

Use of The Pert / Cpm Network To Reduce The Number of Itamarati Municipal Travel Patients

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Abstract — Logistics covers a range of tasks and provides a vision of the organization as a whole. Transportation represents one of the highest logistics costs and managing it properly is a relevant factor for any business. This paper presents heuristic methods for the formation of patient groupings of patients to be transported in the same transport car, aiming to identify the current patient transport route from the Municipality of Itamarati de Minas, MG to the nearest Municipality Cataguases, MG and scale the total trips to meet the number of patients with the fewest trips possible. Therefore, field surveys and documented data were conducted over a period of 33 days to identify opportunities for improvement in Logistic process of transportation of these people to the nearest hospital and as justification the results indicated that through the methodology used PERT / CPM the choice of the best route based on the analysis of the critical path and relocation would reduce by R\$ 45,135.84 in costs variables for the city studied.

Keywords: Logistics; Patient transport; Pert / Cpm;

I. INTRODUCTION

Logistics has taken a very important and strategic position within industries, being expanded to companies and even to other sectors. Logistics is paramount for both private and public management, as its management influences customer service and the general public. With everything the public sector has been approaching the private sector in the logistics area, seeking to reduce costs and improve the level of service.

Due to globalization and its constant changes, organizations need to constantly reformulate logistics strategies in order to lower boundaries and improve their resources.

Transport can be considered as one of the main logistic functions. According to Ballou (2006), transportation is a means of satisfying the displacement needs of people, such as goods in space and time, promoting economic and social development extended to internal and external borders, allowing the production of economic goods in Brazil and beyond.

In addition, it represents the largest share of logistics costs in most organizations. Marques (2012) points out that transportation logistics is a decisive and primordial area for the organizational process strategy, aiming to identify the best route and the best routes, ensuring punctuality and quality in the services provided.

Currently, health services through the government are the most sought after, so the municipalities use transport logistics, given that often small municipalities do not have all the possible resources to serve their users and need to transport them (patients) to other health facilities.

Due to the large use of vehicles to transport its users from one unit to another, it was observed the primacy of choosing the best routes, seeking ways to qualify services and reducing expenses. The lack of management of patient transport flows between hospital units generates higher costs. When this logistics is used in the administration of a health institution, it is an action that manages strategically and rationally, in which case the movements of patients, and as in any other management system, the application aiming at the healthcare environment. health and hospital, organize, coordinate and plan each activity of health institutions.

Given the above, the objective of the present study is to identify the current transport route of patients from the municipality of Itamarati de Minas, MG to the nearest municipality of Cataguases, MG and to size the total trips so as to meet the number of patients with the lowest number of possible trips.

II. LITERATURE REVIEW

A. Logistics

According to the Council of Supply Chain Management Professionals standards, logistics is the process of planning, implementing and controlling the efficient and effective flow of goods, services and related information from the point of origin to the point of consumption for the purpose of meeting customers' requirements.

Dias (2016) states that logistics determines the means of transfers of material resources and equipment of the organization, conducting procurement, transportation, storage and physical distribution as well as managing all information of process activities.

For Evaristo (2010), in order to be able to offer quality service, it is recommended to be able to meet customer expectations. Therefore, such service expectations may vary considerably from customer to customer.

Note that logistics is the organizational part of a company, since planning related to materials, finances, products, employees and information is the area that aims to improve all processes, and that they are carried out at the lowest possible cost and subsequently able to deliver better results.

B. Hospital transport logistics

According to Rodrigues et al (2014) hospital transport logistics is defined as a mix of procurement, inventory control, and distribution activities to meet the needs of hospitals.

According to Mathias et al (2015), health services underwent significant changes, in which various operational and management activities incorporated new conditions essentially for activities related to the acquisition, movement and distribution of supplies and equipment.

The performance of logistics activities consist of the following points:

The performance of these activities should contribute to improve the quality of services provided and customer satisfaction, called patient. This in turn requires agile actions in the supply of inputs and operational activities, diagnostic, important for its recovery. (RODRIGUES and SOUSA, 2014, p.3).

Hospitals also have a logistics system, as they work directly with inpatient outpatient services. In these cases, when the hospital does not have the treatment or operation that the patient needs, the logistics assume the role by transferring them to other hospital institutions to perform the care, as they have greater resources. "These are systems of great complexity, whose management should be focused on both health care and business, with the aim of improving the use of financial resources in order to provide quality care." (CARETA et al., 2011).

C. Route Optimization

The route is made from a source and destination, requiring a series of analyzes to analyze the feasibility of the appropriate route and cargo volume, places of origin and destination and time available to perform the service. Alvarenga and Novaes (2000) attribute routing as the physical

distribution system of products and services in a collection and delivery plan in which the vehicle visits a certain number of customers being located in a certain location.

According to Lachtermacher (2007), the transportation problem is a very common application in operational research and named after it because its resolution method was used to determine the lowest transportation cost per shipping unit.

A literature review on Emergency Medical Services by Aringhieri et al. (2017) highlights for ambulance routing problems, the relevance of developing more efficient methods that are able to determine the optimal or near-optimal route in real time, these methods need to incorporate realistic travel times and consider various aspects stochastically. Establishing the shortest route may not be the best alternative, as the possibility of heavy traffic on a given stretch may eventually increase the travel time of the ambulance to the destination hospital location.

D. Logistic Costs

According to Faria and Costa (2005), the variable costs related to transportation are the distance traveled and that result from: fuel, washes, tolls, oils and lubricants, tires, accessories parts, greases and maintenance materials), while fixed costs are maintenance, labor, insurance, depreciation, licensing, taxes and the opportunity cost of fixed capital. It points out that among the total costs of a vehicle in use of load distribution about 60% are variable and the remaining fixed.

According to Ballou (2006), transportation when carried out by fleet and own equipment can guarantee better operational performance, greater availability and transport capacity and may generate lower costs. However, it can be understood that even using own fleets and or equipment, the cost can still be higher, taking into account the various maintenance that must be performed on a vehicle. "In addition to logistics costs, an efficient logistics costing system must take into account the total costs of the company." (CHRISTOPHER, 2011).

E. Pert/Cpm

According to Tubino (2007), the PERT / CPM Network is the most used technique for project planning, sequencing and monitoring. The technique provides a graphic view of the activities that make up the project; Estimate how long the project will consume; Vision of which activities are critical to meeting the deadline; View of how much time off is available for non-critical activities.

Martins and Laugeni (2006) define the critical path of a project as the sequence of tasks that determine the duration of the project, and the activities that make up the critical path are called

critical activities. Should any delay occur in any of the critical activities, the entire project will be delayed.

III. METHODOLOGY

For the present work, several bibliographic sources, articles and books already published were used and the methodological procedures are classified according to their nature, approach to the problem, objectives and procedures. For Silva & Menezes (2001), the research is applied in nature, since it is directed to a more practical application that seeks to solve a specific problem. The approach to the problem is quantitative because it makes use of numerical analysis with an emphasis on the use of mathematical and statistical methods. As for the objectives, this is an explanatory research, as it seeks to identify factors that contribute to the occurrence of events in order to explore logistical concepts and apply them as tools that contribute to the search for solutions to issues related to the transport of sick people and to logistics costs arising from this transit.

For the procedures are characterized as case study. Thus, the research aims to improve practical issues and meets the interests of public administration and reducing costs. The city object of study has about 4,362 population, located in Zona da Mata Mineira and currently has no projects aimed at this sector.

The method is materialized in this research through descriptive and quantitative exploratory studies of transport logistics processes from a basic health unit to the hospital of the nearest municipality Cataguases, MG. The study was conducted in a basic health unit located in the city of Itamarati de Minas, MG.

In an attempt to reach a larger amount in certain services, the city hall of Itamarati de Minas makes its cars available for the movement of patients to the nearest municipality. Given this, there was a high demand for vehicles to leave at different times and often with few patients on a trip, as described in table 1.

Table 1- Samples of vehicle departure times.
Source: Own.

According to table 1, it is possible to observe that the demand in the schedules in the periods T3 and T4 are very expressive, therefore it demands a high travel demand. Analyzes were performed through field research and documented data over a period of 33 days from May 6 to June 19, 2019, in order to identify opportunities for improvement in the logistics process of transporting these non-urgent patients to the nearest hospital. from the municipality of Cataguases, MG.

We used the PERT / CPM methodology which are two techniques used together for program

evaluation and review and critical path method that have probabilistic characteristics and random variables using time estimates to analyze the choice of the best route through the method. of the critical path.

In order to analyze the best route through the Pert / Com network tool, it was possible to observe and survey the points addressed, as shown below.

For the development of the critical path, the following points were considered: 0 - Basic health unit considered as the origin of the path; 1 - Clover located near the city of Itamarati de Minas where the paths are divided; following the Route I, we have the point 02 - Clover destined to the city of Cataguases arriving by the Granjaria neighborhood; following the Route I we have the point 03 - Clover destined to the city Cataguases arriving by the Vila Minalda neighborhood; the meeting point between the two routes is through point 04 - Gas Station located in Cataguases; The destination of the route is at point 05 - Hospital de Cataguases. Based on the possible routes to be traveled by the vehicle, the following paths were obtained.

IV. RESULTS

To this end, the trips are made daily and without a certain time to perform them, without reaching certain numbers of people to complete the available vacancies in the vehicle. For this analysis, Excel software was used, where the data were computed and a new table 2 was generated for a better visualization of the results.

Table 2- Samples of vehicle departure times after analysis.

| Periods | Time Samples | |
|---------|----------------|----------------------------|
| | Schedule Time | Amount of people (33 days) |
| T1 | 07:00 às 10:00 | 432 |
| T2 | 10:01 às 13:00 | 198 |

| Periods | Time Samples | |
|---------|----------------|----------------------------|
| | Schedule Time | Amount of people (33 days) |
| T1 | 07:00 às 10:00 | 190 |
| T2 | 10:01 às 13:00 | 125 |
| T3 | 13:01 às 15:00 | 170 |
| T4 | 15:01 às 17:00 | 147 |
| T3 | 13:01 às 15:00 | 5 |
| T4 | 15:01 às 17:00 | 0 |

Source: Own.

As shown in Table 2, a rearrangement of the transportation scheduling method may be proposed, in which it was possible to considerably reduce the number of trips for this purpose, results shown in the periods T3 and T4. Due to the relocation of the T3 and T4 period transport shown in Table 1, it was possible to reduce the number of daily trips from 11 to 6 trips.

Path I: Path A (10.6) - B (1.8) - D (6.8) - F (0.8). Following this route it is necessary to travel 20 km from the origin point to the destination point.

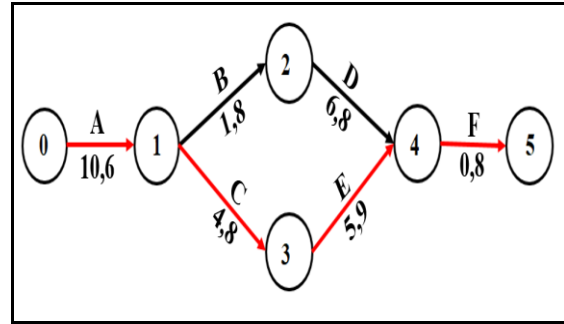


Figure 03-Pert / Cpm of the path under analysis
Source: Own.

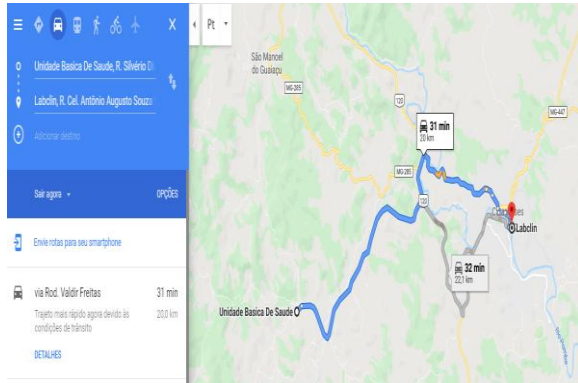


Figure 01-Shortest Route Map Source: Google Maps.

Path II: Path A (10.6) - C (4.8) - D (5.9) - F (0.8). Following this route it is necessary to travel 22.1 km from the origin point to the destination point. For the longest route is shown in figure 2.

For the present study, it was verified that both routes can be adopted for the return trip. With a sample of 33 days, considered in the study following route I, it is possible to obtain a reduction of 1,524.60 Km.

In order to reduce fuel costs it was proposed that when traveling to Cataguases, MG be considered route I, this route allows to save R \$ 528.16 over the 33 days analyzed, considering that the Woskvagem Gol 1.0 car has a yield of 14 km / liter according to the technical file and the average price of gasoline at the station where the supply is made is R\$ 4.85. Another important factor to note is the depreciation of the vehicle, which consequently may be reduced with the reduction of the distance traveled by the vehicle. According to research and documents analyzed the variable costs related to transport of sick patients. for the municipality of Itamarati de Minas, MG as shown in table 3 are:

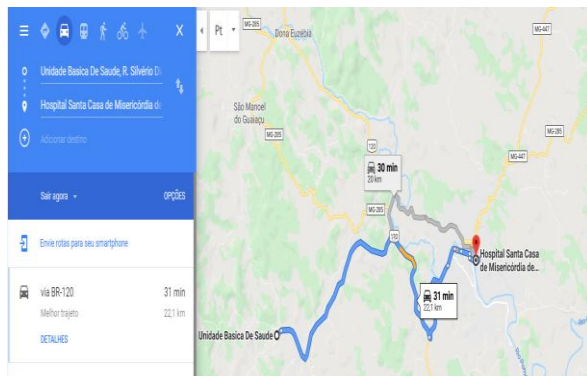


Figure 02- Longer route map Source: Google Maps

Figure 2 shows the map of path II. Considering the values of distances above, it was possible to verify the path considered as a critical path, highlighted in red in Figure 3, since it has a distance of 2.1 km more than the other path.

| Current fuel consumption scenario | | | | | | | | | |
|-----------------------------------|----------------|----------------------------------|----------|------------|---------------------------|------------------|-------------------|------------------|-------------------------|
| No. of daily trips | fuel cost R \$ | fuel consumption in liters / day | daily km | Km / liter | average cons Vehicle / km | consumption days | comb cost Monthly | comb cost Yearly | Annual Maintenance cost |
| 11 | 4,85 | 34,65 | 44,2 | 14 | 3,15 | 33 | 7.427,920 | 89.135,0 | 7.152,00 |

| New fuel consumption scenario | | | | | | | | | |
|-------------------------------|----------------|----------------------------------|----------|------------|---------------------------|------------------|-------------------|------------------|-------------------------|
| No. of daily trips | fuel cost R \$ | fuel consumption in liters / day | daily km | Km / liter | average cons Vehicle / km | consumption days | comb cost Monthly | comb cost Yearly | Annual Maintenance cost |
| 6 | 4,85 | 18,9 | 40 | 14 | 3,15 | 33 | 3.666,6 | 43.999,2 | 7.152,00 |

Table 3 Fuel Consumption Scenario

Source: Own

As shown in Table 3, the annual fuel cost plus the annual maintenance cost for the number of 11 daily trips can be observed at around R \$ 96,287.04 and according to the proposed reduction of 6 daily trips through of the data generated by the critical path being R \$ 51,151.20.

V. CONCLUSION

Within any organization logistics is present, being fundamental in a process of transporting people. In the search for improvement in the transport process of non-urgent patients from the Itamarati de Minas, MG health post to the nearest hospital in the city of Cataguases, MG, it was possible to improve the scheduling and relocation through PERT / CPM for critical path analysis, choosing the best route, reducing the number of trips made from 11 trips to 6, as patients leave at different times and often with few patients in a particular vehicle. As a result, all vacancies were filled and T3 and T4 times eliminated, resulting in lower costs with fewer supplies. It is noteworthy that adhering to the best route choice for the transportation of patients would reduce by R \$ 45,135.84 in variable costs.

Given the above it is at the discretion of the Municipality of Itamarati de Minas, MG and the direction of the Health Center to adhere to the improvements of the study.

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