A METHODOLOGY PROPOSITION FOR LOGISTICS PERFORMANCE INDICATORS SELECTION AND GOALS DEFINITION: A CASE STUDY IN A CIVIL CONSTRUCTION ENTERPRISE[1]

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RESUMO

Com o passar dos anos, como a logística se tornou um fator crítico na criação e manutenção de vantagem competitiva, a medição e a análise de desempenho se tornaram cada vez mais importantes e difíceis no gerenciamento de tal segmento. Sistemas de medição de desempenho logístico devem ser definidos de forma que possam medir se as metas propostas pela organização estão sendo alcançadas. Na literatura existente, há uma grande quantidade de métodos propostos para modelar um processo usando indicadores de desempenho, no entanto, eles raramente abordam a questão das metas dos indicadores. Dentro deste contexto, este artigo propõe uma metodologia composta de cinco macro fases para a definição de um sistema de indicadores de desempenho logístico: (i) definição do processo logístico avaliado; (ii) definição das metas de representação, (iii) avaliação de propriedades do conjunto inicial de indicadores, (iv) legitimação do conjunto de indicadores obtido, (v) determinação das metas para o conjunto de indicadores final. A metodologia proposta se diferencia da literatura existente ao estabelecer as propriedades que os indicadores de desempenho devem satisfazer a fim de representar os processos logísticos e as considerações que devem ser tomadas para definir as metas do conjunto de indicadores final. Para avaliar a aplicabilidade da metodologia, ela é implantada na logística de outbound de uma empresa do ramo da construção civil, e o resultado obtido é um conjunto de KPIs com metas estabelecidas. O conjunto de indicadores logísticos obtido foi consistente com a realidade da empresa, comprovando que a metodologia proposta está aderente com o seu propósito.

Palavras-chave: Sistema de medição de desempenho logístico. Indicadores-chave de desempenho. Metas de indicadores.

ABSTRACT

As logistic competence becomes a critical factor in creating and maintaining competitive advantage, modeling and performance analysis becomes increasingly important and difficult in managing such a segment. Logistic performance measurement systems must be defined so that they can measure whether the goals proposed by the organization are being achieved. In the existing literature there is a great deal of methods to model a process using performance indicators, however, they rarely address the issue of targeting indicators. This paper tries to identify the major properties that indicators should satisfy in order to represent a specific logistic process and considerations that must be taken for a correct definition of the indicators targets. The proposed methodology encompasses five main phases. The first one consists of defining the logistic process evaluated, the second consists of defining the representation-targets, the third verifies the properties of the indicators for an initial set of indicators, in the fourth the set of indicators obtained is legitimized and in the last phase indicators targets are defined. The methodology is implemented in a civil construction enterprise. The set of logistics indicators obtained was consistent with the reality of the company, proving that the proposed methodology is in line with its purpose.

Keywords: Logistics performance measurement. Key performance indicators. Indicators Targets.

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1. INTRODUCTION

This digital era is turning the conventional logistics into logistics 4.0 (ZINN and GOLDSBY, 2020). The efficiency of logistics activities became even more relevant, requiring the arrangement of service areas that can rationalize the processes of supply, production and distribution (CHRISTOPHER, 2011). The technological evolution, such as the internet of things (IoT) has resulted in exponential growth of data (DEV et al., 2019). Performance modeling and analysis become increasingly more important and difficult in the management of such complex manufacturing logistics networks (WU and DONG ,2007). One new challenge that arises with logistics 4.0 is the massive amount of data that can be generated (WINKELHAUS and GROSSE, 2020) and the personnel has difficulties to make quick decisions with this exponential data growth (DEV et al. 2019). Therefore, logistics performance management (PM) is still a key to quantifying the current state and potential improvements within logistics (DORNHOFER et al., 2016).

The performance control and evaluation are two necessary tasks in logistics activities and resources utilization, due to the logistics competences in creating and maintaining competitive advantage (BOWERSOX and CLOSS, 2011). The indicators need to be strategically selected in an organizational performance indicators system, allowing the senior managers to act efficiently to accomplish the planned goals. The selection of the indicators set depends on the complexity of the process evaluated, its importance to the company goals, and the expectation of data use for management (IRFANI et al., 2019).

Some problems can arise in the definition of the logistics performance indicators set (STAUDT, 2015): (i)The growing logistics complexity and the easy information access have led companies to adopt a large number of indicators, making their management increasingly difficult; (ii) if an excess of performance indicators is defined, the chances of duplicity and conflicting goals are higher and it could be difficult for the managers to interpret the overall performance of the process. Dev et al. (2019) affirm that it is difficult to figure out the intricate relationships among different KPIs (Key Performance Indicators). On the other hand, if just a few performance indicators are selected, some logistics processes could be not sufficiently represented (STAUDT et al., 2015). Therefore, problems with the definition and comparison of performance expressions exist (CLIVILLÉ et al., 2007).

Besides the logistics indicators selection, another issue is related to the indicators goals delineation. For Lewis and Slack (2015), the indicators target definition must be related to the company's goals, and it needs to be compared with some type of standard.

There are several methodologies to logistics performance indicators definition. The Supply Chain Operations Reference Model (SCOR) has been widely applied to manage the supply chain performance and logistics performance (Irfani et al., 2019) in this category, that just like the methodology developed by Irfani et al. (2019), analyzes five main attributes for the development of a performance measurement system: reliability, responsiveness, agility, costs and asset management.

It is possible to note that the methodologies do not provide clear steps and requirements to be evaluated during the indicators set definition. The definition of the indicators set ends up depending on the experience of the managers (SCHMITT, 2002). Moreover, to the best of our knowledge, any methodology aggregates the logistics indicators definition with their goals.

In this context, this paper aims to propose a methodology framework to test and identify the most proper indicators to be chosen for a given logistics process, including a procedure to define these indicators targets. The proposed methodology was based on two main previous works, Franceschini et al. (2008) and Lewis and Slack (2015). To demonstrate the framework utilization, the methodology is applied in the logistics distribution area of a civil construction company.

The article is structured in five sections. Succeeding this introduction, section 2 provides theoretical support on logistics performance measurement systems and methodologies for indicator targets definition. Section 3 details the methodology framework for defining a set of logistics performance indicators and their targets. Section 4 presents a case study with an application of the proposed methodology, and Section 5 summarizes the findings, highlighting limitations and opportunities for future studies.

2. THEORETICAL OVERVIEW

This section provides theoretical support to the concepts of methodologies for logistics performance measurement and methodologies for definition of indicators targets.

2.1. Methodologies for logistics performance measurement

Performance measurement systems (PMS) are structures that integrate performance information through performance indicators and key performance indicators (KPIs) in a dynamic and accessible way, in order to achieve consistency and complete performance measurement (LOHMAN et al., 2004). KPIs measure the performance level of processes or strategic objectives, so they help the organization to define and measure its progress towards its goals, while normal indicators only represent performance measures of an activity (PARMENTER, 2007). Based on this definition, a performance evaluation system can be understood as a set of indicators used to quantify the effectiveness and efficiency of operations (IRFANI et al., 2019).

As time goes by, logistics gains relevance at organizations, becoming a crucial aspect of performance and thus demanding greater attention from managers in relation to the execution of their operations. The organization must make an efficient logistics system available so that products reach the buyer within the right period and under the required conditions, otherwise, customer satisfaction in relation to performance will be compromised (KEEBLER and PLANK, 2009).

Considering that logistics should not be treated only as an activity that adds costs to the process, but that it also adds value, one should consider it as a management activity and develop its own performance measurement and evaluation systems, according to its characteristics and particularities (SCHMITT, 2002).

Performance measurement systems (PMS) have become a relevant issue for academics and professionals since the late 80's (GUTIERREZ et al., 2014). Traditionally, financial performance measures have been the main indicator for companies. Since the use of only financial perspectives creates many limitations, Kaplan and Norton (1992) presented the BSC (Balanced Scorecard), a financial and non-financial methodology to enlarge the measures scope taken into consideration. Then, Neely et al. (1995) developed Performance Prism, a new and even more comprehensive structure GUTIERREZ et al., 2014.

Franceschini et al. (2008) presents a methodology for the definition of performance indicators measurement system by means of a more generic approach in comparison to those presented previously, but that can be applied for the definition of a system of evaluation of logistic performance. This methodology differs from the others in a way that it does not carry out a design of indicators, but rather their testing and selection.

In their methodology, Franceschini et al., (2008) illustrates several properties to support analysis and selection of indicators, however, the authors emphasize that before thinking about how to represent a specific aspect of the process, it is important to think about which dimensions of the process should be represented. In practical terms, before defining the process indicators, the representation goals, derived from the companies strategy, must be identified.

Like other business areas, logistics management also requires adequate performance measures and metrics to identify areas for improvement and thus to improve organizations performance (CHAKPITAK et al., 2018). In addition to the organizational PMS structures mentioned above, several other structures can also be used to manage supply chain and logistics performance. One of the best known in this category is the SCOR model (Supply Chain Operations Reference), proposed in 1996 by the supply chain board, which contains as the five main attributes: reliability, responsiveness, agility, costs and asset management (IRFANI et al., 2019).

According to Domingues et al. (2015), logistics is a complex area that can be measured from different perspectives, therefore, many authors of the literature have proposed different models for evaluating logistic performance. Bowersox and Closs (2001), Barbosa et al. (2010), Moons et al. (2019) and Garcia et al. (2011) list asset management, costs, customer service, productivity, and logistic quality as the main attributes to be evaluated in a PMS.

Gutierrez et al. (2014) developed a logistic performance evaluation system following a questioning methodology divided into three phases: design, implementation and use. In each phase, questions are asked for its development and the resulting PMS is classified into four categories, which are: asset control, information reliability, agility, and security of activities.

Keebler and Plank (2009) applied a questionnaire to companies in different segments with the purpose of assessing knowledge about the assessment of logistics performance. This questionnaire included efficiency measures from different points of view, involving business partners, internal focus and cost, productivity, and utilization. Most companies represented by respondents in the survey do not comprehensively measure logistics performance, which is detrimental to its health, as those who understand the value of high-performance logistics are more likely to invest in improvements in their capacity, thus becoming more valuable as business partners.

Staudt et al. (2015) presents a PMS categorized into four dimensions: time, quality, cost and productivity, linked to five main activities of the warehouse: receipt, storage, separation, tracking and delivery. Gong and Yan (2015) and the authors Chakpitak et al. (2018) carry out approaches highlighting the importance of human capital: competence, attitude and intellectual agility, and structural capital: relationships, renewal, development and organization. Meanwhile, Bajec and Tuljak-Suban (2019), move towards a more sustainable approach that reflects economic, social and environmental aspects.

It is possible to note that each author starts from different analysis to create a logistic PMS. All of them point out the importance of relating the analyzed processes to the company's strategic objectives, which is even a decisive factor in differentiating KPIs from simple metrics. Parmenter (2007) explains that KPIs represent aspects of organizational performance that are crucial for the present and future success of organizations, as they are key tools of the control system, which allow decision-making and coherent and strategy-oriented actions (PARMENTER, 2007). The lack of understanding on what are key or critical success processes is the central problem. A company that does not have its processes mapped will certainly find it difficult to classify their degree of importance in relation to corporate strategy (PARMENTER, 2007).

Knowing the importance of the performance indicators for a company, it was found a gap in the literature regarding the definition of targets for these indicators, a theme that is understood to be very important because it is as from the targets that companies will be able to compare whether their operation is improving or not. For this reason, this work proposes a methodology that not only tests the best set of indicators through the properties they should satisfy (FRANCESCHINI et al., 2008), but also directs how the target definitions should be made.

2.2. Methodologies for definition of indicators targets

According to Irfani et al. (2019) the purpose of the organizational goals is translating the intended market position of the organization into performance goals or targets for the operation. For that, strategic decisions are used to set broad objectives that direct an enterprise towards its overall goal, plan the path that will achieve these goals, stress long-term rather than short-term objectives and deal with total picture rather than with individual activities.

The objective of the indicators is to operationalize the goals of the process, that is, they must be able to measure the strategic objectives of the organization, this is verified through the targets of the indicators (SERGEEV, 2005). The achievement or not of the indicators targets will show to the company if its performance is meeting its strategies or not. Accurately calibrating activities performance and their outcomes has many advantages, as well as some risks. Performance measurement is therefore central to successful strategy execution (LEWIS AND SLACK, 2015)

There are many ways of verifying and defining the goals of the indicators. The most traditional are against historical standards of the company itself, competitors, or some idea of absolute perfection. Another very popular, although less used, method for senior managers to drive organizational improvement is to establish operational benchmarks. By highlighting how key operational elements ‘shape up’ against ‘best in class’ competitors, key areas for focused improvement can be identified. It is now taken to mean benchmarking to gain competitive advantage (perhaps by comparison with, and learning from, non-competitive organizations) (LEWIS AND SLACK, 2015).

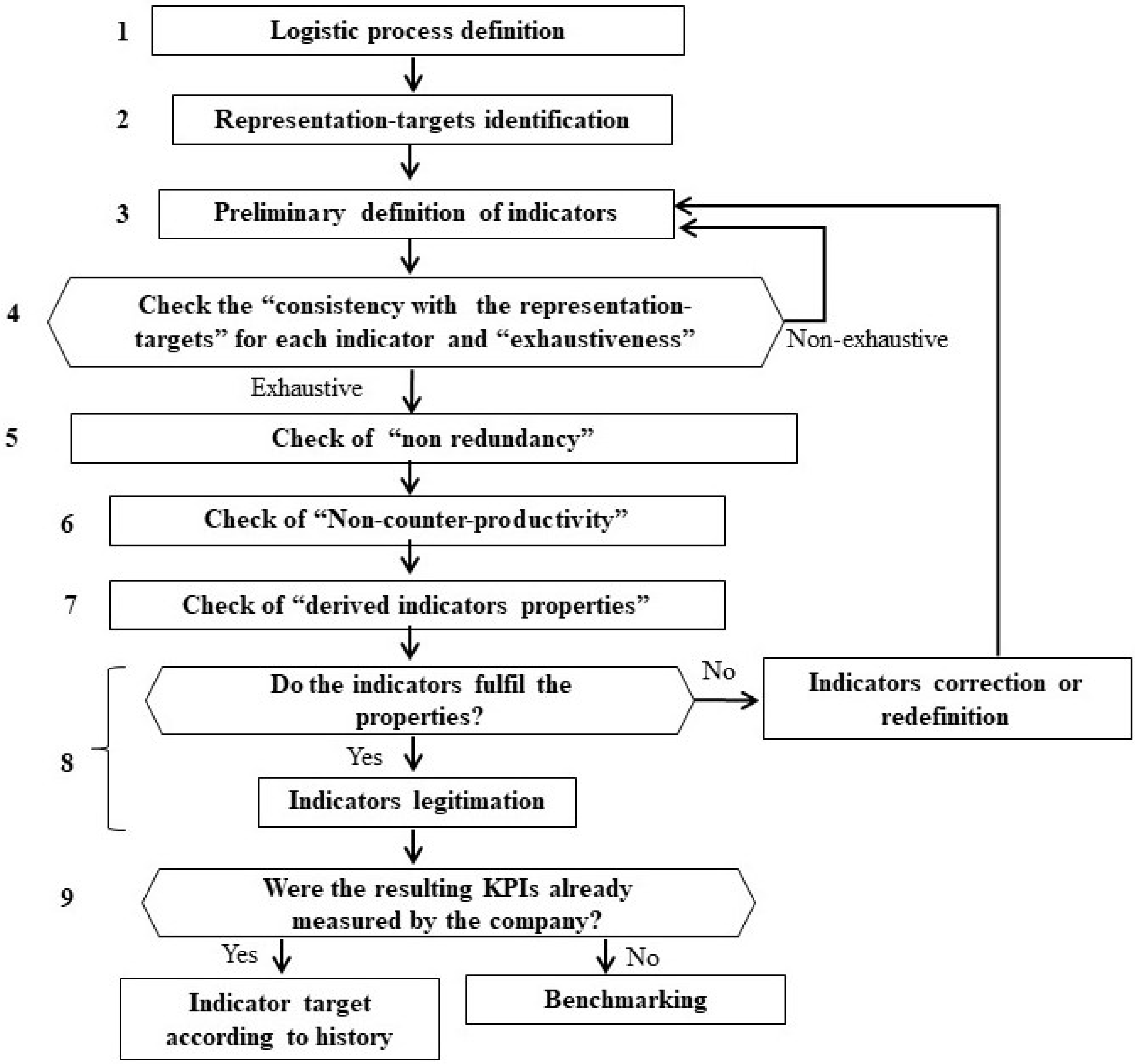
Benchmarking is partly concerned with being able to judge how well an operation is doing. It can be seen, therefore, as one approach to setting realistic performance standards. It is also concerned with searching out new ideas and practices that might be able to be copied or adapted (APDUHAN AND IZHAR, 2020).

Lewis and Slack (2015) presents another tool used for goal setting: Importance–performance mapping is a particularly useful approach in directing operations improvement, because it explicitly includes both major influences on the generic performance objectives that define market requirements: the needs and importance preferences of customers, and the performance and activities of competitors. Both importance and performance have to be brought together before any judgement can be made as to the relative priorities for improvement. Just because something is particularly important to its customers does not mean that an operation should give it immediate priority for improvement.

3. THE METHOLODY PROPOSITION FOR LOGISTICS PERFORMANCE INDICATORS SELECTION AND GOALS DEFINITION

After illustrating concepts about performance measurement systems and indicators targets, a methodology framework for testing and defining a set of indicators as well as their targets has been proposed (Figure 1). Steps 1-9 in Figure 1 were based on the methodology proposed by Franceschini et al. (2008). The authors listed several properties that indicators must satisfy to adequately represent a generic process based on their target representations, resulting in a final set of indicators. In this paper, concepts were adapted to the evaluation of logistics processes and some properties listed by Franceschini et al. (2008) such as simplicity of use and economic impact and level of detail were not maintained. It is very difficult to find information about definition of targets indicators in the literature, but knowing its importance for measuring and comparing the result of the indicators in relation to the company's goals (KEEBLER and PLANK, 2009), it was decided to include step 9 in the proposed method. This last step was based mainly on concepts presented by Lewis and Slack (2015) for bringing different starting points for the definition of indicator targets.

Figure 1- Proposed Methodology.



Source: Author (2021).

As shown in Figure 3, the methodology is based on a top-down test of the following steps:

(1) Organization logistics process definition;
(2) Representation-targets identification;

(3) Preliminary definition of indicators;
(4) For each indicator, check the "consistency with the subgoals of the process and "exhaustiveness";
(5) Verification of "non-redundancy";
(6) Verification of "Non-counter-productivity";
(7) Verification of the properties of the derived indicators: "monotony" and "compensation".
(8) Verification of the need to reapply the methodology (looping). If it is not necessary, the obtained indicators must be legitimized.
(9) Definition of indicators targets.

This methodology is based on a "top-down" testing. First, the logistic process that is going to be studied must be defined, and then, the representation-targets of the organization related to the studied were identified. Since indicators should encourage the achievement of process long-term goals, representation-targets should concern process dimensions, which are strictly linked to the company's strategies.

In step 3, a preliminary definition of a set of indicators must be made. It can be done in many ways: (i) the indicators currently used at the company can be selected, (ii) benchmarking with other companies in the same segment or (iii) through a literature review in databases.

For each indicator it is necessary to verify the "consistency with the representation-target" and "exhaustiveness" (step 4). A set of indicators is a way to represent a process or a part of it. This property says that every indicator should properly operationalize the representation-targets of the process without omissions or redundancies (FRANCESCHINI et al., 2008). For an organizational process, different representation-targets can be identified, and each of them must be represented by at least one indicator. A set of indicators is considered non-exhaustive if there are no indicators referring to one or more specific representation-targets.

Step 5 is in testing the property of "non redundancy". If a set of indicators is exhaustive, and if it continues to be exhaustive even removing one indicator then the removed indicator is redundant (FRANCESCHINI et al., 2008). One possible way to perform this step is comparing the indicators equations, therefore, when removing an indicator that is calculated repeatedly, that indicator will be considered redundant.

In sequence, the property of "non-counter productivity" is required to be checked (step 6). Typically, in a company or in a process managed by indicators, managers and employees focus their attention on indicators linked to short-term rewards or bonuses, overlooking the global targets of their tasks. This behavior can sometimes be counterproductive for the achievement of long-term goals. Therefore, this property identifies the existence of indicators with contradictory objectives, where to reach the goal of one, it will be necessary to compromise the other.

Step 7 verifies the property of derived indicators ("monotony" and "compensation") and the rules under which sub-indicators are aggregated into derived indicators. According to Franceschini et al. (2008), basic indicators are obtained from a direct observation of an empirical system and derived (or aggregated) indicators are obtained combining the information of one or more aggregated "sub-indicators" (basic or other derived). For example, let us consider a derived indicator ITOT measured by the sum of the sub-indicators (Ik, Ii, Il, Im).

If the increase in a specific sub-indicator (Ik) is associated with the decrease in one or more indicators (for example, Ii; Il; Im), causing a decrease in overall performance (ITOT) as well, then Ik is counterproductive.

That is, when a sub-indicator changes and the aggregate indicator remains the same due to the compensation of its sub-indicators, it means that one of the sub-indicators is counterproductive. Therefore, it is interesting for companies that their derivative indicators are monotonous, so that they react to changes in the system and those in decision-making roles can act towards improvement.

After all properties verification have been done, in step 8 is necessary to analyze if the set of indicators obtained meets all the property checks, if there is a need, new indicators should be proposed and the steps should be rechecked (looping). In the same step, the legitimization of the indicators is carried out. For Collins et al. (2009), the criteria that must be included in the legitimation process are: credibility, reliability, ability to transfer results to other situations and the possibility of confirming information. It is crucial that this process is performed in synergy with the company managers familiar with the process.

The last step of this methodology is the definition of the indicators targets (step 9). Independent of the individual performance measures that are extracted from an operation, the meaning derived from them will depend on how they are compared with some type of standard measure. Typically, bases for comparison are against historical standards, improvement goals, benchmarking, competitors or some idea of absolute perfection (LEWIS and SLACK, 2015).

For example, if one of the company's performance measures is delivery performance (in this case defined as the proportion of orders delivered on time, where "on time" means on the promised day). The actual situation of the month has been measured at 83 per cent. However, by itself it does not mean much, it depends on the basis of comparing performance against targets. An obvious basis for comparison involves using an historical standard. Supposing that if it in the year before the performance was 60 per cent, then the actual performance of 83 per cent is good. So, if the improvement goal was 95 per cent, the actual performance of 83 per cent looks decidedly poor. The company may also be concerned with how it performs against competitors performance. If competitors are currently averaging delivery performances of around 75 per cent, the company's performance looks rather good (LEWIS AND SLACK, 2015). This step can be done only for the indicators, since they are the ones that will represent the company's strategic vision (SERGEEV, 2005).

Since every process is a dynamic system evolving over time, company's strategies may change as time goes by. For that reason, every indicator, to be aligned with the representation-target, needs to be constantly modified or improved. Exhaustiveness is a practical tool to periodically check the consistency between subgoals and indicators (FRANCESCHINI et al., 2008). If operational goals or subgoals changes, one or more indicators may not properly represent them, not satisfying the property of exhaustiveness. According to Barbosa et al. (2010), updating the performance evaluation system should be done regularly as the strategic objectives are updated, since the evaluation of logistics performance can indicate opportunities for an organization to improve its logistics and thus directly generate competitive advantages (KEEBLER et al., 2009).

4. METHODOLOGY APPLICATION - A CASE STUDY

This section presents the application of the proposed methodology in a civil construction enterprise to define a set of logistic performance indicators and their targets. The company focus of this study is located in Joinville-SC and has been in the market for more than 75 years, in addition, it is present in more than 13 countries.

The first methodology step is the logistics process definition. A meeting was carried out with the logistic manager in September 2020, and was understood that after the strategic objectives reformulation, which happened in June 2020, no update was made to the set of logistical indicators. Therefore, based on the application of the methodology presented in section 3, a new set of indicators for the studied company is proposed. Initially the information obtained was the company's strategic objectives and the logistics indicators currently used by the company. The step 1consists of defining the logistic process that analyzed, in this case, the distribution logistics.

Step 2 comprehends the definition of the representation-targets. According to Franceschini et. al (2008), the representation-targets must be consistent with the company's strategy. To help their definition, the strategic objectives of the company were presented (Table 1).

Table 1 - Goals of the organization process.

Strategic objectives	Description
Agility	Speed and agility in customer service and channels
Consistency	Reliability in delivering the plan on time, quality and agreed quantities
Use of assets	Efficiency in managing capacity utilization and working capital
Cost Efficiency	Efficiency and cost management
Flexibility	The company's ability to react to changes in the plan in the short term

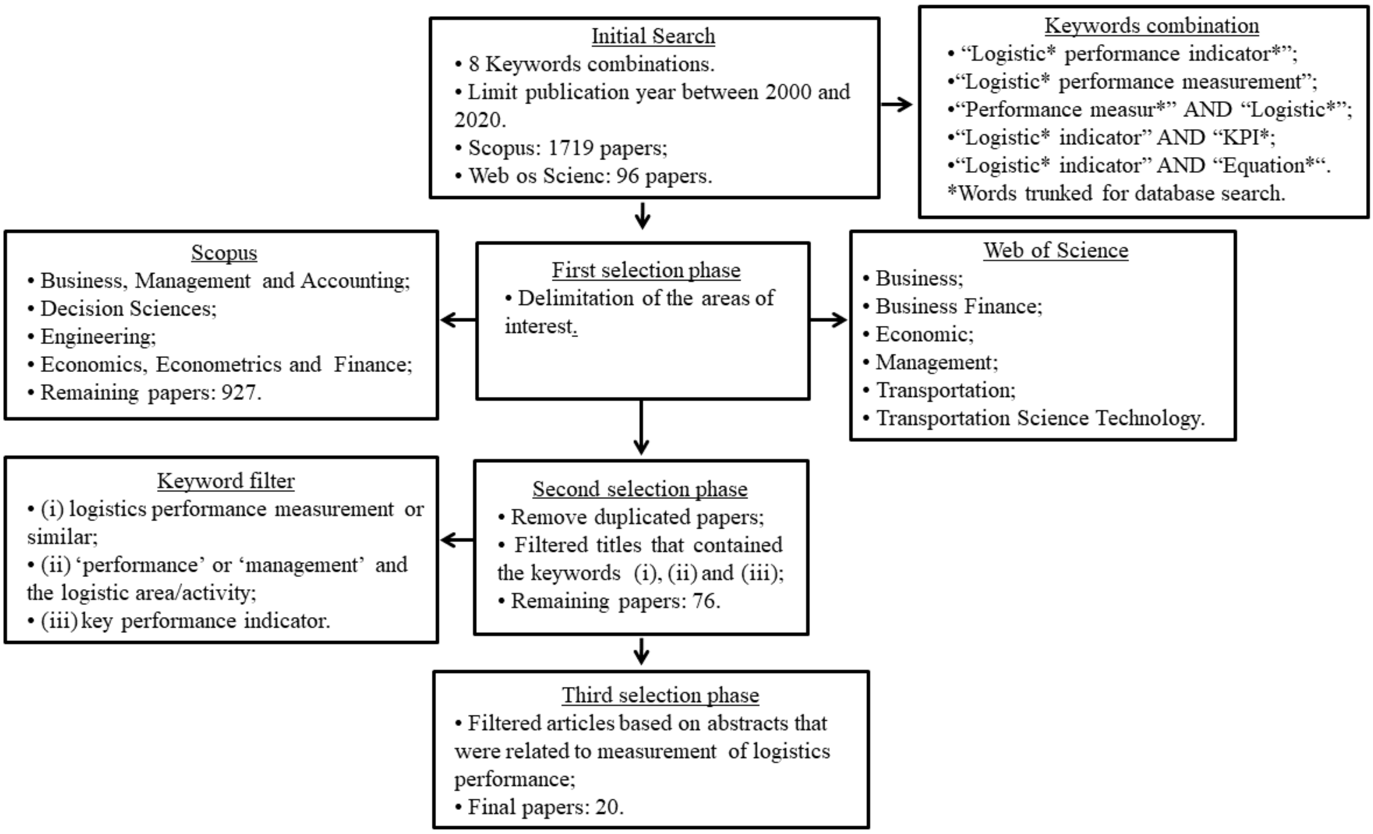
Source: Studied company (2020).

Analyzing the logistics distribution process, the processes carried out in the warehouse and transportation must be considered, and making an analogy of the strategic objectives presented with the categories "time", "quality", "productivity", "cost" and " flexibility ", the representation-targets have been defined as:

- Warehouse time;
- Warehouse quality;
- Warehouse productivity;
- Warehouse cost;
- Warehouse flexibility;
- Transportation time;
- Quality of transport;
- Transportation productivity;
- Transportation cost;
- Transportation flexibility.

In step 3, it is necessary to make the preliminary definition of the indicators. As mentioned in Section 3 the indicators can be defined according to those the company already measures, through benchmarking or database research. In this study, the indicators currently measured by the company were used and, to update the topic, a structured literature review was carried out in the Scopus and Web of Science databases. Figure 2 describes the steps performed in this work to define paper database.

Figure 2- Article search and evaluation process.



Source: Author (2021).

In the initial search phase, a list of keywords combinations used for the database search was defined. The initial search was limited for papers written in English language and a publication year between 2000 and 2020. This range of years offers enough support to make conclusions from the results of content analysis. This initial search resulted in 1719 articles from Scopus and 96 from Web of Science. Then, the area delimitation is applied for (i)Scopus and (ii)Web of Science as: (i) "Business, Management and Accounting", "Decision Sciences", "Engineering", "Economics, Econometrics and Finance"; (ii) "Business", "Business Finance", "Economic", "Management", "Transportation" and "Transportation Science Technology". The number of remaining papers was 927.

In the second selection phase, articles that had the titles related to the keywords: (i) "logistics performance measurement" or similar; (ii) the words 'performance' or 'management' and the logistic area/activity and (iii) "key performance indicator" were filtered. At this stage, the number of articles is narrowed down to 76 papers. Finally, the abstract of these articles was analyzed. In this phase, the papers were filtered according to their relationship to logistics performance measurement. In case of doubt on the papers content, the full text was also verified. The final database contains 20 papers, the authors can be seen in Table 1.

Table 1 - Authors resulting from the structured literature review.

Authors	
Cheng et al. (2002)	Domingues et al. (2015)
Rafele (2004)	Alpan et al. (2015)
Mason et al. (2008)	Ying (2017)

Authors	
Kleeber and Plank (2009)	Chakpitak et al. (2018)
Olugu et al. (2010)	Engelseth et al. (2018)
Barbosa and Musetti (2010)	Irfani et al. (2019)
Camargo et al. (2011)	Bajec and Tuljak-Suban (2019)
Persson and Thunberg (2013)	Moons et al. (2019)
Fiorencio et al. (2014)	Ghade et al. (2020)
Gong and Yan (2015)	Hilmola et al. (2020)

Source: Author (2021).

Considering all the suggestions of indicators from the authors mentioned above, 123 resulting logistic performance indicators are obtained. This list also included the logistics indicators currently used by the studied company, they were: "Returns and allowances", "Customer dissatisfaction", "Total logistics costs", "Inventory turnover", "Warehouse capacity utilization", "On time in full", "Order fill Rate", "On time delivery" and "Order cycle time", becoming a total of 132 indicators. In order to synthesize all these indicators and generate a single set of measures without duplicate information, the analogous indicators were grouped, resulting in 38 indicators.

An example of grouping of similar indicators can be given by the indicator “Warehouse capacity utilization”. It was mentioned by Gutierrez et al. (2014) as "Utilization of storage capacity", by Staudt et al. (2015) as "Utilization of warehouse", by Camargo et al. (2011) as "Warehouse utilization percentage". Thus, the preliminary definition of indicators can be seen in the Table 2.

Table 2- Preliminary definition of indicators.

Indicators	Authors
Carbon dioxide (CO) Greenhouse gas emissions (GHG)	Bajec and Tuljak-Suban (2019);
Cargo damage rate	Domingues et al. (2015); Chakpitak et al. (2018); Gong and Yan (2015); Staudt et al. (2015); Keebler and Plank (2009).
Cargo theft	Domingues et al. (2015);
Customer dissatisfaction	Company (2020); Domingues et al. (2015); Gong and Yan (2015); Ghade et al. (2020); Keebler and Plank (2009).
Customer satisfaction	Olugu et al. (2010); Gong and Yan (2015); Camargo et al. (2011); Ghade et al. (2020); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Delivery efficiency	Chakpitak et al. (2018);
Delivery Lead Time	Chakpitak et al. (2018); Gong and Yan (2015); Staudt et al. (2015).
Dock-to-stock time	Staudt et al. (2015);
Energy efficiency and utilisation	Chakpitak et al. (2018);
Freight cost	Moons et al. (2019); Olugu et al. (2010); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Inventory accuracy	Irfani et al. (2019); Moons et al. (2019); Chakpitak et al. (2018); Camargo et al.

Indicators	Authors
	(2011); Engelseth et al. (2018); Fiorencio et al. (2014); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Inventory cost	Olugu et al. (2010); Ghade et al. (2020); Staudt et al. (2015); Keebler and Plank (2009).
Inventory turnover	Company (2020); Chakpitak et al. (2018); Fiorencio et al. (2014); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Levels of environmental responsibilities	Chakpitak et al. (2018);
On time delivery	Company (2020); Domingues et al. (2015); Irfani et al. (2019); Moons et al. (2019); Rafele (2004); Olugu et al. (2010); Chakpitak et al. (2018); Gong and Yan (2015); Mason et al. (2008); Cheng et al. (2002); Engelseth et al. (2018); Ghade et al. (2020); Bajec and Tuljak-Suban (2019); Hilmola et al. (2020); Fiorencio et al. (2014); Staudt et al. (2015); Keebler and Plank (2009).
On time in full	Company (2020); Domingues et al. (2015).
Order cycle time	Company (2020); Domingues et al. (2015); Moons et al. (2019); Rafele (2004); Olugu et al. (2010); Chakpitak et al. (2018); Gong and Yan (2015); Persson and Thunberg (2013); Camargo et al. (2011); Ghade et al. (2020); Bajec and Tuljak-Suban (2019); Hilmola et al. (2020); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Order Fill Rate	Company (2020); Irfani et al. (2019); Rafele (2004); Olugu et al. (2010); Chakpitak et al. (2018); Cheng et al. (2002); Engelseth et al. (2018); Ghade et al. (2020); Staudt et al. (2015); Keebler and Plank (2009).
Order picking time	Staudt et al. (2015).
Order processing cost	Staudt et al. (2015).
Orders processed/time unit	Bajec and Tuljak-Suban (2019); Keebler and Plank (2009); Barbosa and Musetti (2010).
Orders shipped on time	Staudt et al. (2015).
Outbound space utilisation	Staudt et al. (2015).
Out-of-date deliveries	Domingues et al. (2015).
Percentage increase in demand flexibility.	Rafele (2004); Olugu et al. (2010); Chakpitak et al. (2018); Gong and Yan (2015); Persson and Thunberg (2013).
Perfect order delivery	Chakpitak et al. (2018); Persson and Thunberg (2013); Camargo et al. (2011); Cheng et al. (2002); Engelseth et al. (2018); Hilmola et al. (2020); Staudt et al. (2015); Keebler and Plank (2009).
Picking accuracy	Staudt et al. (2015).

Indicators	Authors
Profit growth rate	Gong and Yan (2015).
Return processing cost	Cheng et al. (2002).
Returns and allowances	Company (2020); Keebler and Plank (2009).
Schedule adherence	Chakpitak et al. (2018); Gong and Yan (2015); Mason et al. (2008).
Stock-out frequency	Irfani et al. (2019); Rafele (2004); Chakpitak et al. (2018); Staudt et al. (2015); Keebler and Plank (2009); Barbosa and Musetti (2010).
Total logistics costs	Company (2020); Ying (2017); Gong and Yan (2015); Camargo et al. (2011); Cheng et al. (2002); Keebler and Plank (2009).
Transportation accidents	Domingues et al. (2015); Bajec and Tuljak-Suban (2019).
Vehicle capacity used	Domingues et al. (2015); Irfani et al. (2019); Chakpitak et al. (2018); Bajec and Tuljak-Suban (2019); Staudt et al. (2015); Keebler and Plank (2009).
Vehicle loading/unloading time	Domingues et al. (2015); Staudt et al. (2015).
Warehouse capacity utilisation	Company (2020); Domingues et al. (2015); Chakpitak et al. (2018); Gong and Yan (2015); Fiorencio et al. (2014); Staudt et al. (2015); Keebler and Plank (2009).
Warehouse labour productivity	Chakpitak et al. (2018); Staudt et al. (2015); Keebler and Plank (2009).

Source: Author (2021).

Table 3- Relation property of the indicators with the subgoals and the exhaustiveness.

Indicators	**Warehouse time**	**Warehouse quality**	**Warehouse productivity**	**Warehouse cost**	**Warehouse flexibility**	**Transportation time**	**Quality of transport**	**Transportation cost**	**Custo do transporte**	**Transportation flexibility**	**Other**
Carbon dioxide (CO2)											✓
Cargo damage rate							✓				
Cargo theft							✓				
Customer dissatisfaction							✓				
Customer satisfaction							✓				
Delivery efficiency							✓				
Delivery Lead Time						✓					
Dock-to-stock time			✓								
Energy efficiency and utilisation											✓
Freight cost									✓		

Indicators	Warehouse time	Warehouse quality	Warehouse productivity	Warehouse cost	Warehouse flexibility	Transportation time	Quality of transport	Transportation cost	Custo do transporte	Transportation flexibility	Other
Inventory accuracy		✓									
Inventory cost	✓										
Inventory turnover			✓								
Levels of environmental responsibilities											✓
On time delivery							✓				
On time in full							✓				
Order cycle time	✓										
Order fill rate		✓									
Order picking time			✓								
Order processing cost				✓							
Orders processed/time unit			✓								
Orders shipped on time								✓			
Outbound space utilisation			✓								
Out-of-date deliveries							✓	✓			
Percentage increase in demand flexibility.				✓						✓	
Perfect order delivery				✓			✓				
Picking accuracy		✓									
Profit growth rate											✓
Return processing cost									✓		
Returns and allowances							✓				
Schedule adherence							✓				
Stock-out frequency		✓									
Total logistics costs				✓					✓		
Transportation accidents							✓				
Vehicle capacity used			✓								
Vehicle loading/unloading time	✓										
Warehouse capacity utilisation			✓								
Warehouse labour productivity			✓								

Source: Author (2021).

In this step, four indicators were removed, the ones classified as “other”, resulting in a set of 34 indicators. Then, in step 5, the non-redundancy property is checked. This property can be verified in the following way: if a set of indicators is exhaustive and continues to be exhaustive, even when removing an indicator, the removed indicator is redundant. To assist this analysis, the indicators definition was presented. Table 4 shows the indicator definition, unit of measurement and classification of the indicator (basic or derived). Then, it is identified the indicators with similar calculations or that were encompassed by derived indicators. (verification of the "non-counter-productibity").

Table 4- Indicators equations and classification.

Indicators	Definition	Units of measure	Classification
Cargo damage rate	Number of orders damaged during delivery activity	%	Basic
Cargo theft	Number of theft events during transportation of products during a a certain period	No. of thefts	Basic
Customer dissatisfaction	Number of customer complaints/number of orders delivered	%	Basic
Customer satisfaction	Number of customer complaints/number of orders delivered	%	Basic
Delivery efficiency	Orders delivered with right products, in the right quantity and in the right places	%	Basic
Delivery Lead Time	Lead time from the warehouse to customers	days and hours	Basic
Dock-to-stock time	Lead time from supply arrival until product is available for order picking	hours and minutes	Basic
Freight cost	The type of cargo, type of vehicle and total distance traveled per trip provide freight cost measures.	R$	Basic
Inventory accuracy	Measures the accuracy (by location and units) of the physical inventory compared to the reported inventory	%	Basic
Inventory cost	Total storage costs/unit	R$	Basic
Inventory turns	Ration between the cost of goods sold and the average inventory	No. of turnovers	Basic
On time delivery	Number of orders received by customer on or before committed date	%	Basic
On time in full	On Time and In Full deliveries per total number of deliveries	%	Basic
Order cycle time	Cycle time from customer order to order delivery	days and hours	Derived
Order fill rate	Orders filled completely on the first shipment	%	Basic
Order picking time	Lead time to pick an order line	hours and minutes	Basic
Order processing cost	Total processing cost of all orders per number of orders	R$	Basic
Orders processed/time unit	Orders processed per a certain period time	%	Basic
Orders shipped on time	Number of orders shipped on time per total orders shipped	%	Basic
Outbound space utilisation	Utilisation of the area inside the warehouse used for packing and shipping	%	Basic
Out-of-date deliveries	Percentage of deliveries executed after the agreed date	%	Basic

Indicators	Definition	Units of measure	Classification
Percentage increase in demand flexibility.	This is the level to which the orders can be changed due to customers demands	%	Basic
Perfect order delivery	Orders delivered on time, in full, without damage and with accurate documentation	%	Derived
Picking accuracy	Accuracy of the orders picking process where errors may be caught prior to shipment such as during packaging	%	Basic
Return processing cost	Costs on returned orders	R$	Basic
Returns and allowances	Number of returned and allowanced orders	Nb of returns and allowances	Basic
Schedule adherence	Percentage of deliveries arriving within a 1-hour tolerance window	%	Basic
Stock-out frequency	Number of stock products out of order	%	Basic
Total logistics costs	Total logistics costs consider the whole range of costs associated with logistics, including transport and warehousing costs and inventory carrying, administration, and order processing costs. Administration and order processing costs are relative to the total volume being handled	R$	Derived
Transportation accidents	Number of accidents occurred during the transportation journey of products during a certain period of time	%	Basic
Vehicle capacity used	Vehicle fill rate	%	Basic
Vehicle loading/unloading time	Spended time loading/unloading the vehicle	hours or minutes	Basic
Warehouse capacity utilisation	The used capacity of the warehouse by the total capacity of the warehouse	%	Basic
Warehouse labour productivity	Total number of items managed to the amount of item-handling working hours	%	Basic

Source: Author (2021).

Starting the analysis by time related indicators, it is noted that "Delivery lead time" and "Vehicle loading / unloading time" are included in the "Order cycle time" indicator. Removing these two indicators, the system remains exhaustive and, therefore, they are redundant. However, it was decided to keep the indicator "Vehicle loading / unloading time" as it is important for monitoring the operation. Then, analyzing the indicators related to transportation, the indicators "Cargo damage rate", "Cargo theft" and "Transportation accidents" were removed. It was decided to maintain the "Delivery efficiency" indicator, which is able to report all damage in transport.

While analyzing indicators related to quality, it was observed that the indicators "On time delivery", "On time in Full", "Order fill rate", "Out of date deliveries" and "Orders shipped on time" are all included in the indicator " Perfect order delivery ". According to Franceschini et al. (2008), derived indicators simplify the analysis and monitoring of processes, so they should be preferred. Therefore, only the “Perfect order” indicator was maintained. Still analyzing quality indicators, it was possible to find another redundancy, but now related to customer satisfaction, as the indicators "Customer satisfaction" and "Customer dissatisfaction" are calculated in the same way and added together result in 100%, it was decided to keep only the "Customer satisfaction".

The indicators related to cost: "return processing cost", "Order processing cost" and "Freight cost" are included in the derived indicator "Total logistics costs". It is decided to remove all of them except for the "Freight cost", this indicator is monitored daily by the company and is also used for studies of routes and BIDs of shipping companies. After this verification step, 21 indicators remained.

Step 6 consists of checking the non-counterproductivity property. This property identifies the existence of indicators with contradictory objectives. To reach the goal of one, it is necessary to commit the other, or even, to reach the goal of a time-related indicator, for example, employees perform the activities incorrectly or in a dangerous way to accomplish the task in a shorter time (FRANCESCHINI et al., 2008)).

By analyzing the current indicators, it was possible to identify counterproductive metrics among the indicators "Order picking time", "Picking accuracy" and "Returns and allowances". Employees will be able to separate products as quickly as possible to shorten the separation time, but they may directly impact picking accuracy due to a greater chance of errors. These errors, in turn, will impact the percentage of returns since the customer will receive the products incorrectly. Non-counter-productive indicators should be avoided, for this reason it was decided to eliminate the indicator “Order picking time”. In cases where it is not possible to eliminate an indicator, measures must be taken to prevent or mitigate non-counterproductivity. As an example, managers must stipulate possible goals to be achieved, combined with good working conditions and innovation of processes and equipment, aiming at greater productivity of the operation (FRANCESCHINI et al., 2008).

Step 7 verifies the derived indicators property. These types of indicators aggregate and summarize information for a given set of sub-indicators for different activities. As shown in Table 4, there are the following derived indicators: "Total logistical costs", "Order cycle time" and "Perfect order delivery". The three derivative indicators presented deal with the sum of sub-indicators of independent processes, when changes are made in only one of the sub-indicators and it is considered that all the others remain the same, the result of the aggregated indicator will be changed, therefore, it appears that they are monotonous.

In day-to-day situations, to achieve goals, for example, it is possible that the system compensates due to process prioritization. An example can be given with the “Order cycle time” indicator. If the delivery generation time has been too long, you can prioritize its separation or billing, so that the total order cycle time remains unchanged. The exceptions are, the monotonous indicators derived from the set and there is no reason to exclude any of them. After all these steps, the resulting set of 20 indicators can be seen in Table 5.

Table 5- Resulting set of indicators.

Indicators
Customer dissatisfaction
Delivery efficiency
Dock-to-stock time
Freight cost
Inventory accuracy
Inventory cost
Inventory turns

Indicators
Order cycle time
Orders processed/time unit
Outbound space utilisation
Percentage increase in demand flexibility.
Perfect order delivery
Picking accuracy

Indicators	Indicators
Returns and allowances	Vehicle loading/unloading time
Schedule adherence	Warehouse capacity utilisation
Stock-out frequency	Warehouse labour productivity
Total logistics costs	

Source: Author (2021).

The next step is to legitimize the indicators, in this work it is done with a logistics manager in a virtual meeting in April 2021 from the study company and was essential to improve the final set of indicators. A comparison is made between the current set of indicators and the one obtained through the methodology.

For the current reality of the company, it is decided to keep the indicators "On time in full" and "Order fill Rate" and eliminate the indicators "Perfect order delivery" and "Orders processed/time unit". Although these indicators are included in the calculation of the perfect order, their individual measurements are important to allow more detailed action on each one of them. The "Percentage increase in demand flexibility" indicator is also eliminated and the "cost of serve" indicator is included in its place. The rest of the indicators are all kept.

Looking forward of better operations management, managers have used Key Performance Indicators (KPIs) to monitor operations as they provide internal and external visibility, and consequently help decision making (KEEBLER and PLANK, 2009). According to that, target definition, in this case study, is set for the KPIs only.

A verification was made on which indicators of the resulting set would be classified as KPIs for the company, and the chosen ones were “Customer satisfaction”, “Inventory accuracy”, “Order cycle time”, “Total logistics costs” and “On time in full”.

After legitimizing the set of indicators obtained with the company it results in a set of key performance indicators capable of operationalizing the organizational goals, however, there is often a question about how to compare actual against target performance, that is the reason why the targets of indicator are necessary. As seen in Section 2.2, there are many ways to set targets for indicators. In this case, all indicators classified as KPIs are already measured by the company. Thus, according to Lewis and Slack (2015), the goals can be defined throughout historical standards. In cases where indicators are not measured by the company, the targets should be proposed through benchmarking. To set the targets for the indicators presented in table 6, a historical comparison of two previous years (2019 and 2020) was used. For the case of the total logistics costs indicator, the target set varies according to the budgeted amount of expenses for the month. These budget projections are made based on simulations of sales price, product weight, inflation, and increase in turnover volume. Therefore this target will not be informed. The set of resulting KPIs and their targets are presented on Table 6.

Table 6- Set of resulting KPIs and their targets.

Indicators	**Targets**	**Units of measure**
Customer disatisfaction	0,52	%
Inventory accuracy	100	%
On time in full	85	%
Order cycle time	5	Days or hours
Total logistics costs	-	%

Source: Author (2021).

5. CONCLUSIONS

In the existing literature there are methods to evaluate a process using performance indicators, but the proposed approach mainly focuses on indicators testing rather than indicators designing. This paper tries to identify the major properties that indicators should satisfy in order to represent a specific logistic process and considerations that must be taken for a correct definition of the indicators targets. To demonstrate its applicability the methodology was applied in a civil construction enterprise. This methodology contributes logistic indicators and their targets, listing steps to be followed without a precise reference structure and properties that are exclusively analyzed with a descriptive approach.

In the studied company, there were nine initial indicators, to update the topic, a structured literature review focused on performance logistic indicators was carried out. After processing the data and applying the methodology, a set of nineteen indicators was obtained, five of them were classified as KPIs and had their goals defined using historical standards. Thus, the case study demonstrates the methodology applicability. The criteria result is defined as satisfactory with the methodology.

For future works, it is proposed to expand the application of the methodology to other areas than logistics, to apply the method in more companies and to monitor compliance with the targets established for the indicators to verify the need for a possible review of these targets periodically.

REFERENCES

APDUHAN, B.; IZHAR, T. A. D. **Towards Ontology Based Data Extraction for Organizational Goals Metrics Indicator**. Computational Science and Its Applications, 20 Ed, 2020.

BAJEC, P.; TULJAK-SUBAN, D. **An Integrated Analytic Hierarchy Process Slack Based Measure-Data Envelopment Analysis Model for Evaluating the Efficiency of Logistics Service Providers Considering Undesirable Performance Criteria**. Sustainability, 11 - 2330, 2019.

BARBOSA, D. H.; MUSETTI, M. A. **The use of performance measurement system in logistics change process:** Proposal of a guide. International Journal of Productivity and Performance Management, 4, 339-359, 2010.

BOWERSOX, D. J.; CLOSS, D. J. **Logistical Management:** the supply chain integration process**.** McGraw Hill, 2001.

CAMARGO, M.; FORRADELLAS, R. Q.; GARCIA, F. A.; MARCHETTA, M. G.; MOREL, L. **A framework for measuring logistics performance in the wine industry.** International Journal of Production Economics, 135, 284–298, 2011.

CHAKPITAK, N.; NEUBERT, G.; WUDHIKARN, R**. A literature review on performance measures of logistics management:** an intellectual capital perspective. International Journal of Production Research, 13, 4490–4520, 2018

CHENG, T.C.E.; LAI, K.; NGAI, E.W.T. **Measures for evaluating supply chain performance in transport logistics**. Transportation Research Part E 38, 439–456, 2002

CHRISTOPHER, M. **Logistics and Supply Chain Management**. Financial Times Prentice Hall, 2011.

CLIVILLÈ; VINCENT; BERRAH, L.; MAURIS, G. **Quantitative expression and aggregation of performance measurements based on the MACBETH multicriteria method.** International Journal of Production Economics 105, 171–189, 2007.

DEV, N. K.; SHANKAR, R., GUPTA, R. and JINGXI, D. **Multi-criteria evaluation of real-time key performance indicators of supply chain with consideration of big data architecture**. Computers & Industrial Engineering 128: 1076–1087, 2019.

DOMINGUES, M. L.; MACÁRIO, R; REIS, V. **A comprehensive framework for measuring performance in a third-party logistics provider**. Transportation Research Procedia 10, 662 – 672, 2015.

DÖRNHÖFER, M; FALK SCHR¨ODER.; and GUNTHNER**,** W. A**. Logistics performance measurement system for the automotive industry.** Logistics Research, 9, 2016.

ENGELSETH, P.; HOEUR, S.; KRITCHANCHAI, D. **Develop a strategy for improving healthcare logistics performance.** Supply Chain Forum: An International Journal, 19:1, 55-69, 2018.

FIORENCIO, L.; GUTIERREZ, D. M.; MARTINS, R. A.; SCAVARDA, L. F. (2015). **Evolution of the performance measurement system in the Logistics Department of a broadcasting company:** An action research. International Journal of Production Economics, 160, 1–12, 2015.

FRANCESCHINI, F.; GALETTO, M.; MAISANO, D.; MATROGIACOMO, L. **Properties of performance indicators in operations management**. International Journal of Productivity, v.57, 2008.

GARCIA, F. A**. A framework for measuring logistics performance in the wine industry.** International Journal of Production Economics, v.135, 2011.

GONG, K.; YAN, H. **Performance Measurement of Logistics Service Supply Chain Using Bijective Soft Set.** Journal of Advanced Manufacturing Systems, 1, 23-40, 2015.

GUNASEKARAN, A.; GHADGE, A.; KAMBLE, S. S.; RAUT, R. **A performance measurement system for industry 4.0 enabled smart manufacturing system in SMMEs**: A review and empirical investigation. International Journal of Production Economics, 229, 107853, 2020.

GUTIERREZ, D. M. ; SCAVARDA, L. F. ; FIORENCIO, L. ; MARTINS, R.A. **Evolution of the performance measurement system in the Logistics**. Internacional Journal of Production Economics, v. 160, 2015.

HILMOLA, O.; KIISLER, A.; SOLAKIVI, T. **Estonian logistics market 2018 survey**: analysis and findings. Scientific Journal of Logistics, 16 (3), 409-420, 2020.

IRFANI, D. P., WIBISONO, D., BASRI, M. H., **Logistics performance measurement framework for companies with multiple roles**. Measuring Business Excellence, 2, 93-109, 2019.

KEEBLER, J. S., PLANK, R. E. **Logistics performance measurement in the supply chain**: a benchmark. Benchmarking: An International Journal, 6, 785-798, 2009.

LEWIS. M.; SLACK, N. **Operations Strategy.** Pearson, 4 Ed, 2015.

LOHMAN, C.; FORTUIN, L.; WOUTERS, M. **Designing a performance measurement system: a case study**. 156. Ed. Eindhoven: European Journal of Operational Research, 2004.

MASON, R., NAIM, M., POTTER, A., WANG, Y. **Aligning transport performance measures with customised retail logistics**: a structured method and its application. International Journal of Logistics: Research and Applications, 11:6, 1367-5567, 2008.

MOONS, K., PINTELON , L., RIDDER , D. D, TIMMERMANS , P., & WAEYENBERGH, G. **Performance indicator selection for operating room supply chains**: An application of ANP. Operations Research for Health Care, 23, 100229, 2019.

OLUGU, E. U., SHAHAROUN, A. M., & WONG, K. Y. **Development of key performance measures for the automobile green supply chain.** Resources, Conservation and Recycling, 55, 2010.

ONWUEGBUZIE, A. J.; JOHNSON, R. B.; COLLINS, K. M. T. **A call for mixed analysis:** A philosophical framework for combining qualitative and quantitative. 3. Ed. International Journal of Multiple Research Approaches, 2009.

PARMENTER, D. **Key Performance Indicators:** Developing, Implementing, and Using Winning KPIs**.** 2007.

PERSSON, F.; THUNBERG, M. **Using the SCOR model's performance measurements to improve construction logistics**. Production Planning & Control, 25:13-14, 1065-1078, 2014.

RAFELE, C. **Logistic service measurement: a reference framework**. Journal of Manufacturing Technology Management, 3, 280-290, 2004.

SCHMITT, N. **An Introduction to Applied Linguistics**. Arnold Publishers, 2002.

SERGEEV, V. **Controling of Logistics Systems.** 1. Ed. Russia: LogForum, 2005.

STAUDT, F. H.; ALPAN, G.; DI MASCOLO, M.; RODRIGUEZ, C. M. T. **Warehouse performance measurement: a literature review**. International Journal of Production Research, 53:18, 5524-5544, 2015.

STAUDT, F. H. **Global warehouse management:** a methodology to determine an integrated performance measurement - Thesis to obtain the degree of doctor of the university grenoble alpes, 172, 2015.

WINKELHAUS, S.; GROSSE, W. H **Logistics 4.0**: a systematic review towards a new logistics system.” International Journal of Production Research 58, 18–43, 2020.

YING, F. **Measuring the invisible A key performance indicator for managing construction logistics performance**. Construction Logistics Performance, 6, 1921-1934, 2017.

ZINN; WALTER; GOLDSBY; T. J. **Global Supply Chains: Globalization Research in a Changing World**. Journal of Business Logistics 41, 4–5, 2020.