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A proposal to improve the delivery process at the last mile. Case. Drugs under cold chains

Una propuesta para mejorar el proceso de entrega en la última milla. Caso. Medicamentos bajo cadenas de frío

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Abstract

Last-mile merchandise deliveries often experience delays, that can damage products. For this reason, this research proceeded to analyze the routes of drugs delivery, which must remain in a cold chain, in a courier company. It was analyzed the delivery process, using a discrete event simulation model in Arena software. This study aims to propose improvements in the delivery process in the last mile. It begins with the search for relevant information in the internet databases, in which the improvement of deliveries in the logistics distribution process was considered. It executes with a quantitative methodological approach, which is structured in four stages: 1. Observation. 2. Collection of information. 3. Analysis and construction of the simulated model. 4. Proposal for improvement. When developing the model, a delay in delivery could be identified, as all couriers follow a single route. Therefore, it was proposed to leave a courier at each of the delivery locations. To comply with several deliveries and reduce waiting times between them, which will generate efficiencies throughout the distribution of the logistics route, to avoid non-compliance with logistics partners and not generate complaints, as well as avoid the dissatisfaction of the customer with the services offered.

Keywords. Cold Chain, Drug Delivery, Logistics Operation, Last-Mile Delivery

Resumen

Las entregas de mercancías de última milla en muchas ocasiones experimentan retrasos que pueden dañar los productos. Por tal motivo, esta investigación procedió a analizar las rutas de entrega de medicamentos, que deben permanecer en cadena de frío, en

una empresa de mensajería. Se analizó el proceso de entrega, utilizando la simulación mediante el software Arena. En este estudio se propone mejorar la entrega de mercancías en la última milla. Se inicia con una búsqueda en internet sobre mejora en las entregas en el proceso de distribución logístico. Elaborado con un enfoque metodológico cuantitativo, que se estructura en cuatro etapas: 1. Observación. 2. Recopilación de información. 3. Análisis y construcción del modelo simulado. 4. Propuesta de mejora. Al desarrollar el modelo, se pudo identificar un retraso en la entrega, ya que todos los mensajeros siguen una sola ruta. Por lo tanto, se propuso dejar un mensajero en cada entrega, para cumplir con varias entregas y reducir los tiempos de espera entre ellas, lo que generará eficiencias en toda la distribución de la ruta logística, con el fin de evitar incumplimientos con los socios logísticos y no generar reclamos, así como evitar la insatisfacción de los clientes con los servicios ofrecidos.

Palabras clave. Cadena de frío, Entrega de medicamentos, Entrega de última milla, Operación logística

1. Introduction

Currently, transport logistics is an economic indicator with great influence worldwide, so a company that efficiently manages transport, will have a competitive advantage over other companies since it will be able to guarantee the times and deadlines that are established for the delivery of goods. It is essential that companies organize efficiently the transport and distribution of goods, according to the excessive growth of the population, especially of urban regions, makes it necessary for companies to organize in the coordination of the different logistics agents.

An efficient operation in the logistics system is one that allows delivery, distribution, and marketing of the merchandise to reach the final route in good condition and in the shortest possible time. [1, 2, 3, 4] [5, 6] [7, 8, 9]. This study was made in a transport logistics company, with a trajectory of 17 years that, to this day, has 6 offices in 27 cities in the country of Colombia. The main activity of the company is to seek to offer the transport of land and air cargo throughout the national territory through its own fleet of vehicles and allies. The company has managed to position itself as a reliable company through the security and constant monitoring of the shipments of its partners.

At the headquarters in Barranquilla, after carrying out an observation and analysis, it was possible to show a flaw within the logistics system with respect to the non-compliance of the times in the delivery of merchandise, which was having an impact on the commitment to the company's partners and customers, causing delays in the logistics operation. Due to the above, it is proposed to carry out this study with the objective of seeking to improve the efficiency of merchandise deliveries in the last mile through a process simulation model with the Arena software® in the company transporting merchandise of medicines with cold chains. For this, a bibliographic review is carried out on some authors who have carried out studies related to this problem and in their reports, it can find some conclusions such as those mentioned below.

2. State of the art

There are different investigations related to the improvement of efficiency in the delivery of goods, such as, for example, in some of the research, through the planning of logistics it was sought to improve the reception and delivery of merchandise through the reduction of time of the operation and home deliveries. Implementing the new planning will there be a better functioning of the different processes of the logistics operation among which is the delivery of goods. On the other hand, they propose a delivery management system model considered an important tool in the productivity and economy of the sector. Also, some seek to efficiently improve deliveries. In other

investigations that we can consider are, in which a structuring was carried out in different merchandise delivery companies nationwide, and its purpose was to improve the logistics operation from dispatch to delivery to the client. The same way in other research, which aimed to formulate a proposal that would improve the process of receipt and delivery of merchandise in a delivery and logistics company in order to provide a quality and safe service, among the conclusions of this study it is evident that in the delivery of certain goods were presenting failures of 40% so it was necessary to expedite deliveries by means of knowledge of customer data in order to streamline the operation.

Likewise, in other research, it was sought to improve the effectiveness of delivery of packages to meet customers, in its work there is evidence of a reduction in times in relation to distribution in a positive way. Likewise, in other, a proposal was elaborated through the PDCA Cycle and the reengineering of processes with the aim of reducing delivery times in the company, for this a diagnosis of each of the logistics processes was made. and a proposal with 3 axes is presented: The PDCA Cycle; The Continuous Improvement of Processes and Total Quality in Service. In the proposal, the analysis of the times was carried out to streamline and improve the process of delivery of merchandise of the company, since within the logistics process a delay in the previous phases in the separation of orders was evidenced, to solve this problem, a business model of the company was made.

The observation and elaboration of a flowchart of the times, quantities, and indicators and with these results to be able to propose an improvement strategy, among the results it is evident that there was a reduction in the delivery time and the days of enlistment. In addition, in other research, it was sought to carry out an organization of the logistics activities with the purpose of optimizing the resources of the company to maintain customers and reduce the delay in delivery of goods, for this a proposal is developed in the inventory phase that benefits and gives excellence in the delivery of the product, the method used was qualitative and quantitative through synthesis and statistical analysis. Among the results, it is expected to improve the speed of product delivery and increase the satisfaction all customers. To other side, in the study of a proposal for improvement in the distribution and transport process is made for the optimization of merchandise delivery of a cement company.

In other research the methodology implemented was the qualitative and quantitative research with the job study, which allowed to structure a proposal that when implemented will generate a positive impact on the coordination and delivery of goods, and satisfaction in the client. A proposal to improve the processes of ordering, dispatch, and delivery in an investment company showed that the decrease in times of the cycle of the processes allows a complete completion of the logistics process, therefore, an improvement in deliveries can generate effectiveness and happiness customers, for this project the methodology implemented was that of process survey, diagram of flows, routes, and Ishikawa, in addition to the taking of times. Another article related to the analysis of logistics operations is the one proposed by, there is evidence of a problem associated with the loading and unloading process which was generating a problem in the delivery of goods for which integration of initiatives is proposed to improve the problem of goods, the results show that there was a deficiency in the infrastructure and logistics processes which generated inefficiency with the delivery of wares. Another research that proposes an improvement in delivery, whose objective

was to identify the causes of the negative perception regarding the delay of unjustified deliveries in a logistics company, for which a model was proposed to improve and optimize the logistics process in terms of deliveries, the solution to problem consisted of implementing a PDVA cycle and second, implementing a technological team to strengthen customer loyalty. [10, 11, 12] [13, 14, 15] [16, 17, 18] [19] [20] [21] [22] [23] [24, 25] [26] [27] [28, 29, 30].

3. Methodology

Development of the project, the quantitative approach of the research was considered, which consists of the collection of data and the numerical measurement of these, to test theories. The project was structured the following methodology, of four stages:

Stage 1: Observation. A method of data collection that allows the systematic, valid, and reliable recording of the different situations; in the case of our research, the observation of the merchandise delivery process was carried out. Through this stage we searched: [31] 1. -Identify failures in the process in the matter of operation time-2. -Compliance with our logistics partners in the last mile

Stage 2: Data collection. The second stage was data collection, which is derived from what was observed in the first stage. According to, the data are obtained through observation, measurement, and documentation; these data are sought in relation to the established categories and subcategories of the research. During this stage, the Arenas software was used to initially simulate the process that was being developed in the company with merchandise distribution. After collecting this initial data, the problem is identified and adjustments and improvements in the simulation are continued to collect the data again. [31]

Stage 3: Data analysis. During this stage of the project, the data collected at the beginning for the first simulation and at the end with the simulation where the improvements for the merchandise distribution process were already proposed. It is important to remember that the analysis step of

Stage 4: Correction and improvements. At this stage, the driver was trained to perform the functions of a courier and was provided with a new instruction on how to carry out the distribution of merchandise in the city. After this, the messengers are sent to replicate the simulation model of Arena®.

4. Development

Data collection. Once the routes have been developed, the data obtained will be exported to the Input Analyzer tool, to perform a goodness-of-fit test and find out the distributions that best fit what was observed. Table 1 shows the use time

Table 1. Current Process Data

Arrival at Base	Download Merchandise	Information is uploaded to the system	Auxiliaries assign distributions	Courier make deliveries	Drugs Delivery					Courier performs online download
					General Clinic of Norte	Caribbean Clinic	Porto Azul Clinic	Murillo Clinic	Clinic Center	
units/hour	minutes	Seconds	minutes	minutes	minutes	minutes	minutes	minutes	minutes	minutes
1	1	2	3	89	45	31	34	55	77	4
1	2	3	3	59	68	92	75	55	32	6
1	1	3	5	76	94	57	91	81	65	6
1	1	2	5	87	71	44	46	31	81	3
6	1	3	4	84	43	85	72	30	92	3
5	2	3	4	54	93	92	67	82	91	6
8	1	3	3	83	77	49	50	66	69	4
4	1	3	5	87	89	48	67	41	36	3
3	1	2	3	86	41	45	76	81	78	4
1	1	3	5	65	88	63	41	79	95	7
2	2	2	3	46	73	83	74	57	62	7
4	1	3	4	63	42	43	84	84	84	4
1	2	2	4	88	55	76	93	78	74	7
4	2	3	4	60	66	91	71	68	81	7
10	1	2	3	51	91	79	32	93	55	5
2	1	3	3	45	40	95	53	92	87	3
4	2	2	4	73	85	92	58	66	36	7
1	2	2	3	39	86	31	70	66	52	7

Table 2. Improved Process Data

Arrival at Base	Download Merchandise	Information is uploaded to the system	Auxiliaries assign distributions	Courier make deliveries	Drugs Delivery				Courier performs online download
					General Clinic of North	Caribbean Clinic	Porto Azul Clinic	Murillo Clinic	Clinic Center	
units/hour	minutes	Seconds	minutes	minutes	minutes	minutes	minutes	minutes	minutes	minutes
1	1	2	3	28	19	24	24	13	20	4
1	2	3	3	26	23	16	20	19	15	6
1	1	3	5	29	26	14	18	12	28	6
1	1	2	5	28	15	20	17	28	15	3
6	1	3	4	29	20	15	17	15	25	3
5	2	3	4	36	14	13	15	23	17	6
8	1	3	3	27	21	16	20	18	16	4
4	1	3	5	30	24	13	26	21	17	3

After, it proceeds to generate the simulation in the Software Arena®, to identify the problem in a timely manner, obtain data and from it generate improvements to our process for the satisfaction of our logistics partners. We parameterized our simulation with 5 replicas of 6 days and 12 hours of work per day. As support, an image of the simulation of the company's current process is in figure number one, and number two.

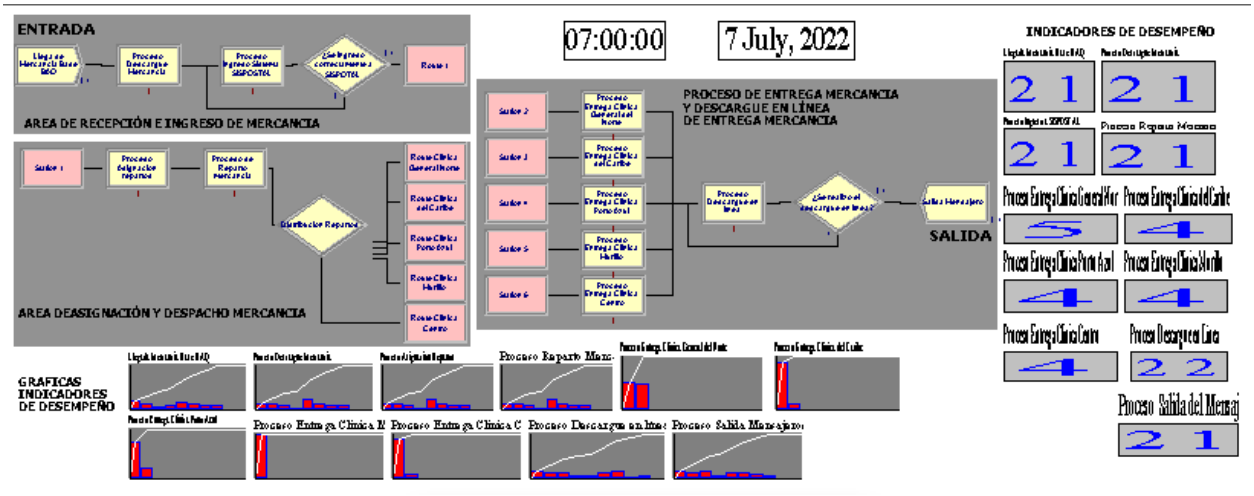

Figure. 1. Modeling actual

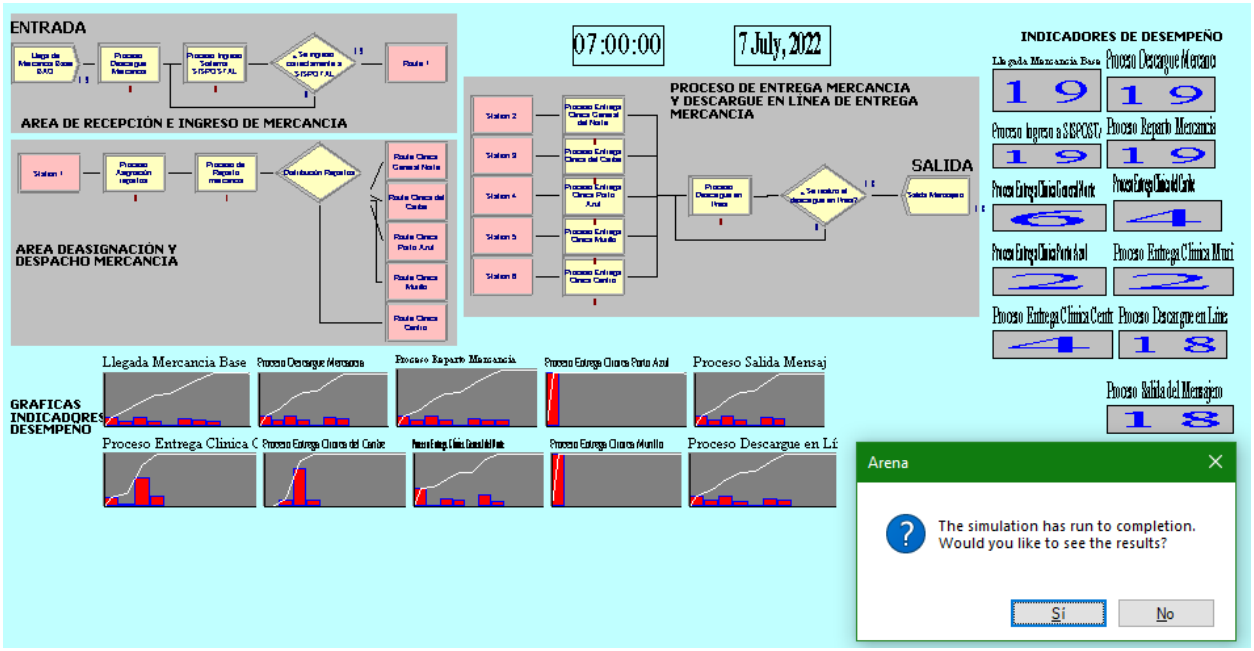

Figure. 2. Modeling with enhancement.

When running our simulation and generating the Report, we see that on average 22 entities left our system indicating that the couriers managed to deliver 22 goods of the 24 on average that entered, giving us a WIP of 3.06 that were the entities that could not complete the process and were in execution. Of which we can highlight that the merchandise had on average a waiting time of 8.5 hours, this being a worrying value when it comes to having goods that have a considerable average wait to be delivered to their recipients. Analyzing this data of waiting time in the delivery of merchandise, we see that the process of distribution of merchandise (Which is when the courier leaves the base and makes the journey to reach the destination) and the delivery times in each Clinic are considerable as evidenced in the following image. With which he affirms that our

problem is in the processes of distribution and delivery of the merchandise, if we observe the percentage of occupation of each of the resources observed in the Scheduled Utilization figure 3.

Table 3. Waiting Time

Waiting Time	Average
Proceso Asignación repartos.Queue	0.00
Proceso de Reparto mercancia.Queue	1.8170
Proceso Descargue en línea.Queue	2.2367
Proceso Descargue Mercancia.Queue	0.00
Proceso Entrega Clinica Centro.Queue	1.8723
Proceso Entrega Clinica del Caribe.Queue	3.1512
Proceso Entrega Clinica General del Norte.Queue	2.0364
Proceso Entrega Clinica Murillo.Queue	2.1910
Proceso Entrega Clinica Porto Azul.Queue	2.0229
Proceso Ingreso Sistema SISPOSTAL.Queue	0.00

Table 4 Scheduled Utilization

Scheduled Utilization	Average
Auxiliar logistico administrativo	0.00024353
Auxiliar operativo	0.02144207
Mensajero 1	0.7600
Mensajero 2	0.7600
Operario 1	0.00801486
Operario 2	0.00801486
Operario 3	0.00801486

Indicating that both messengers have the highest occupancy with the same percentage of 76%. This is because when making the route both deliver a merchandise at the same point, generating that both are occupied the same time and the delay in the rest of the goods increases.

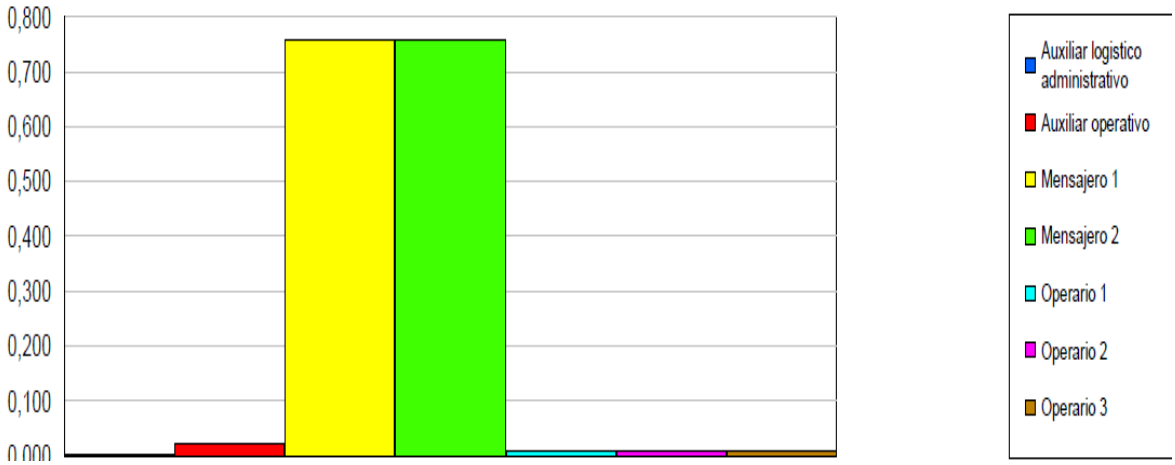

Figure. 3. Scheduled Utilization

5. Propose and Analysis

According to what was observed during the simulation, the following measures are proposed to

improve the times in the operation of merchandise deliveries in the last mile, meeting customer satisfaction. To do this, the first proposed action is. Train drivers to use the "Sispostal" system, which is a program that facilitates online download; Giving you functions not only as a driver but also as an operational assistant to reduce delivery times and prevent the two couriers and the driver from delivering together. From here this model is modified and a first courier is left at the first location or point (North General Clinic) with the respective merchandise and the driver continues the route with the second courier, which should leave at a second point (Caribbean Clinic); The driver must continue the route to the third point (Porto Azul Clinic), where he will deliver the corresponding medications to that logistics partner. Then, the first courier that should have finished the delivery will proceed to make the fourth point that corresponds to the logistics partner (Murillo Clinic), and the second courier that is unoccupied goes on to deliver to the last point (Clinical Center).

Once the improvements have been implemented, and the data collection is taken again, we obtain that in our improved process it is observed that an average of 24 entities leave, which indicates that the couriers managed to make 24 deliveries of the goods to the clinics. The total waiting time of the merchandise to be delivered was reduced to 1.17 hours on average, this being a good indicator with respect to the initial average obtained, in goods that enter the system we have an average of 24.6 compared to the 24 goods delivered. This generates a very minimum WIP of 0.39 on average that are the entities that remained within the system, thoroughly analyzing the waiting time data in the processes we have the following.

when it compared the results between the simulated and the real model, it can be seen is possible to reduce waiting times in processes that presented delays. Which leads to increased productivity and improved efficiency when making the route and delivery of the goods. Regarding the percentages of resource utilization, we see that the courier and the driver who also serves as a courier have a load balance in deliveries, this positively impacts productivity, and we see it reflected in the increase in the number of deliveries made.

6. Conclusion

With the development of this simulation, it can be concluded that following this propose, the process of delivering the goods will be improved in percentages of time and efficiency of 15.38% of the distribution process; since previously, couriers delivered at a single point and had to wait throughout the process of delivering merchandise to the recipient logistics partner. Losing the possibility of advancing in that same period the deliveries at other points, and thus fulfill several deliveries, generating plus efficiency throughout the distribution of the logistics route of delivery. This can help in order not to have breaches, or not generate claims or dissatisfaction for the service acquired, generating fulfilling in the commitment as a company, which seeks to be effective and efficient to become the logistics operators of choice for the partners.

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