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STUDY ABOUT DECENTRALIZATION BASES OF SAMU IN LAGES – SC, BRAZIL

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ABSTRACT

This article refers to the analysis of the Lages bases decentralization of Emergency Mobile Care Service commonly called SAMU, from the observation of the need to decentralize the bases to the problem occurred at peak times in the main avenues and access to the neighborhoods of the City. The SAMU has been established in Brazil through ordinance 1864, dated September 29, 2003, and at Lages the service started operating in 2006, with two basic and one advanced ambulances. The Advanced Support Unit (USA) is administered by the State Government of Santa Catarina, and the basic ones (Basis Support Unit – USB) by the City Hall of Lages. At present, the USA management throughout the state territory is carried out by a Social Organization (OS), through a management agreement signed with the Government of Santa Catarina. Just as the USA are managed by the OS, USB throughout the state are the responsibility of the municipalities. The teams and the ambulances have a base, which is located in the Copacabana neighborhood, São Joaquim street. In these, the team consists in a doctor, a nurse and a driver with emergency services qualification, and in the case of USB, the team consists of a nurse technician and a driver with the same trainings in emergency services that the USA requires. With this information, a study was developed based on a mathematical model that works with notes and criteria to define which would be the three most adequate bases for the decentralization of SAMU de Lages.

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INTRODUCTION

The Emergency Mobile Assistance Service (SAMU) was established in Brazil through ordinance 1864, dated September 29, 2003, and in Lages the service started operating in 2006, with two basic and one advanced ambulances. The Advanced Support Unit (USA) is administered by the State Government of Santa Catarina, and the basic ones by the City Hall of Lages. At present, the USA's management throughout the state territory is carried out by a Social Organization (OS), through a management agreement signed with the Government of Santa Catarina. Just as the USA are managed by the OS, USB throughout the state are the responsibility of the municipalities. In the city of Lages there are three ambulances, one USA and two USB, distributed according to the third paragraph of the ordinance 1864, of September 29, 2003.

With regard to the USA, it is understood that it concerns the entire region, in agreement with the population of the city. The fact that the city's three ambulances are in the same place causes some difficulty serving the most distant communities, especially at the busiest times on the streets, and also because the two most populous neighborhoods of Lages are located at the end of the City. This is justified by the need to optimize the service, in order to reduce the time that ambulances take to get to the occurrences, taking into account that the three

ambulances of the city of Lages are in the same base. The optimization techniques have been growing and gaining space in several areas of application, and these can be used to reduce costs (de Matos and Finardi, 2012). Stochastic optimization is an efficient technique to evaluate an optimal result due to the analysis of several equally likely scenarios (Oliveira *et al*., 2017; Philpott *et al*., 2013). Following these circumstances the objective of this article was to study the application of the concepts of the Gravity Center and Multichrite Analysis (AMD) for decision, apply the basis of the AMD standardization method scales in the selection of criteria, concepts of the Gravity Center method to define the best locations of the Lages SAMU bases and decentralize the location of SAMU ambulance bases, from one to three bases, in order to better serve the Lages population.

THEORETICAL REFERENCE

Facilities Location

One of the most important decisions that a company must make, is the location, be it from any sector. Location is defined as the "geographical position of an operation relative to the resources, other operations or clients with which it interacts" (Slack *et al*., 1997). Knowing where to best locate a facility involves a strategic, long-term issue. Its economic investment can influence all other decisions in the supply chain of a company, that is, the decision is not only an economic issue, but also a survival of the company. For Davis *et al*. (2001, p. 255) "As part of an effort to better serve customers, service operations have adopted a wide variety of location strategies, depending on the specific needs of the customers they intend to contemplate". Generally speaking, according to Slack *et al*., (1997, p.187), When there is a need to change the location, these are usually due to increases or decreases in the volume of demand. As an example it can be mentioned that the increase of the demand of a manufacturer will cause that it has greater capacity. Thus Changes in the cost or availability of supplies for the operation may warrant the location of an installation.

Chiavenato also agrees that (2005), for the industrial location can be mantioned some factors like the proximity of manpower and specialized personnel, proximity of raw materials or suppliers, proximity to consumer markets, ease transportation, energy infrastructure, size location and tax incentives. When dealing with business, it is common to find problems of factories location, warehouses, distribution centers, among others. Detecting facilities along the supply chain network is a fundamental decision problem that gives shape, structure and contours to the complete chain compound, detailing the possibilities used to operate the system, as well as costs and levels of investments. Currently, it is known that the location of emergency services has an extreme importance for the effectiveness of the service, in all aspects, as long as it is to optimize the service or reduce costs. For Slack *et al*., (1997, p. 187) “Locating a fire station well may decrease the average travel time for firefighters to reach fire sites”. Consider, for example, the problem of locating emergency care services by ambulances or by fire station stations in a given region, so that the entire population of the region is within 10 kilometers of at least one of the facilities. In this case, 10 kilometers define the critical distance, and the problem consists in determining the minimum number of facilities and their location in the region under consideration, so that each demand area is less than 10 kilometers from at least one of the facilities found (Galvão *et al*., 1999).

Determining method for the location by Gravity Center : An alternative to seek the best geographical location is through the Gravity Center method, also known as Centroide method. This center can be related to various types of rates such as weight, volume and distance to select the least cost alternative (Souza *et al*., 2015, p.5). Slack *et al*. (1997, p. 195) says that the Gravity Center method consists that it is mainly based on finding a location that minimizes costs for transportation, where each location has a value, which when added together form transport costs. The problems of facilities location deal with decisions about where facilities should be located, considering clients that can be served in order to optimize a certain criterion. This criterion can be, among several, the shortest distance between the company base and the service locations and it can be measured using the Gravity Center. In this way, Slack *et al*. (1997, 195) agrees that the coordinates of the Gravity Center of the least cost location for the store, Xg and Yg, are given by the formulas:

$$Xg = \frac{\sum XiVi}{\sum Vi} \quad \text{and} \quad Yg = \frac{\sum YiVi}{\sum Vi} \tag{1}$$

Xi = the X coordinate of the source or destination i;
Yi = the Y coordinate of the source or destination i;
Vi = the quantity to be sent to the source or destination i (Slack *et al*. (1997).

Another Location Methods

Among other localization methods, there are the Moments Method, which is similar to the Method of the Gravity Center. It is used with weighting of one city, against the others. For each city, it is calculated the moment that the other cities have. The calculation is the unit cost multiplication of transport, quantity and distance. The city with the lowest sum is defined as the best location. There is also the Equilibrium Point Method, where different locations are compared in terms of total fixed and variable operating costs. In this method, there is a need to try to obtain the lines of each equation, and check the intersections of the lines and obtain the best location for each range of values.

Notions of multicriterial decision support (AMD or MCDA)

AMD methods are tools to support decision making in complex situations when there are several potential actions (not necessarily alternatives) to be analyzed in the light of various criteria (Vieira, 1999 p.3). Multicriteria Decision Support (AMD) can be seen as a set of methods that lend themselves to clarifying a problem in which alternatives are evaluated by multiple criteria, which are conflicting in most cases.

Scale Uniformization

The standardization of scales can be divided into three sectors: uniformity for minimum, maximum, average and linear transformation. Uniformization of scales to the minimum occurs when we have a series of values and to assign the weight, we must divide the values by the lowest value obtained in the series. As the standardization of scales to the minimum, in this case we also have a series of values, but to assign the weight to the notes, we divide the values by the highest value obtained in the series. Within this context many techniques and methods available to improve the measurement of our processes, including the safety of people without work or outside (Avila Neto *et al*., 2016; Avila Neto *et al*., 2017; Ramos *et al*., 2016).

Application possibility concepts of location for the health area

The inadequate use of emergency services is detrimental to serious patients who need timely care and non-serious patients who, when seeking hospital care, are not guaranteed follow-up (Gomes and Duarte, 1998). Access to basic care reduces the inappropriate use of emergency services only if the patient has quick access to emergency care in basic care. The location concept is directly linked to the health area, due to the issue of humanitarian logistics, where it is required efficiently and effectively, and the flow of supplies and people for the purpose of saving lives and alleviating the suffering of people vulnerable. Humanitarian logistics is the function that aims at the flow of people and materials in an appropriate and timely manner in the care chain, with the main objective of correctly serving the largest number of people (Nogueira, Gonçalves, 2009). These concepts make clear the direct relationship between the health area (emergency services) and the location part, because if an emergency service is well located, the time and cost of displacement are reduced and emergency care is optimized.

MATERIALS AND METHODS

Research Type

According to Gerhardt and Silveira (2009, p.35) applied research aims to generate knowledge for practical application, aimed at solving specific problems, involving local interests, that say that applied research is motivated by the need to produce knowledge to apply its results, with the objective of "contributing to practical, aiming at a more or less immediate solution of the problem found in reality". In this way, the developed research is characterized as an applied and quantitative type, since the objective is firstly to analyze the entire population of the city of Lages, and then to apply a mathematical model to define the best places for the bases of the Lages SAMU ambulances.

Region divisions of Lages city

According to IBGE, the city of Lages currently has about 158,620 inhabitants, an area of 2,631,504 km² and 70 neighborhoods. For the execution of this research, the city of Lages was divided in three regions, North, South and Central. The criterion used for the division of the city was the population, since the separation happened so that the regions were with a relatively proportional number of inhabitants. In addition to the regions, to be able to do the calculations using the scales standardization, they were also divided into microregions to fit the criteria used, always trying to aim proportionality in the number of inhabitants.

Analysis criteria

Following the Gravity Center method, some criteria has been established so it was possible to reach the notes of each region. These criteria were defined by the author of the research, and they are: population served by microregion, quantity of serious services analyzed by microregion, and distance approximation of each service for each possible base. For the choice of possible bases, it was taken into account the fact that it is a health establishment or properties belonging to the public power.

REGIONS

North

The northern region is composed of neighborhoods: Vista Alegre, Restinga Sêca, Nossa Senhora Aparecida, Guarujá, Conta Dinheiro, Gethal, Pisani, Jardim Panorâmico, Vila Mariza, Maria Luiza, Do Tributo, Jardim das Camélias, São Sebastião, São Francisco, Vila Maria, Dom Daniel, Sagrado Coração de Jesus, Da Chapada, Da Bates, Coral, Frei Rogério, Passo Fundo, São Paulo, Da Penha, São Miguel, Pinheiro Seco, Santa Maria and Ponte Grande.

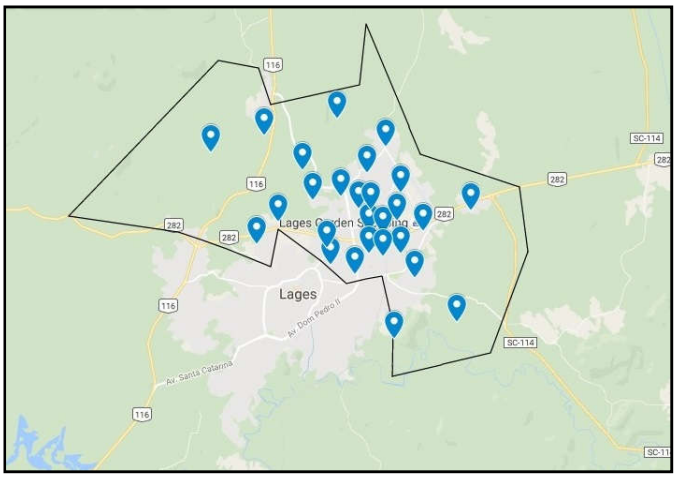

Fig. 1. Mapa região norte (*Google Maps*, 2016)

The possible chosen bases for the northern region are the Seara do Bem Children's Hospital, Health Unit of Coral and Health Unit of Guarujá neighborhoods. The northern region was divided into 3 microregions, which are the following:

Microregion 1

The microregion 1 is composed of Tributo, Guarujá, São Sebastião, Vila Mariza, Dom Daniel, Pisani, Jardim Celina, Restinga Seca, Vista Alegre, Nossa Senhora Aparecida and Da Chapada.

Microregion 2

The second microregion covers the neighborhoods Ponte Grande, Penha, São Miguel, Santa Maria, Da Bates, Jardim Panorâmico, Gethal, Pinheiro Seco.

Microregion 3

And the last northen microregion is composed by the neighborhoods Coral, Conta Dinheiro, Passo Fundo, São Paulo, São Francisco, Maria Luiza, Vila Maria, Frei Rogério, Sagrado Coração de Jesus, Jardim das Camélias.

South Region

This region is composed by the neighborhoods Petrópolis, Beatriz, São Pedro, Ipiranga, Boqueirão, Promorar, Bela Vista, Santa Helena, Santa Catarina, Santa Clara, Do Triângulo, Cidade Alta, Morro Grande, Caroba, Centenário, Araucária, São Luiz, Cruz de Malta, Santa Cândida, Santo Antônio, Santa Mônica and Bom Jesus.

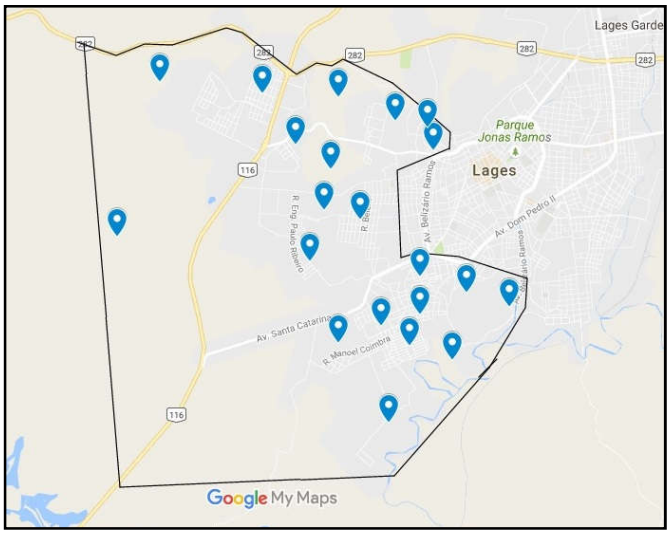

Fig. 2. Mapa região sul (*Google Maps*, 2016)

The posssible bases for the South are Education Secretary of Lages municipality, Health Unit of Centenary neighborhood and the Military Fire Department Base of Cidade Alta district. As it follows, this region was subdivided in:

Microregion 1

The first South microregion is composed by Petrópolis, Beatriz, São Pedro and Ipiranga.

Microregion 2

The neighborhoods covered by this microregion are Santa Helena, Araucária, Centenário, Cruz de Malta, Bom Jesus, Santo Antonio, Morro Grande, São Luiz and Triângulo.

Microregion 3

The third southern microregion was divided into Santa Mônica, Caroba, Bela Vista, Promorar, Santa Catarina and Santa Clara.

Central Region

This Region is composed for the neighborhoods Centro, Da Brusque, Santa Rita, São Cristóvão, Habitação, Universitário, Vila Nova, Vila Comboni, Popular, Caravágio, Guadalupe, Ferrovia, Caça e Tiro, Copacabana, Várzea and Morro do Posto.

The possible bases chosen for the central region are the next: Pronto Atendimento Tito Bianchini, 6º Batalhão de Polícia Militar, SAMU Lages Current Base and the under construction building of the new Regional Police Station. This region was subdivided in four sections that are:

Fig. 3. Mapa região central (*Google Maps*, 2016)

Microregion 1

Composed by the neighborhoods Brusque, Santa Rita, Guadalupe, Vila Comboni, Morro do Posto and Copacabana.

Microregion 2

Composed by the neighborhoods Caravagio, Ferrovia, Universitário and São Cristóvão.

Microregion 3

Composed by the neighborhoods Popular, Vila Nova, Habitação, Caça and Tiro and Várzea.

Microregion 4

The last central microregion is composed only for the neighborhood Centro.

RESULTS

North Region

For the approximate distance criterion of each service for each possible base, the possible notes for the bases were relatively similar, with little difference between them. The Coral Health Unit obtained the grade 7.26, being the worst of this criterion.

After this one, comes the Guarujá Health Unit with note 7.70, and lastly, the Seara do Bem Children's Hospital with the note 8.07, being the best in this criterion. In the criterion number of serious consultations analyzed by microregion the notes were more dispersed from each other, and again the Seara do Bem Children's Hospital obtained a maximum score, that is, 10.0, followed by the Guarujá Health Unit with 5.5 and the Coral Health Unit with a minimum grade of 1.0. Finally, in the criterion population served by microregion, again there were grades scattered from each other, but not as much as in the previous one. The Seara do Bem Children's Hospital received a maximum score being better than Guarujá Health Unit (score 7.53) and Coral Health Unit with 1.0. The final notes for the region's bases are in the following table:

Table 1. North Final Grades

Microregion	Grade
Guarujá Health Unit	20,73
Coral Health Unit	9,26
Seara do Bem Children's Hospital	28,07

Source: Authors

Considering the final grade result of the possible bases of the North Region, the most appropriate base for the region in question is the Seara do Bem Children's Hospital.

South Region

About the approximate distance of each service for each base, the grades had a relatively small difference between themselves, and the Centenário Health Unit holds the highest note with 7.24. Next, we have the Municipal Education Department with 6.86 and the Fire Department Military Base of the Cidade Alta district with 5.42. Analysing the number of serious consultations by microregion, two bases obtained relatively close notes, the Centenário Health Unit with a grade 10.0 and the Fire Department Military Base of the Cidade Alta district with 8.2. Finally, the Municipal Education Department with a grade of 1.0. With regard to the population criterion served by micro-region, two other bases similarly obtained similar scores, and the Centenário Health Unit had a maximum score of 10.0, and the Fire Department Military Base of the Cidade Alta district reached close to this value with 9.65. At last, the Municipal Education Department, like the previous criterion, had a minimum grade of 1.0.

Table 2. South Final Grades

Microregion	Grade
Municipal Education Department	8,86
Centenário Unit Health	27,24
Cidade Alta Fire Department Military Base	23,27

Source: Authors.

Considering the result of the final grades for the possible bases of the South Region, the most appropriate basis for the region in question is the Centenary Health Unit.

Central region

This region differs from others due to the fact that it possesses four possible bases, being in the criterion approximate distance of each service for each possible base, three of them had similar grades. The Pronto Atendimento Tito Bianchini had received the highest grade of the criterion, 7.09, followed by the current SAMU base of Lages with 6.02, the New Police Station Building, 6.42 and finally the 6º Batalhão de Policia Militar with 3.84. In the criterion number of serious consultations analyzed by microregion, there were grades with a notorious dispersion among them, once again the Pronto Atendimento Tito Bianchini having the best score among the possible bases, 10.0, then the current basis of the Lages SAMU with 3.76, the new police station building with 1.69 and finally the 6º Batalhão de Policia Militar with a grade of 1.0. In relation to the criterion population served by microregion, again scattered notes, however with a new base reaching maximum mark, which is the new Police Station Building with 10.0, after comes the Pronto Atendimento Tito Bianchini with 2.91, the Lages SAMU current base with 1.41 and the 6º Batalhao de Polícia Militar with 1.0.

Table 3. Central Region Final Grades

Microregion	Final Grade
Lages SAMU current base	11,19
6º Batalhão de Polícia Militar	5,84
New Police Station Building	18,11
Pronto Atendimento Tito Bianchini	20

Source: Authors

Following this result, it is concluded that the most appropriate central region base is the Pronto Atendimento Tito Bianchini.

DISCUSSION

The presented research has a great social importance, since it proposes a service improvement that is used by practically the entire population residing in the city of Lages, because health is a basic necessity of all human beings. During the study, some data were used of serious care performed by basic ambulances, that is, serious problems that can happen in the daily life of any person. The application of industrial localization concepts methods in the health area, was a great challenge in the course of the work since it was necessary to adapt the models that they could be applied, and with some adjustments, it was successful. Also, it can be concluded that in the northern region, the most indicated base according to the criteria presented is the Seara do Bem Children's Hospital, in the Southern Region, the most appropriate basis according to the criteria is the Centenary Health Unit and at Central region, the base that most stood out in the grades related to the criteria was Pronto Atendimento Tito Bianchini.

The analysis presented was only the first step that can be done, because it is known that the world is constantly changing and services need to be updated. Through this work, a range can be opened with innumerable options of other researches of this area to be carried out, since, as previously mentioned, the health area is constantly changing due to a series of factors that demand changes. In this way, the social approach to research can again be cited, since in the case of serious care any second is important, and the population in general needs the service to be functioning in a way that could serve them with excellence.

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