IDENTIFICATION OF PHYSICAL CONSTRAINTS IN THE LOGISTIC SYSTEM OF TRADING ENTERPRISES IN HOLGUIN, CUBA

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ABSTRACT

At present, it is of utmost importance in every organization, the identification of the restrictive resources for their performance, due to the high competitiveness that the world market presents, where the inadequate availability of the resources requires them to carry out analysis and improvement of its management. The trading enterprises are some of the more affected, since their organization, raise the price of the product or service, when being essential in the management of their capacities. In this context, it is indispensable to possess tools that allow identifying all that resource, process or market conditions that represent a physical constraint in the fulfillment of its functions. Due to the inexistence of the above-mentioned instrument, was develop the present research with the objective to develop an instrument that in an empiric way allows identifying the principal physical constraints in the logistic system of trading enterprises in Holguin, Cuba. Its application enabled the elaboration of the Current Reality Tree, in the territory and the classification of the trading enterprises selected as object of study to the more frequent physical constraints in its logistic system.

KEYWORDS: Trading enterprises; Physical constraints; Logistic system.

INTRODUCTION

In business management, logistics is the distinguishing element par excellence in a competitive market and with expectations and demands increasingly in higher customers. In this sense, the authors agree on the approach that logistics is seen as:

> "The action of the labor group aimed at ensuring the design and management of material, informational and financial flows, from their sources of origin to their final destinations, which must be executed in a rational and coordinated way with the objective of providing the client with the Products and services in the quantity, quality, time and place demanded, with high competitiveness and guaranteeing the preservation of the environment" (Suárez, J., 2008, p. 27).

Organizations must have logistical systems that adapt to achieve higher levels of competitiveness. Particularly in marketing companies, this need is increased because their goal and survival depend on excellence in their logistics system given the diversity of natures of decisions, the need to reduce to the maximum the costs incurred and the times that lengthen the logistic cycle, which demands the use of methods and techniques that allow the optimization of the resources that are managed.

> "The resources are scarce, the processes are complex, and the information that is required for proper decision making is becoming more critical. For this reason, the tools of support to the management of the companies and to the decision-making are paramount" (Curbelo and Delgado, 2014, p. 37).

In the logistics systems of marketing companies, a number of resources are managed that require integrated coordination in their interaction. In this stage; the implementation of the Process Assurance Model (PAM) (Fig, 1) is considered opportune.

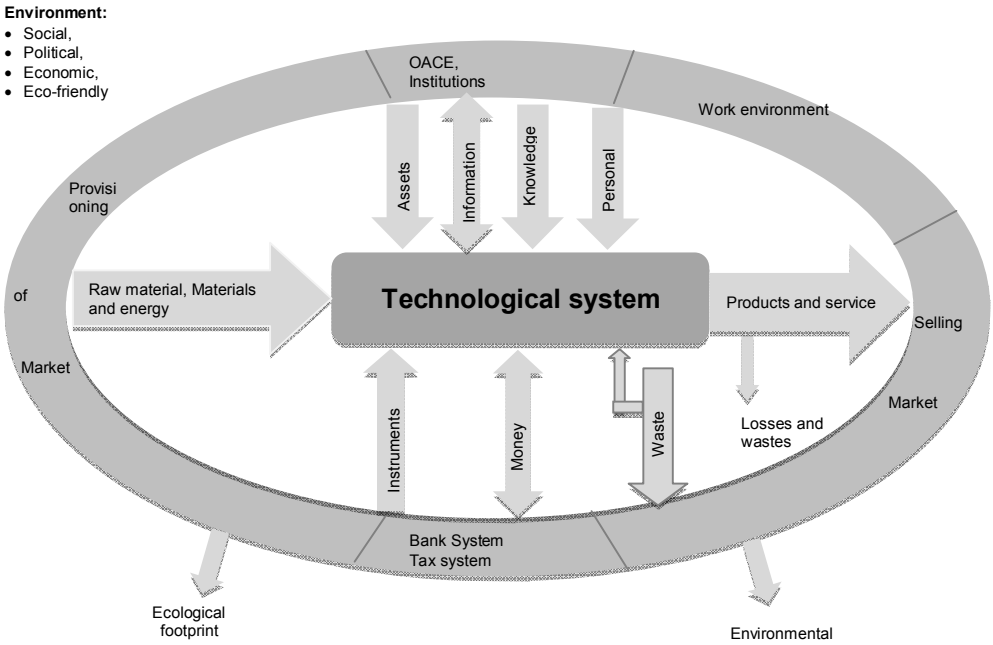

Figure 1: MAP elements
Source: Suárez, J, (2008, p. 9)

It is a criterion shared by the authors that the MAP can be understood as:

> "A set of resources, services and conditions that must be assured according to certain methods, qualities, moments and quantities to guarantee the performance of a

> process according to certain standards. The MAP expresses the way to dynamically assure the conditions for the performance of a process in function of the design made in it, In turn, it is the basis for planning and controlling budgets" (Suárez, J., 2008, p. 8).

There are several approaches to continuous improvement as a way of managing the resources within the organizations for their improvement, as a distinctive element for logistics management; it is the Theory Of Constraints (TOC).

> "The Theory of Constraints, considering that it is oriented to the logistics flow, the need to adopt a process approach, its high level of integration, to have the ultimate goal of achieving efficiency and effectiveness of the organization, are the more suitable as a philosophy of improvement to be applied to the logistics management of organizations" (Pravia, M., 2010, p. 30)

The TOC proposes a series of steps for the determination of the restrictions that affect the management in the companies, classifying them in physical and political restrictions. It is a TOC assumption that physical constraints can be found in three scenarios: resources, processes and the market. Regardless of the different steps for determining the constraints that are defined, the common element in its procedures is that its first step consists in its identification. Process that becomes complex depending on the composition, structure and magnitude of the company being investigated; in this aspect the identification of physical restrictions in trading companies is considered a complicated process.

In Cuba, one of the sectors that most demand these approaches is the one belonging to the Ministry of Internal Trade. Within this are developed trading companies, whose main objective is to intermediate between one or several suppliers and one or several customers. In the territory of Holguin, a situation similar to that of the previous consultation is revealed (Duany, 2011; Leyva, 2011; Peña, 2012; Martínez, 2013; Ricardo, 2013; Simón, 2013; Hernández, 2014; Avila, 2015), whose practical object of research has been constituted by commercialization companies in the territory, evidence symptoms that denote the presence of physical restrictions in its logistic system, these are summarized below:

1. Non-compliance with basic storage principles.
2. Failure to meet deadlines.
3. Increase in losses due to breakage and maturity.
4. Deficiencies in the provision of services, the projection of orders and in the supply of suppliers.

The conclusion allowed to conclude that the contradiction between the practical necessity of identifying the physical restrictions in the logistics system of trading companies

and the non-existence, at least explicitly, of an instrument that identifies the main physical restrictions, reason why this constitutes a problem to solve. Consequently, the objective of this article was to develop an instrument that empirically identifies the main physical restrictions in the logistics system of trading companies.

DEVELOPMENT

1.- Considerations of TOC

> "Restrictions theory is one of the best-known theories, invented to address chronic problems in the industry, including distribution, engineering, finance, sales marketing, strategy, and change management. They are also known as the Thought Process, which is applicable in any problem-solving situation" (Sukalova and Ceniga, 2015, p. 135).

According to Simsit et al., (2014) TOC has become an important theory focusing on the weakest link (s) in a chain. The TOC focuses on processes as if they were links of the same chain and not as processes independent of each other. At the same time the theory focuses on the weakest points that constitute bottlenecks for the whole company and tries to determine the relationship between them, therefore, this philosophy of integrated management changes the way of thinking of managers and becomes an important tool for solving root problems.

> "The TOC has a wide range of implementation. The theory can be applied in: production, logistics, supply chains, distribution, project management, accounting, research and development, sales, marketing and more. Its central idea is that every system has at least one weak point,…" (Simsit et al., 2014, p. 931).

The thinking processes described in the TOC have been applied in different areas: Business Management (Naor, Bernardes y Coman, 2013; Ren, Luo, Yang, Ji y Gong, 2013; Chang y Liang, 2014; Hajek, 2014; Costas, Ponte, de la Fuente, Pino y Puche, 2015; Demchuk y Baitsar, 2015; Wu, K. y Zhao, 2015), in the Financial Economic Management (Majercak, Cisko y Majercakova, 2013; Hajek y Tanger, 2014; Hilmola y Gupta, 2015; Myrelid y Olhager, 2015), the Operations Administration (Baptista, Lucato, Coppini y Fortunato, 2013; Tsai, Chen, Leu, Chang y Lin, 2013; Ok y Park, 2014; Sobreiro, Mariano y Nagano, 2014; Golmohammadi y Mansouri, 2015; Hilmola et al., 2015; Rabbani y Tanhaie, 2015; Wu, K. et al., 2015) and in the Business Logistics (Pravia, 2010; Jiang y Wu, 2013; Oglethorpe y Heron, 2013; Selviaridis, 2014; Wu, H. H., Lee y Tsai, 2014; Cespón, Castro, Curbelo y Varela, 2015; Golmohammadi, 2015), however, the authors consider that their

methodological treatment is still insufficient, a situation that is manifested by the fact that, in spite of the similar state in the territory of Holguin.

> "When you look at the Theory of Constraints, its basic principle emphasizes the importance of identifying and eliminating bottlenecks in manufacturing that are managed not only to increase productivity but as a tool to measure and control the flow of materials. The only problem is how to truly identify these restrictions" (Izmailov, A., 2014, p. 927).

The weakest links within companies are the constraints; they are the ones that determine their overall performance. …"Every system must have at least one limitation." (Goldratt, E., 1990, p. 49) So the first step of TOC's approach is precisely to identify.

> "Within this first step where the limiting system(s) are identified, there may be systems that have only one limitation, and it is assumed that there is some appreciation of the magnitude of their impact on total throughput. If not, you can present trivia in the list of limitations, called chopsticks. At this point it is not necessary to assign priorities according to their impact because there are still no precise estimates and the number of limitations is very small. In any case, they must all be treated" (Goldratt, E., 1990. p. 50).

In TOC, the construction of the Current Reality Tree is proposed for the detection of the policy restrictions, which in this study will be adopted in this step but with the exception that it will be used to show the relationships that are established between the restrictions physical properties.

This paper proposes an instrument based on the physical resources (which can be converted into a physical constraint for the logistic system in a commercialization company) as stated in the MAP and the logical thinking proposed in the TOC, allows the identification of the effects Undesirable and the root cause(s).

2.- Design of the instrument

In the Holguín province, more specifically in its head municipality (Holguín), there are 20 trading companies according to statistical data of Holguín Provincial Economy and Planning. The selection of the sample was made taking into account several aspects: representation of all sectors present, functions performed in the sector, products that market, number of companies per sector and the percentage they represent of the total. There is a great variety in terms of sectors, standing out the companies belonging to the People's Power that represent 35.3% of the entities analyzed. They are followed in importance by companies that belong to the Council of State as well as companies that are subordinated to the Ministry of Internal Commerce (MINCIN), which represent 11.7% of the total.

In the present study were prioritized those that are dedicated to commercialize products in a wholesale manner due to the large volumes of resources they handle and the importance of this type of trade for the country and the territory of Holguin. On the basis of the above criteria, the following ten companies were selected:

Denomination

Provincial Company Producer and Distributor of Food Holguín (NUMA)
Trading Company ESCAMBRAY UCT Holguín (ESCAMBRAY)
Universal Products Trading Company (CPU)
Wholesale Company of Food Products and Other Consumer Goods of Holguin (EMPA)
Provincial Collection Company (Acopio)
CIMEX Corporation S.A (CIMEX)
Marketing and Distribution Company of Medicines of Holguín (EMCOMED)
ITH Wholesale Company (ITH)
Construction Materials Company Holguín (Medano)
Company AZUMAT Logistics (AZUMAT)

For the design of the instrument (Table 1), the resources that were considered in the MAP that could constitute a physical restriction (supplies, assets, people, means and waste) were taken into account. The instrument was designed in a pilot test to verify if the questions were correctly designed, as well as the internal consistency and reliability of the scale (ascending lickert, 1 minor degree and 5 major degrees).

Table Nº 1: Instrument designed

Description of the items to be evaluated	1	2	3	4	5
Supplies					
1. Procurement of supplies is managed					
2. The amount of supplies needed to meet customer demand is acquired					
3. Supplies are purchased on time					
4. The logistics system has identified the suppliers by which it acquires its supplies					
5. Do you have the means to transport the supplies					
6. Means of transport comply with the parameters established for transportation					
7. Fuel needed to transport supplies					
8. It has the capacity to store supplies					
9. Proper use of storage capacity					
10. You have the necessary means to store supplies					
11. There is the necessary means to manipulate the supplies inside the warehouse (means of lifting)					
12. Supplies are delivered on time					
13. The quantity of supplies required to meet customer demand is delivered					
14. Delivered supplies comply with established quality standards					
15. Supplies are packed correctly					
Assets					

16. There is a correct installation of the means in the logistic system					
17. It has the necessary materials for the installation of the assets in the logistics system					
18. There is the necessary means to carry out the maintenance of assets in the logistics system					
19. A maintenance plan is established for assets within the logistics system					
20. The equipment is repaired on time					
21. There is the necessary means to carry out the repair of the assets in the logistics system					
22. It has the necessary inputs to carry out the processes of the logistics system					
23. The assets owned by the logistics system are used correctly					
24. Assets are used to fulfill various tasks					
25. There are spare parts for equipment					
Personal					
26. It has the necessary personnel to fulfill the functions of the logistics system					
Means					
27. The necessary means are available to meet the objective of the logistics system					
28. The logistics system has suppliers that provide the means of work					
29. The means of work are in correct condition					
30. The means used have the necessary technology					
31. There is a planned maintenance plan to extend the useful life of the work environment					
32. The means of work are repaired in the event of a break					
33. These means are exploited at their maximum capacity					
Waste					
34. The waste generated by the logistics system is correctly collected					
35. Established areas within the company for the location of reusable or non-reusable waste					
36. The waste generated by the logistics system is processed					
37. Waste that is not considered waste is reused in the logistics system					
38. There is a correct treatment of waste					
39. There are means of transport established for the transportation of the waste to places of disposal or re-use					
Physical Restrictions					
40. It is known which resource can represent a physical constraint within the logistic system					
41. A high level of importance is accorded to physical restraints					
42. A method is applied to identify physical constraints in the logistics system					

Source: Own Elaboration

With the information obtained, the data matrices were created and then processed using the Statistic Program for Social Sciences (SPSS) for Windows version 19.0, the Cronbach Alpha coefficient was calculated, resulting in $\alpha > 0,7$ (0,874), considered as acceptable for the purposes of the research. The instrument was applied to an expert (selected according to the procedure proposed by León et al., (2016) corresponding to each of the selected companies.

3.- Results

The method of social network analysis was selected for the study as part of the multivariate analysis of the information, in order to determine the level of association

between the items evaluated in the instrument. After the information was processed in the software Ucinetfor Windows: Software for Social Network Analysis, results were obtained by means of their respective net (Fig. No. 2).

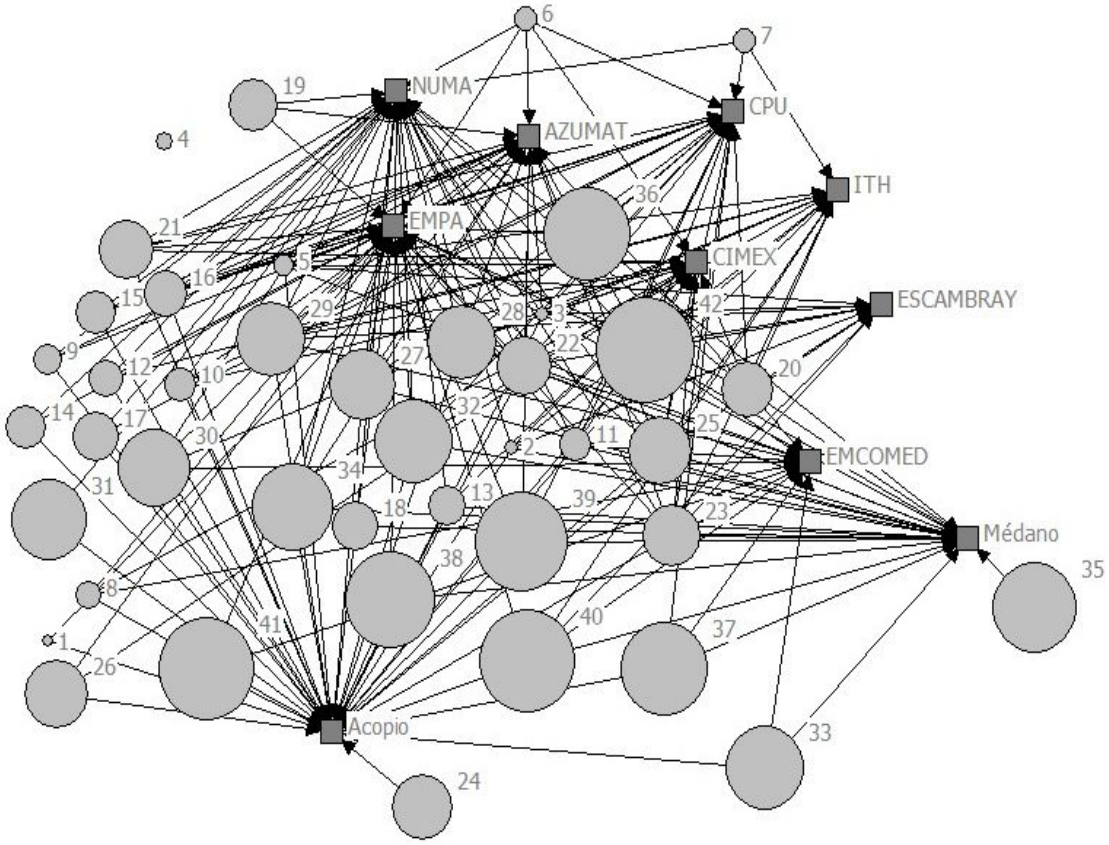

Figure 2: Analysis network for the evaluation of the items in the instrument applied by company
Source: Own Elaboration

From this analysis it was concluded that the companies ESCAMBRAY, Médano, ITH, EMCOMED and CIMEX are in an advantageous position with respect to the other organizations analyzed, regarding the appearance of physical restrictions. On the other hand the restrictions that affect to a greater extent, according to the valuations given, are the following:

31- There is no planned maintenance plan to extend the life of the work media
32- The means of work are not repaired on time in the event of a break
34- The waste generated by the logistic system is not correctly collected
35- There are no established areas within the company for the location of re-usable or non-reusable waste
36- The waste generated by the logistics system is not processed by the entity
37- It is not re-used in the logistics system, those wastes that are not considered as waste
38- There is no proper treatment of waste

39- No means of transport established for the transportation of waste to waste or reuse sites
40- It is not known which resource can represent a physical constraint within the logistic system
41- A high level of importance is not given to the identification of physical restraints
42- No method is applied to identify physical constraints in the logistics system

The quantitative analysis of the results was performed through the analysis of the centrality measures (Table 2). This is a report that generates the software itself; in this case the following measures were selected:

Table Nº 2: Measures of centrality

Items	Degree of centrality	Closeness	Harmonic proximity
1	2	216,000	23,917
2	6	202,000	27,333
3	9	196,000	29,333
4	0	2,704,000	0,000
5	9	198,000	29,083
6	5	210,000	25,917
7	3	222,000	23,583
8	4	210,000	25,500
9	4	208,000	25,750
10	5	206,000	26,417
11	8	198,000	28,667
12	4	208,000	25,750
13	4	206,000	26,000
14	3	210,000	25,083
15	5	206,000	26,417
16	5	206,000	26,417
17	3	210,000	25,083
18	4	206,000	26,000
19	3	216,000	24,333
20	10	194,000	30,000
21	6	204,000	27,083
22	8	198,000	28,667
23	10	194,000	30,000
24	1	222,000	22,750
25	10	194,000	30,000
26	3	212,000	24,833
27	6	202,000	27,333
28	8	198,000	28,667
29	8	200,000	28,417

30	5	206,000	26,417
31	2	212,000	24,417
32	6	202,000	27,333
33	3	214,000	24,583
34	5	204,000	26,667
35	1	252,000	19,000
36	4	210,000	25,500
37	4	208,000	25,750
38	3	208,000	25,333
39	5	204,000	26,667
40	6	202,000	27,333
41	3	212,000	24,833
42	10	194,000	30,000
Companies			
NUMA	31	183,000	38,833
ESCAMBRAY	10	225,000	24,833
CPU	21	203,000	32,167
EMPA	29	187,000	37,500
Acopio	36	173,000	42,167
CIMEX	17	211,000	29,500
EMCOMED	14	217,000	27,500
ITH	14	217,000	27,500
Médano	21	203,000	32,167
AZUMAT	20	205,000	31,500

Source: Own Elaboration

Degree of centrality: expresses the number of elements to which an element is attached,
Closeness: is the ability of an element to reach the remaining elements of the network,
Harmonic proximity: is the ability depending on the connections of an element to reach the remaining elements of the network.

Based on the above, the measures of centrality were analyzed, which allowed to conclude the following:

1. The companies with the greatest number of restrictions are: Acopio, NUMA y la EMPA.
2. The most advantageous position in this respect is the ESCAMBRAY.
3. Among the restrictions that appear more frequently, the following stand out:
   - 3- Supplies are not purchased on time
   - 5- You do not have the means to transport the supplies
   - 11- The necessary means to manipulate the supplies inside the warehouse (means of lifting)
   - 20- The equipment is not repaired in time

22- The necessary inputs are not available to carry out the processes of the logistic system
23- The assets owned by the logistics system are not properly used
25- There are no spare parts for the equipment
28- The logistics system does not have all the suppliers that provide the means of work
29- The means of work are not in correct condition
42- No method is applied to identify physical constraints in the logistics system

4. The graphical analysis and later the results of the measures of proximity and harmonic proximity, allowed to identify that the restriction 4 (The logistics system has not identified the suppliers for which it acquires its supplies), is not present in any of the analyzed entities.
5. Restrictions 24 (Assets for multiple tasks are not used) and 35 (No established areas within the company for the location of reusable or non-reusable waste) are the only constraints associated with a single enterprise, emphasizing that the last one is one of the restrictions that greater incidence in the company Médano.

4.- Making the Current Reality Tree

In order to identify the main constraints presented by logistic systems in the commercialization companies analyzed, the Current Reality Tree (ARA) was made (Fig, 3).

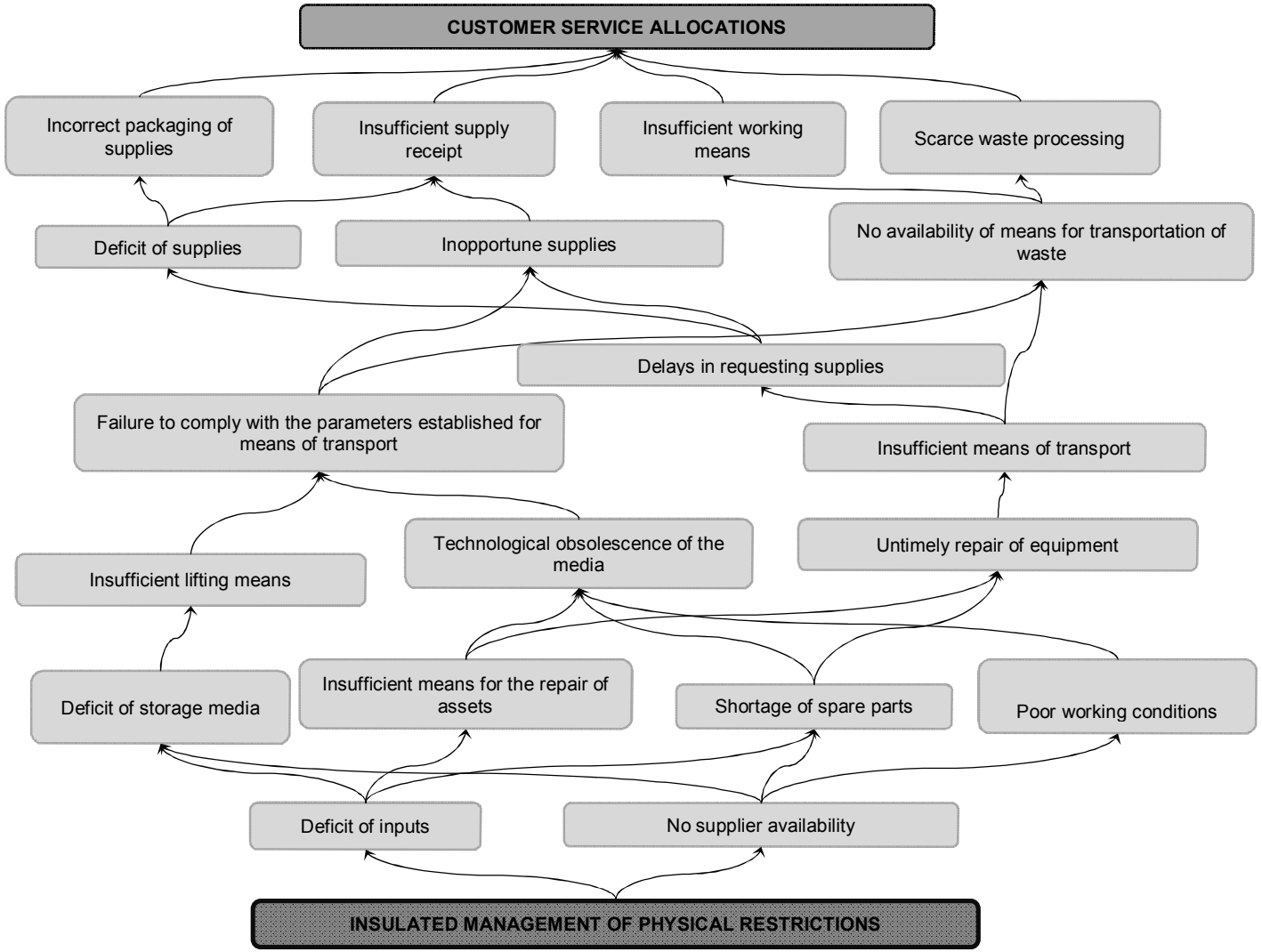

Figure Nº3: Current Reality Tree of the physical restrictions in the trading companies under study in the territory of Holguin
Source: Own Elaboration

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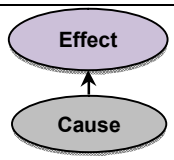
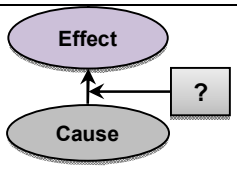
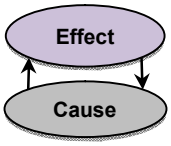
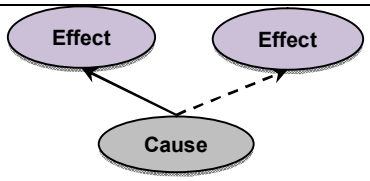
Obtaining the weights of the items evaluated in the instrument, to select the ones that would be represented in the ARA, it was necessary to use the average as a method of univariated analysis of the information. However, the authors agree with the statement that:

> "It is always possible to build a clear and logical ARA, in which at least one of the root causes leads to most EFIs. Generally, during the construction of the ARA, new EFIs are identified that were not detected in the list of the same, all of them and their logical causal relationships constitute the strategic diagnosis that one wishes to carry out." (Cespón et al., 2015, p. 350).

By means of data processing in Microsoft Excel 2010, the averages were determined according to each of the 42 evaluated items and the average value of these, resulting in 3,72. The items whose average was below 3,72 were defined as deficient because this means that most of the assessments given by the experts to these elements were low. According to Lacerda and Rodrigues (in Silva et al., 2014) the tree of actual reality is solid and appropriate to the problem, it becomes necessary of some considerations, which are used to validate and conceive the ARA, as presented in Table Nº 3 that represents the flow of entities.

Table 3: Flow of entities within the Current Reality Tree

Illustration	Description
	Verify if the cause and/or effect really exist
	Verify if there is a direct between the effect observed and the affirmed cause
	Such a situation should be avoided, being so, the cause would not produce effect
	Using another effect to show that the cause does not produce the observed effector to show that the cause generates an effect that backs the original effect-cause relationship

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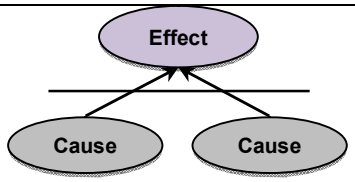
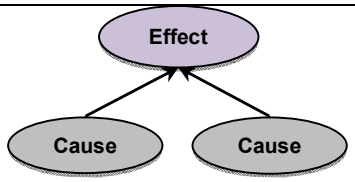
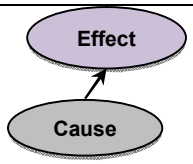
	The chart should be read in the following way: It is caused, therefore it is the cause
	The chart should be read in the following way: It is caused or later it is the cause
	Relationship cause-effect or the very existence of entities. If it were the case, to formulate an additional explanation to the cause-effect relationship, of the relationship or of the entity

Source: Silva et al. (2014, p. 12)

The technique was used to explain the interdependencies that exist in the logistics system, by evaluating the network of effect-cause-effect relationships between undesirable effects. For the construction of this it was necessary to achieve the actions proposed by Rodrigues, L, (in Silva et al., 2014):

Action 1, Making the list of undesirable effects from the selected items with greater manifestation.

Action 2. Relation of effects, through a process with high scrutiny, with common elements among them, respecting the relation of effect - cause – effect.

Action 3. Read tree from bottom to top, performing continuous checks to detect possible errors and rectifying them whenever necessary.

Action 4. Brainstorming the people related to the issue addressed in the areas under study to obtain judgments on the making of ARA.

Action 5. Extend the tree with the new criteria (if necessary).

Action 6. Examination of the ARA looking for effects that do not have clearly defined the causes that originate them.

Action 7. Elimination of objects that are superfluous or redundant.

Action 8. Presentation of the ARA designed to other people involved in the situation that were not present in the previous analysis, in order to identify possible omissions or undetected redundancies.

Action 9. Review ARA entry points and determine which problem to prioritize.

Action 10. Choice of the problem that influences or intervenes in a greater number of unwanted effects (root problem).

As can be seen in the ARA, a root cause was identified, this being the isolated management of the physical restrictions in the trading companies under study and as a consequence of this, the need arises to manage the physical constraints in an integrated manner through a Method, technique or procedure, where the know-how to be established is established.

CONCLUSION

1) As a philosophy of continuous improvement TOC is projected to manage the logistics flow, despite its application in the selected commercial companies as object of study, has a tool that allows the identification of physical restrictions in its logistics system as the first step of its methodology,
2) For the grouping obtained from the derived analysis and the centrality measures obtained from the processing of the information from the application of the instrument, companies were obtained with the most unfavorable situation regarding the presence of physical restrictions, as well as the physical restrictions more frequent and with greater incidence.
3) The creation of the ARA made it possible to identify that the lack of an integrated approach in the management of physical restrictions in the logistics system of commercial companies in the territory of Holguin, leads to a deterioration of customer service levels, which constitutes a problem to be solved.

REFERENCES

Please refer to articles in Spanish Bibliography.

BIBLIOGRAPHCIAL ABSTRACT

Please refer to articles Spanish Biographical abstract.

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