LOGISTICS PLANNING ACCORDING TO THE PL9A METHOD AS APPLIED TO THE EVALUATION OF THE LOGISTICS SYSTEM OF AN AUTOMOTIVE MANUFACTURING PLANT. CASE STUDY.

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Abstract

Management of the logistics system in an AUTOMOTIVE production plant involves planning processes in which methods and standards are applied, including APS, S&OP, SCM and others. Planning and scheduling for a plant in the AUTOMOTIVE industry requires consideration of information, material, capital and human resources requirements in relation to the production capacity and the availability of resources.

In the article, a logistics planning process is presented according to the PL9A method. The PL9A method uses mathematical modelling to examine and holistically evaluate the efficiency of a logistics system, including determining its capacity, logistics costs and the capital expenditure required for executing a defined logistics task.

The article presents the results of a study and evaluation of the assumptions adopted for the developed logistics plan whose primary function is to answer the following questions:

1. Does the plant's existing logistics system provide the capacity to perform the logistics task set out in the assumptions for the logistics plan?
2. What technical and organisational bottlenecks exist in the logistics system that may negatively affect the performance of the logistics task resulting from the implementation of the logistics plan?

Keywords: Logistics Planning, Logistics Audit, Supply Chain, Automotive

1. INTRODUCTION

Modern automotive production plants operating within complex global supply chains manage their planning processes using a range of methods and standards. A critical success factor in the planning and scheduling process for a complex logistics system is a comprehensive approach and consideration of both resources (material, capital and information) and assets (human and manufacturing) in relation to the production capacity of the plant, the availability of the resources required to execute a specific production or distribution plan.

This article presents the logistics planning process using the PL9A method, based on a systematic approach. The PL9A method uses mathematical modelling tools, oriented to the examination and evaluation of the logistics system efficiency considered comprehensively. The PL9A method allows to perform a process of evaluating the efficiency of a logistics system, which includes determining its capacity, logistics costs and capital expenditure required in relation to the logistics task.

A study of the applicability of the PL9A method was carried out in a study of the logistics system of an automotive plant, the aim of which was to identify the points of system incompatibility significantly affecting the performance as well as the technical and operational efficiency of the logistics system.

2. LOGISTICS PLANNING METHODS

Logistics planning is an organized process covering the entire operations within a company related to planning future activities, making economic, business and operational decisions. Logistics planning extends across production, procurement, warehousing and transport processes with the purpose of adapting production and logistics processes to the changes in the relevant supply chain parameters.

The fourth industrial revolution is changing the way businesses and their functions are perceived in the socio-economic system. The global supply chains in which these operate are subject to evolution and dynamic change due to increasing computerisation, robotisation, automation and, above all, due to the dynamically changing socio-economic environment.

It is worth noting the existing problem of evaluating an enterprise's logistics system against its evolution according to the Industry 4.0 concept [1]. It is worth noting the existing problem of evaluating enterprises against the criteria that classify and describe an Industry 4.0 enterprise. The lack of methods for examining and evaluating enterprises is important for the process of integrating enterprises in supply chains and assessing their potential and market valuation.

On the practical side, the following methods of logistics planning are currently in use:

1. Planning methods according to TOC limit theory
2. APS planning methods - Advanced planning and scheduling
3. MRP Material Resource Planning
4. MRPII planning methods - Manufacturing Resource Planning
5. APICS Logistics Planning
6. Planning with demand forecasting DEM
7. Production process planning according to REFA
8. Methods and tools for order fulfilment planning

Our own research into logistical planning methods and a literature review confirm that the above-mentioned planning methods are characterised by high labour intensity and undefined levels of effectiveness and efficiency. This is also confirmed by research into the effectiveness of implementing changes in production, as described in a study conducted by PWC [2].

Our own research, conducted in January 2021, identified 12 solutions in the form of software applications supporting the management of international supply chains. The software categorised as 'SCM Management' is used to manage and control international supply chains. The applications allow, according to their developers, the effective management of orders, transports, deliveries and support of billing processes between contractors [5]. An examination and evaluation of the application specifications indicated the limited functionality of the applications used in terms of support for planning processes, including assessment of the degree of utilisation of logistical resources including infrastructure consisting of linear and point elements.

2.1. Barriers to the integration of supply chains

The analysis of the literature and the results of the conducted own research indicate the complexity of logistical planning processes and revealed the existence of many barriers affecting the processes of integration and cooperation of enterprises within supply chains.

The emergence of new planning methods and their implementation is subject to the improvement of those functions of the logistics system that may be relevant to the efficiency of the planning process and the evaluation of its effectiveness. The issue of constraints [3] in system development and their practical

application is presented in the publication [opcit]. The authors examined the logistics planning processes used in supply chain management and identified the factors and barriers that are relevant to affecting the efficiency and quality of supply chain management.

The analysis of barriers in scientific publications on the integration of supply chains is presented in Figure 1.

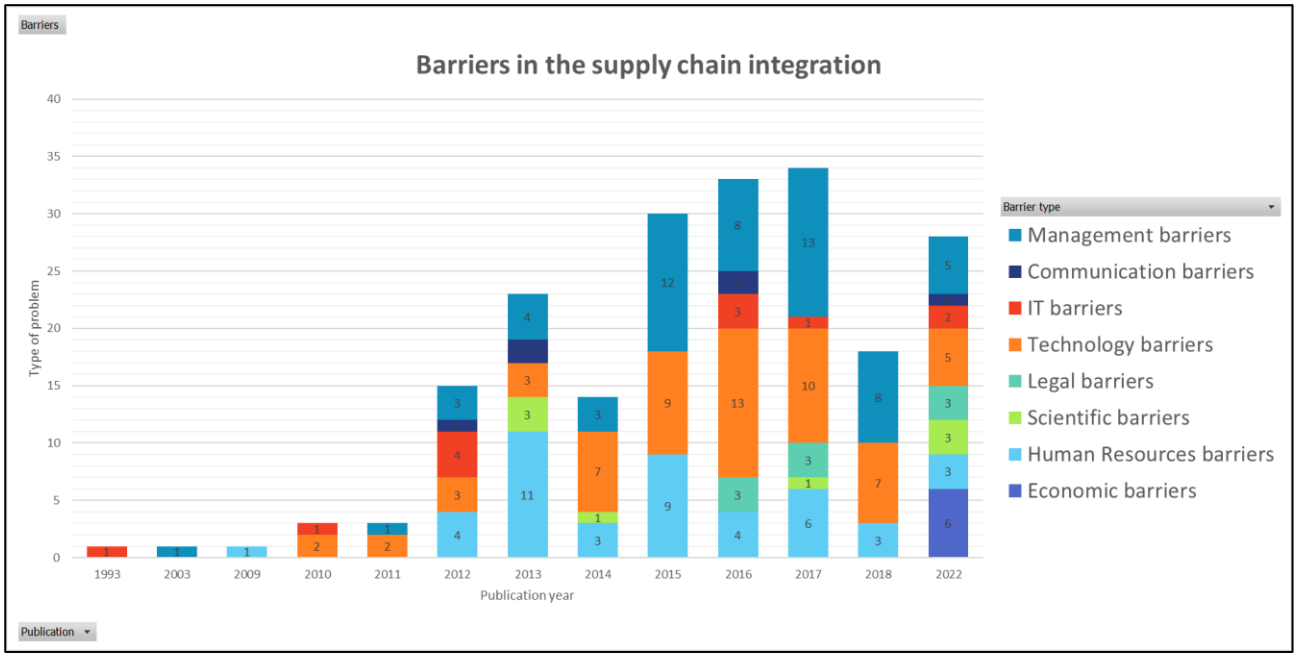

Figure 1 Identification of barriers in the integration of supply chains in scientific publications over the years 1993-2022 – Own research

Based on the study, it can be concluded that the overall set of identified barriers [6, 10] is reflected in the amount and degree of infrastructure utilisation and its adaptation in relation to the material flows. Barriers and problems in multi-channel supply chain management also affect the overall operational and economic efficiency of the company.

3. PL9A LOGISTICS PLANNING METHOD

In the PL9A method [4], logistics planning is systemised and the logistics planning process itself is based on verifiable and measurable quantities.

The PL9A logistics planning method presented in Figure 2 [6,7] illustrates planning as a process involving not only business and logistics processes but also market processes, represented by quantities characterising supply and demand. The planning process of the PL9A method includes the mapping of the company's logistics system accompanied by a study and simulation in the LOGPLANNER application [7], in which the logistics plan parameters are determined, including logistics capabilities such as stock, handling and storage capacities.

In PL9A planning method, study area and logistics task are defined. A study area is a phase-distinct subsystem of the logistics system that can be attributed with the occurrence of relationships assigned to the cause-and-effect relationships characteristic of the phases Procurement, Production, Work in Progress and Distribution. A logistics task is a set defined by the material flows and correlated logistics infrastructure resources that form the logistics system of a supply chain link.

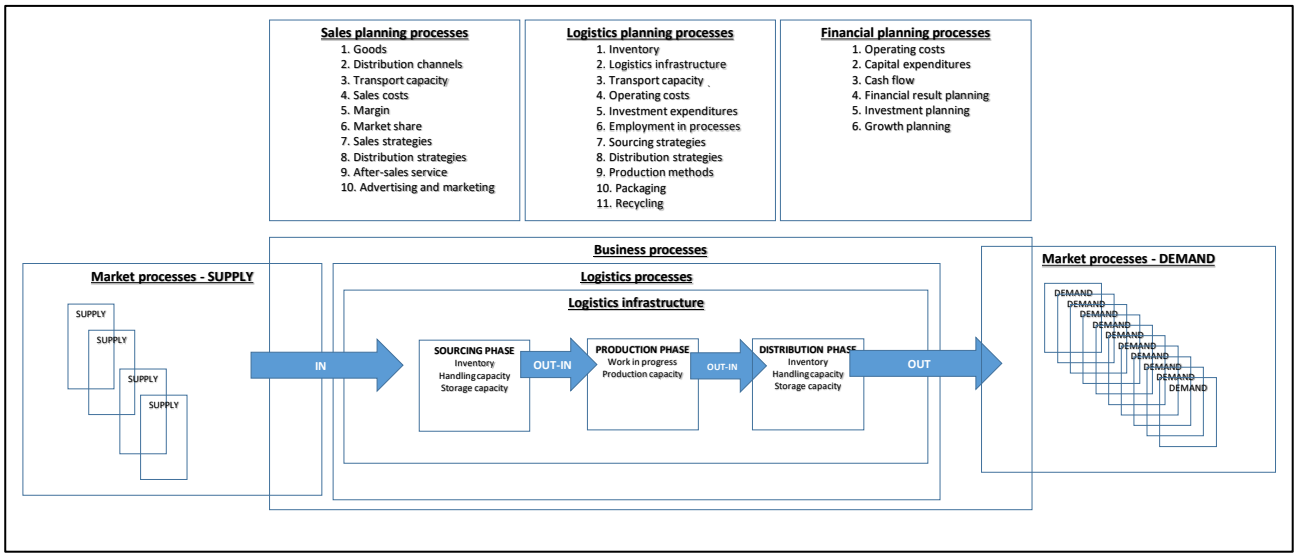

Figure 2 The PL9A logistics planning method in the process perspective – Own research

Execution of the planning process according to the PL9A method enables to define the infrastructural resources necessary to perform the logistical task assigned in the logistics plan. The result of planning according to the PL9A method is the determination of quantities that characterise logistics facilities in terms of relations between, among others, the capacity of the logistics system, the labour intensity of logistics processes, the amount of investment necessary to acquire infrastructure elements and the logistics costs.

The PL9A logistics planning process, described in systematic approach and mapped in the LOGPLANNER application, enables performing an assessment of a supply chain with multiple units using computer simulation and mathematical modelling methods.

4. EVALUATION OF THE LOGISTICS SYSTEM OF AN AUTOMOTIVE PRODUCTION PLANT WITH THE PL9A METHOD

In 2018, the STERLOG team was involved in a project focused on the evaluation of the company's logistics system, which included the development of a conceptual design for the re-engineering of the logistics and warehousing system of an automotive manufacturing plant. The project covered the areas of procurement, production and distribution logistics.

The production plant, classified as a large enterprise, supplies its products directly to the assembly lines of automotive market leaders in the Just-In Time system and to the aftermarket. The project included an assessment of the implementation of the SAP IT system in the area of logistics and the establishment of directions for the development of IT systems and tools.

4.1. Logistics system evaluation

The first stage was to assess the state of the company's logistics in terms of meeting the requirements of the Logistics 4.0 concept. The AL9A Logistics Audit method was used to examine the state of logistics and determine the parameters of the logistics system. The results of the assessment are shown in red colour in Figure 3. During the survey, an objective was defined - the expected state of logistics, intended as an outcome of the conducted project works. The postulated state of logistics is shown in green colour in Figure 3.

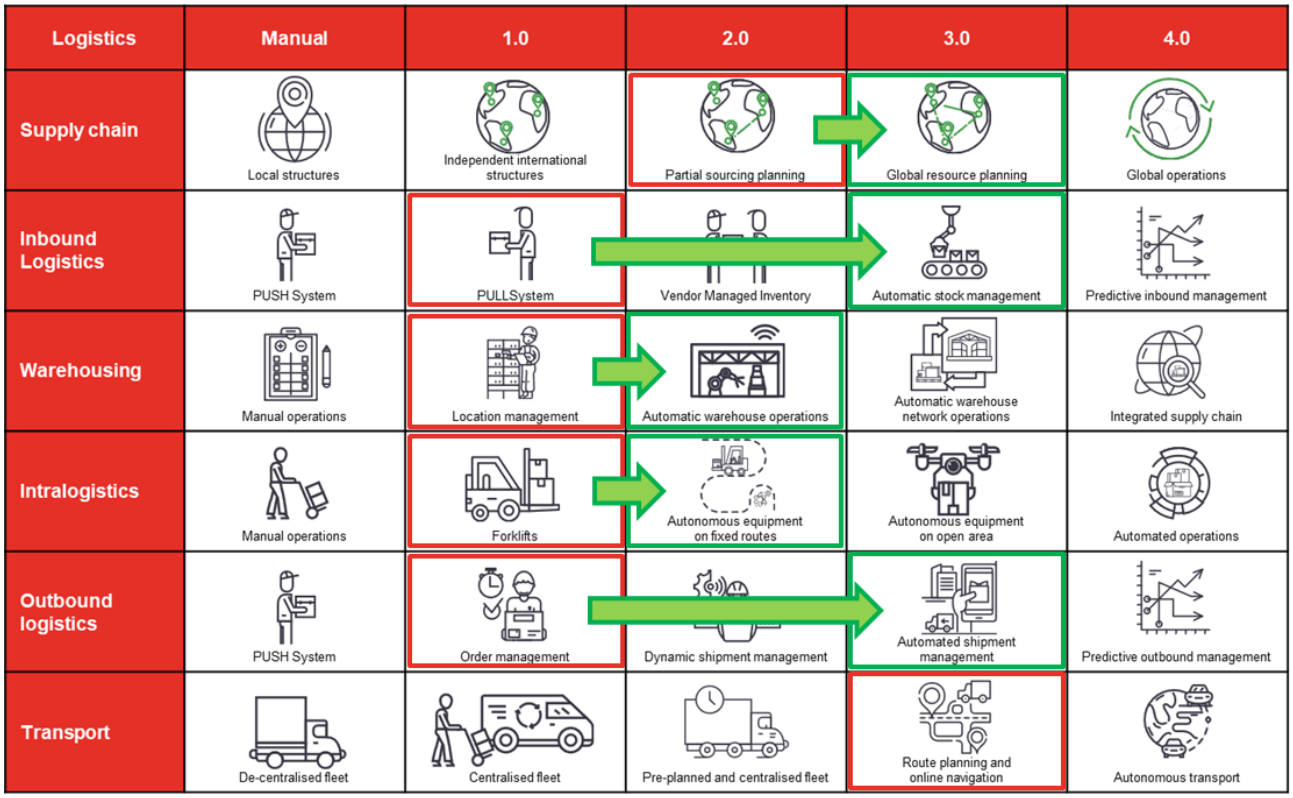

FIgure 3 Conclusions of the AL9A logistics audit - Logistics development guidelines according to the Logistics 4.0 concept – Own study

The assessment of the state of logistics revealed that the most developed subsystem of the examined company was the transport system. In the supply chain management processes, procurement planning was only partially implemented, which was due to system incompatibilities identified in the areas of Inbound Logistics, Warehouse Management, Intralogistics and Outbound Logistics. The overall state of supply chain management and the associated limited global resource planning capabilities were a result of the IT solutions implemented in logistics and the delay in data transfers within the IT system. In addition, a system mismatch was identified related to the lack of controlling of flowing cargo streams in the logistics units. The assessment of the state of the logistics system was the starting point for developing a concept for the re-engineering of the warehousing and distribution system.

4.2. Logistics system re-engineering

The PL9A Logistics Planning method was used to develop concepts for the re-engineering of the logistics system of the production plant. As part of the designing works, a logistics task was defined, which resulted in the development of 7 concepts for the remodelling of the storage and distribution system diversified in terms of logistics infrastructure in the areas of storage and intralogistics. The results of the design work according to the PL9A method are presented in Table 1. The successive approximation method was used to develop the logistics system concepts. The presented concepts varied in terms of the storage infrastructure:

1. Concepts 1.1 - 1.5 were developed to define the maximum capacity of the storage and distribution system in the new logistics organisation.
2. Concepts 1.6 and 1.7 included all processes carried out in the Value Added Services and Special Areas.
3. Concept 1.7 provides the best match to the defined logistics task in terms of capacity, performance of processes in the Value Added Services and Special Areas.

Table 1 Comparison of concepts for the re-engineering of the logistics system of an automotive production plant

A	Capacity								Concepts with arranged Value Added Services and Special areas	
Pos	*Type*	*Unit*	*Current state*	*Concept 1.1*	*Concept 1.2*	*Concept 1.3*	*Concept 1.4*	*Concept 1.5*	*Concept 1.6*	*Concept 1.7*
1	**Total capacity**	**ppl**	**13 600**	**18 055**	**17 043**	**16 955**	**16 943**	**16 955**	**13 994**	**15 218**
1.1	Racks capacity - Warehouse+Production	ppl	-	11 476	7 780	8 500	15 736	8 500	7 234	10 402
1.2	Blocks capacity - Warehouse	ppl	13 600	5 372	8 056	7 248	-	7 248	6 760	4 816
1.3	Mezzanine	ppl	-	1 207	1 207	1 207	1 207	1 207	-	-
2	**Warehouse capacity**	**ppl**	**13 600**	**17 295**	**16 283**	**16 195**	**16 183**	**16 195**	**13 234**	**14 458**
2.1	Racks capacity	ppl	-	10 716	7 020	7 740	14 976	7 740	6 474	9 642
2.2	Blocks capacity	ppl	13 600	5 372	8 056	7 248	-	7 248	6 760	4 816
2.3	Mezzaniane	ppl		1 207	1 207	1 207	1 207	1 207	-	-
3	**Expected capacity**	**ppl**	**14 960**	**14 960**	**14 960**	**14 960**	**14 960**	**14 960**	**14 960**	**14 960**
4	**Mezzanine - Special ares**	**m2**	**-**	**-**	**-**	**-**	**-**	**-**	**5 101**	**5 101**
5	**Difference (Instaled - Expected)**	**ppl**	**- 1 360**	**3 095**	**2 083**	**1 995**	**1 983**	**1 995**	**- 966**	**258**

The conceptual design of the storage and distribution system in Concept 1.7 fulfils the defined objectives including:

1. Elimination of internal movements - "digging„
2. Improved system capacity by 12%
3. Optimization of forklift utilization - reducing the number of equipment by 7%
4. Reduction in order picking times - reduction for OEM by 13% and for Aftermarket by 65%

5. CONCLUSION

The results of the research on planning methods presented in this article indicate the high labour intensity and undefined level of effectiveness and efficiency of the implemented IT tools. The planning methods presented in Chapter 2 do not take into account the characteristics and functions of logistics, whose main function is to process streams of goods, capital and information.

Commercially available tools and methods to support logistics planning processes, in the form of planning, modelling and simulation applications, make it possible to reduce the impact of the identified barriers on the quality of planning processes. However, the conducted research revealed the significant impact of the lack of standards in logistics planning and the resulting limited adaptability of logistics systems to change.

The new PL9A method for logistics planning presented in this article takes into account the paradigm of changes and continuous adaptation of the technical and organisational system of enterprises to the new economic, social and legal context. The PL9A method makes it possible to significantly improve the logistics planning process and reduce the negative impact of bottlenecks and barriers identified in the AL9A logistics audit on the quality of logistics planning.

The results of the research and evaluation of the assumptions made for the developed logistics plan in the automotive production plant allow for an affirmative answer to the hypothesis posed in the first question of Chapter 1 - The existing logistics system in the plant provides the capacity to implement the logistics tasks defined in the assumptions for the logistics plan. Concept 1.7 meets the postulate of expected capacity by providing conditions for the implementation of tools allowing real-time operations planning.

It is crucial to answer the second question regarding the presence of bottlenecks in the logistics system that can negatively affect the performance of the logistics task.

By implementing the changes, a number of benefits can be generated, which includes:

1. Increase in total system capacity,
2. Reduction of employment in material handling processes,
3. Reduction of the forklift fleet maintenance costs,

4. Reduction of employment in administration and office processes.

The survey was used in the development of investment projects and the low-cost changes were implemented in the first year after the research.

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