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Supply Chain In The Hematology Department

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Abstract

This article presents literature research on the logistics and supply chain of the metrological service, analyzing and representing the four main links in the supply chain: collection, process, inventory and distribution, for which an analysis of the study methods applied in each of them was performed. The main contribution of this research is to make known each process carried out in the supply chain, its problems and the results obtained from the different study methodologies found.

Keywords. Blood banks; Blood supply chains, Logistics, Blood.

1. Introduction

Blood is fundamental for the survival of human beings, since it transports vital substances to the cells of the body; it is also of vital importance for medical procedures; it is a resource that cannot be replaced by any other.[1] Its supply and demand are not regular and change according to emergency cases, sometimes it is scarce [2] and therefore requires a more delicate and specialized treatment than other products to avoid negative effects on blood.

Its supply and demand are not regular and change according to emergency cases, sometimes it is scarce [2] and for this reason it requires a more delicate and specialized treatment than other products to avoid negative effects on blood.[3] The logistics used for blood aims to manage and use it in a more efficient and effective way.[2] The operation of blood banks is based on the following principles:[3] The management of blood is a key factor in its use.

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The operation that occurs in blood banks consists of several processes which are established by standards to ensure the safety of the donor who provides the blood and the patient who will receive it later, for this filters established for donors such as: being older than 16 years, not being pregnant, being free of diseases; once this is fulfilled, the donation is made, the sampling tubes are marked and the proper storage of the obtained blood.[4] Once the blood has been collected, the blood is stored in the blood bank.

Once the blood has been collected it is generally divided into 3 components such as red blood cells, plasma and blood platelets, which have different components and therefore have different shelf life,[5] red blood cells as the most required component of blood can be used for anemia and blood loss in surgeries, etc. Platelets are responsible for stopping bleeding by clotting blood when vessels are damaged. The number of platelets in the blood is 270 000 per cubic microliter and platelet dysfunction increases the risk of bleeding. Plasma constitutes approximately 55% of the total blood volume of the body and plays a major role in emergency situations. [6]

Perishable supply chains consist of products with a fixed shelf life and limited production/collection; managing them requires competent decision making. And they are often complex and difficult to manage, especially when perishable products are involved. With a very high level of service.[7] The supply chain consists of supply chain hubs.

The supply chain consists of blood centers, blood facilities, and blood donors. Blood centers perform the functions related to blood transfusion, including blood registration, screening, processing, storage, and distribution. Blood facilities are responsible for collecting blood from donors and transporting it to blood centers. Blood can be donated only at facilities within a certain geographic distance. [8]

This supply chain has become a challenge due to the increased demand for blood, especially after disasters. Blood supply chains include various processes, such as collection, PROCESSING and inventory, as well as distribution of blood and blood derivatives from donors to recipients. [9]

The goal of the blood supply chain is to supply acceptably safe blood to hospitals. It is paramount that blood is accessible in hospitals for transfusion purposes as shortages can be life-threatening to patients. [10]

Forecasting has a major impact on the main decisions made in a blood supply chain. In fact, for example, the combination of blood forecasting and blood testing. Component forecasts have a strong impact on the inventory levels of blood components in a blood center, being determinant to avoid blood shortages or out-of-date blood supply.[11] The blood supply of emergency blood in natural disasters and natural disasters has a strong impact on the blood supply chain.

Emergency blood supply in natural and man-made disasters has proven to be a challenge.[12] Disasters often pose many problems, such as destruction, financial losses, loss of life, transportation and difficulties as well as manpower shortages, capacity limitations in emergency centers in affected areas.

After a disaster occurs, the essential need for water, food, shelter, medical equipment and other critical items requirements, as well as blood, as a scarce and vital commodity is more evident. Despite developments in the medical industry, so far no alternative for blood has been found. Supply chain management is looking for approaches to support suppliers, vendors and consumers so that services, production and distribution are always on time and in appropriate locations to meet customer demands.

In many countries, a great deal of money is spent on blood supply chains, even though blood is donated for free. The processes of blood collection and infectious disease testing comprise the bulk of these costs, while the processes of blood storage and distribution account for a small percentage of the cost.[6] The supply of donated blood is irregular.

The supply of donated blood is irregular and its demand in disaster situations is not precisely known. Efficient matching of supply and demand is not easily possible. In addition, blood is a degradable product, which in turn increases the complexity of the problem. Blood shortages have an irrecoverable cost to society because they result in increased mortality rates. In addition, blood wastage is also unrecoverable because donation is only possible by individuals and there must be a certain period between two blood donations from each person.

Therefore, maintaining a sufficient amount of blood and administering it to meet the demands is an important and vital issue. Due to the limited expiration date of blood and blood products and the need to keep them in a specific temperature range, there are restrictions on holding and transporting blood and blood products. Blood must be stored in a cool place such as a refrigerator. Therefore, we need some refrigerators to transport them. Logistics has a critical role in supporting the supply chain and disaster management, where any negligence in the performance of this function will affect the whole process.[13] The blood supply chain must be in a safe and secure environment.

The blood supply chain must be efficient and sustainable to ensure blood needs. The perishable nature of blood products increases the complexity of the supply chain making it difficult to determine optimal quantities of blood. Limited donations have negative impacts, forcing blood bank management to be effective for two main reasons. First, blood cannot be manufactured or substituted for other products, and is only supplied by eligible individuals.[14] Second, blood is not available in the blood bank.

This article aims to conduct a literature review that addresses the issue of logistics that occurs in the blood supply chain, analyzing the results to different studies that address the issues of scarcity, waste, cost reduction and optimization, there will be 4 links such as blood collection, blood processing, inventory and finally distribution.

2. Background

Therefore, maintaining a sufficient amount of blood and administering it to meet the demands is an important and vital issue. Due to the limited expiration date of blood and blood products and the need to keep them in a specific temperature range, there are restrictions on holding and transporting blood and blood products. Blood must be stored in a cool place such as a refrigerator. Therefore, we need some refrigerators to transport them. Logistics has a critical role in supporting the supply chain and disaster management, where any negligence in the performance of this function will affect the whole process.[13] The blood supply chain must be in a safe and secure environment.

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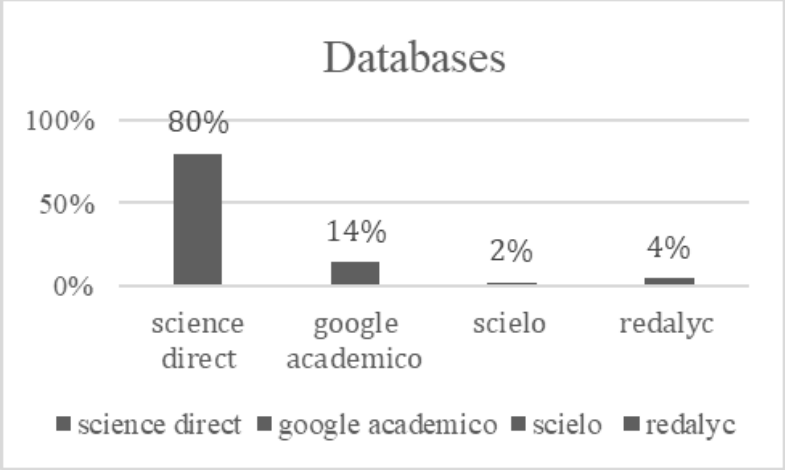
3. Method

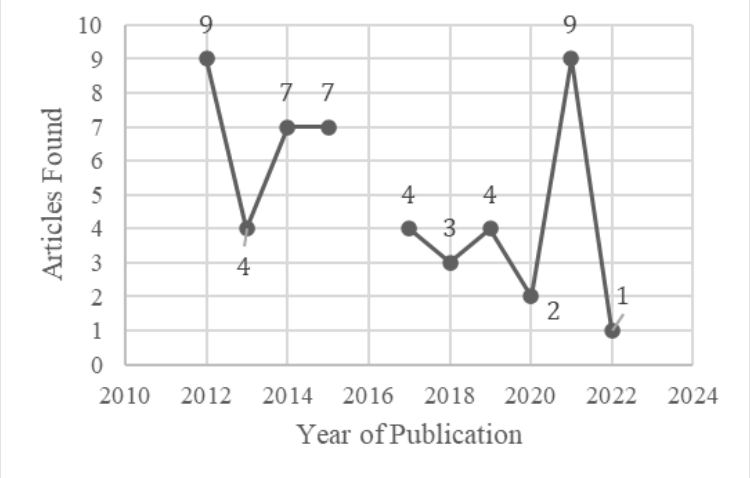
The research methodology for the development of this research article was initially the choice of the topic to be addressed "logistics and blood supply chains and treatment", for this an arduous search of articles was conducted based on the exact points we intended to address such as the links that make up the blood supply chain for this were used different databases such as: scielo, redalyc, sciencedirect, google academic; the keywords used are: "blood banks", "supply chains", "logistics" "blood distribution" "blood treatment" "blood logistics",we also made use of Boolean search engines that facilitated the search as "blood" supply chain, logistics AND blood supply chain ; We also used the due revision of each article in publindex to corroborate that they were approved or indexed; we had a historical restriction of 10 years, that is, articles from 2012 to date; where we obtained as a result 50 articles related to the topics of supply chains, blood, blood banks, logistics; most of them in English.

Figure 1. Number of articles consulted in the research.



Source: Own elaboration

Figure 2. Year of publication of the articles investigated.



Source: Own elaboration

4. Results

The blood supply chain involves a very important process in which a product is obtained that is of vital importance for the human being. Therefore, it must be carried out with the utmost caution, taking into account all aspects that are important in the care and quality of the product. Two types of blood banks were found: fixed and mobile. In the mobile blood banks, processes such as collection and production are carried out in order to later be taken to the fixed blood banks located in hospitals and clinics.

More than 100 million units of blood are collected each year worldwide, in blood banks, blood products, such as red blood cells (RBCs), are usually stored for days or weeks, but RBC units degrade and are ground during storage at variable and unpredictable rates.[15] The conditions and peculiarities of the blood chain are not always clear.The conditions and particularities of the perishable supply chain make it necessary to posit new variables, parameters, constraints and objective functions.[16]

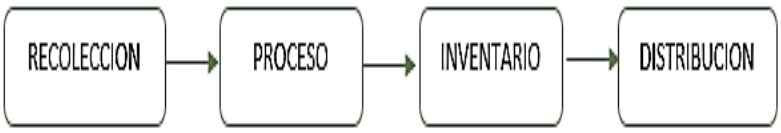
In the case of technology selection in blood product collection processes, the collection costs associated with the technology used and the number of donors required to meet the demand are in conflict. Similarly, in the blood supply chain, these types of decisions become more complex when considering the characteristics of the system itself, such as proportionality of blood types and compatibility between products.[17] Within blood banks, blood banks make decisions about the quality of the blood supply chain.

Within blood banks there are many activities that are part of the process before delivering the finished product for which a set of regulations imposed by both national and international organizations must be met in order to optimize all processes such as the former American Association of Blood Banks (AABB), the World Health Organization (WHO) and other standards.

In some countries, blood banks adhere more strongly to voluntary regulations, depending on their own policies, resource constraints, and needs.[4] In other countries, blood banks adhere more strongly to voluntary regulations.

The links in the supply chain are shown below, based on different studies that have been carried out for each of the processes.

Figure 3. Blood supply chain



Source: Own elaboration

Collection. This is the first link in the blood supply chain, and its purpose is to obtain the amount of blood and blood products needed to meet the demand.[18] The collection process is carried out through voluntary blood donation at fixed or mobile blood banks.

The collection process is carried out through voluntary blood donation that takes place in fixed or mobile blood banks, there are different types of decisions to be made among those in which bag the blood will be packed since each one has its own characteristics, not all donations can undergo the same processes, so an analysis is applied before being sent to the next link in the chain, which in this case is the process.

The following table1 shows the articles that have been written about blood collection or donation, where the methodology used in each study is explained in order to meet the objective.

Table 1. Methodology of the collection studies.

METODOLOGIA	HERRAMIENTAS	OBJETIVO	REFERENCIA	%	TOTAL
Programación Matemática	Minería de datos	Descubrir patrón de llegada y fuerza laboral	[19]	20	60%
	Red de colas				
	Lineal entera mixta	Aumentar utilidad, ubicación de puntos de donación	[20]	20	
		Planificación de recolección de sangre móvil	[23]	20	
Medición Longitudinal	Encuesta	Causas de falta de donantes	[21]	25	20%
Simulación	Redes de Petri	Asignación de recursos	[22]	25	20%

Source: Own elaboration

In the blood collection process, three studies were found where mathematical programming was the methodology chosen for its realization; With the objective of discovering the arrival pattern of donors in order to know what was the necessary workforce at each stage and donation, this study is performed using a cluster analysis of data to find the days and hours with more comparable arrivals, thus demonstrating that with an arrival pattern identified with data mining methods and workforce size determined with queueing network model can help to better plan the workforce and thus obtain better quality and optimize resources in a blood center. [19]

In order to increase the utility and motivate to donate blood a study using mixed integer linear programming method is done to define the location points of donation points, in addition to this an allocation of donors to the nearest facilities was done so that they had to travel short distances reducing the number of facilities, transportation costs and thus obtaining a better utility. [20]

Thinking the maintenance of the process donors a linear measurement study is made with the participants who had donated for the first time and what had been the aspects in which it did not let the donors remain permanent, through this study it could be concluded that the main failures were poor planning, and the vaso vagal effects after the donation. [21]

By Petri net simulation model the performance of collection systems for all types of blood components was evaluated taking into account key quantitative components of the system, donor arrival processes, absences, dropouts, deferrals, resource capacities and performance indicators resulting in a useful indication for resource allocation during different periods of the day for both fixed and mobile sites [22].

A two-step mobile blood collection planning framework is proposed which are annual and weekly planning, using mixed integer programming models for annual planning of fixed or variable mobile collection, the donation forecasting model is based on population demographics, donor generosity and donor availability obtaining as a result that annual planning with variable collection frequencies brings significant improvement, its use may be more hazardous if the annual demand and the necessary donation forecasting parameters are not well known.[23]
Process.Processing is the next step after collection. Production is the stage in which a unit of blood is received at the blood center, tested and possibly fractionated. This stage is concerned with replenishing blood product inventories during normal and emergency periods. [18]

Before moving on to the storage and inventory stage, in this process the blood that is received is analyzed in detail, in order to subsequently make a decision in order to make the most of the product that is received, it is fractionated to separate the different components that the blood brings and thus have the maximum utilization for subsequent storage.

A blood network was designed to address costs such as blood decomposition in order to maximize the social impact of blood decomposition by designing an efficient network using stochastic programming with multiobjective metaheuristic algorithms in various conditions for validation results in an efficient, objective and sustainable blood chain to provide optimal costs and greenhouse gas emissions that increases the social impact of blood decomposition. [24]

With the aim of minimizing the total cost, shortage and waste levels in hospitals an integer programming model was performed that take into account the age the blood units, uncertain demand rates and provides cross testing by transfusion, as a result a considerable decrease in waste, shortage and total cost is obtained. [25]

One of the products derived from blood are platelets, a study was conducted with the objective of improving costs were developed integer programming models with biobjective approach in which the first objective was to maximize the freshness of platelets and the second was to minimize the total cost, to evaluate the robustness of this model different numerical tests were performed obtaining as a result a robust budget optimization exceeding the value of the expected cost.[26] the following table 2 shows the articles that have been made on the process where the methodology used in each study to meet the objective is explained.

Table 2. Methodology of the process studies.

METODOLOGIA	HERRAMIENTAS	OBJETIVO	REFERENCIA	%	TOTAL
Metaheuristica	Algoritmo	Minimizar costos y maximizar el impacto social	[24]	25	25%
Programación Matemática	Estocástica			25	75%
	Entera	Minimizar costo, escasez y desperdicio	[25]	25	
		Maximizar frescura de plaquetas y minimizar costos	[26]	25	

Source: Own elaboration

Storage.The storage (inventory) of blood supply chains is performed in fixed blood banks, this process is performed after the blood has received its respective fraction that is performed in production.

Researchers began to develop new methodologies to study the inventory policies of blood products. Perishability. The perishable nature of blood products, along with special characteristics such as matching and mismatching, greatly increase the complexity of this problem. The perishable nature of blood products, together with special features such as matching and mismatching, adds considerably to the complexity of this problem, and has stimulated many theoretical developments in this area that have had of application beyond the blood supply chain. [18]

Table 3 shows the different blood supply chain storage studies that have been performed classified by their methodology.

Table 3. Methodology of Storage Studies

METODOLOGIA	HERRAMIENTAS	OBJETIVO	REFERENCIA	%	TOTAL
Simulación	Eventos discretos	Modelo para representar inventario y comportamiento de proveedores y consumidores	[27]	12,5	20%
		Obtener estimaciones de la disponibilidad diaria	[31]	12,5	
		Analizar y proponer políticas de inventario	[33]	12,5	
	Estocástica	Reducir escasez de plaquetas	[29]	12,5	20%
Metaheuristica	Algoritmos	Optimizar el sistema de inventarios	[28]	12,5	20%
Programación Matemática	Algoritmos	Gestión adecuada del inventario	[30]	12,5	20%
Logística	IOT	Eficiente gestión de base de datos	[32]	12,5	20%

Source: Own elaboration

Through the simulation of discrete data, a model was developed to represent the inventory and ordering behavior of a supplier and consumers in ten regional networks consisting of databases that monitor the movements made both inbound and outbound, obtaining a model that was implemented in two pilot sites

that was tested, verified and validated giving accurate results, subsequently implemented in the eight missing regions and is currently used by the blood services of Canada. [27]

It was proposed to optimize the inventory system of the highly perishable supply chain taking into account the age of the existing items, it is composed of two metaheuristic algorithms such as evolution difference and harmonic search obtaining as a result a centralized control of the supply chain to a large extent reducing the outdatedness of the system remarkably. [28]

Seeking to reduce platelet shortage by inventory incorporating real life scenarios such as uncertainty of demand and limited supply in the blood center a mathematical model simulation model is developed modified stochastic genetic algorithm is developed overcoming the limitations of the current one such as long convergence time and a high probability of obtaining a local optima [29].

To search for a proper inventory management seeking to minimize shortage and waste costs along a blood supply chain a whale optimization algorithm is created considering the costs of ordering from blood centers, lateral transshipment, transportation, inventory holding, shortage and waste demonstrating that lateral transshipment between different demand nodes has a large impact on the balancing leading to simultaneously reduce shortage and waste costs [30].

A stock and flow study developed a simulation model of the U.S. blood supply to obtain estimates of the daily availability of blood available on a daily basis with uncertainty and its ABO/Rh type, the model simulated the impact of the potential for different first-in, first-out blood management practices showing higher steady state estimates of the level of blood supply than the unused scenarios.[31] In order to have a detailed approach to the issue of blood supply, the model was developed to simulate the impact of the potential for first-in, first-out blood management practices showing higher steady state estimates of the level of blood supplies than the unused scenarios.

In order to have a detailed approach for an efficient blood bank database management system an application was developed that reminds donors when they become eligible again, the location of nearest blood centers, IOT is used to interface the application with the server as well as inter-application communication. [32]

To analyze and propose inventory policies in a regional blood center, a simulation model was created that replicates the activities that occur throughout the supply chain, including donor arrivals, testing, production, inventory management, and dispatch by analyzing twelve scenarios each with distinct policies composed of a combination of an optimal inventory, ordering point, and donation level. The best scenario demonstrates that unmet demand and waste can be decreased relative to current practices. [33]

Interviews with blood inventory managers at the best-performing hospitals revealed 6 key themes that together drive good performance in blood stock inventory management. These themes are human resources and training, stock levels and ordering patterns, inventory transparency, simple inventory procedures, focus on freshness, and internal collaboration within the hospital. All of these issues highlight the importance of having high quality, trained, and experienced staff.[34] The following are some of the key issues to consider.

Distribution.The distribution process is the last link in the blood supply chain, distribution processes are processes that can vary because there are blood centers that are within hospitals and clinics therefore

they distribute blood to themselves depending on the demand they have, instead when they are regional blood banks must transport the blood from a center where excess demand to a center that has a shortage. Hospitals usually order blood from their local blood center on a daily basis, based on historical data, forecasts and clinical expertise. [18]

In order to identify how many blood vehicles to operate and minimize the distance traveled an integer programming is used, the model is extended to incorporate in blood potentials and durations of blood mobiles. The optimal routes are determined using CPLEX solver and branch and price algorithm having As a result, the proposed algorithm solves the shape problem up to 30 location in 3600 s. [35].

A mobile blood collection system was designed with the aim of increasing the levels of blood collection was proposed a new vehicle called shuttle that was responsible for the collection of blood in the mobile points and stores it in the deposits in order that the mobile points make the full journey without the need to make daily returns to the deposit is made a set of Pareto optimal solutions depending on the quantities of blood, logistics costs and finally a sensitivity analysis is performed on some important design parameters obtaining as a result that the proposal is very viable for future implementation. [36]

Table 4 shows the different blood supply chain distribution studies that have been carried out classified by their methodology.

Table 4. Methodology of storage studies.

METODOLOGIA	HERRAMIENTAS	OBJETIVO	REFERENCIA	%	TOTAL
Programación Matemática	Números enteros	Identificar la cantidad de vehículos y minimizar la distancia	[35]	50	50%
Soluciones optimas	Pareto	Aumentar los niveles de recolección de sangre	[36]	50	50%

Source: Own elaboration

5. Discussion

The design of a blood supply chain network plays a prominent role in location and allocation of blood facilities, as well as the allocation of related supply chain flows. Due to the nature of blood products, shelf life is an important issue in this field.[40] In order to assess whether a blood allocation policy is in place, it is important to determine whether the blood supply chain is in place.

In order to evaluate whether there is a red blood cell allocation policy that can increase health benefits without forcing the blood supply, a policy of transfusing blood that has less than 42 days in inventory was proposed, to evaluate that policy a simulation model was performed focusing on the balance between the average age of transfused blood and the fraction of transfused blood that is imported, having as a result of this policy is that the age of blood transfusions can be reduced in order to reduce morbidity and mortality.[37]

An investigation was conducted on the dynamic problem of blood supply chain decision making by applying an inventory policy (FIFO and LIFO) obtaining as a first result the out-of-date and shortage, a

blood withdrawal decision making method based on EWA (estimated withdrawal and aging) strategy is proposed, also an optimal model was established to achieve the shortest transshipment time and maximum freshness of transported blood, furthermore an allocation planning model was established with multiple priority requirements and looking for the minimum shortage having as a result that safety stock, target stock and demand fluctuation range have a significant impact on the blood inventory control effect. [38]

In order to reduce shortage, obsolescence and minimize cost a research was conducted where a combined linear programming and approximate dynamic programming (ADP) model was implemented which obtained that the ADP approach was practical and the model showed great promise with the improvement of reward system, decreases shortage and the amount of expired platelets.[39]

Studies were conducted that integrate the entire blood supply chain rather than a detailed process of each link in the chain in order to find optimal solutions or evaluate the activities involved.

It seeks to develop a new approach to simulation especially taking into account the possibilities of situation with blood types and age of blood, simulation was chosen because the data: stochastic demand, multiple products, possibility of compatible substitution, processes and outcomes are controlled over time as discrete events having as a result accelerates the circulation of all blood types, maximizes their utilization and reduces out-of-date rates. [41]

Identify critical variables for their reduction or elimination to ensure the quality, safety of blood and its hemocomponents, a modal analysis of failures and effects is performed which allowed finding the critical quality characteristics of the processes that are developed in blood banks reaching the conclusion that the main failures that occur in the violation of established processes of operation and preparation of personnel. [42]

To design a closed loop blood supply chain network taking into account the transport flow and quality aspects for this they use a difference evolution algorithm driven by the extension of two new versions to solve the problem, they perform a sensitivity analysis on the model parameters to inform some managerial ideas resulting in solving a variety of randomly generated numerical problems from three categories of examples validated the new proposed algorithms and showed that they have a better performance than the classical algorithm of when they all solve the blood supply chain problems considered.[43]

To improve the efficiency of blood supply chain simulation and Taguchi method is performed for which four factors were chosen such as minimum donor arrival rate, maximum inventory level, inventory level and delivery policy and demand obtaining accurate data which gives efficiency improvement which is what was sought. [44][45]

To evaluate the systematic impact of a shorter shelf life for red blood cells in the blood supply chain a simulation method was performed, also a network model of the production and distribution system was built and validated resulting in a minimal impact on the inventory shortage in large blood banks (hospitals) but blood banks have a much higher shortage rate so it would not be feasible to reduce the shelf life.[46] A novel approach was proposed for the evaluation of the impact of a shorter shelf life for red blood cells in the blood supply chain, which was also validated by a network model of the production and distribution system resulting in a minimal impact on the inventory shortage in large blood banks

(hospitals) but blood banks have a much higher shortage rate so it would not be feasible to make a shelf life reduction.

A novel approach was proposed to address the solution of large stochastic operational optimization problems (SOP) by using machine learning models were selected the four most used machine learning models in a blood supply chain, the four models tested successfully learned a limited number of solutions of a stochastic programming approach and be able to perform independently.[47] In order to improve the quality of the customer service system in a blood donation center, the tests were performed with internal consistency tests with Alpha of the service quality model (servqual), the tests were performed with internal consistency tests with Alpha of the service quality model (servqual).

Looking for quality improvement in the customer service system in a blood donation center was evaluated if the service quality model (servqual) is implemented, the tests were performed with internal consistency tests with Cronbach's Alpha and discrimination index which evaluated the content validity of the two questionnaires by exploratory factor analysis giving a result that is very useful to assess the perceived quality of care as long as it is approached in a unidimensional way.[48] In the case of a disaster, studies are conducted to assess the perceived quality of the service as long as it is approached in a unidimensional way.[49] In the case of a disaster, studies are conducted to assess the perceived quality of care in the blood supply chain.

In the event of a disaster, studies are carried out that require optimal decision making, whether for location, allocation or relief, in which two models are developed to help make decisions in cases that are not foreseen[49][50].

In the decision making process of the blood supply chain there is an application and a game that were developed to help people to have an optimal planning and to use the resources in an optimal way.[3][7][7

6. Conclusions

With respect to the donation, the main characteristic of the study methods is to carry out proper planning to be able to meet the demand that arises in the different situations along the chain.

The process, which is the second link in the chain, presented the most important characteristics of scarcity and increased costs, which were the objectives on which the studies were based: cost reduction and being able to meet the needs of the demand for blood.

In the storage link, the objective to be addressed was the optimization of the inventory and reduction of the out-of-date rate in order to have a greater clarity of the amount of blood available for its subsequent distribution.

In distribution, the most important issue is the fulfillment of the transport time since, being a perishable product, there is a risk of possible damage, which would generate an increase in costs and, most seriously, the non-fulfillment of the demand, with which the life of the patients who need transfusions is at stake.

The literature that addresses the issues of blood, supply chains and their logistical treatment is quite scarce, very few articles have addressed the issue with the due importance that this requires, in Colombia only 2 articles talk about these issues unlike other countries like Canada and the United States that have more literature on the subject, on the other hand, the restriction of the age of the information was also an important limitation in our research because before 2012 we found a large number of articles that addressed these issues, however we could not make use of these because of their year of publication.

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Appendix A. An example appendix

Authors including an appendix section should do so after References section. Multiple appendices should all have headings in the style used above. They will automatically be ordered A, B, C etc.

A.1. Example of a sub-heading within an appendix

There is also the option to include a subheading within the Appendix if you wish.

Makalenin Türkçe başlığı buraya yazılır….

Özet

Türkçe özet.

Anahtar sözcükler: anahtar sözcükler1; anahtar sözcükler2; anahtar sözcükler3

AUTHOR BIODATA

Insert here author biodata**.**