

LOGISTICS AUDIT 9A IN THE ASSESSMENT OF SUPPLY CHAIN EFFICIENCY OF COMPANIES OPERATING IN THE INDUSTRY 4.0

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Abstract

The fourth industrial revolution (Industry 4.0) sets new challenges not only for the development of manufacturing processes but also for logistics processes and supply chains. Logistics in the fourth industrial revolution (Logistics 4.0) focuses on increased integration of enterprises within open supply chains, development of IT systems supporting management and control processes and automation of logistics processes. Point elements of logistics infrastructure requires adaptation to the changing significant parameters of the supply chain, the size of the material flows associated with the development of omnichannel sales and changes in the labour market. Commonly used solutions - financial analysis and indicator assessment - are used to assess operational activity and have limited effectiveness in diagnosing incompatibilities within logistics system and recommending improvements to changes in supply chains. The key success factor is the development of an effective method of evaluation of the logistics system operating within open supply chain, which will allow identifying areas of incompatibilities and propose solutions to increase the operational efficiency and economic effectiveness of the supply chain in accordance with the Logistics 4.0 concept. The authors of the article will present the author's method of Logistics Audit 9A and its use to assess the efficiency of the entire supply chain and its compliance with the Logistics 4.0 concept and will present the results of the study of three companies operating in one industry that have implemented different logistics solutions over a period of three years.

Keywords: Industry 4.0, supply chain, warehousing, automation, omnichannel

1. INTRODUCTION

Modern customers - final consumers, business, enterprises and public institutions, expect enhanced products and customer service. Aiming to satisfy growing expectations and evolving demand, Industry 4.0 was introduced as a concept for digital transformation in manufacturing to achieve connected operationally and informatively supply chain links [1-3].

To fulfil demand for individualised products, confront growing international competition and challenge shortened product life cycles [4], companies implements omnichannel sales strategy, which integrate different methods of purchasing products.

Own research indicates that customers' patience in terms of delivery time has been substantially reduced. Customers in different sectors requires same day or next day delivery with a maximum lead time of 72 hours.

Demand transformation and consequent fourth industrial revolution indicates direction of changes that need to be implemented in supply chains to meet the requirements of Industry 4.0. and to achieve Logistics 4.0 **Figure 1** presents the roadmap for logistics in Industry 4.0., from classic - human orientated solutions to most advanced autonomous and predictive operations within open supply chains.

The presented logistics 4.0 concept implies progressive integration of actors within supply chains through development of IT systems supporting management and control processes to fulfil operations according to customer requirements and concentrate on value chain. The significant part of the logistics processes requires

the implementation of automation - information or operational. The existing elements of point logistics infrastructure, such as warehouses, distribution centres and cross-dockings, require re-adapting to the changing parameters of supply chain: material flows and orders structure. Managing logistics costs with lead times will be essential to achieve business success as the competitors will continue to push down prices.

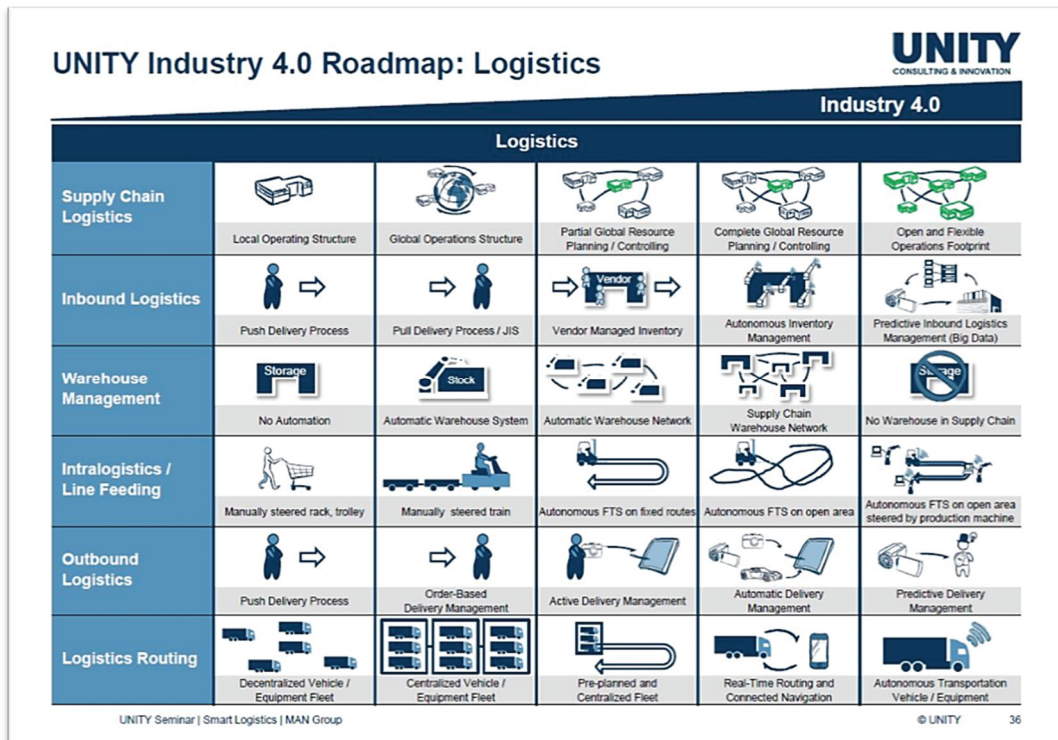


Figure 1 Smart logistics and supply chain according to UNITY Consulting and Innovation [5]

The aim of the paper is to compare methods of assessment of the supply chain and their compliance with the requirements of the Logistics 4.0 concept, as the revolution requires new methods of evaluation to identify the areas of incompatibilities and propose solutions to increase the operational efficiency and economic effectiveness of the supply chain. New method of evaluation of supply chain will be presented with result of implementation on supply chain costs.

2. SUPPLY CHAIN EVALUATION METHODS AND MEASURES

Literature studies regarding supply chain evaluation methods measures concentrate on evaluating the efficiency and effectiveness of logistics based on costs, indicators and measures analysis [6-9]. This approach to evaluate supply chain evaluation refers only to the operational activities and has limited effectiveness in the identification of malfunctions in supply chains and the assessment of implemented improvements. The more recent studies [10] addressing the issue of indicative assessment of the logistics system the authors propose 9A Logistics Audit method as a complementary to the indicative analysis. The proposed method includes performance measurement indicators characterizing the intensity of logistic processes, structure and amount of resources used in the logistic system.

Since no comprehensive studies of methods evaluating the efficiency of the supply chain and their compliance with the Logistics 4.0 concepts, this approach has to be considered as a pilot-study. The available studies address the Logistics 4.0 challenges faced by modern logistics in the fourth industrial revolution but none determine the conditions for compliance of the supply chain to Logistics 4.0 requirements, nor the defined purpose of the Logistics 4.0.



3. SUPPLY CHAIN ASSESSMENT APPLYING LOGISTICS AUDIT METHOD 9A

The 9A Logistics Audit is a company's own method of assessing the condition of a company's logistics system, including the identification of processes requiring improvement and where unreasonable logistics costs arise. The core value of the solution is the evaluation of the major elements, optimization of processes and operating costs, taking into account risk management in logistics processes.

The 9A Logistics Audit covers the analysis of the enterprise's strategic areas:

- Operating costs - including costs of underinvestment in the logistics system.
- Technical and organisational conditions of the logistics system.
- Processes and material flows.
- Compliance with quality standards - e.g. HACCP, ISO, OHSAS.
- Level of customer service.
- Competitiveness of the offer through the application of advanced logistics solutions.
- Environmental friendliness in processes - ecology and safety precautions.
- Level of safety, hygiene and ergonomics at work.
- Innovative potential in logistics processes.

The process of evaluating a company's logistic system according to the 9A Logistics Audit method involves determining the basic parameters and values characterising the logistic system of a particular company by taking into account the identification of material flows processed in the supply chain. The key issue for the assessment is the identification of the actual physical values of material flows in order to correlate them with executed transport and handling processes in the form of a process map.

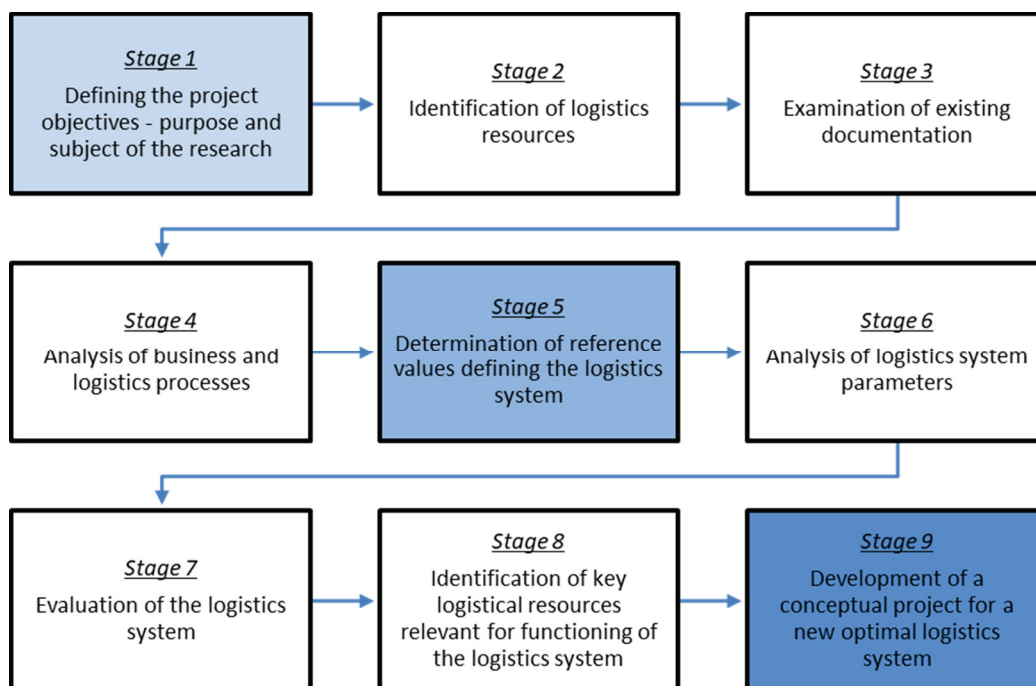


Figure 2 The 9A Logistics Audit process [own study]

The process of evaluation of the enterprise using the 9A Logistics Audit method is presented in **Figure 2**. Due to the nature of the study and its intensity, the Decision-makers - Management Board and Owners, expect a quick, reliable and comprehensive assessment of the logistic activity of the company, which is not finished with

the report with conclusions but with the conceptual design of a new logistic system. The indicator analysis is carried out after the determination of the reference values characterizing a specific logistic system at the stage of analysis of logistic system parameters. The analysis is used to prepare the final evaluation and simulation of processes during the creation of a new supply chain concept.

The presented evaluation process using the 9A Logistics Audit method presents selected, basic stages and processes. It is natural that the process of assessment and evaluation using the 9A Logistics Audit method also includes the adaptation of audit procedures and processes to the enterprise's unique features, including:

- type and extent of the company,
- level of internationalization of business processes,
- structure of the company,
- legal and organisational form,
- IT systems,
- degree of automation and robotization of processes,
- market environment,
- other security and safety issues.

4. RESULTS OF EVALUATION OF LOGISTICS SYSTEM USING LOGISTICS AUDIT METHOD 9A

In 2016, STERLOG Polska conducted a study of three logistics systems of retail companies with logistics orientation, operating on the consumer goods market, in the same market segment and being direct competitors. The survey was conducted on the basis of marketing materials and industry information published by companies and made available to the public. Due to the short period of activity of enterprises, technological parameters concerning investments and the flow of goods have been assessed.

Throughout 2014 - 2016, all three companies were engaged in investment projects involving the construction of new storage and distribution facilities with technical and technological equipment, including warehousing logistics and distribution of goods. The basic assumption underlying the investments was to ensure that orders are delivered in less than 14 days. The basic values characterising the companies are presented in **Figure 3**. The reference value is company A's results.

The compared logistics systems are technologically differentiated:

- Company B implemented fully automated warehouse, the most advanced solution.
- Company C has implemented a classic, mechanized warehouse system, characterized by low added value of the processes.
- Company A has implemented a mixed system that automates the most time-consuming warehouse processes and a mechanised system that can be automated in the future depending on the market situation. This system has been designed using the 9A Logistics Audit method.

All investments are characterized by a long period of economic utility of at least 10 years, with different levels of maintenance costs and flexibility. Therefore, the authors of the study determined the risk of success of a particular investment. Investment in an automated warehouse generates very high risk due to high capital consumption, very limited possibilities of increasing flexibility and high maintenance costs. A classic logistics system is characterised by medium investment risk due to the low added value of the processes and, consequently, the inability to compete with logistics. The mixed system is characterised by low risk due to the better adaptation of processes and technologies resulting from a number of additional analyses prior to the investment decision and the choice of the optimal storage technology.

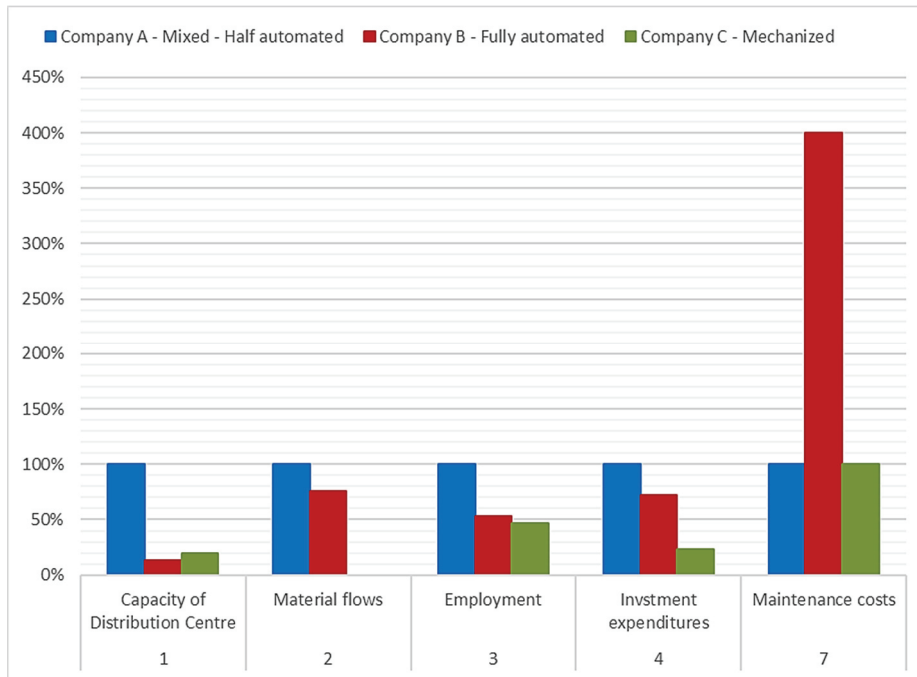


Figure 3 Logistics systems characteristics [own study]

Figure 4 shows selected results of a comparative assessment of new logistics systems. The data are presented in relative values. Reference values are set by the logistics system of company A.

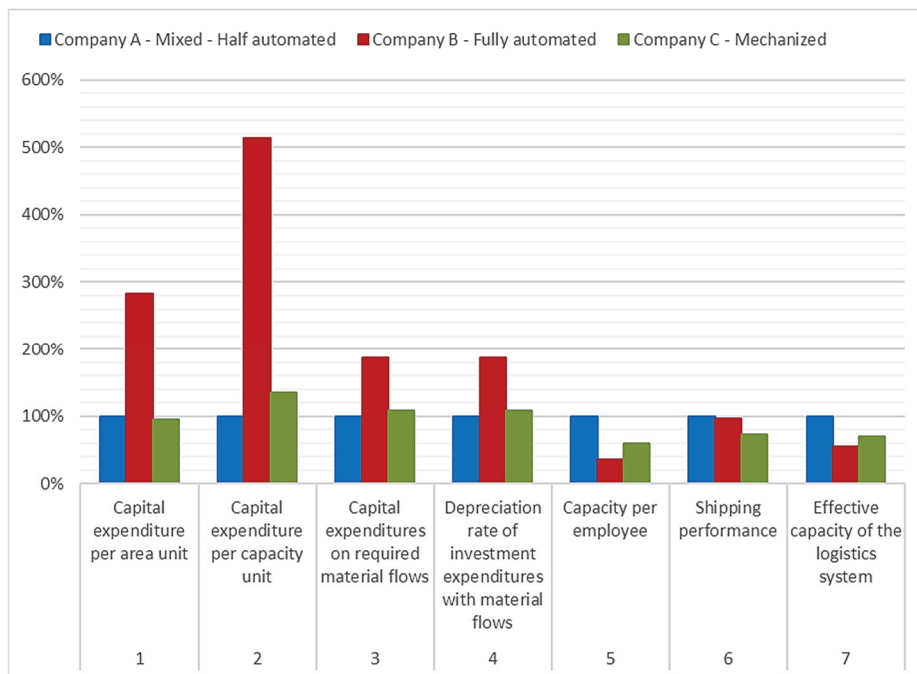


Figure 4 Comparative assessment of new logistic systems [own study]

A comparative assessment of three logistics systems of enterprises operating in the same sector reveals that the project carried out by company B related to the high automation of logistics processes is characterised by limited efficiency. This feature is presented by an indicator of capital expenditures on the required material flows.

The performance indicators of the automatic and mixed system are at the same level, however the number of SKUs and the related offer range should be taken into account. In the mixed system, the capacity of the system per employee is almost three times higher.

The rate of depreciation of investment expenditures with material flows is used to show how much more load units need to be moved for the investment to be depreciated within 10 years. The study shows that the automatic system will "pay for itself" much longer than other solutions. In the economic analysis of the whole project, it should be taken into account that company B will have to add depreciation costs to the price of the product or reduce the margin.

Designing logistic systems and processes in companies with market orientation based on verified logistic data only strengthens their potential. Creation of new solutions increasing the competitiveness of the supply chain on the basis of the Logistics Audit method 9A allows to achieve optimal performance and the implementation of the assumed level of customer service significantly below the assumed 14-day deadline.

5. CONCLUSION

The fourth industrial revolution raises new requirements regarding the organization of the supply chains. Contemporary logistics structures require technical and technological improvements to fulfil growing customer demands and methods for the evaluation of the efficiency and competitiveness of the supply chain. Proposed 9A Logistics Audit method for assessment improvements in the supply chain may provide a framework for developing a method for assessing the compliance of the supply chain with Logistics 4.0 requirements.

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