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OPERATIONAL ANALYSIS OF A LOGISTIC PROCESS IN THE PETROLEUM EXPLORATION AND PRODUCTION CHAIN INTEGRATING ISHIKAWA, BOWERSOX AND LIKER TOOLS IN PROBLEM IDENTIFICATION: A CASE STUDY

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ABSTRACT

The objective of this article was to demonstrate the research and use of an operations analysis model unique to logistic activities that could integrate the use of three tools to identify and analyze problems in a process and to prove the interdependence of losses and gains between the various factors that make up an activity. In this proposal the research of context, concepts, application and evaluations on the models chosen for the integration was made. After designing the integrated model, it was tested in a real case of application and the results of the analysis were obtained, taking care to contextualize all the technical, social and cultural aspects involved in the process. In the end, the conclusion exposed the positive and negative aspects of the logistic process evaluated and demonstrated the effectiveness of the integration of tools, identifying opportunities for improvement with the prioritization and indication of a tool for the solution of the deviations.

Keywords: Operational analysis; logistics; problem identification.

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1. INTRODUCTION

All parts of an organization need to be involved and committed to process analyzes simply because each one performs a different process, and the analysis assesses how the work is actually performed, evidencing good practices and losses that need to be mitigated (Krajewski, 2009). In this sense, it is important to consider the analysis of processes in the context of logistics within companies, especially those operating in the petroleum exploration and production chain.

The intelligence report of the *Serviço Brasileiro de Apoio às Micro e Pequenas Empresas* – SEBRAE (Brazilian Micro and Small Business Support Service), published in August 2015, highlights that an effective logistics process becomes a key part for companies operating in the oil and gas chain, avoiding delays and losses, and ensuring the quality of the product and service delivered. Generally, there is no tolerance for delays in this segment, due to the high value of the availability of facilities working at sea.

Another question considered was the identification of how much logistics operations consume resources in companies in general, this is useful to quantify the possible meaning of the losses in this segment. According to the survey carried out by the Institute of Logistics and Supply Chain (ILOS) in 2014, 7.6% of company revenues were destined to cover the costs of logistics operations in organizations. This number is objective evidence that this part of the operation deserves prominence in organizational analyzes.

In all of the most important activities of oil exploration and production activity is the construction of producing wells. Among the elements that constitute an oil well the steel pipes can be highlighted. Thomas (2004) argues that pipes can account for up to 20% of the total value of an oil well, hence the need for maintenance and preservation of these tubular elements, an activity performed by private companies and requiring the design and operation of a logistics system that meets the demands of the sector. The company that will be studied in this article works with the provision of logistics services and maintenance of pipes, which are used in the construction of oil wells.

Considering the previous statements, it can be concluded that the analysis of logistic operations processes in companies operating in the petroleum exploration and production chain, especially in the maintenance of pipes, is relevant. The analysis of operations then appears as a set of tools that can support this initiative to improve the performance and quality of the logistics process. This should be everyone's concern in the organization, making internal and external customers satisfied with costumer care or exceeding their expectations regarding the service provided or product supplied, as stated by Krajewski (2009).

In this direction, it is salutary to introduce the concept of operations analysis so that an alignment of expectations is made on the course of work and the deliveries of an analysis project.

2. RELEVANT CONCEPTS

The problem-solving analysis phase should consist of exploration of areas not yet understood. This is a crucial step to discover and understand the potential and root causes of problems. The analysis cannot be obscured by preconceived ideas of the causes of deviations, and it must proceed until it makes evident the causes of the problems and their relations of interdependence (Liker, 2007).

In the organizational context, for analysis to take effect it is essential to consider that before there is a stage of data collection, observations, and information acquisition. This is how we describe in numbers and facts the complexity of a scenario that is, in most cases, dynamic.

It is also possible to position the analysis as an intermediate step between the task of data collection and the elaboration of strategies and action plans that would be based on the analytical conclusions of the past. A good standard of data collection, an efficient procedure and efficient processing are certainly fundamental requirements for the construction of a quality analysis (Werkema, 1995).

Logistics in an organization is a system of operations and, according to Deming (1997) a system must create something of value and generate results - the basic premise of an operations analysis method. If the analyzes do not generate the necessary answers to the fundamentals of strategies that contribute to the sustainability of the business, then this method is not useful.

To find answers about systems, such as logistics, Crosby (1994) states that data analysis should be of practical use to all stakeholders. Thus, it is defined that if an analysis is merely theoretical it will not have been successful, because in the field of pure and simple theory there is no generation of value for the organization.

Logistics as a system of operations must be sustainable and, for this, it must continually improve its performance; in this sense, Juran (1991) teaches that a continuous analysis of events can be a great aid in a general program of improvement of the organization. Therefore, the analysis is a necessary step in the process of continuous improvement of companies. And this dynamic of transformation can be the difference between the continuity or not of an enterprise.

The understanding is that operations, such as logistics, are an important part of a business, and the function of

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these operations is to generate the goods and services that are made available by the organization to the market (Slack, 2013). Each company has a function of operations because each of them produces some mix of products or services. Operations are always related to the end of business activity, because without them there is no business. Operations are divided into processes that also produce goods and services, but on a smaller scale within the organization.

In order to develop the topic of logistics operations analysis, the objectives of this type of operation are first aligned. On this, Bowersox (2010) states that the design and management of logistic systems operations of each company have at least six different objectives, which are determinant and basic for logistic performance, which are: rapid response, minimum variance, minimum inventory, handling consolidation, quality and life cycle support, the latter related to reverse logistics and spare parts supply operations.

To conduct an analysis on the subject, one must understand the contribution of logistics in the context of operations. For Bowersox (2010), the operational responsibility for logistics is directly related to the availability of raw materials, semi-finished products and finished product inventory, where they are requested, at the right time and at the lowest possible cost. Faced with such a complex responsibility, there is much room for the almost infinite exercise of analyzes of all kinds, mainly because logistic operations costs have grown every year in Brazil (ILOS, 2014). Thus, there are many opportunities for improvements in processes and operations.

The previous concept guides us under what would be the objectives of logistics operations; however, it is relevant to clarify what would be the evolution of these activities if we applied methods of operational analysis.

Knowing logistics responsibilities, concentrating on what is expected from an analysis, Niebel (2009) states that method analysts use analysis to study the operations of all the productive and unproductive elements of an operation, to increase productivity by time unit and reduce costs, with the objective of maintaining or improving quality. It also says that when used correctly, analytical methods develop a better method for work by simplifying operating procedures and material handling, as well as using equipment more effectively. Therefore, companies can increase production and reduce unit costs, ensuring quality and reducing defective manufacturing or service, thereby increasing operator motivation through improved working conditions and minimizing fatigue.

In this understanding, the methods of analysis are applied and, based on them, the efficiency of logistics operations is sought. In this way, it is ensured that processes contribute to the achievement of operational goals, as described by Slack (2013). According to him, the ultimate goal of every operations project is to ensure that process performance is adequate for whatever it is trying to achieve. The author complements by saying that some kind of logic should link what the operation as a whole is seeking to achieve and the goals of its individual processes.

To go ahead in an analysis that involves processes, it is necessary to conceptualize the term process. Campos (2014) defines process as being a set of causes that provoques one or more effects and that this can be divided into families of causes (raw materials, machines, measures, environment, manpower and method), which are also called manufacturing factors or service factors.

Another concept is given by Werkema (1995), adding that process is a combination of the elements equipment, inputs, methods or procedures, environmental conditions, people and process information or measures, aiming at manufacturing or providing a good service. When the author cites a combination, she broadens the understanding of the concept, as it denotes integration between the cited factors, introducing systemic thinking as a possible approach.

From this point of view, process analysis should consider these combined factors and first identify the losses and then the improvements needed to enable the logistics operation to achieve its objectives.

To identify possible process losses, Liker (2007) reports that Toyota has identified seven major types of non-value-added activities in business or manufacturing processes, whose definitions can be applied to product development, order picking, and the office, not only to the production line. An eighth type of loss has been added to this list. Losses are: overproduction, waiting time, transportation, overprocessing or improper processing, excess inventory, unnecessary offsets, defects, and non-use of the creative capacity of employees.

Process losses should not be tolerated because they affect the competitive capacity of the entire organization. Porter (1999) warns us that a company is only capable of outperforming competitors if it can establish a sustainable difference. The company needs to deliver higher value to customers or generate comparable value at a lower cost, or both. And in order to achieve lower costs, it is necessary to reduce process losses.

With the process concepts of Campos (2014) and Liker's process loss concepts (2007), a matrix of the relationship between process factors and losses is proposed. The objective is to show that to identify the losses in an evaluation it is necessary to examine all the process factors. It is also pos-

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sible to affirm that the change in a process factor can result in several losses or mitigate several of them, since there is a combination between the cited factors.

According to Bowersox (2010), to begin the analysis of an existing situation, it is necessary to carry out data collection and performance evaluations that characterize the current logistics environment. A basic analysis requires an internal survey, a market assessment, a competitive assessment and a technological assessment to define the possibilities for improvement. The focus will be the internal survey, since a method is searched for the processes internal to the organization.

The internal survey is necessary to achieve the clear understanding of the existing logistic procedures. It includes historical performance, data availability, strategies, operations, policies and tactical practices. The survey usually covers both the total logistic process and the procedures of each logistic function. For Bowersox (2010), a complete self-assessment, in an internal survey, requires the examination of key resources and cites the workforce, equipment, facilities, relationships, and information. Thus, it practically confirms all the process factors cited by Campos (2014).

Table 1 then confirms what Campos (2014) states: an effect of a process is affected by several causes, including other factors of the same process or other processes.

To do the analysis, you also need to understand how a process management is performed. According to Werkema (1995), this management is done through control items - measurable characteristics, which are monitored periodically so that possible undesirable results of the process can be detected. When a control item does not reach the desired result, there is a problem that needs to be solved from a managerial decision.

Drucker (2010) states that good decision makers know how to define a problem before solving it. For him every decision is risky: a compromise of current resources in an uncertain and unknown future. Thus, problem definition is the most important element in making effective decisions, but it is the one that managers give less attention to because they seek to cure symptoms rather than illness by using a medical analogy.

Campos (2014) confirms Drucker's (2010) perception and states that in order to conduct good management, one must first learn to locate the problems and then learn how to solve them.

In this context, there is a demand for tools to support the localization, definition and preliminary analysis of problems. Bowersox (2010) proposes a tool called "topics for the internal survey", used to carry out a self-assessment of the logistic process that allows its identification of difficulties and deviations. Topics are organized into a table that is subdivided into general issues, decision-making issues, and issues relating to measurable process performance items. Thus, the author corroborates with Werkema (1995) and Drucker (2010) regarding the need to analyze the process from a measurable perspective and have a structured decision-making process to solve problems.

Internal survey questions should lead logistical process managers to a reflection on the application of concepts in the areas of customer services, materials management, transportation, warehousing and storage. These questions relate to the general aspects of the process, how decisions are taken and, finally, how performance measurement is done.

There is no template with the exact answers in this survey, the objective is to guide the manager to unveil the logistic process itself, analyzing the answers that he has been

Table 1. Matrix of relation between processes and losses

		The eight Lean Manufacturing losses							
		Overproduction	**Waiting time**	**Transport**	**Overprocessing or incorrect**	**Excess Inventory**	**Unnecessary movement**	**Defects**	**Non-use of creativity**
Process factors	Feedstock	x	x	x	x	x	x	x	x
	Machines	x	x	x	x	x	x	x	x
	Measures	x	x	x	x	x	x	x	x
	Environment	x	x	x	x	x	x	x	x
	Manpower	x	x	x	x	x	x	x	x
	Method	x	x	x	x	x	x	x	x

Source: Adapted from Campos (2014) and Liker (2007)

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able to elaborate and to reflect on which answers he could not provide. Since unanswered questions already indicate a deficiency of the process in producing information about facts and data resulting from the execution of the tasks (Bowersox, 2010).

In a second moment, a critical analysis of the performance measurements is carried out. Everything that is outside the appropriate should be seen as a problem and therefore must be considered. The next step is the examination of the decision-making process and its influence on the measurable items.

To conclude, it is recommended to evaluate the general aspects answered, which may contain relevant information about problems and even the fundamental cause of many deviations.

Table 2 shows Bowersox's proposal (2010).

Bowersox (2010) states that the internal survey should focus, above all, on a comprehensive assessment of the capacity and of the shortcomings of the existing system. Each item in the logistics system must be carefully examined for its declared objectives and its ability to achieve those objectives.

Is the logistics management information system, for example, consistently monitoring and measuring the delivery of service objectives pursued by the marketing department? Are materials management procedures adequately addressing production needs? Does the current distribution network efficiently meet customer service objectives? Finally, how do you compare the evaluation and performance capacity between business units and locations of operation? These and similar issues form the basis of the self-assessment required for internal analysis. The total survey aims to identify opportunities that can motivate or justify a new project or an improvement of the existing logistics system.

The purpose of the internal survey is not the detailed collection of information, but the obtaining of a vision that leads to a diagnosis of the existing processes and logistic procedures, as well as the proof of data availability. More precisely, the internal survey aims to identify areas where there are substantial opportunities for improvement.

3. RESEARCH METHOD

Barros et Lehfeld (1990) describe bibliographical and documentary research as being highly effective because it enables the researcher to obtain knowledge already cataloged in libraries, publishers, internet, video libraries and so on. This type of research was the choice in the conceptual phase of this work.

In the field research, the researcher assumes the role of observer and explorer, directly collecting the data in the place where the phenomena occurred or will occur (Barros et Lehfeld, 1990). Thus, in this study, the proposal was to apply the internal survey proposed by Bowersox (2010), in a company that has relevant logistics processes in its operations. In the sequence, we will analyze whether the answers of the survey will give support to the questions of the author after the survey.

Two individual interviews were conducted to collect the information, one with the company's planning and logistics manager and another with the internal logistics coordinator. The questions were based on the internal survey and were confirmed in observations at the place of execution of the proceedings.

4. CASE APPLICATION (CASE STUDY)

4.1 Description of Company X

The company that was evaluated is located in the city of Rio das Ostras, RJ, and has 250 employees. It was founded in 2013 with the objective of providing services to oil exploration and production companies.

The operation of the company encompasses several manufacturing and service rendering processes, among which we can highlight seven processes that are related to logistics activities:

- Transportation of products from client companies to the company headquarters;
- Storage of own and third party products;
- Supply of production lines with materials to be processed;
- Withdrawal of processed products from production lines to finished product tanks;
- Transport between production units within the company;
- Dispatch and delivery of processed products to customers;
- Receipt and incoming product conferencing.

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Table 2. Topics for internal survey

General inquiries (Qualitative)	Decisions	Performance Measurements (Quantitative)
Storage		
What storage and handling facilities are currently used and what functions do they perform?	How are the consolidation decisions taken at each location?	What are the shipping and storage volumes of each facility?
What product lines are maintained in each facility?	What decisions are made by the handling staff and how does this staff take them?	What are the main performance parameters of deposits?
What storage, handling and other value--adding functions are or can be performed on each facility?	How are products stored? How are decisions in terms of product selection made?	How are they used? What is the current performance level? What are the characteristics of the economic performance of the installation?
Customer service		
What is the current flow of information?	How are decisions made on the sources for order fulfillment?	What are the key performance parameters of customer service?
What is the profile of the requests and what is their evolution?	What happens when there is no stock to fulfill an order?	How are the parameters used?
How are orders received?		What is the current performance level?
Materials Management		
What is the current flow of materials?	How are the key decisions about manufacturing capabilities and allocation to distribution centers made?	What are the main limitations of production capacity and distribution centers?
What procedures are followed in each plant and in each distribution center?	How are production planning and scheduling decisions made?	What are the key performance evaluation parameters for materials management?
		How are they used? What is the current performance level?
Transportation		
What modals are currently used?	How are modals and carriers determined for each load?	What are the main parameters of transport performance?
What is the weight profile of orders and charges and what are the differences?	How are carriers evaluated?	How are they used?
What are the procedures for requesting carriers, payment and exchange of information with them?		What is the current performance level?
What is the flow of information from shipment documentation?		What are the characteristics of the economic performance of each modal and each carrier?
Inventory		
What value-added functions does the inventory currently play?	How are inventory management decisions made?	What is the total cost of maintaining inventories?
	Who makes the decisions and what information is used for this purpose?	What are the main inventory performance parameters?
		How are they used?
		What is the current level of performance?

Source: Bowersox (2010)

The organization in question is ISO 9000 certified and is periodically audited by clients and by the parent company.

In logistics, it does not have its own equipment. Forklifts, trucks and carts are hired from other companies, which provide the manpower required for the operation of these features. There is an own team that takes care of the planning and coordination of activities related to logistics.

The standardization of activities is basic and meets regulatory requirements, but at a level that still demonstrates some opportunities for improvement.

The area of the company is not fully integrated, although it is located in the same locality, there are five distinct operational and storage execution spaces, which implies a great demand for internal transportation. There are basic indicators of performance monitoring.

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Application of internal withdrawal method in company X

In this stage we will apply the tool proposed by Bowersox (2010).

In order to complete the evaluation, the supplementary questions raised by the same author will be answered based on the internal survey of Bowersox (2010):

a) Is the logistics management information system, for example, consistently monitoring and measuring the delivery of service objectives pursued by the marketing department?

Part of the process, yes. The deficiency lies in the traceability and identification of old stock items.

With regard to indicators, there are conflicts of objectives between them.

b) Are materials management procedures adequately addressing production needs?

No. The procedures are still very basic and need improvement.

c) Does the current distribution network efficiently meet customer service objectives?

Partially. Older work orders have difficulty getting out.

d) How do evaluation and performance capabilities

Table 3. Topics for internal survey: application

General inquiries (Qualitative)	Decisions	Performance Measurements (Quantitative)
Customer service		
What is the current flow of information? 1- Customer. 2- Sales team. 3- Planning team. 4- Logistics team. 5- Production team. 6- Planning team. 7- Logistics team.	How are decisions made on the sources for order fulfillment? Through a critical analysis of cycle times, internal prioritization, line occupation; available space and available transport and transportation resources.	What are the key performance parameters of customer service? Lead time. Percentage of delays. Customer inventory volume in the company. Number of complaints for integrity problems in the office. Adherence to requested deadline.
What is the profile of the requests and what is their evolution? Requests generally have two profiles: 1- Requests for product repair and this implies the logistics of withdrawal, processing and delivery. 2- Requests for new products and this implies in receiving raw material, processing and dispatch of finished products.	What happens when there is no stock to fulfill an order? The request is not processed and forwarded to the demand planning sector. Check with the supplier for the shortest possible supply, in an emergency, evaluating cost-benefit ratio.	How are parameters used? In critical performance analysis. In trend monitoring. As a performance indicator. As support for the decision-making process and for the fulfillment of the strategy.
How are orders received? Through an ERP (Enterprise Resource Planning).		What is the current performance level? Partially satisfactory for percentages of delays and number of complaints, stops. Insufficient lead time and stock volume.
Materials Management		
What is the current flow of materials? There are two flows: Services - 1) Material comes from the customer. 2) Material is received and stocked. 3) Material is processed. 4) Material is dispatched and delivered. Products - 1) Material comes from the supplier. 2) Material is processed. 3) Material is dispatched and delivered.	How are the key decisions about manufacturing capabilities and allocation to distribution centers made? Decisions are made on the basis of the deadline, quantity, complexity and availability of the processes involved.	What are the main limitations of production capacity and distribution centers? There are dimensional limitations for processing; storage, handling and transportation limitations.

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What procedures are followed in each plant and in each distribution center? Each process has its own procedures that are in line with the company's operational strategy.	How are planning and scheduling decisions made? Decisions are made on the basis of the deadline, quantity, complexity and availability of the processes involved.	What are the key performance evaluation parameters for materials management? Delivery time; proper integrity and amount.
		How are they used? They are monitored. What is the current performance level? Satisfactory, but with great demand from past processes.

Transportation		
What modals are currently used? Road transport. And in case of emergency air transport.	How are modals and carriers determined for each load? The modal is chosen according to the term. The carriers are chosen based on the availability contracted and cost.	What are the main parameters of transport performance? Punctuality with regard to contractual deadlines; cargo integrity; QSMAS compliance; contractual compliance; vehicle integrity; communication and monitoring.
What is the weight profile of orders and loads and what are the differences? There is a lot of diversity due to the diversity of products and orders.	How are carriers evaluated? There is an evaluation by the contract technical manager that follows a matrix standard. The valuation is quarterly.	How are they used? In the bi-monthly assessment and transport monitoring.
What are the procedures for requesting carriers, payment and exchange of information with them? Delivery schedule according to the deadlines to be met .		What is the current performance level? Partially satisfactory, due to difficulties of manpower management for extra driving functions of the vehicles. Poor monitoring and communication.
What is the flow of information from shipment documentation? 1) Revenues. 2) Dispatch.		What are the characteristics of the economic performance of each modal and each carrier? Road transport is most cost effective in most cases.

Storage		
What storage and handling facilities are currently used and what functions do they perform? Storage yards are used with sleepers and containers.	How are the consolidation decisions taken at each location? Depending on the demand and capacity of the equipment.	What are the shipping and storage volumes of each facility? Around 1,250 pieces per month, as a whole.
What product lines are maintained in each installation? There are three service lines and their respective facilities: accessories; repairs; inspection.	What decisions are made by the handling staff and how does this staff take them? These are operational-level decisions. Decisions are made on the basis of work patterns and instructions from the manager.	What are the main performance parameters of deposits? Traceability; product integrity, physical adherence - system, efficiency of movement; machine usage rate.
What storage, handling and other value-adding functions are or can be performed on each installation?	How are products stored and how are product selection decisions made? The products are stored according to their specification, status and quantity.	How are they used? As check items. What is the current performance level? Satisfying, but with opportunities for improvement. What are the characteristics of the economic performance of each facility? The facilities are self-sustaining and generate dividends. There is room for increased efficiency.
Supply of production lines; removal of finished products for dispatch; moving parts between production lines.		

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Inventory		
What value-adding functions do stocks currently play? None; however, they are necessary to enable the programming and planning of operations.	How are stock management decisions made? They are taken in accordance with the planned demands for service and when there is availability of material in stock and of processing capacity in the production lines.	What is the total cost of maintaining inventories? High.
	Who makes these decisions and what information is used for them? Planning, logistics and supply management.	What are the key performance parameters for stocks? Volume, lead time and age.
		How are they used? Control items.
		What is current performance level? Partially satisfactory, due to the method of localization that it provides today. However, the level of performance is still hampered by the liabilities of old materials in stock.

Source: Bowersox (2010) with information about the company X.

compare between business units and operation places?

> There is no comparison possible as there is only one unit in operation.

Improvement items in the company's logistics process were identified both in the internal survey and in the supplementary questions. Thus, the analysis proposal fulfills its objective of understanding the activities and process factors involved.

In these deficiencies it will also be possible to identify the eight losses conceptualized previously. In later stages, possible solutions to deviations will be discussed and any applicable ethical issues will be examined.

5. IDENTIFICATION OF INTERACTIONS AND PRIORITIZATION OF PROBLEMS

After the application of the internal survey, there are a set of problems that need to be classified and solved. A table that integrates the process factors described by Campos (2014), the eight process losses raised by Liker (2007) and the information survey proposed by Bowersox are presented (2010).

Eight problems were identified in the logistic process evaluated. Many of these deviations affected more than one process factor and/or generated more than one type of loss and this was an aggravating factor at the moment of the evaluation of the potential of damage of each deviation. It is not the aim of this article to discuss problem solving methods; however, it is recommend a technique of prioritization and a solution technique for application in the localized deviations.

As a tool for prioritizing problems, Marshall (2012) presents the GUT matrix as the representation of problems together with obtaining quantifications that seek to establish priorities to address them, in order to minimize their impacts and direct resources that could be used in the equation of difficulties. The problems are listed and analyzed under the aspect of gravity (G); urgency (U) and trend (T). Usually an integer between 1 and 5 is assigned to each of the dimensions of the GUT, with 5 being the highest and 1 being the lowest, and then the values obtained for G, U and T are multiplied in order to obtain a value for each problem or risk factor analyzed. Problems with the highest score will be dealt with as a priority.

The problems based on the information acquired during the interview were prioritized and the occurrence and prioritization of the problems were validated with the company object of the field research. Subsequently, the procedure for settling deviations was defined. As it was aligned with the practice of lean manufacturing, the method of applying the so-called A3 format, described by Liker (2007), was chosen, as it says that there are three distinct stages in the problem-solving process.

First, the initial proposal is made to gain consensus on approaching the problem. If agreement to proceed is established, the next step comes after identifying the roots of the problem. At this point, a proposal is usually made to get acceptance and approval of the recommended solutions. The commitment of the performers of the tasks and the supervision of those responsible for the processes are fundamental for achieving success in the following step of this method.

Still following Liker's reasoning (2007), once countermeasures are accepted and implementation begins, the process advances to the second stage of *status* reporting. This stage provides information and updates people to see if the activity is on schedule. It is recommended that there be little

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Table 4. Matrix of relation between processes, losses and problems

		The eight lean manufacturing losses							
		Production beyond demand	**Waiting time**	**Transport**	**Process above or below specification**	**Excess Inventory**	**Movement not required**	**Defects**	**Non-use of creativity**
Process factors	Feedstock		Long lead time for products and services			Large volume of raw material stock (product that belongs to the customer waiting for service rendering)		High % of production line stops due to lack of supply	
	Machines			Dimensional limitations due to design errors affecting customer service					
	Measures	Low operational efficiency in all storage and transportation processes							
	Environment			Layout limitations due to design errors affecting accessibility to raw materials, work in process and finished products					
	Manpower			Low qualification of service providers					
	Method			Inefficient communication between the company and contracted companies					

Source: Adapted from Campos (2014) and Liker (2007)

flexibility in relation to the dates proposed for the delivery of the works; if an exception is granted there is a risk that it will be used as a precedent by other project members.

The third stage is the final report when the activity ends. At this time, there is usually no need to even question the details of the activity itself. The focus is on achieving the result. In general, the final presentation is not made before the countermeasures have been successful in eliminating the problem and the desired results have been achieved. This is the summary of the A3 format method, which uses the logical sequence provided in D.M.A.I.C (define; measure; analyze; improve; control) quoted by Werkema (2011).

Table 5. G.U.T Matrix

Item	Problem	G	U	T	GxUxT
1	Lengthy lead time for products and services	5	3	5	75
2	Large volume of raw material stock (product that belongs to the customer awaiting service)	5	4	3	60
3	Low operational efficiency in all storage and transportation processes	4	3	3	36
4	Low qualification of service providers	3	3	3	27
5	High % of production line stops due to lack of supply	3	4	2	24
6	Layout limitations due to design errors affecting accessibility to raw materials, work in process and finished products	3	3	2	18
7	Inefficient communication between the company and contracted companies	2	2	3	12
8	Dimensional limitations due to design errors affecting customer service	2	3	1	6

Source: Marshall (2012)

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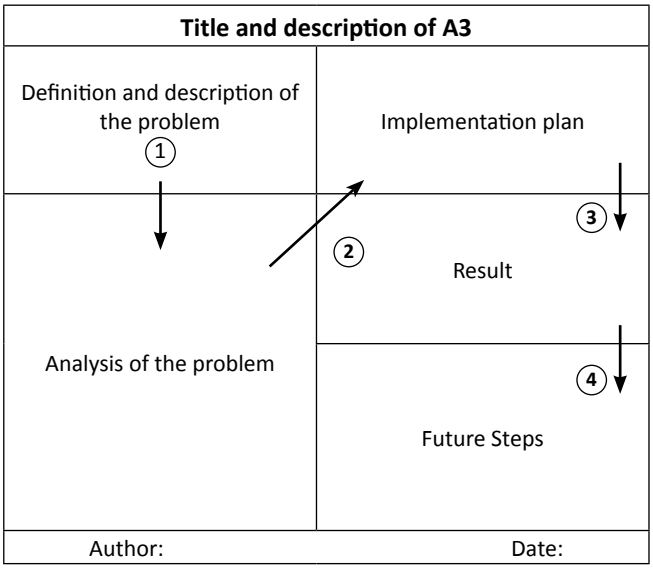
Table 6. A3 reporting process of problem solving

Before	During	After
Presentation of the proposal	Status report	Final report
Comparison with other problems Clarification of objectives Orientation offer Consideration of other options Consensus and approval	Progress check Checking the direction of the activity Orientation offer Offer additional support Offering additional features	Verification of successful achievement and delivery of results Celebration of success Evaluation of other considerations

Fonte: Liker (2007)

Table 7. A3 reporting flow of problem solving



Source: Liker (2007)

Applying the A3 report is an excellent way to enable visual management and leveling and integrating problem-solving information across a company's various sectors. Its simplicity allows its use by any type of organization that seeks improvement in its results, as Rodrigues affirms (2014).

No ethical implications were identified in the recommendation of this problem-solving flow.

6. CONCLUSION

This article was completed with the statement that the goal was achieved. The term operational analysis was defined and the concept was contextualized within the internal logistics segment. Success was achieved in finding an operational analysis model that had been elaborated with the focus on examining logistic activities and their particularities. The internal survey model presented by Bowersox (2010) proved to be effective in identifying problems in the management and operation of an organization already structured and operating for at least three years.

On the other hand, the relationship established with the process factors defined by Campos (2014) shows that universal and simple concepts of process models can help classifying the problems and, therefore, better target solutions efforts to the appropriate focus at that moment.

It is worth noting that the losses described by Liker (2007) are not restricted to the manufacturing environment and can occur in service processes and other types of economic activities, such as the logistic process in a service delivery context.

In a scenario of resource constraints, prioritization of problems constituted good practice. Thus, the matrix G.U.T presented by Marshall (2012) was essential for the planning of a future allocation of resources and for the equation of the issues evidenced in the internal survey.

Thus, with the information of what was a priority, it was possible to identify a technique for solving problems that stands out for its simplicity and effectiveness, attributes that the report in A3 format have deserved by the results already obtained with its use.

But the best lesson of this paper was that analyzes reveal interdependence between process factors in generating expected effects or problems to be solved. The confrontation of the fundamental causes of the losses mentioned goes through the exercise of the systemic thinking, considering the connections among factors with specific function, as reported by Falconi (2014). When one understands this concept, it is accepted that, in order to analyze processes and solve the problems presented, it is necessary to cultivate a culture of collaboration between the different components of the organizational structure, thus amplifying competences that, separately, could not achieve the same results.

REFERENCES

Barros, A. J. P. et Neide A. S. L. (1990), Projeto de pesquisa: propostas metodológicas, Vozes, Petrópolis, Rio de Janeiro.

Bowersox, D. J. (2010), Logística empresarial: o processo de integração da cadeia de suprimentos, Atlas, São Paulo.

Campos, V. F. (2014), TQC: Controle da qualidade total (no estilo japonês), Falconi, Nova Lima, Minas Gerais.

Crosby, P. B. (1994), Qualidade é investimento, José Olympio, Rio de Janeiro.

Deming, W. E. (1997), A nova economia para a indústria, o governo e a educação, Qualitymark, Rio de Janeiro.

Drucker, P. F. (2010), Gestão, Agir, Rio de Janeiro.

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DOI: 10.20985/1980-5160.2018.v13n3.1265

Falconi, V. (2014), O verdadeiro poder, Falconi, Nova Lima, Minas Gerais.

ILOS - Instituto de Logística e Supply Chain (2014), Panorama: Custos logísticos no Brasil, ILOS, Rio de Janeiro.

Juran, J. M. (1991), Controle de Qualidade: conceitos, políticas e filosofia da qualidade, McGraw-Hill/Makron, São Paulo.

Krajewski, L. J. (2009), Administração de produção e operações, Pearson Prentice Hall, São Paulo.

Liker, J. K. (2007), O modelo Toyota: manual de aplicação, Bookman, Porto Alegre, Rio Grande do Sul.

Marshall Junior, I. (2012), Gestão da qualidade e processos, FGV, Rio de Janeiro.

Niebel, B. W. (2009), Ingeniería industrial: métodos, estándares y diseño del trabajo, McGraw-Hill, Cidade do México, Distrito Federal.

Porter, M. (1999), Competição: estratégias competitivas essenciais, Campus, Rio de Janeiro.

Rodrigues, M. V. (2014), Entendendo, aprendendo e desenvolvendo sistema de produção *lean manufacturing*, Elsevier, Rio de Janeiro.

SEBRAE – Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (2015), Relatório de inteligência setorial - Petróleo e Gás, SEBRAE, Rio de Janeiro.

Slack, N. (2013), Gerenciamento de operações e de processos: princípios e práticas de impacto estratégico, Bookman, Porto Alegre, Rio Grande do Sul.

Thomas, J. E. (2004), Fundamentos da engenharia de petróleo, Interciência, Petrobrás, Rio de Janeiro.

Werkema, C. (2011), *Lean seis sigma*: introdução às ferramentas do *lean manufacturing*, Elsevier, Rio de Janeiro.

Werkema, M. C. C. (1995), As sete ferramentas da qualidade no gerenciamento de processos, EDG, Belo Horizonte, Minas Gerais.

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