. The truth is that only the future will tell in which direction these technologies will develop, but as of now, we can say with certainty that they affect most parts of supply chains, increasing their productivity and decreasing their costs.

REFERENCES

[1] Wang, G., Gunasekaran, A., Ngao, E. W.T., Papadopoulos, T. (2016). Big data analytics in logistics and supply chain management: Certain investigations for research and applications. Int. J. Production Economics, 176 (2016), 98-110.

[2] Dutta, D., Indranil, B. (2015). Managing a Big Data project: The case of Ramco Cements Limited. Int. J. Production Economics, 165 (2015), 293-306.

[3] Tan, H.K., Zhan, Y., Ye, F., Chang, Ch. (2015). Harvesting big data to enhance supply chain innovation capabilities: An analytic infrastructure based on deduction graph. Int. J. Production Economics, 165 (2015), 223-233.

[4] Ivanović. Z., Bauk, S., Drašković, M. (2014). Regional units and sustainable logistics system solutions. Economics and Economy, 1 (3), 47-63.

[5] Faber, N., Koster, R.B.M., Velde, S.L. (2002). Linking warehouse complexity to warehouse planning and control structure: An exploratory study of the use of warehouse management information systems. International Journal of Physical Distribution & Logistics Management, 32 (5), 381-396.

[6] Rvce, R.A., Rvce, K.N.S., Rvce, T.M.R. (2012). Impact of warehouse Management System in Supply Chain. International Journal of Computer Applications, 54 (1), 0975-8887.

[7] Poon, T.C., Choy, K.L., Chow, H.K.H., Lau, H.C.W., Chan, F.T.S., Ho, K.C. (2009). A RFID case-based logistics resource management system for managing order-picking operations in warehouse. Expert System with Applications, 36 (2009), 8277-8301.

[8] Chow, H.K.H., Choy, K.L., Lee, W.B., Lau, K.C. (2006). Design of a RFID case-based resource management system for warehouse operations. Expert System with Applications, 30 (2006), 561-576.

[9] Al-Faguaha, A., Member, S., Guizani, M., Mohammadi, M., Aledhari, M., Ayash M. (2015). Internet of Things: A Survey on Enabling Techologies, Protocols, and Applications. IEEE Communication surveys & tutorials, 14 (4), 2347-2376.

[10] Ng, I., Scharf, K., Pogrebna, G., Maull, R. (2015). Contectual variety, Internet-of-Things and the choice of tailoring over platform: Mass customization strategy in supply chain management. Int. J. Production Economics, 159, 76-87.

[11] Obogne, M.H., Lidasan, H.S. (2005). A study on the impact of information and communication technology on urban logistics systems: A case in metro Manila. Journal of the Eastern Asia Society for Transport Studies, 6, 3005-3021.

[12] Stefansson, G., (2002). Business-to-business data sharing: A source for integration of supply chains. Int. J. Production Economics, 75, 135-146.

[13] Cloebbecke, Powell, P. (1998). Competitive Advantage from IT in Logistics: The Integrated Transport Tracking System. International Journal of Information Management, 18 (1), 17-27.

[14] Craighead, C. W., Patterson, J. W., Roth, P. L., Segars, A. H. (2007). Enabling the benefits of Supply Chain Management Systems: an empirical study of Electronic Data Interchange (EDI) in manufacturing. Int. Journal of Production Research, 44:1, 135-157.