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## The Logistics 4.0 Implementation Supported by the Balanced Scorecard Method

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**Abstract:**

**Purpose:** The main purpose of this research was to develop a strategy supporting effectively the implementation of the Logistics 4.0. concept dedicated to small and medium transport enterprises.

**Design/Methodology/Approach:** The research process consisted of the theoretical and the empirical parts. The analysis of the current literature about the main assumptions of the Logistics 4.0 and methods of strategy building was conducted in the theoretical part. The model of the strategy map based on the Balanced Scorecard method was developed in the empirical part.

**Findings:** The proposed model supports the implementation of new solutions that use new technologies for modern communication and information transfer as well as limiting the main threats associated with them. Implementation of the Logistics 4.0 is a real challenge especially for small and medium enterprises due to the high costs of new technologies introduction and the necessary infrastructure. Therefore, solutions that support the implementation of the Logistics 4.0 are particularly important, increasing the effectiveness of its implementation and reducing the risk of liquidity loss. The model allows the implementation of Logistics 4.0 to be easily monitored and controlled and efficiency to be increased.

**Practical Implications:** The proposed model is a simple solution that can be easily applied in small and medium transport enterprises in practice. Its implementation costs are low.

**Originality/Value:** The presented research is a part of a large own study which main goal is to investigate the possibility of applying existing management methods and developing new methods for the effective implementation of the Industry 4.0 concept in practice.

**Keywords:** Logistics 4.0, Industry 4.0, Balanced Scorecard (BSC), transport company, strategy, strategy map.

**JEL codes:** M2, M11, L60.

**Paper type:** Research article.

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## 1. Introduction

The Fourth Industrial Revolution brings pressure on major changes in industrial enterprises as well as in the transport sector. There are new requirements for business structures, processes and logistics (Holubcik *et al.*, 2021). Logistics 4.0 aims at full digitization and automation of processes and expands significantly the scope of logistics operations to manage and coordinate all functions and activities between companies in the supply chain. Logistics' tasks are no longer limited to organizing and managing transport, but also managing functions and coordinating activities between logistics companies throughout the supply chain (Furmann *et al.*, 2017).

An implementation of the Logistics 4.0 assumptions in practice may completely revolutionize logistics processes. The access to information in real time, data collection and the ability to quickly process, analyze and use it in decision-making processes, full automation of processes and the use of Cloud Computing (CC) and enabling access by many users without the need to install special software take today's logistics to a new dimension. They give the possibility of a progressive improvement in efficiency and flexibility. They also generate many problems that must be overcome on the way to this new reality. An important role in this revolution is played by cost optimization, control of the company's financial liquidity and a new approach to strategic controlling.

The aim of the article is to present the possibilities of using the Balanced Scorecard to support the implementation of the assumptions of the Logistics 4.0. The article proposes a model of the strategy map based on the Balanced Scorecard method, dedicated to transport companies. The main objective of the model is to support strategy building during the implementation of new technologies, modern communication and information transfer solutions, and to reduce the related risks in transport enterprises.

## 2. Literature Review

### 2.1 Main Assumptions of the Logistics 4.0 Concept

Generally, the Industry 4.0 concept should lead to a leap in technical performance in enterprises and economical saving (Bona *et al.*, 2021). The Logistics 4.0 concept means a special approach to management of the development, design, control and implementation of object flow networks oriented to change, the basis of which are pattern recognition, generalization and self-organization, and use new technologies and innovative services (Göpfert, 2016; Wehberg, 2016). The concept based on technological and intelligence devices and equipment using online tools, seeking to respond to faster, automatic and virtual information systems (Silva *et al.*, 2019).

According to the Industry 4.0 concept, transport is called intelligent transport elements, based on intelligent sensors, which independently optimize the route based

on information collected from various types of sensors about what is happening on the route and sent via the Internet to road users in real time. Information about the time of arrival at the place of unloading and the necessary documents are sent digitally. A necessary requirements of the Logistics 4.0 are flexibility and ability to adapt logistics systems to changing conditions (Schmidtke *et al.*, 2018).

The biggest challenge is to use modern technology to minimize downtime in transport. Optimization also applies to cargo transportation. Communication with the fleet manager and the provision of information on the availability of transport capacity takes place according to the assumptions of the Logistics 4.0 via digital technology, which ensures incomparably better use of capacity and loading planning in real time, and significantly reduces time and costs of transport, thus increasing its efficiency and effectiveness (Groński, 2019).

Logistics 4.0 uses innovative information technologies based on, Internet of Things (IoT), Internet of Service (IoS), e-commerce, mass configuration, city logistics, as well as 3D printing and API economy, enabling both information and real-time cash flow (Jadczak, 2019). It covers mutual data exchange, digitization and the use of Cloud Computing technology. Besides, technologies supported Logistics 4.0 are also: Cyber-Physical Systems (CPS), Big Data (BD), mobile-based systems, social media-based systems, wireless sensor networks, Blockchain, augmented reality, drones, automatic guided vehicles, artificial intelligence, Cyber Security (Winkelhaus and Grosse, 2020; Lee *et al.*, 2015; Radivojevic and Milosavljevic, 2019; Ilin *et al.*, 2019; Kodym *et al.*, 2020; Bona *et al.*, 2021).

The Logistics 4.0 concept provides for the creation of digital supply chains that ensures availability of all information related to the supply chain in the cloud, full transparency throughout the entire supply chain in real time, minimizing errors in complex processes using augmented reality solutions, reducing the complexity of management through decentralization, autonomous taking decisions, increased automation based on human-machine interaction, increased potential and versatility of optimization using Big Data applications, flexible material flow patterns and increased automation using an interaction with people in real time (Digital Supply Chain, 2019).

In logistics systems automatic identification, automatic data collection, real-time localization, data processing and analysis under the Logistics 4.0 are applied (Radivojevic and Milosavljevic, 2019). Automatic data capture systems (ADC) are also introduced, which allow data to be sent directly to the IT system without the need to enter from the keyboard. Such systems are already used in enterprises. In addition, optical (barcodes), magnetic (magnetic tapes), electromagnetic (radio waves) and biometric (voice recognition) tools are used for automatic identification (Korczak and Kijewska, 2009). Another example of logistics automation is R&D work on autonomous vehicles. New intelligent communication technologies such as vehicle-to-vehicle and vehicle-to-infrastructure create completely new possibilities.

Their use can significantly accelerate the development of autonomous vehicles. Logistics 4.0 also assumes the development of the RFID (Radio Frequency Identification) technology, which is already very often used today, using radio barcodes or EPC (Electronic Product Code), which are a combination of RFID technology with the possibilities of the Internet. Many warehouses use RFID systems to locate forklifts and stored goods. Information is read by special sensors. RFID is also used to generate information about the revision of goods in the warehouse or the space used on the shelves (Waszkowski et al., 2016).

## **2.2 The Role of Strategic Controlling in the Implementation of the Logistics 4.0**

Sustainability and mass customization caused an increase of complexity and demands in logistics systems. Therefore, there is a need to develop other planning and controlling mechanisms (Winkelhaus and Grosse, 2020). The implementation of the Logistics 4.0 requires careful preparation due to the high cost-consumption of new technologies, the necessary infrastructure and a need to employ well-trained employees who can properly use them in practice. Strategic controlling methods, which consist in the effective use of a well-thought-out and quickly implemented strategy, can be a significant support in the implementation of the Logistics 4.0. Performance evaluation is an essential part of implications of the Industry 4.0 technologies (Keivanpour, 2021).

As shown by the experience of the current observations and research conducted in enterprises (Saniuk and Saniuk, 2018) the most important changes related to the implementation of the Industry 4.0 concept include, technical infrastructure (demand for machines and devices), automation of machines and devices and ensuring communication between them, employee competences (skills employees needed to control the automated production system) and cooperation with other companies (building relationships and competences that will allow for joint production of products in supply chains creating intelligent factories of the future with other companies).

The Balanced Scorecard allows not only a strategy to be built, but also the implementation of the most important strategic goals to be monitored and controlled through the designed system of measuring the achievement of goals. BSC is called a strategic system that explains the strategy and translates it into specific operational activities, what means that it is possible to measure and control the implementation of the strategy (Świdarska, 2010; Jabłoński and Jabłoński, 2011). BSC provides communication in the enterprise in both directions. It is a strategic management system that balances short-term goals with long-term goals in a multidimensional way by designing goals, performance measures and initiatives (Świdarska, 2010).

Supplementing the traditionally used financial measures by measuring the most important areas in a modern enterprise, such as: customer needs and relations, business processes and future-oriented development of the enterprise, greatly

facilitates and helps to gain a competitive advantage on the market and enables effective competition on the market in conditions of strong competition. Besides, the roles of indicators in strategy formulation is significant (Ocampo *et al.*, 2021) as well as building an appropriate strategy brings many benefits in the implementation of the assumptions of the Industry 4.0 concept (Lepore and Spigarelli, 2020).

### **3. Materials and Methods**

The presented research is a part of a large own study which main goal is to investigate the possibility of applying existing management methods and developing new methods for the effective implementation and use of the Industry 4.0 concept in practice. The main purpose of research described in this article was to develop a strategy supporting effectively implementation of the Logistics 4.0. concept. The research process consisted of the theoretical and empirical parts. The analysis of the current literature about the main assumptions of the Logistics 4.0 and methods of strategy building was conducted in the theoretical part.

The model of the strategy map based on the Balanced Scorecard method was developed in the empirical part. The main aim of this model is to develop strategic goals that allow the implementation of Logistics 4.0 assumptions and at the same time reduce a risk of the main threats related to the implementation of the Logistics 4.0 concept. This model is dedicated to small and medium transport enterprises.

### **4. Research Results**

The presented research in the empirical part consisted of two stages:

- 1) identification of main threats associated with business management resulted from the implementation the Logistics 4.0 concept;
- 2) model building.

Based on a thorough analysis of the research results conducted so far, the most important threats related to the area of business management resulting from the implementation of the assumptions of the Logistics 4.0 have been identified, which are presented in Table 1. A significant threat is the risk of liquidity loss which means the inability to pay all liabilities of the enterprise within the time limits specified in the documents. It results from the need to implement many new, costly technologies, technical and IT solutions, as well as the limited availability of funds, especially in the SME sector, which mainly includes transport companies. Due to a very fast technical and technological progress, fixed assets quickly become subject to economic wear. For this reason, investments in modern technologies must bring a sufficiently quick return on the invested capital to be able to generate a profit during their lifetime.

**Table 1.** The main threats related to the implementation of Logistics 4.0 in the area of business management

No	Reason	Threat	Strategic goal reducing the risk of a threat
<b>FINANCIAL PERSPECTIVE</b>			
1	High costs of introducing new technologies	The risk of losing financial liquidity	Reducing the risk of losing financial liquidity
2	Rapid technical and technological progress	Fast economic consumption of fixed assets	Increasing the rate of return on invested capital (ROIC)
<b>CUSTOMER PERSPECTIVE</b>			
3	Strong pressure on increasing number of transport services	Deterioration of the transport service quality and many complaints	Increasing effectiveness of control and efficient indicator system
<b>INTERNAL BUSINESS PROCESSES PERSPECTIVE</b>			
4	Significant increase in indirect costs	Incorrectly estimated unit costs of services resulting from inaccurate accounting for indirect costs in traditional costing methods	Increasing the accuracy of estimating the unit costs of transport services
<b>LEARNING &amp; GROWTH PERSPECTIVE</b>			
5	Frequent changes in strategy	Traditional budgeting too static, too time-consuming to make frequent changes	Introducing a new cost planning method that allows for quick changes related to the strategy
<b>ECOLOGICAL PERSPECTIVE</b>			
6	Growing pressure on activities related to environmental protection	high costs associated with exceeding pollution standards	Introducing new improvements to reduce pollutions and to build image of a company that cares about the environment

*Source:* Own study.

The strong pressure on increasing the quality and a number of transport services resulting from strong competition are particularly important in customer perspective. The criteria in the assessment of transport services are primarily, delivery time (from the moment of placing the order to receipt of the shipment), completeness of deliveries (in accordance with the specification), flexibility of deliveries (adapting the time and method of delivery to customer expectations), reliability of deliveries and delivery price (Jeszka, 2009; Gajewska, 2015; Lai and Cheng, 2009).

Strategic goals which improve processes in transport companies and the assumptions of Logistics 4.0 are proposed in the of internal business processes perspective. Based on own research, the most important ones include:

- increasing the level of automatic route optimization based on information recorded

- by sensors and sent via the Internet in real time,
- increasing the automatic communication of devices and means of transport with each other as well as communication and with other participants in the supply chain,
- increasing the level of digital transfer of information on the availability of transport capacity,
- reducing downtime,
- increasing the flexibility of transport processes,
- increasing optimization of the capacity utilization and real-time loading planning.

As a result of new solutions implementation, the cost structure changes in the enterprise. With increasing automation, indirect costs increase (it is often huge increase). In this situation, there is a risk of erroneous estimation of unit costs of services resulting from inaccurate settlement of indirect costs (very averaged) in traditional cost calculation methods usually used in transport companies. In this perspective, the goal of avoiding this risk was also planned, resulting from the need to change the cost calculation method.

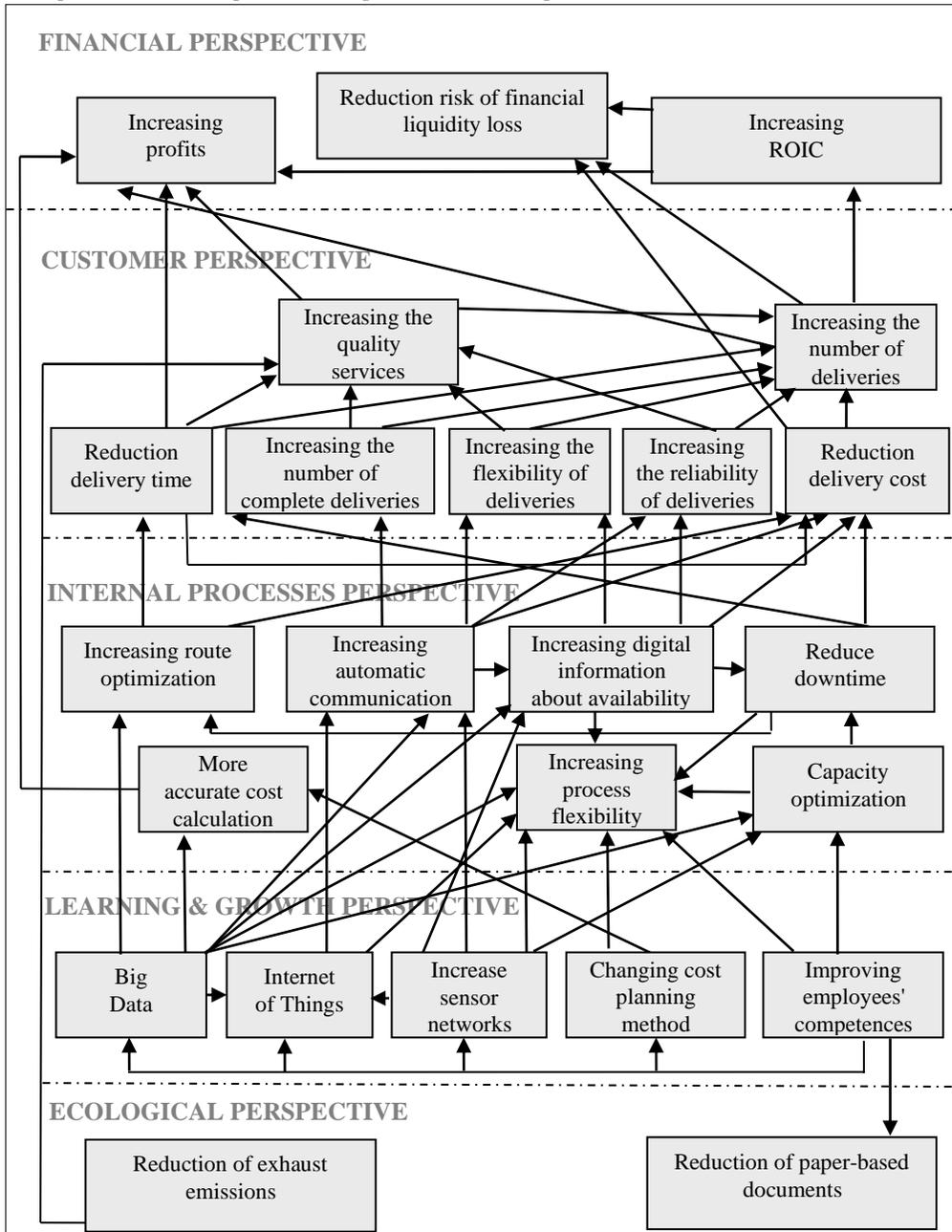
First of all, a development of new technologies and Logistics 4.0 solutions, improve employee competences and change cost planning, resulting from the need for frequent changes in the strategy in learning and growth perspective were proposed. On the other hand, an additional fifth ecological perspective takes into account the reduction of paper-based documentation and the reduction of exhaust emissions.

The article proposes the use of the Balanced Scorecard (BSC) method, which is a comprehensive system for planning and implementing a strategy. It can be used not only to reduce the risk of liquidity loss, but also to monitor and control the most important areas of the functioning of a modern transport company. The model of a strategy map based on BSC dedicated for transport companies implementing the Logistics 4.0 concept is presented in Figure 1. According to the Balanced Scorecard approach there are four main perspectives: financial perspective, customer perspective, internal business processes perspective and learning and growth perspective. The new model proposes one more perspective connected with ecology (ecological perspective).

## **5. Conclusions**

The model of the strategy map proposed in the article supports the implementation of Logistics 4.0 assumptions and allows the risk of the main threats related to the implementation of this concept to be reduced. This model is dedicated to small and medium transport enterprises and is based on the Balanced Scorecard method. The presented model of the strategy map helps to quickly implement a frequently changed and updated strategy and is a modern tool, adapted to the current, very changing environment, which requires a quick response to emerging new market opportunities and threats.

**Figure 1.** Model of the strategy map based on BSC approach dedicated for enterprises which implement Logistics 4.0 concept



Source: Own study.

This model includes strategic goals in five perspectives, financial, customer, internal business processes, learning and growth and ecological. Therefore, a "balanced"

approach to the management of a transport enterprise is possible, which allows the most important areas of transport enterprises at the same time to be monitored and controlled. In addition, the connections of all goals show the cause-effect relationships of individual strategic goals and allow to accurately know and control their effects. An important advantage of this model is the possibility of simultaneous implementation of modern technologies and Logistics 4.0 solutions, analyzing their effects and impact on each of the perspectives, and thus reducing or avoiding the related risks, such as:

- loss of the company's liquidity;
- implementation of new solutions, the use of which is not profitable but generates costs;
- erroneous estimation of the unit costs of services, which may lead to the sale of services below the actual cost of their performance;
- the use of too time-consuming cost planning, which does not take into account the currently implemented strategy.

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