Design of a Supply Chain Performance Monitoring System for a Company in the Context of the COVID-19 Pandemic

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Abstract.

Research background: Design of a methodology for the measurement of logistics processes in production plants to plan, control and manage logistic chain links. The article develops theoretical knowledge in the field of logistics chain management and methods of monitoring them.
Purpose of the article: Material flow and logistics performance management is one of the most important areas for a manufacturing company, which significantly contributes to the overall results of the company's management and its competitiveness. In order for the company to have its resources to use effectively, it needs to have information on its performance and weaknesses in the chain. The condition for obtaining this data is a system for measuring performance in accordance with the company's goals.
Methods: For the analysis of the current state and the identification of weak points in the measurement process, the root cause analysis will also be used, which aims to identify weak points in the process.
Findings & Value added: The aim of the paper will be to create a brief theoretical a basis that will enable the analysis of the current system of evaluation of logistics performance and supply chain in the selected company and the identification of weaknesses with regard to the strategy and philosophy of the company and a proposal for changes that would increase the efficiency and effectiveness of the Supply chain. The most significant contribution can be attributed to the proposal for implementation systematic evaluation of suppliers using a scoring model designed specifically for company.

Keywords: *Supply chain; JIT; balanced scored card; SCOR model; performance measurement.*

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1 Introduction

Many companies have realized that through successful logistics management and supply chain, they can offer their customers better services, in better quality and in less time.

In order to make these efforts as effective as possible, it is necessary to systematically monitor and evaluate the processes and activities within the SC.

The main task of Supply Chain Management is to find a way to effectively use information and communication technologies to optimize the supply chain, which has a positive effect on all its components.

One of the purposes of measuring performance is to determine the effectiveness of SC. There are many theoretical frameworks for measuring performance, but only a small part of them deal directly with SC management. This is one of the main reasons why in the 21st century this topic is given great attention not only in theory but also in practice.

Supply chain management has become one of the most discussed topics in the literature and is considered a key strategic element in many organizations. Nowadays, markets have become more dynamic and are characterized by rapid changes in customer requirements. These changes have put pressure on businesses to ensure a smooth flow of material and information between actors in the supply chain.

The ability to measure supply chain performance leads to better understand the operation of the SC and provides important feedback from which the chain can be optimized.

The existing interdependence of the partners requires the introduction of specific control mechanisms to detect problems well in advance so that corrective action can be taken if necessary. It is important in examining the supply chain to take into account the fact that SC includes all companies involved in the transformation, sale and distribution of raw materials and products to the final consumer.

This has two implications for research into the logistics performance and management of SC. First, some research is focused on monitoring supply chain management, that is, performance is monitored in multiple organizations. Second, research must take into account the relationship between the structure of the channel and the function of individual members. [1, 2, 3, 4, 5, 6, 7]

There are too many approaches to measuring performance to clearly establish general conclusions derived from the literature on the relationship between logistics practice and performance.

However, it can be argued that from a strategic point of view, the goal of SC, respectively supply chain management, is the creation of a competitive chain, while the operational goal is the effective setting of processes. It is important to make sure that processes are seen as part of the chain and not isolated. Such an approach requires the companies concerned to focus their goals on achieving the top goal of the chain and not to focus only on local optimals.

Due to the growing complexity of supply chains, chain control and evaluation of overall functioning is becoming a challenging task.

2 Methods

2.1 Methods for monitoring Company Logistics Supply chain

Until now, the **traditional theory of measuring performance** has in most cases focused on financial indicators such as ROI, cash flow, profits, etc. The disadvantage of the traditional approach is the tendency to retrospectivity, disregard for intangible elements and late evaluation of information. This has forced researchers to rethink their approach to measuring data and metrics and to revisit this topic in the new context of the modern economic environment.

Given the turbulent changes in the business environment and information technology over the past decades, we must also think about how we will evaluate the company's performance and which criteria deserve the most attention.

Author Majercak, et.al emphasize that one of the major changes in perceptions of performance and productivity is the modernist paradigm that today's businesses cannot compete individually as separate entities, but only as part of a chain. As a result of these changes, it is necessary to create a performance measurement system that will be a combination of financial and non-financial criteria and will take into account the performance of enterprises as part of the SC. The basic features of traditional metrics are, for example, profit orientation and short-term orientation, with subjective evaluation predominating. In contrast, innovative metrics are of a longer-term nature, measuring progress or development instead of comparing with the standard, and striving for greater objectivity.

Characteristic features are impersonality, accuracy and relatively easy availability of data. The data is often very accurate and in many cases available for a long time. It is therefore easy for a company to collect and evaluate such data. Measuring net income or return investments (ROIs) are useful ways to determine a company's profitability. Profitability is a particularly useful goal because it directly reflects the goals of internally consistent groupings of the organization, although this may not be a good indicator of a company's long-term viability. The criticism of traditional business performance indicators is that, in most cases, the performance assessment is based on historical accounting data. Their biggest drawback is that they do not take into account the risk, the impact of inflation, do not deal with the time task of money and do not compare the result of managing the opportunity cost. Financial indicators play a major role in measuring performance-oriented business performance. Also, the analysis of the financial performance of the company is the basis for the analysis of non-financial factors affecting the strategic success of the company. [8, 9]

The innovations in the approach to measuring performance, which have taken place since the 1980s, arose mainly in the name of criticism of traditional methods oriented to the economic result of the company. From a number of modern methods of measuring performance, there are approaches of authors, who set out specific indicators that should provide the most effective achievement of the objectives. Chopra defined what criteria must be taken into account in order for a company to be able to identify effective indicators. Performance indicators must correspond to the company's objectives:

- *Based on the selected indicators, it must be possible to compare the company with competitors in the same area*
- *Clearly defined purpose and method of calculation of each measurement*
- *Preference of objective and ratio indicators*
- *The selection of indicators should be based on a discussion of stakeholders.*

In addition to the aforementioned critical argument, the authors also state the need for a holistic view of the company's performance, which would also provide support for long-term strategic goals aimed at future development and strengthening competitiveness. Although the economic result tells about the current situation of the company, it only describes the impact of past activities. It does not answer the question: How should the company go, what is key for further development?

Concept traditional measurements is therefore not suitable for the use of these measures as a tool for strategic decisions but rather as an operational or tactical tool. Part of the modern approach to measuring performance is the emphasis on qualitative indicators. These measurements cannot be expressed exactly in numbers but are based on subjective evaluation, which may take the form of a scale that includes some kind of evaluation.

The field of performance measurement has undergone significant changes in recent decades, and it can be argued that the importance of logistics in the company has grown steadily and so it is logical that more attention has been paid to how to measure its performance and manage this process. Since the 1980s, we can observe a departure from classical financial methods of evaluation and the development of new methods for measuring the performance of logistics and SC. [10, 11, 12, 13]

Coordination and optimization of SC has become one of the strategic goals of companies. As a result of deepening globalization, geographical boundaries and constraints are losing ground.

The phenomenon is an increased need for integration, which has resulted in the extension of the term "supply chain". Non-financial performance indicators came to the fore, including, for example, the quality and importance of the customer. Businesses have begun to increasingly implement modern technologies such as RFID, EDI, pick to light and others. The trend not only in logistics is the integration of processes and the creation of strategic alliances. Integration can take place at the internal as well as at the inter-company level within the supply chain. Unification brings with it space for eliminating waste, shortening delivery time product synergies and the exchange of know-how. Based on the new requirements for performance measurement, systems of indicators and methods have been created under the term supply chain performance measurement, which offer an alternative to classical methods of performance measurement. The structure of modern tools should be adapted, especially in the context of the SC, to the requirements for inter-company performance measurement.

3 Results

Methods for determining weights

In the case of evaluation of variants on the basis of several criteria, it is necessary to assign a weight v_i (non-negative number) to each criterion, which expresses the significance of a particular criterion in relation to the other criteria. The final value of the criterion weight must belong to the interval <0,1>, while the sum of the values of all weights must take the value 1 according to relation (1).

$$\sum_{i=1}^{n} v_i = 1 \tag{1}$$

The methods of determining the weights relevant to the issue of this dissertation can be divided as follows on the basis of whether, in addition to determining the weights of individual criteria, the mutual evaluation of their level in different variants:

1. **Methods used as a matter of priority for determining the weights of the criteria:**
   - *Equal weights method*

- *The order method*
- *100 point allocation method*

We have described these methods in detail below.

2. **Methods allowing, in addition to determining the weights of the criteria, the mutual evaluation of the level:**
   - *Decision matrix method*
   - *Modified decision matrix method*
   - *Analytical multilevel method (Saaty method)*

Equal weights method

This method of determining the weights is based on the assumption that the weight of all criteria is the same, while the value of individual weights decreases with increasing number of assessed criteria. The calculation of the weights of individual criteria is performed according to the following relation (2):

$$v_i = \frac{1}{n} \; pre \; i = 1,2, \ldots, n \tag{2}$$

In practice, the use of the equal weighting method is eliminated only in cases where the assessor does not have information available to distinguish the significance of individual criteria. [14, 15, 16]

The order method

This method of determining weights is based on the assumption that several assessors are involved in the process of determining weights. It follows from the above that there are p criteria and q experts. The criteria are arranged in order of importance. The natural numbers p, p - 1, ..., 1 are then assigned to this order so that in the case of the criterion with the highest significance, ie the first criterion in the order is assigned the number p, the less significant criterion, ie the second criterion is assigned the number p - 1 and the least important criterion, ie the last criterion in the order is assigned the number 1. According to the given conditions, the number 〚and_ij is the number assigned to the i - th criterion by the j - th expert. [17, 18]

The calculation of the weight of the i-th criterion by the j-expert is realized according to the relation (3):

$$v_{ij} = \frac{a_{ij}}{\sum_{i=1}^{p} a_{ij}} = \frac{a_{ij}}{\frac{p*(p+1)}{2}} \tag{3}$$

The final final weight of the i-th criterion is then realized according to relation (4):

$$v_i = \frac{\sum_{j=1}^{q} v_{ij}}{q} = \frac{\sum_{i=1}^{p} a_{ij}}{\frac{p*(p+1)*q}{2}} \tag{4}$$

Experts will therefore determine the score for each criterion by ranking it on the basis of its significance. The resulting weight of the criterion is then calculated as the ratio of the points obtained by a particular criterion to the total number of points obtained by all criteria from all experts. The method allows the implementation of the determination of the weights of the criteria by involving a larger number of experts. However, the disadvantage is the

fact that the final scope of the point evaluation of the criteria is limited by an integer number.

100 point allocation method

This method of determining weights again assumes the existence of p criteria and q experts. In this case, the significance of individual criteria is evaluated by assigning points in the range from 0 to 100, while the higher the significance of a particular criterion, the higher the number of points the expert will assign to the criterion. Again, the principle that the total number of points awarded to each criterion must be equal to 100.

The calculation of the normalized weight of the i-th criterion by the j-th expert is realized according to the relation (5):

$$v_{ij} = \frac{b_{ij}}{100} \tag{5}$$

The final final weight of the i - th criterion is then realized according to relation (6):

$$v_i = \frac{\sum_{j=1}^{q} v_{ij}}{q} \tag{6}$$

Methods of Decision Analysis

The methods of decision analysis are based on the conditions of certainty regarding the final effect of the decision and on the condition of uncertainty (uncertainty) regarding the estimation of the decision risk. They work with the information obtained in the analysis phase of the problem and measure the effect and risk of the decision according to as many criteria as possible. In general, this means that the methods of decision analysis touch on the problem of so-called multicriteria decision-making resp. multicriteria optimization and therefore the most important step in the decision analysis is undoubtedly the choice of criteria. [19]

In practice, several different methods are used, which are based on a similar principle. In principle, they deal with the assessment of several variants of solving a specific problem with predetermined criteria and the subsequent determination of the final order of the assessed variants. However, the methods are different in the way of determining the so-called weights of individual criteria and how they numerically evaluate the degree of fulfillment of criteria in the case of individual variants of the solution. [20, 21]

The most used decision analysis methods include the Decision Matrix Method (DMM), the Modified Decision Matrix Method (FDMM) and the Analytic Multilevel Method (Saaty method). [22]

Decision Matrix Method (DMM)

One of the basic methods can be considered the so-called the Decision Matrix Method (DMM), which is also modifiable for several variants. One of the possibilities is to use, for example, a point scale from 1 to 10 to assign values to the weights (importance) of individual criteria. solutions meet the individual selected criteria, ie. from "1" - does not meet at all and after "10" - meets absolutely.

Based on the final ranking, the decision then determines the largest weighted sum (the sum of the products of the evaluations, as the variants meet the criteria, and the weights of these criteria). However, this procedure has the disadvantage of a high degree of subjectivity, even in the case of determining the weight of individual criteria, as well as in

the evaluation of the fact, as the assessed solutions meet the specified criteria. [23]

3 Discussion

Material flow and logistics performance management is one of the most important areas for a manufacturing company, which significantly contributes to the overall results of the company's management and its competitiveness. In order for the company to have its resources to use effectively, it needs to have information on its performance and weaknesses in the chain. The condition for obtaining this data is a system for measuring performance in accordance with the company's goals.

The paper outlines the most well-known approaches to measuring performance in the company and within the supply chain. There are many different theories and methods, but it is still possible to define a set of characteristics that combine these approaches. Scientists agree that each case needs to be approached individually depending on the area being studied. In the first step, key performance indicators must be established for each company or department. The authors are generally of the opinion that the effectiveness of the results is not guaranteed by the large number of selected criteria or the complexity of the measurement, but on the contrary by a simple procedure and, in particular, the correct selection of appropriate metrics for a particular business. Only on the basis of the correct identification of these factors, the results of the measurement can be a relevant basis for future decisions of managers, whether at the operational or strategic level.

Classical methods are not able to cover all the effects on efficiency and performance. Qualitative dimensions such as customer satisfaction, service, etc. came to the fore. It is therefore advisable to combine both soft and hard indicators and metrics in the analysis. As it was mentioned, the maximum efficiency of the result is achieved by precise determination of specific criteria, using a combination of hard and soft measurement techniques.

4 Conclusion

Implementation of supply chain management and performance measurement logistics is not an easy task but is associated with many obstacles. The supply chain is based on information sharing, strategies, goals and planning. These are all elements that the company does not like to share with its competitors or with its customers. By discovering not only its weaknesses but also its competencies and know-how, it is exposed to a considerable risk of losing control over these data. Olsen summarizes typical problems or shortcomings of performance measurement systems in his work. He emphasizes that the weak points are the lack of connection with the strategy of any organization, the excessive focus on financial indicators and too isolated and incompatible measurements. The consequence of these shortcomings is the inaccuracy of the resulting data and thus the wrong basis for future decisions. [5] The situation would be improved if we minimized the number of metrics used in the measurement system. [12] It is necessary to disengage from the revaluation of historical data as the most important focus of research and to try to predict developments rather than on the basis of assumptions obtained by qualitative measurements. It is important to realize that supply management chain is a complex task and the implementation of performance measurement brings with it a number of complications. Authors describe this process as a multifactor process, based on close and long-term cooperation between organizations. [15] Nedeliakova, Nedeliak an Majercak argue that up to 70 percent of attempts to implement the SC performance measurement system fail. [14] Success depends on creating a new culture based on sharing learning, transparency and

trust. The key task is the continuous development of integration in order to improve the performance of the whole chain. The condition is therefore not only the integration of SC members but also the internal interconnection of efforts to continuously improve and measure performance in the company. Another obstacle that significantly complicates the measurement of SC performance is the fact that the results of measuring the performance of the chain is difficult to assign to a particular company or entity within the SC.

The problem is the clear demarcation of components not only between the components of the SC, but also within the company itself. [10] Despite these obstacles, the choice of performance measurement system is an important factor for a company's success.

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