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WAREHOUSING SYSTEM OF FREDCOR COKE WAREHOUSE: SOME PROPOSALS

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Abstract

Improvement in facility layout was crucial in enhancing productivity and efficiency in retail business. This research aims to identify an ideal arrangement of the existing layout within FredCor Coke Warehouse, a retail distributor of softdrinks including Royal, Coke, Sparkle, Sprite, water, alcoholic drinks, energizer drinks, and Magnolia. Coca-Cola as one of the key suppliers. However, the current layout revealed several issues, like excessive travel distances and difficulties in locating products due to mixed product placement, poor space utilization, and inefficient allocation which hinder worker productivity and effectiveness. A quantitative experiment research approach was adopted along with the SLP techniques and time study to investigate operational flows and process inefficiencies. The results showed serious inefficiencies in the layout, such as in pick-up, storing to picking took 11042.82 seconds covering 6454 cm distance, in Coca-Cola delivery, picking to locating took 4704.082 seconds covering 4857 cm distance compared to 4461 cm that only took 1692.7567 seconds in inbound to QA/QC process and in FredCor delivery, the longest process was storing to picking that took 12633.768 seconds covering 4878 cm distance. So, the findings call for a new arrangement in order to reduce the distance travelled, improve storing, and optimize space because a less structured layout delays workflow and reduce worker productivity, so addressing these will lead significant improvements in the productivity of the warehouse and its workers, supporting FredCor's competitiveness and sustainability in the retail softdrink distribution business. The research showed that facility layout optimization was crucial for driving process success and productivity.

Keywords: Warehouse; SLP Techniques; Time Study; Arrangement Layout; Space Utilization

1. Introduction

Inefficient warehouse layouts posed a significant challenge for many businesses, particularly with the increasing demand for order fulfilment. A disorganized layout led to wasted space, extended picking times, and inefficient workflows, all of which reduced productivity. For instance, improper shelving arrangements and failure to maximize vertical space severely limited the storage capacity of a warehouse (Sharma, 2019). Therefore, the design of a warehouse played a critical role in determining the overall efficiency and cost effectiveness of its operations. The layout of a warehouse reflected its operational efficiency, which directly impacted its market success. FredCor Coke Warehouse, a leading distributor in the beverage industry, was founded in 2019 and had dimensions of 15.10 m (49.54 ft) by 58.84 m (193.06 ft). The layout was organized by pallet positions, with each pallet occupying approximately 1.2 m (4 ft) by 1.0 m (3.3 ft). Based on this setup, the warehouse accommodated 94 pallet positions for Coke (mL), using about 112.8 m^2 (1,214 ft^2), 50 pallet positions for Coke (L), using approximately 60 m^2 (645 ft^2), and 202 pallet positions for Royal, with additional areas designated for Sprite, water, and storage of empty containers, occupying around 242.4 m^2 (2,608 ft^2). The warehouse served as the primary distributor of Coca-Cola products in the Danao area and 2 also covered half of Compostela. Operating manually, the warehouse relied on human labour for organizing and managing tasks without digital support, which was crucial for handling its large product distribution (Montes, 2024). The facility was specifically designed to store and distribute Coca-Cola beverages, ensuring that it was always ready to meet the needs of retailers and customers.

FredCor Coke Warehouse faced many of the challenges commonly encountered in warehouse operations. These included an inefficient layout that hampered productivity, prolonged picking times, and the underutilization of storage space, where unrelated items were stored, wasting valuable area. Additionally, safety measures were inadequate, particularly in areas vulnerable to leaks. These issues ultimately compromised the overall performance of the warehouse, leading to customer dissatisfaction. As the need for greater efficiency in warehouse operations grew, it became increasingly clear that an improved layout at FredCor Coke Warehouse was necessary. Addressing the warehouse challenges was vital for boosting operational efficiency, increasing output, and maintaining a competitive edge. By resolving these issues, companies could streamline their processes and improve customer satisfaction (Sharma, 2019).

Given that a better warehouse design could lead to improved performance and results (Yener et al., 2019), the researchers aimed to conduct a study focused on evaluating the warehouse layout at FredCor Coke. The objective was to propose a more efficient design that would enhance the facility's productivity and efficiency.

1.1 Statement of the Problem

This study aimed to design an improved facility layout to enhance productivity at FredCor Coke Warehouse.

Specifically, it sought to address the following questions:

1. What is the current process flow in FredCor Coke Warehouse?
2. What is the current layout of FredCor Coke Warehouse?
3. What is the analysis of the current warehouse layout using:
   3.1. Muther's Grid
   3.2. PERT/CPM

4. Based on the findings, what was the proposed layout to improve productivity?

1.2 Scope and Limitations

This study aimed to analyze and improve the current arrangement of the FredCor Coke Warehouse. It focused on evaluating the efficiency of the existing setup by examining workflow, equipment placement, space usage, and material handling. The study also suggested a new layout strategy designed to address these issues, enhancing overall efficiency, productivity, and operational ease within the warehouse. The scope included an assessment of how the proposed changes might impact operational flow, lead times, and the general movement of goods in and out of the facility. The study was confined to the FredCor Coke Warehouse, and its findings may not have applied to other warehouses. It did not consider external factors such as labor policies, corporate strategies, or market conditions. Furthermore, the involvement of personnel and training requirements related to the new layout was not included in this study.

2. Research Methodology

2.1. Research Design

This study employed a quantitative research design, focusing on time study measurements to evaluate the efficiency of the facility layout in the FredCor warehouse. The main goal was to collect data on distance and time, which could then be analyzed descriptively to understand how effectively the warehouse space was utilized. By using standard measurement tools, the researchers sought to gather accurate and quantifiable data regarding workflow efficiency within the warehouse. This approach not only enhanced the reliability and validity of the findings but also facilitated a systematic and repeatable examination of how the facility layout influenced operational performance.

2.2 Research Process Flow

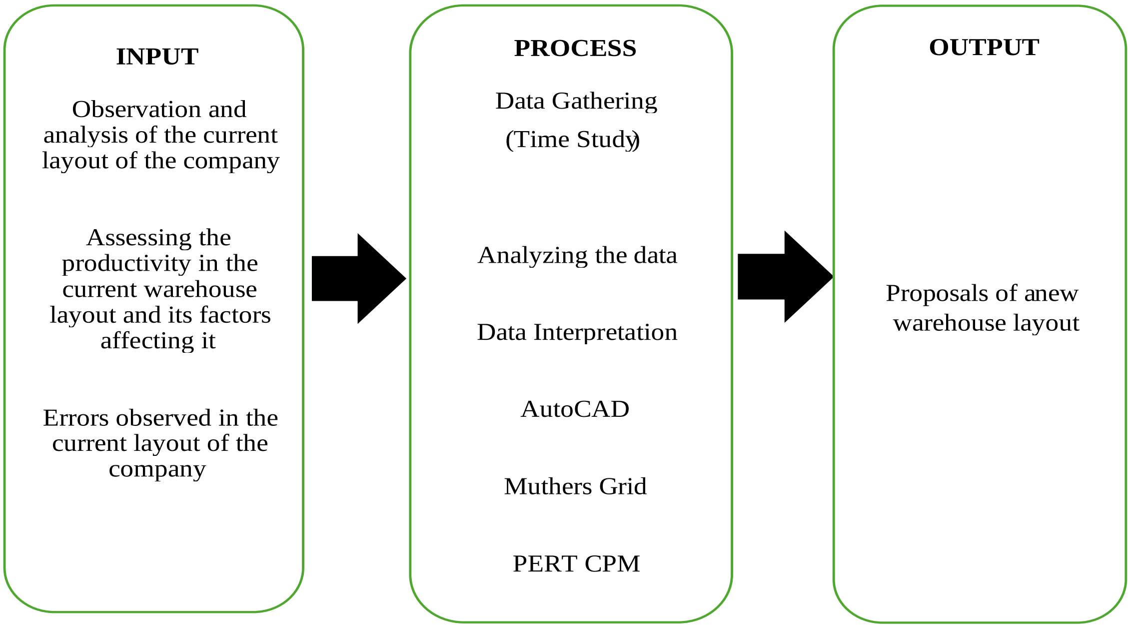

Figure No. 2 Research Process Flow Study

Figure 2 illustrated the study's flow, which acted as a roadmap for carrying out the research. It adhered to an input-process-output model, where the existing layout, the evaluation of productivity within that layout, and the identified errors were considered the input. The process encompassed the methods employed to address the input and generate an output, which was the suggested warehouse layout.

2.3 Data Gathering

The study was conducted through two primary phases: pre-data gathering and data gathering and analysis concerning distance and time in every process. In the pre-data gathering phase, the researchers drafted a permission letter that required approval from the research instructor, the Chairman of Industrial Engineering, and FredCor Coke Warehouse. Once the request received approval, the researchers prepared and modified tools for time study measurement to align with their study's objectives. Afterward, the researchers visited the warehouse to administer it. The researchers conducted time studies in every process, namely inbound, picking, storing, picking, and outbound. The aim was to collect data, which was expected to be completed within two weeks. Afterward, they recorded the time taken for each process. The distances between various processes involved in warehousing were also noted to analyze productivity and efficiency. The data collected informed the development of a proposed warehouse layout designed to enhance productivity and efficiency. Additionally, the current layout of the company was also documented.

2.4 Treatment of Data

In Problem 1, the researchers used a flowchart diagram to visually map the warehouse process flow and categorize information effectively. This provided a clear step-by-step depiction of workflows, facilitating understanding and communication.

Meanwhile, in Problems 2, and 3 the researchers employed Muthers grid and PERT-CPM, which helped to identify key areas for improvement or action. Together, these tools streamlined decision-making and improved warehouse productivity.

3. Results and Discussion

3.1 Current Process Flow of Fredcor Coke Warehouse

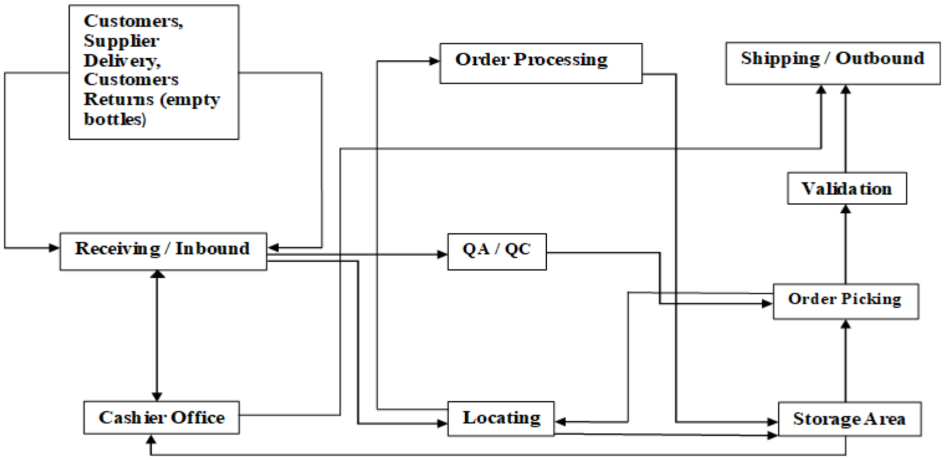

Figure 4. Process Flow in FredCor Coke Warehouse

Figure 4 showed the operational flow at the FredCor Coke Warehouse and is structured around three primary functions: pick-ups, deliveries of suppliers, and customer returns such as empty bottles. The process begins with Coca-Cola products are delivered to FredCor Coke warehouse by suppliers. Each delivery is accompanied by delivery documents that list the products or returns being brought in. When Coca-Cola supplies arrive at the receiving area, the supervisor checks the items for damage, verifies their quantities, and ensures that they match the information provided in the delivery documents. Workers use forklifts to remove full bottles from delivery trucks and store them in the designated storage area. After all the full bottles have been stored, the workers will repeat the process for the empty bottles, loading them onto the truck for shipping. Once this is done, the supplier will proceed to the cashier to complete the payment transaction before heading out for shipping. Once FredCor delivers coca – cola products to their designated areas, such as Danao and Compostela, workers utilize trolleys to transfer products from the storage area to the trucks. They then validate that the products are correct before proceeding to shipping. Upon arriving at the warehouse for pick-ups, the customer will first visit the cashier to complete the order and payment process before heading back to the receiving area. There, workers will unload empty bottles from different vehicles, including trucks and tricycles. Next, they will use trolleys to move the empty bottles to storage. After that, they will retrieve the customer's order from storage, where workers will verify the orders and load the beverages onto the truck for shipping. In terms of customer returns, when a customer arrives with empty bottles without a prior order, workers unload these bottles from the truck and subsequently store them in the designated area using trolleys.

The operational flow at the FredCor Coke Warehouse, while structured around essential functions such as pick-ups, deliveries, and customer return, exhibits inefficiencies that can hinder productivity. It involves several interconnected processes that govern the movement of goods and documents within the facility. These processes include inbound operations, locating, order processing, storage, order picking, validation, and outbound activities. Specific transitions like "Inbound to Cashier Office," "Storage Area to Order Picking," and "Validation to Outbound" help define the flow of tasks. However, inefficiencies, such as repeated movements between locating and storage, point to potential bottlenecks that could impact overall performance. According to Mohamud et al., (2013), the connection between warehouse efficiency and warehouse characteristics have been widely studied. A study discovered that layout of the warehouse, the process flow includes backtracking and cross-movement, and the warehouse design were significant factors that can impact the effectiveness of warehouses. Furthermore, the research emphasized how crucial warehouse design is, to accomplish warehousing effectiveness. The writers contend that the warehouse's layout and warehouse's design can affect order processing times and effectiveness of material handling.

3.2 Current Layout of FredCor Coke Warehouse

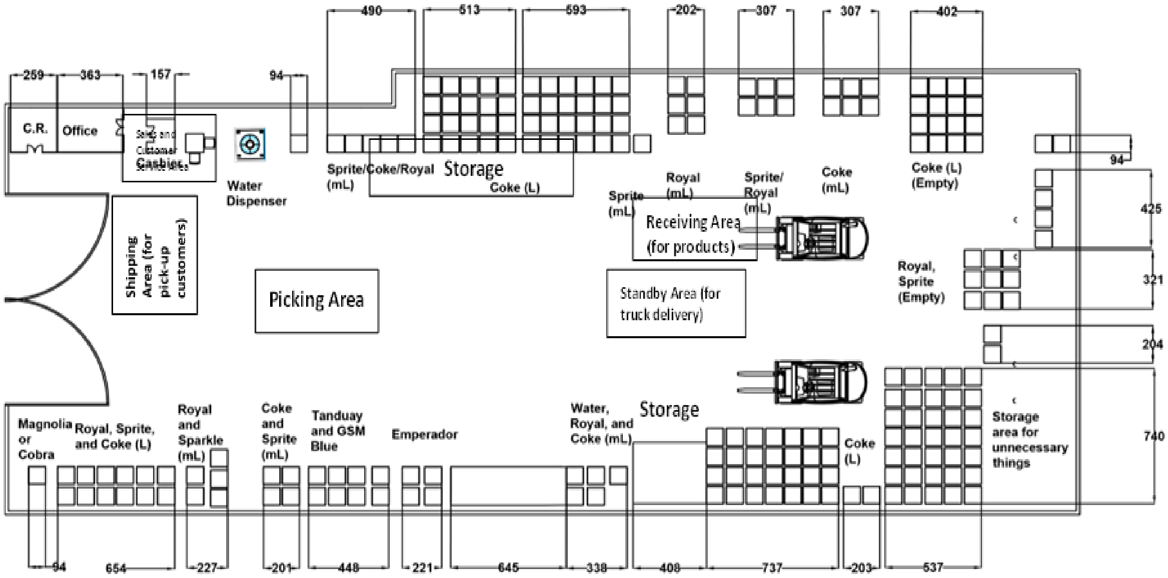

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Figure 5. Current Layout of FredCor Coke Warehouse

Figure 5 showed the current layout of FredCor Coke Warehouse. In the current layout of the warehouse, the pathways and the workplace of each process involved in the warehouse were unsuitably utilized. There were spaces that did not need a huge area, yet they occupied a larger space than others that needed to be prioritized. The improper use of space hindered workers from moving comfortably while working because the areas intended for pathways were blocked with other items. The products were disorganized, resulting in delayed order fulfilment, wasted valuable time searching for products, and affected efficiency. The areas of the processes involved in the warehouse were separated by a great distance. The workers had difficulty obtaining their needs in other workplaces, and a greater amount of walking time was recorded. The performance of the workers was not efficient if the processes were separated by long distances.

Complicated layout leads to long distance travelled and is time-consuming for the workers. The distance and standard time travelled for the flow of operations is summarized in the table below.

Table 1. Standard time of each Pick-Up process flow and the distance between each process

Process Flow			
From	To	**Distance (cm)**	**Standard Time(seconds)**
Inbound	Cashier	3276	1 987.708

Cashier	Locating (empty bottles)	4372	6 648.391
Locating (empty bottles)	Order Processing	3023	5 963.125
Order processing	Storing	3438	5 230.811
Storing	Picking	6454	11 042.82
Picking	Validating	3216	1 753.86
Validating	Outbound	1927	1 899.084

Table 1 showed the standard time in seconds of the varied pick-up processes in the FredCor Coke warehouse setting. The process flow data give detailed information on beverage movement, capturing both distances travelled and standard time for each process. The starting point of the flow is from the inbound area to the cashier; this process covers a distance of 3,276 cm and takes approximately 1,987.708 seconds. Next from the cashier is finding empty bottles, which calls for a much longer distance, 4,372 cm and much more time at 6,648.391 seconds; this stage is laborious or complex. Finding empty bottles marks the continuation to order processing in a much shorter distance of 3,023 cm in 5,963.125 seconds. It implies that even though the distance is not very long, the time required is still pretty long, probably because of sorting or other processing steps. Next, order processing results in storing, with a distance of 3,438 cm and a time of 5,230.811 seconds that is somewhat shorter. The reduction in time could be due to more orderly storage mechanisms that make it easier to place items quickly. Transition from storage and picking marks the longest distance in the process flow at 6,454 cm and the highest recorded time at 11,042.82 seconds. It was an indication of less efficient retrieval processes where more movement is made within the storage area. Following picking, the products move into validation. In this step, the distance reduces to 3,216 cm; the time reduces down to 1,753.86 seconds, hence implying a more streamlined and efficient process. Lastly, validation leads to the outbound phase, which covers the shortest distance of 1,927 cm in 1,899.084 seconds, indicating a final quality check before the product exits the system.

The data indicates areas that could be improved in terms of finding empty bottles and picking since they take the longest processing times. Improving in these areas could 29 be achieved by improving the layout design to increase efficiency in general and decrease delays.

A study by Chondromatidis et al. 2024 titled Investigating the Impact of Completion Time and Perceived Workload in Pickers-to-Parts Order-Picking Technologies, analyzed the link between order picking and completion time and concluded that longer times of completion are linked with a greater workload for picking. Long completion times contributed to low productivity and decreased the job satisfaction of a worker because inefficiency exists in the picking process itself. According to Casella et al. 2023, picker congestion increased travel distances and times as a result of delays and waiting times. Additionally, Bataineh et al. 2020 established that delays associated with picking elevated operational costs while, at the same time, undermining service quality; thus, longer taking times had ripple effects on the supply chain's performance.

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Table 2. Standard time of each Coca-Cola Delivery process flow and the distance between each process

Process Flow			
From	To	**Distance (cm)**	**Standard Time(seconds)**
Inbound	QA/QC	4461	1692.7567
QA/QC	Picking	2933	3046.962
Picking	Locating	4857	4704.082
Locating	Storing	4106	4188.676
Storing	Cashier	5747	2162.8154
Cashier	Outbound	8026	1244.3569

Table 2 showed the data about the standard time of the delivery process of Coca-Cola and revealed the different standard times and varied distances to each step of the delivery process. The data showed products were first transferred from the inbound section to the QA/QC area, which had covered 4,461 centimeters and took about 1,692.76 seconds. After QA/QC, the products were moved to the picking area, which was 2,933 centimeters. However, this stage took a much longer time, as it had a standard time of 3,046.96 seconds. The increased time was an indication that the picking processes were taking longer because the products were not well arranged. After picking, the products were taken to the locating area, and they covered 4,857 centimeters in 4,704.08 seconds. The significant time spent in this stage indicated that finding and arranging selected items for further processing needed careful handling and strategic placement. From the locating stage, the products were put away, moving 4,106 centimeters and taking approximately 4,188.68 seconds. The relatively long time spent in storage indicated potential delays in shelving and categorizing items efficiently. After storage, the items proceeded to the cashier section, where a distance of 5,747 centimeters was covered in 2,162.82 seconds. The last transition was from the cashier to the outbound section, covering the longest distance of 8,026 centimeters but taking only 1,244.36 seconds. This meant that despite the extensive movement, the outbound process was relatively swift.

The overall process flow revealed inefficiencies in some stages, such as picking, locating, and storing, where extended processing times could contribute to delays in warehouse process. The longer durations at these stages suggested that improvement layout designs could enhance efficiency. Additionally, the significant distance covered during different phases indicated the need for strategic placement of products to minimize unnecessary movement and reduce overall processing time. The findings underscored the importance of streamlining warehouse process to enhance productivity and reduce lead times, ultimately improving order fulfilment and customer satisfaction.

According to Mohamud et al. (2023), they emphasized the fact that longer picking and storage times caused delays and led to inefficiencies in warehouses. The findings recommended rearranging layouts for optimizing workflows as well as shortening the distances moved across the warehouse. Additionally, Kalinowski et al. (2024) highlighted that locating products was a significant issue in warehouses, greatly influencing other operations, notably order picking. Longer locating times significantly affected order picking efficiency and, therefore, affected the warehouse.

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Table 3. Standard time of each FredCor Coke Delivery process flow and the distance between each process

Process Flow			
From	To	**Distance (cm)**	**Standard Time(seconds)**
Inbound	Locating	6177	6 248.408
Locating	Storing	4557	8 884.723
Storing	Picking	4878	12 633.768
Picking	Validation	5627	9 471.27
Validation	Outbound	7349	3 603.2

Table 3 showed the data about the standard time of delivery process of FredCor Coke, revealing different standard times and varied distances to each step of the delivery process. During the first stage, from coming to locating, the distance covered was 6,177 cm and took approximately 6,248.408 seconds. This meant that receiving and initial placement were consuming a lot of time, with inefficiencies. After items were found, they were sent into storage, and a distance of 4,557 cm was covered in approximately 8,884.723 seconds. More time passed than distance covered, thus implying that the whole storage process involved the allocation in designated warehouse zones necessitating accuracy and proper categorized of products. The distance between storage and picking was 4,878 cm, with a standard time of 12,633.768 seconds. This was the most time-consuming stage in the process, meaning that the picking process involved complex navigation, retrieval, or delays due to product accessibility and arrangement. This stage was crucial because it directly affected the speed of order fulfilment and warehouse efficiency. After picking, the items went to the validation stage, covering 5,627 cm in 9,471.27 seconds. Finally, from validation to outbound shipping, the goods covered 7,349 cm in about 3,603.2 seconds. This was the shortest time recorded in the entire process, indicating that once validation was done, the items were efficiently moved to the outbound section for shipment.

The consequences of this process flow on the warehouse operations were quite significant. The extended period of some of the stages, such as picking and storing, suggested inefficiencies that would negatively impact productivity in general. Significant time consumption in these areas might be attributed to poor warehouse design, inefficient product management systems. Improved warehouse design, improved workflow strategies and arrangement could enhance overall operational efficiency, reduce order processing time, and improve customer satisfaction.

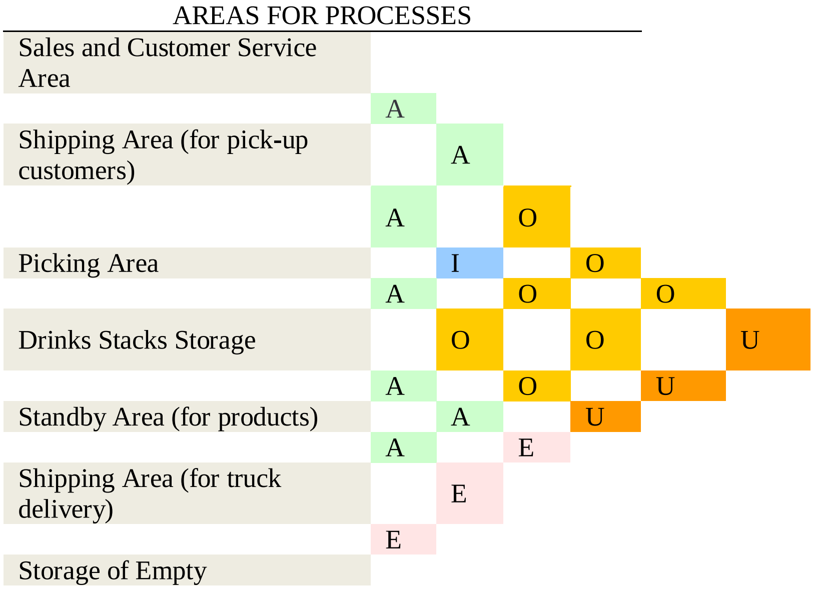
According to a related review by Grosse et al., 2020, order picking was often been described as one of the most labor- and time-consuming internal warehouse processes. Research indicated that order picking consumed about 55% of the labor of a warehouse just because most of this labor was spent in walking between points to fetch items. This "walking search" not only added labor cost but also inefficiency in the accomplishment of logistics order fulfilment as it sometimes created delays and nearly 75% picking errors during the whole process of order picking.

Table 4. Total number of cases of softdrinks and alcoholic drinks sold and its percentage per week

Category of Drinks	No. of Cases Sold	No. of Percentage
	LITER	
Coke	200	66.67%
Sprite	50	16.67%
Royal	50	16.67%
	mL, 8oz.	
Coke	500	45.45%
Sprite	300	27.27%
Royal	300	27.27%
	1.5 LITER	
Coke	50	50%
Sprite	30	30%
Royal	20	20%
	140 mL	
Coke	300	46.15%
Sprite	150	23.08%
Royal	200	30.77%
	290 mL	
Coke	100	40%
Sprite	70	28%
Royal	80	32%
	ALCOHOLIC DRINKS	
Tanduay	5	15.15%
Emperador	3	9.10%
GSM	10	30.30%
Kulafo	15	45.45%

The table above illustrated the weekly sales of soft drinks and alcoholic beverages in cases in FredCor Warehouse. The table grouped the sales into drink type and volume. The sales for soft drinks, particularly for Coke, remained high in all categories. For instance, at 1-liter, sales stood at 66.67% for Coke, while Sprite and Royal each stood at 16.67%. For the 8 oz category, Coke was the highest with 45.45%, followed by Sprite and Royal at 27.27%. In the 1.5-liter segment, Coke once again topped at 50%, followed by Sprite at 30% and Royal at 20%. In the 140 ml smaller volume, Coke again led with a share of 46.15%, while Royal and Sprite had 30.77% and 23.08%, respectively. In the 290 ml size, Coke was ahead at 40%, Royal followed at 32%, and Sprite at 28%. Under the alcoholic beverage segment, Kulafo led at 45.45%, while GSM followed at 30.30%. Tanduay and Emperador had 15.15% and 9.10%, respectively. The data suggested that Coke had a strong preference among soft drinks, and Kulafo among alcoholic beverages. It meant that Coke was a staple product in the warehouse, while Kulafo was the most preferred alcoholic drink. The data also showed a higher volume of soft drink sales compared to alcoholic beverages, reflecting potential consumer preferences.

3.3 The Current Muthers Grid of FredCor Coke Warehouse



CODE	DEGREE OF CLOSENESS
A	Absolutely necessary
E	Very important
I	Important
O	Ordinary important
U	Unimportant
X	Undesirable

Figure 6. Current Muthers Grid of FredCor Coke Warehouse

The figure 6 presented the muthers grid that corresponded to the layout of the FredCor warehouse. Observing the grid revealed a misalignment in the arrangement of the facility areas, particularly in how the receiving area (for products) overlapped with the shipping area (for truck delivery), causing congestion.

The layout indicated that the workflow and movement of goods were not entirely optimized. This lack of logical sequencing between areas contributed to congestion and inefficiencies. Moreover, while the dimensions of the facility areas appeared sufficient, there were still spaces that were not properly utilized, creating an absence of clear pathways that impacted operational flow. Workers, delivery trucks, and forklifts might have resorted to using any available space to move through the facility, potentially leading to delays or workplace hazards. Additionally, FredCor's manpower was sufficient for the warehouse workload.

Warehouse congestion led to delays, mistakes, accidents, and inefficiencies in warehouse operations according to LinkedIn (2024), and inefficient space utilization according to CPL Group (2023) could lead to wasted space, longer picking times, and disrupted workflows, all of which negatively impacted process flow and led to warehouse inefficiency. In addition, Anjos et al. (2021) emphasized layout issues such as overlapping workflow as one of the problems concerning facility layout; this study was concerned with determining an arrangement of non-overlapping indivisible departments within a facility due to the implementation of a multi-row layout.

3.4 The Current PERT CPM

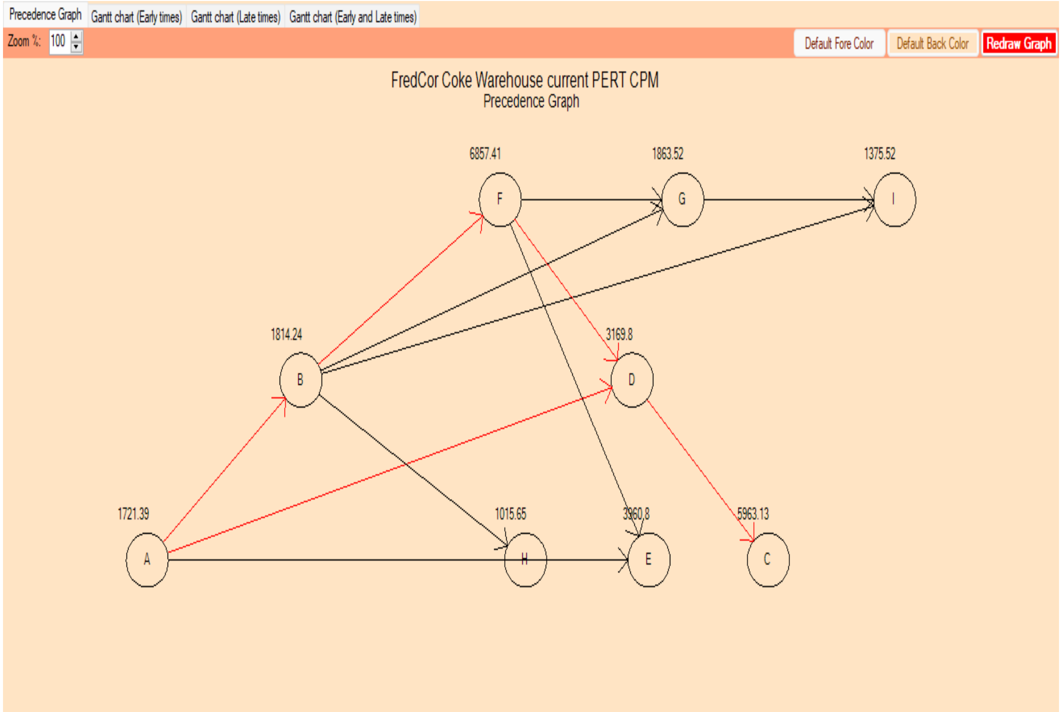


Figure 7. Current CPM diagram of FredCor Coke Warehouse through POM-QM

The figure 7 presented the PERT CPM corresponding to the existing layout of FredCor Coke warehouse. By observing the graph, it was apparent that the flow of work was not efficient, as evidenced by the critical path (red arrows) and task dependencies (black arrows). It appeared that some of the tasks in this particular setting were completed faster than others, and this had the effect of making the whole process slower than it would otherwise have been. Although the durations and the ordering of activities were specified, the critical path analysis established the most time-consuming activities that needed to be completed in priority order to alleviate future delays. On the other hand, the sequence of tasks in the existing setup did not appear to facilitate efficient functioning since they were disordered and could lead to congestion. Due to such operational inefficiencies, the movement of goods was not timely, which called for optimization in order to enhance productivity and lead to minimal delays in warehouse operations.

The critical path significantly impacted the process in the warehouse. According to Husin et al., the problems with the critical path affected the flow of work and could lead to delays in tasks. The study clearly pointed out that managing the sequence of tasks and eradicating congestion observed in the critical path analysis were crucial for enhancing the effectiveness of warehouse operations. Highly prioritized activities located on the critical path hence may have led to operational delays, calling for a proper assessment of the critical path to ensure constant and efficient circulation of materials (Manenti and De Toni, 2020). Disrupted and cramped task sequences, which were present on the critical path, had negative impacts on the flow of products in warehouses (Tamosaitiene and Gaigalis, 2020). According to these studies, critical path optimization was one of the critical factors that needed to be implemented for effective execution of tasks as well as achieving operational efficiency. These studies demonstrated how delays in the critical path negatively impacted production in warehouses.

Table 5. PERT data result of FredCor Coke Warehouse

Activity	Early Start	Early Finish	Late Start	Late Finish	Slack
A	0.00	1721.39	0.00	1721.39	0.00
B	1721.39	3535.63	1721.39	3535.63	0.00
C	13562.84	195252.96	13562.84	19525.96	0.00
D	10393.03	13562.84	10393.03	13562.84	0.00
E	10393.03	14353.83	15565.16	19525.96	5172.13
F	3535.63	10393.03	3535.63	10393.03	0.00
G	10393.03	12256.56	16286.92	18150.44	5893.89
H	3535.63	4551.28	18510.31	19525.96	14974.68
I	12256.56	13632.07	18150.44	19525.96	5893.89
	Project	19525.96			

The table 5 showed the PERT/CPM data result as a structured approach to FredCor Coke warehouse layout and processes, with clearly defined major activities and their timelines. The activity sequence began with Inbound (Activity A) and then proceeded to Outbound (Activity I), making it a process that could be considered highly controlled. Additionally, activities A, B, C, D, and F had no slack time. This implied that any delays in these critical tasks affected the overall project completion date to 19,525.96 time units. It underlined how important these activities were for maintaining the flow of the project and efficiency.

Activity E, which involved storing tasks, and Activity G, which involved validating, had slack times of 5,172.13 and 5,893.89 time units, respectively. As a result, this indicated that the schedule had an allowance. The warehouse structure also followed a logical path from receiving items to processing orders and finally distributing them, which was vital for efficiency. This could assist in absorbing unforeseen delays in other project areas or improving resource allocation. This result improved our comprehension of the current workflow and provided insights into possible improvements in resource management and process optimization of the warehouse system.

According to a study by Bagshaw (2021), project management emphasized that zero slack activities required rigorous monitoring, advising the application of PERT and CPM techniques to ensure critical activities adhered to critical schedules without delays. Furthermore, according to Iheonu et al. (2023), zero slack held an important position; activities with zero slack were very critical because they could not afford any delays without affecting the overall process flow. Inefficiency or delay at any point could disrupt the entire workflow. This directly emphasized that these activities required close monitoring and potential optimization for efficiency improvement.

3.5 Summary of Findings

The calculation and findings of the gathered data revealed that the current layout of the warehouse significantly hinders the workflow of the process, leading to the making of a new proposed organized layout. In the concise data that were gathered from the time study measurement of the current layout, the inefficiencies in the warehouse process were reflected in various stages of the process flow. The longest processing time occurred when locating empty bottles, covering 4,372 cm in 6,648.391 seconds, and picking, which covered 6,454 cm in 11,042.82 seconds. The shortest time recorded was during validation to outbound, covering 1,927 cm in 1,899.084 seconds, showing efficiency in final product checks. The warehouse layout hindered smooth operations, with excessive distances between critical areas, causing unnecessary movement and increased processing time. Inefficient in order fulfilment arose due to disorganized product placement, leading to longer retrieval times. Improving storage arrangement and streamlining workflow could improve overall efficiency.

The delivery process of Coca-Cola products further highlighted inefficiencies, particularly in the picking and locating stages. The picking stage, covering 2,933 cm, took 3,046.96 seconds, while locating spanned 4,857 cm and took 4,704.08 seconds, indicating delays due to poor organization. Storage also contributed to inefficiencies, covering 4,106 42 cm in 4,188.68 seconds. Despite outbound processes covering the longest distance of 8,026 cm, it had a relatively short processing time of 1,244.36 seconds, implying efficiency in final distribution. According to the theory of constraints (TOC), which posits that any complex system is limited in achieving its goals by a small number of constraints. In this case, the lengthy storage time could be identified as a constraint that hinders the workflow of the process. Also, the data showed that the pathways are not wide enough for trucks and forklifts to move in and out of the area. These findings suggested that better warehouse design and strategic product placement could minimize movement, reducing delays and improving workflow.

The delivery process of FredCor Coke products revealed that storage and picking stages had the longest processing times. The storage stage covered 4,557 cm in 8,884.723 seconds, while picking spanned 4,878 cm in 12,633.768 seconds. The significant time spent in these areas indicated poor warehouse arrangement, leading to navigation challenges and inefficiencies. The final validation stage covered 5,627 cm in 9,471.27 seconds, while outbound shipping was more efficient, covering 7,349 cm in 3,603.2 seconds. These results underscored the need for improved warehouse layouts, optimized workflows, and better inventory management systems to enhance productivity and reduce lead times.

Sales data from the FredCor warehouse demonstrated that Coca-Cola remained the most preferred soft drink, leading across all volume categories. Coke sales stood at 66.67% for the 1-liter category, 45.45% for 8 oz, and 50% for the 1.5-liter segment. Royal and Sprite had lower sales, with Coke maintaining dominance. Among alcoholic beverages, Kulafo was the top-selling product, holding 45.45% of sales, followed by GSM at 30.30%. The data indicated a strong preference for Coke in the warehouse, reflecting consumer 43 demand patterns. Soft drinks had higher sales volume than alcoholic beverages, suggesting potential growth opportunities in the non-alcoholic beverage segment.

The warehouse layout, as presented in the Muther's Grid, revealed inefficiencies in space utilization. The receiving and shipping areas overlapped, causing congestion and delays in workflow. The absence of clear pathways forced workers and forklifts to navigate through obstructed areas, reducing operational efficiency. The PERT/CPM analysis further highlighted inefficiencies in task sequencing. The critical path revealed that delays in key activities such as storing (Activity E) and validating (Activity G) could affect overall workflow. The total project completion time was 19,525.96-time units, with no slack time for major activities like inbound processing and order picking. Streamlining task dependencies and improving layout arrangement could improve efficiency and reduce delays. Conclusion After carefully analyzing the data using Systematic Layout Planning (SLP) and evaluating task plans and processes with Muthers Grid and PERT/CPM, the following conclusions were reached: It concluded that the researchers proposed to reorganize FredCor Coke Warehouse to maximize space use, improve processes including picking, locating, and storing, and increase worker efficiency and a productive working environment for warehouse employees.

3.6 Conclusion

After carefully analyzing the data using Systematic Layout Planning (SLP) and evaluating task plans and processes with Muthers Grid and PERT/CPM, the following conclusions were reached:

It concluded that the researchers proposed to reorganize FredCor Coke Warehouse to maximize space use, improve processes including picking, locating, and storing, and increase worker efficiency and a productive working environment for warehouse employees.

4. Recommendation

Based on the outcomes and conclusions, the researchers came up with a recommendation for FredCor Coke Warehouse, which will operate their business primarily in Danao City. Considering the data findings, to improve efficiency, improve processes including picking, locating, and storing, and utilize the space properly, the researchers proposed process flow and proposed an organized layout as shown in Figures 8 and 9 to guarantee that the customers are satisfied, reducing travel time and increasing overall efficiency.

The following recommendations are proposed to improve worker efficiency and productivity.

4.1 Proposed Process Flow of FredCor Coke Warehouse

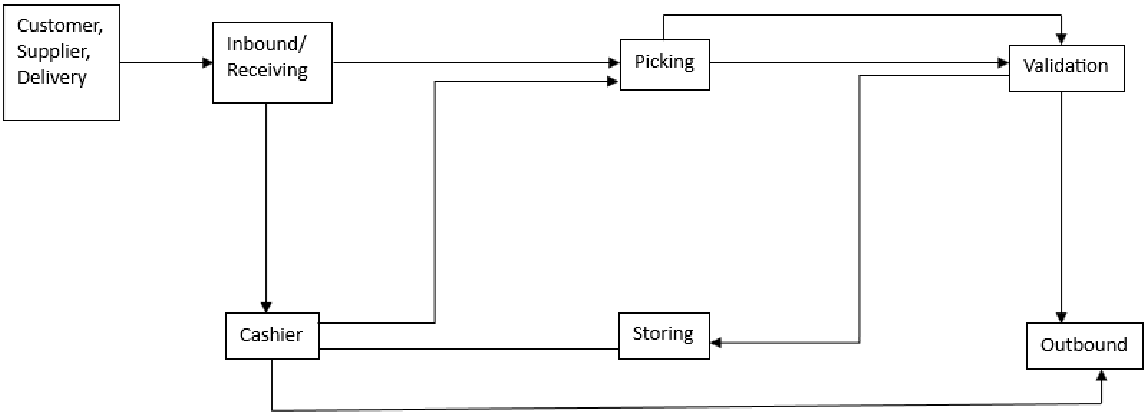


Figure 8. Proposed Process Flow for FredCor Coke Warehouse

The figure 8 shows the proposed operational flow of the FredCor Coke Warehouse is structured around three primary functions: customers, deliveries of suppliers, and delivery. The process begins with Coca-Cola products being delivered by suppliers, accompanied by delivery documents listing the products or returns. In the Inbound/Receiving area, the supervisor check all the items for damages or any changes, including counting of items and ensuring the items match those listed on the delivery documents. Workers use forklifts to off load all the fully packed bottles from the trucks into the storage compartment. Then after, the employees will repeat the same process for the empty bottles but this time they will be able to place them in trucks which are meant for delivery back to the suppliers. Afterwards the suppliers proceed to the Cashier to make payment before departing. For customer pick up, the process started by customers coming to the cashier to complete the order process by paying. The worker takes the unloaded empty bottles from the customer's vehicles and store them in the storage area. The ordered beverages are then taken out from the storage, once the orders are checked, the products are loaded onto trucks for transportation. Meanwhile, when consumers arrive with used bottles and have not placed any order, these used bottles are removed from the customers' vehicles, which could be cars, trucks, tricycles among others. The used bottles are then evaluated in terms of damages to determine if it can be reused or be recycled. Once evaluated, they use trolleys to transport the bottle back to storage areas as they are organized by their types or condition.

The new process flow of the warehouse emphasizes simplicity and efficiency by eliminating unnecessary back-and-forth movements. Through the rearrangement of the layout and the simplification of the tasks, there is an improvement in the operational flow from the deliveries to the pick-ups, as well as the customer return handling. With such changes, the completion of tasks is faster and more precise. This enhanced structure maintains the efficiency of the operations while simplifying the processes for all the people who are involved.

4.2 Proposed Layout of FredCor Coke Warehouse

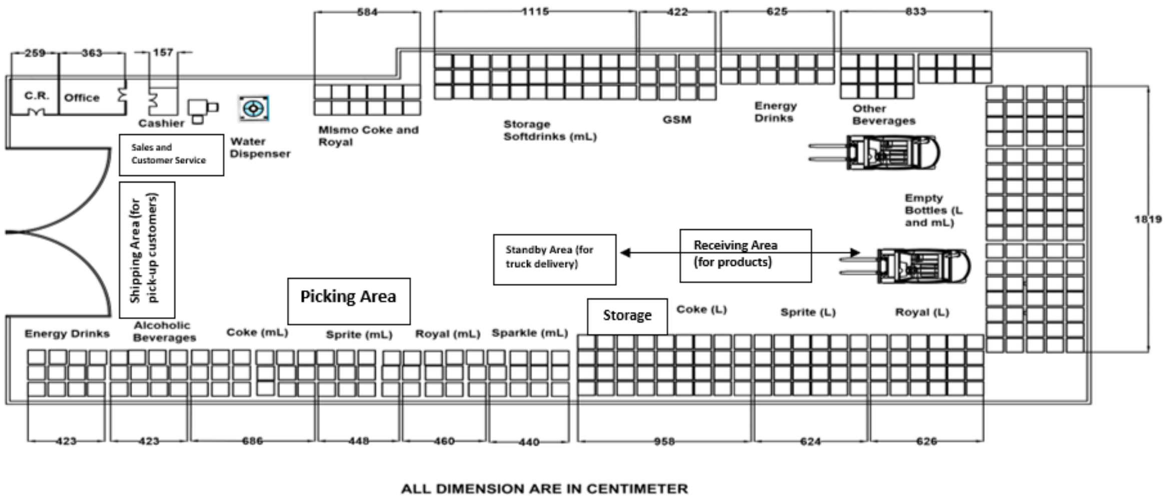


Figure 9. Proposed Layout for FredCor Coke Warehouse

4.3 Proposed Muthers Grid of FredCor Coke Warehouse

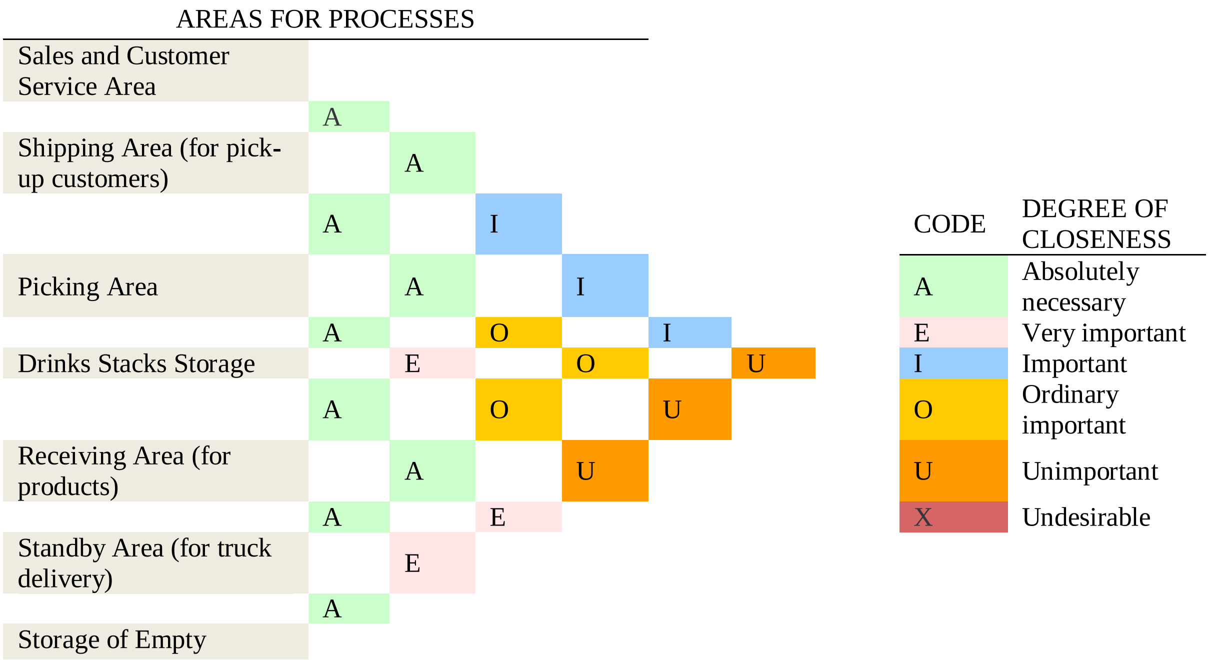


Figure 10. Proposed Muthers Grid for FredCor Coke Warehouse

The proposed muther grid shown is based on the proposed layout for FredCor's facility. After utilizing all the spaces and arranging all the products accordingly and based on popularity, the arrangement of areas has been designed based on the operational flow and the necessity of proximity between areas. Areas: Sales and Customer Service Area, Shipping Area (for pick-up customers), Picking Area, Drinks Stacks Storage, Receiving Area (for products), Shipping Area (for truck delivery), and Storage of Empty were all rated A because they are all absolutely essential to be next to one another. Thereafter, each area has been evaluated based on the degree of nearness and closeness necessary, ensuring an efficient process flow for FredCor's operations.

According to Muther & Lee, which is further quoted in a paper by Jasrotia et al. (2024), closeness rating by assigning closeness rating, from A for "Absolutely necessary" to X for "Undesirable," is emphasized in the method of Richard Muther's Simplified Systematic Layout Planning (SLP). As this approach guarantees that departments with high contact needs are must positioned next to one another. In addition, Principles of Process Layout Design by IWDSS (2019), proximity is to show relevance between areas in order to minimize travel distance. As the principles applied in the proposed layout of FredCor warehouse, guarantees an efficient work and process flow.

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