Contribution to the Logistic Evaluation System in the Transportation Process in Santo Domingo, Ecuador

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Abstract:

Purpose: The objective of the present research is to design and apply a methodology to evaluate the logistics system in the transportation process in a base vehicle pool, which contributes to decrease the costs of distribution and to increase the performance of the logistics system of the organization.

Design/methodology/approach: The proposal of a holistic technology for the management of this process is carried out, which integrates indicators and tools that improve control and decision-making activities in this area.

Findings: The application of the procedure developed in the selected organization contributed to the identification of deficiencies related to the availability of the equipment and the needs of the clients, the low technical availability of the automotive plant, the low utilization of the capacity of the freight vehicles, the absence of a plan of measures to diminish the empty routes of the transport and the overconsumption of fuel due to the accomplishment of extra trips. Aspects that contributed to the redesign of some of the main functions of physical distribution such as itinerary planning, selection of means of transport and analysis of operating indicators, aspects that favored the optimization of the number of trips and, consequently, the adequate use of the equipment and the loads to be transported, observing a saving of 15% in the fuel consumption per load transported.

Originality/value: The originality of the present research lies in the combination of different theories and techniques that contribute from a holistic approach to the logistics evaluation of the transportation process, facilitating the optimization of transportation requirements, its operation and maintenance.

Keywords: logistic system, evaluation methodology, transportation process

JEL Codes: L23, L91, L97.

1. Introduction

The need to study logistics management is acknowledged to be important, highlighting several authors, who in some way have contributed to the development of this science in areas such as the positioning of the production system, design and study of production processes and the design of services and production plans, the allocation of resources, among other aspects that are of vital importance, while also agreeing on the business operation of creating a total system to manage the flow of information to achieve an opportunity, and thus become competitive companies with capacity for innovation to increase the value of products and customer satisfaction (Chang & Lin, 2016; Ayala-Bécquer, Bustillo-González & Sánchez-Fernández, 2001; Ballou, 1991; Altendorfer & Zsifkovits, 2016;

Fahimnia, Reisi, Paksoy & Özceylan, 2013; Chase, Jacobs & Aquilano, 2009; Swink, Melnyk, Cooper & Hartley, 2014; Heizer & Render, 2009; Krajewski, 2012; Magee, 1968; Carrasco, Mataix, & Carrasco-Gallego, 2017; Stoner, 1996; Raza, Lang & Jedermann, 2017; Cespón-Castro & Auxiliadora-Amador, 2003; Vélez, 1996; Lee & Lam, 2012; Afonso & Santana, 2016; Movahedipour, Yang, Zeng, Wu & Salam, 2016; Mimouni, & Abouabdellah, 2016; Martínez-Vivar, Sánchez-Rodríguez, García-Vidal & Pérez-Campdesuñer, 2016).

In this context, logistics evaluation is considered to be of great importance, contributing to determine if the business processes are being adequately met, and to detect the main problems that may exist within the automotive pool, using indicators that measure efficiency and efficiency, such as level of service that is rendered and therefore the one perceived by the client, being considered as a primary factor in the economic development of the organization.

The present investigation involves an analysis of the different strategies used in Rancho Mary Base vehicle pool, recognized for delivering quality products, which has presented some difficulties in the distribution system. Based on the logistic evaluation, it has been possible to determine that it does not have a preventive and corrective maintenance plan for its automotive pool, causing non-compliance at the time of delivery of the products, causing returns and dissatisfaction on the part of the customers. Likewise, it has been detected that the distribution routes are not planned, arriving to verify informality by the workers who are in charge of the distribution of the products in the units of the company, that are used for personal purposes not programmed in the work schedule.

The elements discussed above show the existence of both theoretical and practical contradictions, since there is a need to organize the transport system in the company under study and the lack of a methodological tool that contributes to the implementation. Therefore, the objective of this paper is to design a methodology to evaluate the logistics system in the transportation process in the Rancho Mary Base vehicle pool.

2. Theoretical Analysis

From a logistical point of view, any reflection on modern business management is basically framed in two fundamental ideas: on the one hand the business logistics management and, on the other, the opportunities that the technology offers. To illustrate the logistics management, it is interesting to make a series of considerations about its scope, its role and its integrative character, a question that can be made on the basis of three concepts: the definition of logistics management, customer orientation and cost analysis towards permanent improvement of the system.

On the other hand, logistics involves four subsystems recognized in the literature, among which are listed: Procurement, production, distribution and reuse, which in their holistic operation contribute to the performance of the business system (Chang & Lin, 2016; Ayala Bécquer et al, 2001; Ballou, 1991; Altendorfer & Zsifkovits, 2016; Fahimnia et al, 2013; Chase et al, 2009; Swink et al, 2014; Heizer & Render, 2009; Krajewski, 2012; Magee, 1968; Carrasco et al, 2017; Stoner, 1996; Raza et al, 2017; Cespón-Castro & Auxiliadora-Amador, 2003; Vélez, 1996; Lee & Lam, 2012; Afonso & Santana, 2016; Movahedipour et al, 2016; Mimouni, & Abouabdellah, 2016; Martínez-Vivar et al, 2016).

In particular, the function of distribution and transport is a key activity of logistics, influencing two essential aspects: the utility of place and time, which means having the goods at the place and time needed. According to this criterion, there is a great variety of concepts around this important activity, being one of the most used both in practice and in the academic context contributed by Cespón-Castro and Auxiliadora-Amador (2003), who refers to transport: as a key activity to logistics, whose function is the transfer of materials and goods to points of consumption, in addition to adding value of time and place.

Under this criterion, it could be stated that the transport system (TS) constitutes the set of modes, means and facilities or infrastructure, which serve as a material basis for the execution, by man, of transportation activities, through the economic and juridical relationships established in an organization (Lee & Lam, 2012; Afonso & Santana, 2016; Movahedipour et al, 2016; Mimouni & Abouabdellah, 2016; Martínez-Vivar et al, 2016). In the

previous approach the elements that compose this system materialized in the material base and the economic and legal relations.

In this way excel authors such as Chang and Lin (2016), Ayala-Bécquer et al (2001), Ballou (1991), Altendorfer and Zsifkovits (2016), Fahimnia et al (2013), Chase et al (2009), Mimouni and Abouabdellah (2016), Martínez-Vivar et al (2016), who agree that transportation decisions belong to both the operational and tactical levels; With an emphasis on the tactical level when selecting the transport company with which cooperation and operational ties will be established, when deciding the mode of transport to be used. For both decisions should consider the impact that will occur in costs. The most economical mode of transport does not necessarily result in lower costs for the entire supply chain, usually cheaper transport modes have longer delivery times and the minimum quantities to be transported are higher, leading to high levels of inventory along the logistics channel.

This presupposes the preference for fast delivery modes for products with a high index of the value of the goods against the weight, where inventory levels are important costs, and on the other hand delivery modes of transport are preferred for products with a low index of value against weight and for which, it is less important to reduce inventory costs.

It is a serious mistake to ignore inventory costs when deciding which mode of transport to use, since a wrong decision can reduce the performance of the supply chain. Likewise, the analysis that is presented is valid when the decision to select a specific means of transport is presented, in the presence of several alternatives.

This is why the present article tries to develop a methodology that contributes to the design of a logistics assessment system, in the transport processes, particularly in the object of selected practical study. This methodology systematically addresses an integrative approach by fully assessing the distribution process. It also incorporates a set of indicators that contribute in its analysis to the decisions related to the subcontracting, purchase and maintenance of vehicles dedicated to transportation.

3. Methodology

Before beginning to detail the phases and steps of the methodology for the evaluation of the logistics system in the transport process, the organization should be characterized, emphasizing the logistic distribution system.

In this point of the characterization will be provided with information on the activity of the company as its main supplier, characterization of human resources, mission, vision, objectives and values.

The characterization of the logistic distribution system aims to recognize the real problems in the functioning of the distribution subsystem as:

- Distribution destinations
- Distribution equipment
- Products to be distributed

3.1. Phase I. Diagnosis of the Transport Function within the Distribution System

Step 1. Service level evaluation. In order to carry out the diagnosis of the physical distribution function, it is necessary to start from an evaluation of the level of service that is provided and perceived by the customer, which can be evaluated from three points of view.

- The level of service offered
- The level of service provided
- The level of service provided by the customer

Therefore, the company's main objective is to ensure the quality of the service offered and the perceived service. This measurement is made from indicators that are collected within the company, for example, internal data about the quantity of orders that have been delivered out of date, records of unpaid quantities and defective items, calculated as follows.

Service Level	Formula
Term	Number of orders out of time / total orders
Quantity	Number of incomplete orders / total orders
Quality	Number of defective items / total items

Table 1. Service level evaluation

For the calculation of the reliability of the service level provided by the company, the following formula shall be used:

$$F= \prod(1-\frac{CF}{N}) * (1-\frac{CT}{N}) * (1-\frac{CP}{N}) * 100\% \tag{1}$$

It is: F: Reliability; CF: Number of failures in term; CT: Quantity of failures in volume; CP: Number of quality failures; N: Total observations.

In order to calculate the level of service perceived by the customer, a survey will be conducted on a sample of customers, which will evaluate fundamental aspects that will be compared with the data obtained in the level of service, in order to know the gap that exists between the two levels to take the necessary corrective actions.

Step 2. Evaluation of the main efficiency indicators. Several indicators are now needed to measure efficiency. In this research will be carried out the specific distribution activity that require the current organizations within the distribution activity specifically to external transformation.

Technical indicators: These are those that are related to the technical characteristics of means of transport, consumption standards of these, needs, compliance and quality of repairs and maintenance.

Economic indicators: These are related to the planning of transport production and its results, highlighting the financial status of the activity and the expenditures of resources consumed in its execution.

Operational indicators: Includes the set of indicators required for the organization of the transportation process, due to its high incidence of transportation.

Step 3. Checklist evaluation. To complete the evaluated one will be necessary the application of a checklist appropriate to the activity of transport, obtained by the department of warehouse of the organization.

The application of these checklists will lead to the main differences in the management of this subsystem, activities that are not carried out and must be carried out. This analysis will serve as a basis for the next phase of the methodology, the analysis and design of the different transport functions.

3.2. Phase II: Evaluation of the Transport Function within the Distribution System

Its objective is to evaluate the fundamental activities within the subsystem and if necessary to implement a design that improves the operation of the transport within the distribution.

Step 1. Definition of itineraries. The problem of distributing one or several products to several points through multiple possible routes, depending on the distances between them and the distance from each one to a distribution center, is a typical problem in the field of logistics. However, the selection of the method to be applied will depend on the level of complexity, in the present investigation two methods will be applied: the Sweep, which is included within the error test group, and the Traveler Agent method, considered within the called heuristics (Cespón-Castro & Auxiliadora-Amador, 2003).

Step 2. Determination of the need for means of transport. Transportation represents a major element within the organization. For an adequate performance in determining the number of trips to be made or means of transport to guarantee the distribution and supply of a purchase order of the customer or final consumers.

There are different aspects that must be taken into account during the organization of the means of transportation, such as the characteristics of the means and the load. In the case of the latter it is necessary to

know: quantity to be transported (Q), volume of the unit (Pb), coefficient of utilization of the useful volume of the space (Km). As for the means of transport, the static load capacity (q) and volumetric capacity (CW) must be known.

Step 3. Transportation Balance. It is necessary to start from the knowledge of the amount of equipment that will be needed for the transportation of the goods and of the transportation capacity that the organization has, decisions will be made regarding the contracting of these services, or if it is necessary to acquire a greater park of equipment to assume in case the amount of equipment that is needed is greater than the capacity with which it is available.

At the end of the evaluation of each of the phases discussed above, a summary of the main deficiencies detected will be carried out and measures will be projected to solve them. The last phase of this procedure is to perform a new evaluation of the subsystem from the implementation of the proposed measures.

Step 4. Proposal for solutions. In this phase, given the developed diagnosis, a set of measures is proposed that will contribute to the solutions for the improvement of the logistical process of transport.

3.3. Phase III: Implementation and Adjustment

Objective: In this phase the implemented solutions will be implemented and the necessary adjustments will be made that contribute to the good operation of the system.

In this phase, the level of service perceived by customers will be recalculated and if it coincides with the level of service expected then the standards will be raised within the distribution policy, and thus contribute to the achievement of a better performance by the organization. However, if the service level still does not meet the customers' expectations then the complete subsystem diagnosis will be resumed, thus showing its fundamental characteristic in continuous improvement.

4. Results

Characterization of the organization.-The "Rancho Mary" Company, founded in 2001 at the proposal of the company PRONACA, works as a distributor of the balanced products available at that time. It is characterized by being a transfer yard and have the exclusivity of the mega distribution of balanced food of the company PRONACA in the lines: pigs, cattles, pets, horses and organic fertilizers, this being its only supplier.

As mentioned above, Rancho Mary is responsible for the distribution of balances and fertilizers in different places around Santo Domingo de los Tsáchilas, below are the distances and the demand for each route.

Regarding the products to be distributed, it is known that Rancho Mary is responsible for the distribution of balanced products for cattle, horses, pigs, pets and organic fertilizers, each of these bags have a weight of 45 kg, which is shown in the following table of demand of the different places of Santo Domingo and the neighboring towns (see Table 2).

In terms of distribution equipment, the Table 3 shows the equipment used by the company for sale and distribution of the products.

Destinations	Demand (Tons)					Total Demand (Tons)	Number of trips (trips per year)
	Cattle	Horses	Pigs	Pets	Organic Fertilizers		
Santo Domingo	453	25	1490.00	156	50	2174.00	832
La Catorce	196	5	341.60	80	40	662.60	104
Patricia Pilar	92	16	945.15	90	38	1181.15	104
Granjas	650	12	986.00	63.1	60	1771.10	520
El Carmen	685	19	1169.20	62	25	1960.20	156
La Concordia	285	6	1058.00	95	18	1462.00	104
Alluriquín	195	1	58.00	45	30	329.00	208
San Gabriel	96	1	85.90	1	20	203.90	208
Santa María del Toachi	197	10	128.80	2	15	352.80	208
Valle Hermoso	101	5	170.83	1	8	285.83	104
La Unión	98	8	185.96	1	3	295.96	104
San Jacinto	50	2	96.30	1	5	154.30	104
Nuevo Israel	30	2	35.90	0.5	2	70.40	104
Total						10903.24	2860

Table 2. Demand according to destination

License plate	Capacity (Tons)	Year	Model	Fuel Tank (Liters)	Fuel Consumption in City (L/100km)	Fuel Consumption in Road (L/100km)
PLQ0853	4000	2006	Canter 4.0 Ton	100	10.9	9.7
PTB0776	6000	2007	Gh1 Jmua	200	12.9	10.9
PCB7952	4000	2012	Fsr 34n Truck 2p	200	12.9	10.9
JBA5567	10000	2015	Canter Fe85 Pg6s 2p	100	10.9	9.7
JBA5658	4000	2015	Hfc 1035kd Ac 2p	100	10.9	9.2
PCK9852	1498	2016	Aveo Family Ac 1.5 4p	45	5.1	5.1
PCM4778	2499	2014	D-Max Td 2.5 Cs 4x2	76	10.9	13.9
PPA1095	2000	2010	Grand Vitara Sz 2.0l 5p	66	13.52	12.5
PBY9821	1995	2012	Grand Vitara Sz 2.0l 5p	66	13.52	12.5
PCA5408	1995	2012	Grand Vitara Sz 2.0l 5p	66	13.52	12.5
PCN4355	2000	2015	Sportage Lx Dab Ac 2.0	55	12.1	17.1

Table 3. Distribution equipment

4.1. Phase I. Diagnosis of the Transport Function within the Distribution System

Step 1. Service level evaluation. To carry out the evaluation of the level of service that the company provides to its customers, it is necessary to start measuring Rancho Mary internally in the following manner:

- Number of deliveries made out of time
- Number of shipments that presented problems with quality and quantity.

With the records provided by the company, the level of service offered by the entity was calculated. The data to be used correspond to the year 2016 according to the criteria explained in Table 4.

Number of Orders	Orders Delivered Out of Time (2016)	Incomplete Delivered Orders (2016)	Returned Orders (2016)
235	27	38	180

Table 4. Level of service

Substituting in the reliability indicator gives the following:

$$F = \left(1 - \frac{27}{235} * 1 - \frac{38}{235} * 1 - \frac{180}{235}\right) * 100\% = \ 0.8851 * 0.8382 * 0.234 = 17.36\ \% \tag{2}$$

As can be observed, the logistics system presents a very low level of service, rising to 17.36%, with particular emphasis on orders delivered out of time by 88.51%, incomplete ones by 83.82% and those returned by 23.4%, this being which most affects the deterioration of this indicator in general.

Fifty surveys were applied to different clients of the company and the following results were obtained generally:

- 60% of the requests are answered and there is a 40% existence of deficiencies in this indicator.
- 68% is in agreement with the offered offered however it is evident that it does not meet the expectations of our clients.
- The time required by the entity for the preparation of the contracts, reach customer satisfaction by 72%; However, there is a low percentage that do not reach desired expectations, so you have to analyze the times required for the presentation of such document as this makes the customer can access an immediate credit.

Step 2. Evaluation of the main efficiency indicators. Economic indicators: In order to evaluate this indicator, the difference between the fuel consumed and the kilometers traveled for each equipment is taken into account.

Table 5 shows the actual fuel consumption used by equipment during the period 2016, which amounts to 4,173 liters in a general way. It should be noted that the company has not defined the fuel plan to be used for travel, but it is evident that there is a high consumption upwards approximately 5 km per liter.

License plate	Total kilometers traveled (2016)	Total Planned Fuel Consumption in Liters (2016)	Total Actual Fuel Consumption in Liters (2016)
PLQ0853	89960	256	351
PTB0776	104968	237	443
PCB7952	115082	238	484
JBA5567	95066	236	402
JBA5658	133639	120	1111
PCK9852	17992	298	60
PCM4778	41122	115	358
PPA1095	38574	149	259
PBY9821	36015	141	255
PCA5408	53976	148	364
PCN4355	107952	1269	85
Total	834345	3208	4173

Table 5. About Fuel Consumption

The possible causes of this over consumption so high in the year are:

- There is no adequate control of kilometers traveled by vehicles
- That they were traveling more miles than planned so this would increase fuel consumption or,
- That the equipment for some technical defect is consuming more than norms.

Operational indicators:

Existing average equipment (Ee). It allows to know the amount of existing equipment that the company has in a period of time that is analyzed. The calculation showed that there are an average of 11 teams on average.

Average working equipment (Et). It expresses the number of equipment that on average work in the analyzed period of the total of existing equipment. This indicator showed that nine equipments were kept working.

1. Inactive average equipment: Indicates the amount of equipment that, on average, remains inactive (not working). On average, zero equipment were inactive during the year 2016.
2. Average equipment in repair: It allows to know the amount of equipment that on average are in repair and maintenance in the analyzed period. In the period were maintained in repair two equipment.
3. Coefficient of utilization of the equipment pool αa: With this indicator we can analyze the use of existing equipment within the park. The indicator showed that 81% of the park was used.
4. Technical availability coefficient αt: It expresses the degree of percentage disposition of the equipment to work, that is, the technically fit. During the period, 81% of equipment was suitable for use.
5. Coefficient of utilization of the static capacity (ysT): It expresses the degree of efficiency in which the nominal load capacity of an equipment is used. This indicator showed a value of 62%, indicating that there is poor operational planning, which will be detected when the checklists are applied.
6. Coefficient of utilization of the dynamic capacity (ydin): It expresses the degree of efficiency which takes advantage of the load dynamics of an equipment. In this case these values correspond to the value of the utilization coefficient of the static capacity 62% since during the sampling period the equipment went to the same destinations.
7. Coefficient of utilization of the routes (β): It is possible to analyze the degree to which the distance covered has been carried out with load. This analysis yielded a value of 59% since the equipment moves loaded mainly in one direction.

Step 3. Checklist evaluation. The evaluation of the checklists made to the personnel in charge of the logistics of Rancho Mary gave other elements to the diagnosis. To summarize, in the evaluation of the checklist some deficiencies were found in the following questions, giving a percentage of 50%, which are listed below.

- Transportation needs do not immediately meet customer demand.
- There is no planning in the transport request.
- Technical conditions do not guarantee the protection and safety of personnel.
- There are not enough means of transport.
- They do not have operating manuals for transport management.

4.2. Phase II: Evaluation of the Transport Function within the Distribution System

As reflected in the aforementioned model, for the continuous improvement of the physical distribution, the characteristics of the products, the quantity to be distributed and the location of the destinations are taken into account, the rest of the functions are evaluated. These elements have already been treated in previous sections so it will continue describing how the definition of routes occurs.

Step 1. Definition of itineraries. In order to execute the transport plan, it is necessary to choose the most economical type of vehicle for each route, the correspondence of the type of vehicle with the character of the load transported and the conditions of operations. This is a precondition for the profitable use of transport. In this case

the trucks will be selected as they are vehicles within the same category. The isocostal method shall be used for the selection of the means of transport.

	PLQ0853	PTB0776	PCB7952	JBA5567	JBA5658
PLQ0853	X				
PTB0776	-12.57	X			
PCB7952	-7.29	-7.37	X		
JBA5567	-10.04	-13.33	2.21	X	
JBA5658	-12.35	-12.04	-11.82	22.66	X

Table 6. Distance Intersections with Fuel Consumption in Kilometers

As it can be seen in Table 6, negative intersections are discarded, on the other hand the smallest distance to which is transported is 2.21 Km so that only the intersection of 22.66 km will be taken. As shown in Table 7, thus it can be concluded:

Before the 22.66 km	After the 22.66 km
JBA5658	PLQ0853
JBA5567	PTB0776
PCB7952	PCB7952
PTB0776	JBA5567
PLQ0853	JBA5658

Table 7. Optimal transportation

This is the order of priority to use the computers. As it can be seen, the latest equipment are the most expensive so if possible you will be dispensed with their services. For the design of the itineraries was based on the demand of each destination is well above the load capacity of the equipment, so a series of trips will be made to each destination (round trip) before grouping destinations.

As a first element, the quantity that can be transported in each type of equipment was calculated, based on the calculation of the volumetric capacity of each unit of load of the product and of the specific volumetric capacity of the equipment (see Tables 8 and 9):

Gross weight (Pb)	Volume	Length (l)	a	Width (h)	Vet
0.045	0.252	1.2	0.6	0.35	5.6

Note: Pb: gross weight. Vet: volumetric capacity of the product

Table 8. Volumetric capacity of the product

q (Tons)	Volumetric Capacity (CW)	Capacity Volumetric equipment (Cwe)
10	20.57	2.057
6	20.57	3.4283
4	20.57	5.1425

Table 9. Volumetric capacity of the equipment

As it can be seen, the product is lightweight for each type of equipment, both for 4, 6 or 10 ton equipment load capacity.

	Pb/q	Volume/CW	Vet/Cwe	Un	Nu-rec	Un-rec * Pb	Static Sigma
Products	0.045	0.252	5.6				
Equipment	10	20.57	2.057	81.62	81	3.6	0.36
	6	20.57	3.4283	81.62	81	3.6	0.6
	4	20.57	5.1425	81.62	81	3.6	0.9

Table 10. Coefficient of equipment utilization

In general, 81 bags of balanced feed can be transported. From the static sigma and the load capacity of the equipment, the number of trips for each destination was determined:

Destinations	Distance (Km)	Demand	Static Sigma	Nv	Days	Ne	Remaining amount
Santo Domingo	5.4	70	0.3645	19	5	0.1011	0.75
La Catorce	60.3	80	0.3645	22	4	0.0998	0
Patricia Pilar	40.3	90	0.3645	25	5	0.0988	0
Granjas	50.9	100	0.3645	28	6	0.0980	0
El Carmen	33	90	0.3645	24	5	0.1029	2.52
La Concordia	44.8	80	0.3645	21	4	0.1045	3.46
Alluriquín	58.4	60	0.3645	16	2	0.1029	1.68
San Gabriel	14.6	30	0.3645	8	5	0.1029	0.84
Santa María del Toachi	61.6	50	0.3645	14	4	0.0980	0
Valle Hermoso	31.6	60	0.3645	17	4	0.0968	0
La Unión	72.1	60	0.3645	16	3	0.1029	1.68
San Jacinto	30.1	49	0.3645	13	2	0.1034	1.62
Nuevo Israel	26	56	0.3645	15		0.1024	1.33
Total		875		238	5		13.86

Note: Nv: Number of trips; Ne: Number of equipments

Table 11. Load Capacity per Equipment

As can be seen, there are 13.86 tons remaining to be transported. For this amount the grouping of destinations will be done by the savings method. For the design of these itineraries we took into account the time restriction (8-hour workday) and the transportation capacity of each equipment.

Starting from the distances matrix, the savings matrix was made:

	Santo Domingo	El Carmen	La Concordia	Alluriquín	San Gabriel	La Unión	San Jacinto	Nuevo Israel
Santo Domingo	X	33	43.7	58.4	14.6	32.6	30.1	31.3
El Carmen	33	X	59.7	89.7	44.3	64.1	47.4	7.00
La Concordia	43.7	59.7	X	94.9	54	69.1	29.1	50.4
Alluriquín	57.4	89.9	95.1	X	58.2	25.8	85.7	82.7
San Gabriel	14.6	44.3	59.9	58.2	X	34.6	40.1	37.3
La Unión	32.6	64.1	69.1	25.8	34.6	X	59.9	57
San Jacinto	30.1	47.4	29.1	85.6	40.1	59.9	X	21.3
Nuevo Israel	31.3	7.00	50.4	82.7	37.3	57	21.3	X

Table 12. Distances Matrix

|	Santo Domingo	El Carmen	La Concordia	Alluriquín	San Gabriel	La Unión	San Jacinto	Nuevo Israel
Santo Domingo	X	102.2	44.8	79.8	14.6	43.3	73.9	95.2
El Carmen	102.2	X	59.7	89.7	44.3	64.1	47.4	7.00
La Concordia	44.8	59.7	X	94.9	54	69.1	29.1	50.4
Alluriquín	79.8	89.7	94.9	X	58.2	25.8	85.7	82.7
San Gabriel	14.6	44.3	54	58.2	X	34.6	40.1	37.3
La Unión	43.3	64.1	69.1	25.8	34.6	X	59.9	57
San Jacinto	73.9	47.4	29.1	85.7	40.1	59.9	X	21.3
Nuevo Israel	95.2	7	50.4	82.7	37.3	57	21.3	X

Table 13. Savings Matrix
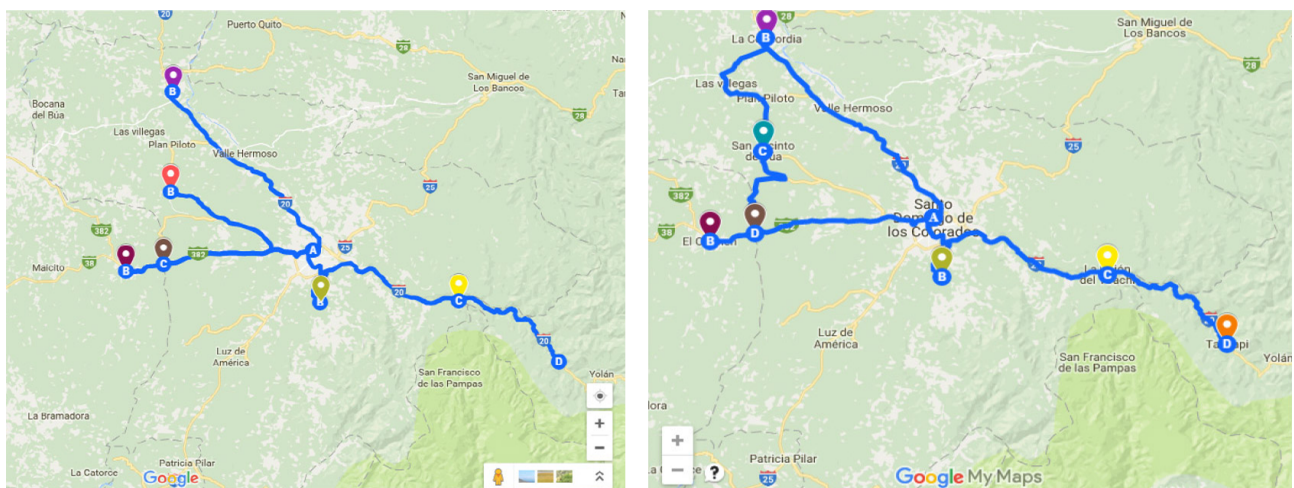
Figure 1. Current route maps

Figure 2 shows the route established by the entity. The truck (1) from Santo Domingo to San Jacinto, returning by the same road until arriving at New Israel, then continuing to El Carmen, to finally return to Santo Domingo in each place with a discharge time of 30 minutes; The truck (2) from Santo Domingo to Concordia and then returning to Santo Domingo with a 30 minute stop; The truck (3) from Santo Domingo to San Gabriel, returning

to arrive to the Union of the Toachi and Alluriquín and finally to Santo Domingo, also has a discharge time of 30 minutes in each place. All this route makes a total of 288.8 km with 3 trucks of 4 tons.
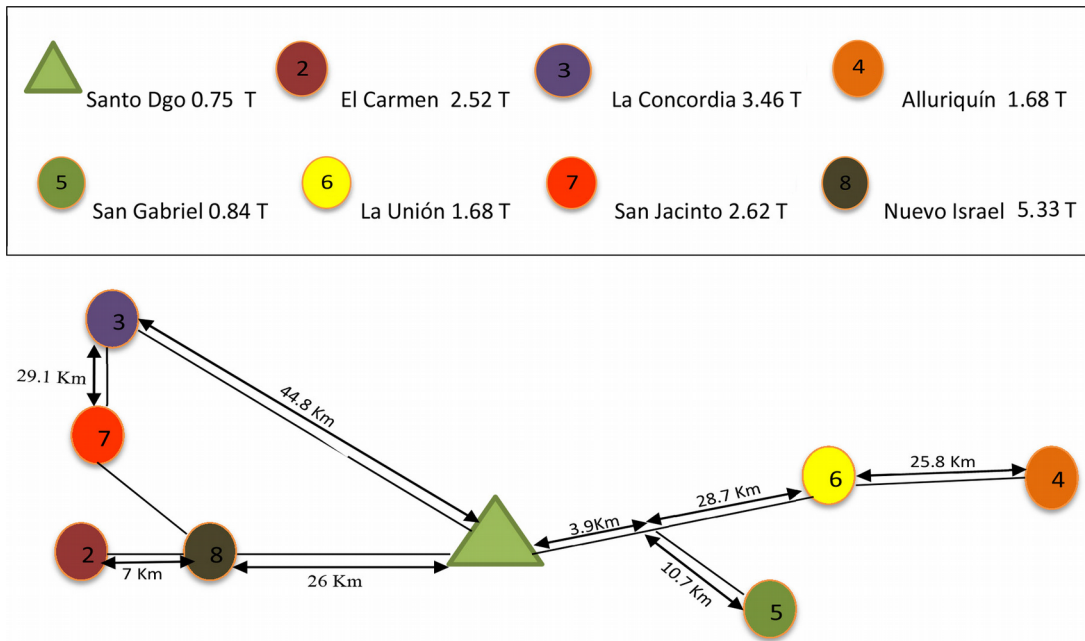

Figure 2. Improved route location graph

An improvement in the distribution of the routes is proposed, taking the following routes:

- First round trip, from Santo Domingo to La Concordia, San Jacinto, New Israel, El Carmen and return to Santo Domingo.

  Calculation:

  Total kilometers traveled = (44.8 + 29.1 + 21.3 + 7 + 33) = 135.2 Km

  Time according to speed (90 Km/h) = $\frac{135.2\ Km}{90\ Km/h}$ = 1.50 h * 60 min. = 90 min

  Time of loading and unloading (30 min in each place) = 150 min + 90 min = 240 min

  Time in hours (240 min) / (60 min / h) = 4 hours

  Total tons = 8.93

- Second round trip, from Santo Domingo to San Gabriel, La Unión del Toachi, Alluriquín and return to Santo Domingo.

  Calculation:

  Total kilometers traveled = (14.6 + 10.7 + 28.7 + 25.8 + 58.4) = 138.2 Km

  Time according to speed (90 Km/h) = $\frac{138.2\ Km}{90\ Km/h}$ = 1.53 h * 60 min. = 92.13 min

  Time of loading and unloading (30 min in each place) = 150 min + 92.13 min = 242.13 min

  Time in hours = $\frac{242.13\ min}{60\ min/h}$ = 4 hours

  Total tons = 4.75

As can be seen, from the previous distribution for the transport of leftovers (13.86 T), the following sequence will be obtained that generates the optimal path. What would be to assign a 10 T truck with a working day of 8 hours and a maximum travel speed of 90 km per hour: Santo Domingo - La Concordia, traveling 44.8 km with a stop of 30 min for a total of 3.46 T; Following trip to San Jacinto at a distance of 29.1 Km, transporting 1.62 T with a discharge time of 30 minutes; To continue to New Israel at a distance of 21.3 km, to download 1.33 T; To continue to El Carmen with a distance of 7 km to download 2.52 T, with a discharge time of 30 minutes; Finally return to Santo Domingo for a total time per tour of 4 hours.

This same truck is loaded again with 4.75 T and will begin the tour in the city of Santo Domingo to download 0.75 T with a discharge time of 30 min; To follow San Gabriel with a distance of 14.1 km, transporting 0.84 T in a stop of 30 minutes, turning to reach the main route, traveling 10.7 km; The journey continues to arrive at the Union of the Toachi, crossing 28.7 km to download 1.62 T in a time of 30 minutes; Arrives at its destination Alluriquín with a route 25.8 km to download 1.68 T in 30 minutes; Finally returns to Santo Domingo, making a total time for 4 hours tour and fulfilling the working day.

The operational planning is shown in Table 14, where 1 equipment was needed to carry out the transportation. A summary of the main results with the new planning is shown below:

	New alternative	Old alternative
Ne	1	3
Nv	2	3
Q	13.86 tons	13.86 tons
Total Distance	240.4 km	288.8 km
q	10 tons	4 tons
Consumption (liter/100 km)	10.9	9.7
Saving in liters	26.2	84

Table 14. Operational planning

Following the logic of the previous organization, it can be stated that weekly fuel consumption is reduced by 57.81 liters, in addition to giving a better use to the routes made with load to each vehicle.

Transportation needs. The means of transport used in the distribution yielded a value of 8, which is below the current equipment park (11), so it is sufficient.

5. Conclusions

The theoretical review allowed the identification of the main limitations of the logistic evaluation of the transport, while contributing with the holistic technology proposal for the management of this process, which integrates indicators and tools that improve the control and decision-making activities in this area.

When the evaluation system was implemented in the company under analysis, specifically in the transport function, it was detected that the availability of the equipment does not respond to the needs of the customers and there is no procedure to know the use of the capacity of the vehicles of load in the transport, being observed like main consequences the economic losses and the dissatisfaction of the customers.

The main functions of physical distribution were redesigned, such as route planning, selection of means of transport and analysis of operating indicators, which contributed to the optimization of the number of trips and consequently the adequate use of the park of equipment and loads to be transported, with a saving of 15% in the fuel consumption per load transported.

Declaration of Conflicting Interests

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