Advances in Global Innovation & Technology

Simulation with Arena Software: A Case Study in a Cold Cuts Storage Company

Simulação com o Software Arena: Um Estudo de Caso em uma Empresa de Armazenagem de Frios

Simulación con Arena Software: Un estudio de caso en una empresa de almacenamiento de embutidos

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Resumo:

O objetivo do presente estudo foi elaborar uma simulação nas operações logísticas uma empresa especializada no transporte e armazenamento de frios. Este tipo de mercadoria requer temperaturas baixas e criogênicas. Com a utilização do software Arena, a empresa poderá identificar possíveis gargalos, desperdícios, atrasos e ineficiências nos processos da empresa, e propor soluções para otimizar o tempo, o custo, a qualidade e a satisfação dos clientes. A teoria de simulação destacou o passo a passo do uso do Arena, desde a modelagem, análise de dados e dos relatórios dele. A metodologia partiu de um estudo bibliográfico, descritivo e de caráter quantitativo. Também foi utilizado o método do estudo de caso através da pesquisa de campo de uma empresa real, onde se coletou os dados de tempos para se analisar e elaborar a simulação em Arena. Os resultados da pesquisa realizada no processo logístico de retorno de rota, conferência de carga, descarregamento e manobra de caminhões em uma empresa de distribuição de produtos que demandam temperaturas rígidas, demonstrou a eficácia do software Arena para aprimorar essas operações e que a empresa possui uma operação eficiente, com atendimento dentro do turno estabelecido.

Palavras-chave: Transporte; Arena; Simulação; Logística.

Abstract:

This study aims to develop a simulation *of a company's logistics operations specializing in cold cuts, transporting and storing loads that require low or cryogenic temperatures, and using the Arena software to identify possible bottlenecks, waste, delays, and inefficiencies. In the company's processes, propose solutions to optimize time, cost, quality, and customer satisfaction. The simulation theory highlighted the step-by-step use of Arena, from modeling, data analysis and reporting. The methodology was based on a bibliographical, descriptive and quantitative study. The case study method behind a field investigation of an honest company was also used, where time data was collected to analyze and prepare the simulation in Arena. The results of the research carried out in the logistical process of route return, cargo checking, unloading and maneuvering of trucks in a company distributing products that require rigid temperatures demonstrated the effectiveness of the Arena software in improving these operations and that the company has an efficient operation, with service within the established shift. It is concluded that Arena software allowed each stage of the process to be simulated in detail, from the arrival of the vehicles to the final positioning maneuver.*

Keywords: Transport; Arena; Simulation; Logistics.

Resumen:

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El objetivo del presente estudio fue desarrollar una simulación en las operaciones logísticas de una empresa especializada en el transporte y almacenamiento de fiambres. Este tipo de producto requiere temperaturas bajas y criogénicas. Con el uso del software Arena, la empresa podrá identificar posibles cuellos de botella, desperdicios, retrasos e ineficiencias en los procesos de la empresa, y proponer soluciones para optimizar el tiempo, el costo, la calidad y la satisfacción del cliente. La teoría de la simulación destacó el uso paso a paso de Arena, desde el modelado, el análisis de datos y la elaboración de informes sobre él. La metodología se basó en un estudio bibliográfico, descriptivo y cuantitativo. También se utilizó el método de estudio de caso a través de la investigación de campo de una empresa real, donde se recolectaron los datos de tiempo para analizar y elaborar la simulación en Arena. Los resultados de la investigación realizada en el proceso logístico de retorno a la ruta, conferencia de carga, descarga y maniobra de camiones en una empresa que distribuye productos que demandan temperaturas rígidas, demostraron la efectividad del software Arena para mejorar estas operaciones y que la empresa tiene una operación eficiente, con servicio dentro del turno establecido.

Palabras clave: Transporte; Arena; Simulación; Logística.

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1. INTRODUCTION

Preveoeste (2022) states cold storage companies are crucial in the food chain, intermediating perishable products such as dairy, meat and fish. They guarantee safe and quality products for their consumers and play a vital role in the supply chain.

Therefore, with their cold segments being part of the food and beverage industries, these companies produce, process, store and distribute a range of chilled and frozen products.

Their audiences vary according to their products, but they generally serve a wide variety within their chain, including retailers, wholesalers and businesses for end consumers.

This study aimed to develop a simulation of a company's logistics operations specializing in the transportation and storage of cold products. This type of merchandise requires low and cryogenic temperatures. Using Arena software, the company can identify possible bottlenecks, waste, delays and inefficiencies in its processes and propose solutions to optimize time, cost, quality and customer satisfaction.

To this end, a case study was conducted on an honest company where the internal procedures were timed from reception desk reception to dispatch based on order demand.

2. THEORETICAL BASIS

2.1 Simulation history

Simulation is a practice in which a model replicating some elements of real life is used to test scenarios under controlled conditions in an environment like the real one but created artificially.

According to authors Pazin and Scarpelini (2007, p. 1):

> Simulation is a teaching technique based on the principles of task-based teaching. It uses the partial or total reproduction of these tasks in an artificial model known as a simulator. Its application is generally related to practical activities that involve manual skills or decision-making.

According to Mecalux (2018), simulation in logistics began to attract attention after the Apollo 13 mission in 1970. NASA started the process by using the term "digital twin" to describe this type of simulation and began to apply it in its operations: "A digital twin is a virtual representation of a physical system or process in real-time" (SILVA, 2023).

In Brazil, logistics management practices began to be adopted only in 1990, when it was understood that systematic process planning would be crucial to organizing materials, from their movement to storage (BALLOU, 2007).

Simulation has become a valuable tool for companies to improve their supply chain management. This has allowed them to make changes and assess their effects without impacting operations. With technology advancing, companies

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can now create and test equipment, products and processes in a virtual world before putting them into operation (SALIBY, 1999).

2.2 The Arena Software

Rockwell Automation developed the Rena software. It is well known worldwide as the primary tool for discrete event simulation and has a vast community, with over 350 thousand users (PARAGON, 2019).

According to Silva (2007), Arena is software that models various environments and simulates multiple processes in manufacturing, services, and other areas.

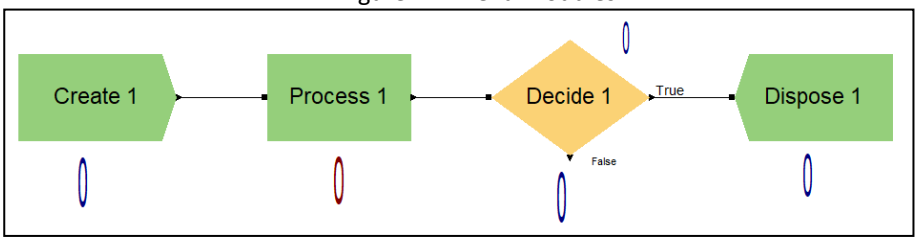
Arena visualizes the system as a set of workstations providing customer services. It is used to simulate the most diverse environments, from production lines to the flow of customers in queues (ALVES et al., 2019).

The software has several features that enable a deep understanding of daily business operations, creating various scenarios. This is essential for detailed analysis and effective decision-making at each project stage, empowering teams to achieve excellent results.

The Arena has several modules that assist in process modeling. The two main modules are the flowchart and data modules. These modules help describe real applications and illustrate the current scenario of the areas through a flowchart (UNOPAR, 2020).

Modeling in Arena begins with Entities. Entities are the circulating part of the model, following the logic established by the flowchart and interacting with the resources. The Entity Data module gathers the definitions and parameters related to all types of entities the model uses.

Figure 1 – Arena Modules



Source: Prepared by the author (2024)

The modules present in Arena are represented in Figure 1.

- *Process: The process* flowchart module represents any action within the system that takes time to complete. It can also represent the occupation of a machine or operator (resource). You can define the action to be performed (simple occupation, for example), the time spent on the process and the associated cost situation (PARAGON, 2012).
- *Dispose*: This flowchart module functions opposite to the *Create module*. It removes entities from the system and collects statistics about them when activated.

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- *Decide*: In the context of Arena software, the term "*Decide*" may refer to the software's ability to assist in decision-making. It allows you to create studies on specific systems without compromising the company in which they operate, allowing the software user to improve their productivity and reducing bottlenecks and unnecessary costs. In addition, Arena's Decide module is used to

3. METHOD

3.1. Methodology

This article was based on bibliographic research, characterized by reading books, academic articles, newspapers or any other technical or academic material to provide a complete overview of a specific topic (OLIVEIRA, 2022).

In addition, the case study technique was applied to field research since field research is a reality-based research methodology focused on observation, data collection, analysis and interpretation of results. The objective is to verify what the subject does rather than what he says he does (THIBES, 2022).

The research was quantitative in nature. Quantitative data present the numbers that prove the general objectives of the study (MACHADO, 2021).

Additionally, a time and motion study were conducted to enrich the analysis and understand how time is used in logistics operations (MARTINS; LAUGENI, 2005).

3.1. Data analysis

The flowchart in Figure 2 below represents the logistics processes of the company studied, starting with the arrival of the vehicle at the company's entrance, the receiving process (parking the car, docking, opening the vehicle and checking the invoice), then the separation processes are analyzed, including two employees to execute this process (separation of family by pallet and grouping by family), starting with shipping, the outputs were visualized, including the assembly and grouping processes for loading.

An existing cold storage company located in the city of Bebedouro-SP was used. This company handles the storage of refrigerated and cooled products, product reception, checking, storage and shipping.

The primary analyses were the entry of vehicles from arrival at the gate to arrival at the dock, the time it takes for the vehicle to position itself and dock at the dock, the time to unload and place products in the antechamber, their checks and the period for storage. The times of each process from arrival to storage were determined through estimates by operators seen every day of the month, considering all the differences between drivers and employees. The data collected (table 1) were applied to the Arena software (PRADO, 2012).

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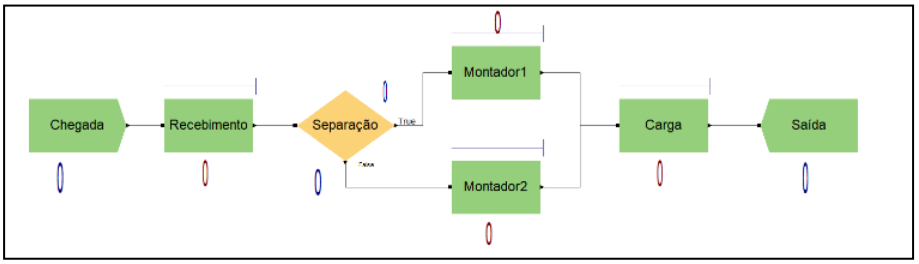
Figure 4 – Flowchart of the Company Studied.



Source: Prepared by the author (2024)

Table 1 – Spreadsheet with the times collected

Nº	Entrada 5 a 15min	Recebimento na Doca 12 a 25min	Separação 24 a 35min	Carga 5 a 10min
1	9	16	33	8
2	7	18	31	5
3	5	18	24	8
4	9	21	35	9
5	8	22	25	10
6	15	15	31	6
7	8	19	33	9
8	6	22	34	8
9	6	20	30	8
10	8	13	33	10
11	10	15	30	10
12	9	19	27	6
13	5	20	30	5
14	7	25	26	9
15	9	14	30	9
16	10	14	29	7
17	9	13	35	7
18	6	24	28	9
19	15	19	32	7
20	12	22	31	6
21	8	18	29	6
22	14	12	34	6
23	8	12	32	10
24	12	22	27	8
25	7	24	32	8
26	7	20	30	8
27	14	25	33	5
28	13	25	24	7
29	12	19	30	8
30	11	20	31	6

From Table 1, the data collected from column 1 (Input 5 to 15 min) was transferred and entered a notepad. After that, it was saved in a text file. To create the histogram in Figure 5, the *Input Analyzer tool* located in the "Tools" tab was used, where the data from the text file with the data from the first column was inserted, after which the histogram below was generated.

Figure 4 shows the statistical expression for column 1, i.e., 4.5 + WEIB (5.37, 1.7). This expression was entered in the Arena Create module. The following statistical expressions were created in the same way as in Figure 5 but were not inserted here for reasons of space. Column 2, the receiving column, resulted in the expression statistics. 11.5 + 14 * BETA(1.08, 0.969). Column 3, the separating column, resulted in the expression statistics. NORM(30.3, 2.99). Column 4, the loading column, resulted in the expression statistics. 4.5 + 6 * BETA(1.38, 1.29).

All these expressions were adequately inserted into the flowchart in Figure 4, and their results are found in the next item.

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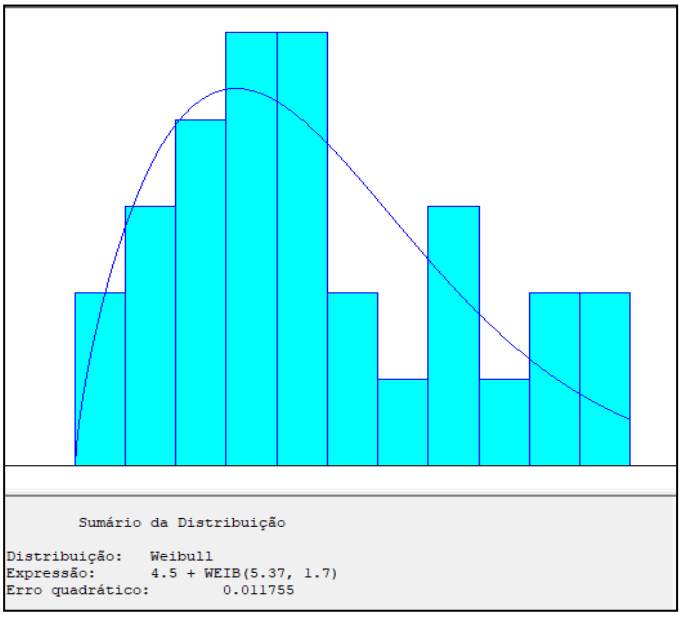
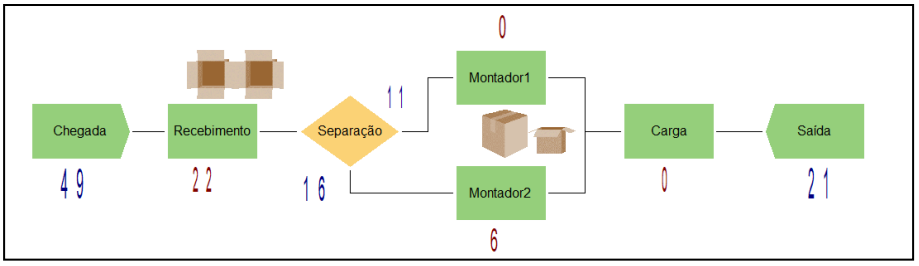
Figure 5 – Arrival *Input Analyzer (*Create)



Source: Prepared by the author (2024)

Figure 4 - Simulation *layout*



Source: Prepared by the author (2024)

As can be seen in Figure 4, it is possible to observe in the shipping sector the queue times (Time), with some bottlenecks in the receiving process (128 minutes, that is, more than two hours of the queue), due to the lack of employees at the company's reception and the difficulty in parking the vehicle at the dock to continue with the unloading. During shipping, there were no bottlenecks in the exit of products in the waiting lines (*Number Waiting)*, and all employees were on time.

Figure 5 - Queue report

Queue Detail Summary

Time

	Waiting Time
Carga.Queue	0.57
Montador1.Queue	5.66
Montador2.Queue	14.92
Recebimento.Queue	128.27

Other

	Number Waiting
Carga.Queue	0.03
Montador1.Queue	0.13
Montador2.Queue	0.65
Recebimento.Queue	12.09

Source: Prepared by the author (2024)

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In Figure 8, one can observe the efficiency (*Inst Util*) with the use of employees in the company. Only operator 1 was excessively used, with 100% (or 1) utilization. The other employees have utilization below 85% in their respective tasks.

Figure 6 - Usage report

Resource Detail Summary

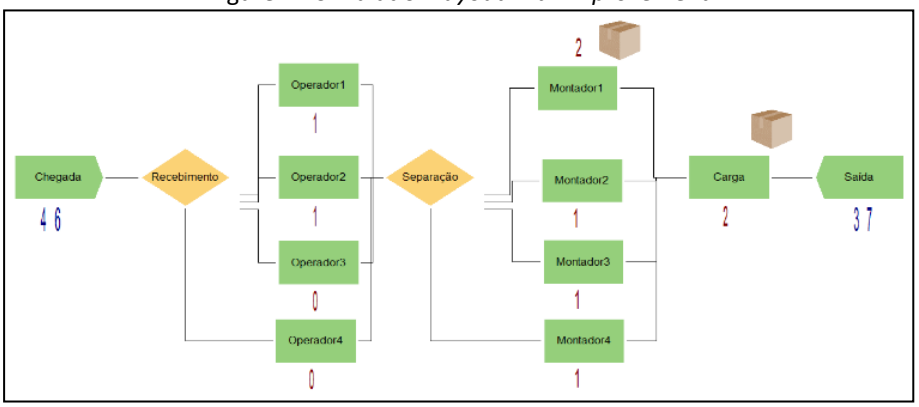
Usage

	Inst Util	Num Busy	Num Sched	Num Seized	Sched Util
Montador 1	0,69	0,69	1,00	11,00	0,69
Montador 2	0,68	0,68	1,00	11,00	0,68
Operador 1	1,00	1,00	1,00	28,00	1,00
Operador 2	0,34	0,34	1,00	21,00	0,34

Source: Prepared by the author (2024)

Figure 6 shows the new layout with the improvements. Compared to Figure 6, it was noted that after the upgrades, the users had no margins for error for each employee.

Figure 7 - Simulation *layout with improvement*



Source: Prepared by the author (2024)

In Figure 7, you can see the average times for each operator and assembler in the processes through the queues in minutes. The simulation greatly improved after including one more employee in the company, reducing these times compared to the report in Figure 7.

Figure 8 - Post-improvement queue report

Time

	Waiting Time
Carga.Queue	8.36
Montador1.Queue	53.19
Montador2.Queue	13.30
Montador3.Queue	16.76
Montador4.Queue	20.28
Operador1.Queue	13.24
Operador2.Queue	6.07
Operador3.Queue	4.29
Operador4.Queue	1.15

Source: Prepared by the author (2024)

Figure 8 shows the report that accompanies Figure 10. It demonstrates the

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improvement in the process entities by reducing the queues with the resources listed below.

Figure 9 - Report of people in queues after improvement

Other

	Number Waiting
Carga.Queue	0.82
Montador1.Queue	1.39
Montador2.Queue	0.28
Montador3.Queue	0.38
Montador4.Queue	0.69
Operador1.Queue	0.52
Operador2.Queue	0.08
Operador3.Queue	0.13
Operador4.Queue	0.03

Source: Prepared by the author (2024)

Figure 9 shows the report demonstrating improvements in the process entities by reducing the queues with the resources listed below.

Figure 10 - Post-improvement usage report

Resource Detail Summary

Usage

	Inst Util	Num Busy	Num Sched	Num Seized	Sched Util
Montador 1	0,72	0,72	1,00	12,00	0,72
Montador 2	0,65	0,65	1,00	11,00	0,65
Montador 3	0,48	0,48	1,00	8,00	0,48
Montador 4	0,74	0,74	1,00	12,00	0,74
Operador 1	0,39	0,39	1,00	11,00	0,39
Operador 2	0,71	0,71	1,00	19,00	0,71
Operador 3	0,40	0,40	1,00	10,00	0,40
Operador 4	0,85	0,85	1,00	44,00	0,85

Source: Prepared by the author (2024)

5. Final Considerations

The simulation of the company's operations identified the need to improve the number of employees during operations. Thus, a solution was proposed to optimize the process.

It is essential to highlight that the simulation results did not deviate from the company's current scenario. Therefore, the improvements can become suggestions for improving the sound management of employees' tasks, thus generating savings and organization among them, optimizing processes and generating satisfaction in deliveries.

Therefore, it was clear that the Arena software allowed for the detailed simulation of each stage of the process, from the vehicles' arrival to the final positioning maneuver.

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