

Construction Services Company – Purchases Process and Warehouse System Improvements

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Abstract — *In the manufacturing industry, engineers focus on positively impacting all areas related to product output. When the output is tangible, several methodologies and assessments can be implemented to improve the production of this product. But when the output isn't tangible, implementing these methodologies becomes more complex, even more so when all the related variables are different. These situations tend to happen in the service industries, such as the construction industry. As part of this research, the construction industry has been selected due to identified issues affecting the service provided to internal and external customers. Many variables can affect the service provided in this industry but, the variables to be considered in this research impact directly the schedule and cost of a project. This research hopes to find a significant impact that positively changes the quality of the services provided and also seeks to find a positive impact on the scheduling and cost of projects.*

Key Terms — *Construction Industry, Inventory Control, Purchases Process, Warehouse Management.*

RESEARCH DESCRIPTION

This research will take place in the material and equipment management of the construction services industry. Three areas will be analyzed to improve each of them. These areas consist of (1) the material and equipment purchasing process, (2) the internal warehouse material and equipment management system, and (3) the internal warehouse material and equipment inventory control. These areas have been selected for the study because of existing material and equipment market shortages. These issues have negatively impacted project schedules and costs due to the material and

equipment shortage and long lead times for material and equipment deliveries. To improve the three areas mentioned, it is essential to identify the methods, systems, or any other useful tool that helps reach this research's objective.

RESEARCH OBJECTIVES

One of the objectives of this research is to identify how to proceed with the current market system regarding materials and equipment with a robust system that can have the capacity to reduce the time in the material and equipment purchasing process. Also, this system should facilitate the material and equipment purchasing system for all the parties involved. This system will also improve the internal warehouse's material and equipment management easily and effectively. Finally, this system will help the company view, track, and manage the equipment and material inventory easily and in real time.

Through this research and the analysis development of the areas to be studied, the expectation is to improve the processes in the purchase and warehouse departments. Additionally, by enhancing the purchasing department, the projects' schedules and costs are expected to be positively impacted. Improving the warehouse department, their system, and methods, including inventory control, the expectation is that all the parties will be able to use a reliable system that will aid them in viewing, tracking, and ordering what they need easily and effectively.

RESEARCH CONTRIBUTIONS

The most significant contribution of this research would be the ability to implement a system that can speed up ordering and purchasing materials

and equipment. Additionally, this research could contribute to implementing a control, monitoring, and management system for materials and equipment within the company's internal warehouse. Both implementations would bring the company considerable improvement in the purchasing and warehouse departments. These improvements would impact the process of all active projects being executed and, therefore, would positively impact the company's performance within the industry.

LITERATURE REVIEW

As part of this research, the areas of concern are the material purchase process, equipment and materials management in the internal warehouse, and inventory control. After reviewing previous studies [1, 2, 3, 4, 5, 6], the inventory control of the internal warehouse is a relevant area to research. Specifically, the inventory control of the internal warehouse, other studies provide insight into how the objectives to be achieved in this research can be achieved through the implementation of a robust inventory control system as per established by Anon [1] "By knowing in detail all the merchandise of a company, its flow, and operations can be better planned and organized." Even the purchasing department can be impacted, according to Conexión ESAN [2], where it was indicated that the inventory management and warehouse administration processes "... directly affect the management of the purchasing department and represent investment amounts that can represent a significant percentage of their assets." As part of the impact of inventory control on the purchasing department, the following benefits were found by Conexión ESAN [2]: (1) Generation of more excellent significant resources that could be used to purchase materials and assets. (2) Possibility of planning purchases. (3) Monitor cash flow to determine investment easily. (4) Reduces the material that will not be used. (5) Increased productivity and competitiveness.

Each of the previously mentioned benefits directly impacts the company's costs positively. A

company that manages to implement an effective inventory control system will benefit not only from functionality but also economically. Conexión ESAN [2] found a positive correlation between project cost and inventory control, thus indicating that economic benefit can be achieved.

The same study also emphasized the benefits of managing the inventory control system and warehouse management to optimize the company's operational logistics [2]. Lastly, the impact on the company's productivity, efficiency, and performance is beneficial. This productivity, efficiency, and performance impact places the improved company at high levels of competitiveness within the market to which it belongs. Therefore, it can be concluded that implementing an inventory control system is crucial and highly effective within a company.

The study by Suarez Presutti [4] further exposed the benefits and risks attributable to the issue of inventory control in warehouses. Suarez [4] found that one of the risks is material theft and said that poor inventory management in a warehouse or a company could even result in theft: storage items can be stolen without the knowledge of company management or even staff linked to the warehouse supervision activities, that is, common in cases where adequate techniques, methods, and support systems for continuous inventory tracking are not implemented.

Another risk found by Suarez [4] was related to production time and customer satisfaction due to poor inventory management. One of the most critical factors that a company must consider is customer satisfaction. Suarez [4] mentioned that poor inventory management is a crucial point that directly impacts customer satisfaction. Poor inventory management can cause limitations in the amount of material required to perform a task or project, resulting in production time loss. The before mentioned loss negatively impacts the schedule of a project and consequently will cause customer dissatisfaction. Similarly, this can occur if a customer requires service, and due to poor inventory management, the company can't provide

the service requested. This issue can give a wrong impression to the customer, and the company's competitiveness in the market can be affected. In contrast, a company with effective inventory control and optimal levels of essential material to satisfy customer needs will win long-term customer loyalty [4]. Olivo Narvaez [6] also found that poor inventory management negatively impacts the company's performance and customer satisfaction.

Another factor mentioned by Suarez [4] is the losses due to atmospheric events or unexpected sinister events. Most companies have insurance that covers all kinds of events that may affect their facilities, equipment, and materials, from hurricanes, fires, thefts, earthquakes, etc. With an effective inventory control system, the company could make accurate claims for the losses caused by the event. This also benefits the company by being able to reorder materials, achieving an efficient and fast inventory retaking process accurately.

An additional benefit is the excellent use of the spaces dedicated to storage. According to Suarez [4], companies that have a systematic understanding of their inventory also find that in the future, they will never need additional storage space (except if the installed capacities of production, marketing, or the business itself are expanded), since they efficiently managed the existing physical facilities dimensions destined for inventory operations. This information is essential since having material storage spaces implies considerable costs. Therefore, having inventory control in a company also results in cost control.

Some systems and methods were used in previous research [6, 7] to improve issues similar to those exposed in this study. Olivo Narvaez [6] uses the ABC System to classify the material in a warehouse. This system could determine the essential material required in a warehouse and the material that is not commonly used. This classification will help to have effective material inventory control in the warehouse. A study by Perez and Torres [7] also implemented a Materials Requirements Planning (MRP) System to supply the production material requirements using an

optimum inventory investment. This is also an objective of this research to improve the cost of projects and inventory storage.

In conclusion, several previous studies [1, 2, 3, 4, 5, 6] confirm that inventory control of a company's internal warehouse is the most significant interest needing further investigation. Establishing inventory control will impact the following areas (1) the construction material and equipment ordering system, (2) the internal warehouse material and equipment management system, and (3) the internal warehouse material and equipment inventory control.

METHODOLOGY

The method intended to be used in this research is brainstorming. Given that this research is looking at the output of a service, the first thing that must be done is to carry out a questionnaire to all the parties involved in the different areas of study of this research. The data collected from this questionnaire will be used to create brainstorming. Once the brainstorming is completed with all the collected data from the questionnaires, two tools will be used to identify the root cause of the problems identified in the questionnaires. One of the tools is the 5 Whys method, and the other is the Fishbone Diagram or Cause and Effect Diagram. The intention is to identify if the exact root cause will arise through both tools.

Once the root cause of the problem is identified, future research could be recommended. One of the future research recommendations is to use a section or portion of the company (a sample) to implement the possible improvement alternative to analyze the behavior and see if changes are identified that confirm that the desired objectives are met. If this selected portion (sample) of the company reflects positive changes, after analyzing the results and ensuring that the goals were achieved, implementing the improvement in the rest of the company (population) could be considered.

The steps of the project methodology are as follows:

1. Conduct a questionnaire to all parties involved in the system(s) to be investigated.
 2. Use the collected data from the questionnaires to create the brainstorming.
 3. Use the problems identified in brainstorming in both 5 Why's and a Fishbone Diagram tool.
 4. Analyze and identify one possible root cause or improvement alternative obtained by both tools.
 5. Recommend future research based on the collected data.
3. Incomplete requisitions of material or equipment movements between projects and warehouse.
- C. Warehouse Inventory Control
1. Little or no training for warehouse personnel.
 2. Unauthorized personnel performing material and equipment movements in the warehouse.
 3. Equipment cannot be tracked effectively or easily.

RESULTS

After receiving the results of the questionnaires, the observations were analyzed with the brainstorming tool. It was found that there are some problems identified in the three areas of study of this research. The issues identified in each area of study are:

- A. Purchasing Process
1. Incomplete requisitions
 2. Requisitions without explicit or complete material or equipment specifications
 3. Received material with incorrect specifications.
- B. Warehouse material and equipment management
1. Procedures are not followed correctly.
 2. Defective equipment received on projects from the warehouse.

The problems identified in the brainstorming were analyzed using the 5 Why's and Fishbone Diagram tools. Both tools show up a possible root cause for the issues identified.

RESULTS ANALYSIS – PURCHASING PROCESS

One of the problems identified in the Purchasing Process area is the incomplete requisitions. Figure 1 and Figure 2 present the results of both analyses. That is the outcome when using the 5 Why's and Fishbone Diagram tools.

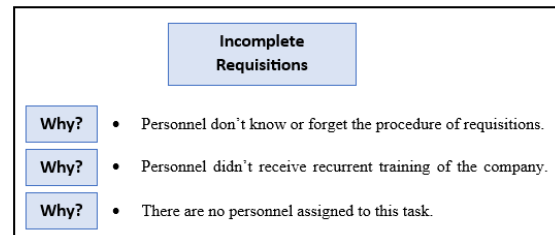


Figure 1
5 Why's Tool

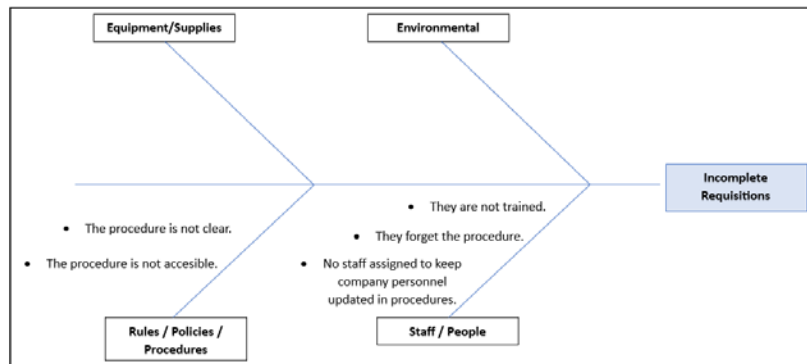
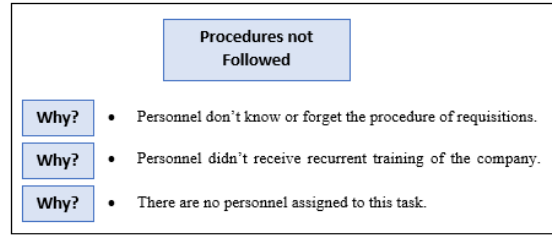


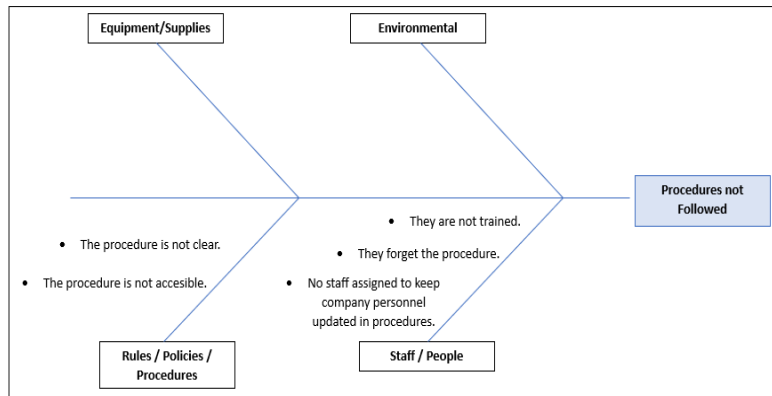
Figure 2
Fishbone Diagram Tool

RESULTS ANALYSIS – WAREHOUSE MATERIAL AND EQUIPMENT MANAGEMENT

One of the problems identified in the warehouse material and equipment management area is that the procedures are not followed correctly. Figure 3 and Figure 4 present the results of both analyses. That is the outcome when using the 5 Why's and Fishbone Diagram tools.



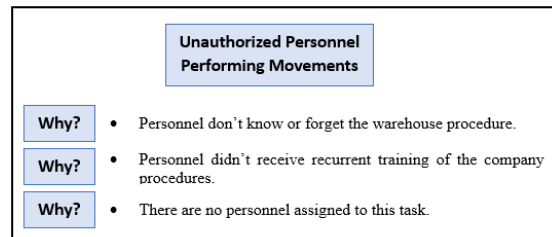
**Figure 3
5 Why's Tool**



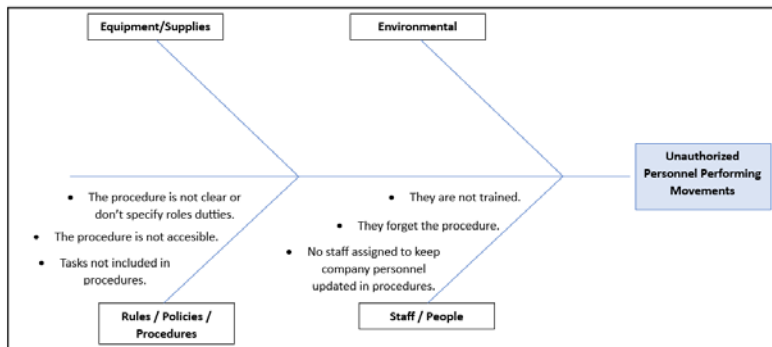
**Figure 4
Fishbone Diagram Tool**

RESULTS ANALYSIS – WAREHOUSE INVENTORY CONTROL

One of the problems identified in the warehouse inventory control area is that unauthorized personnel are performing material and equipment movements in the warehouse. Figure 5 and Figure 6 present the results of both analyses. That is the outcome when using the 5 Why's and Fishbone Diagram tools.



**Figure 5
5 Why's Tool**



**Figure 6
Fishbone Diagram Tool**

ANALYSIS

Both tools used for this research's three areas of study show a possible root cause of the identified problem in each area. This likely root cause is the same for all the analyzed problems of the three areas of study. This probable cause is that the company doesn't have someone accountable to update all the staff on the company procedures. Based on this, a possible recommendation and a potential improvement shall be to standardize all the processes in this research's three areas of study. Then, update the procedures and retrain all the company staff to ensure that everybody knows the right way to perform all the activities in the company. Another recommendation is to complete recurrent training (e.g., annually) on the company procedures to keep all the staff updated. These recommendations will improve the company's performance with internal and external customers. The economic impact may not be reflected immediately but at the end of the projects due to the reduction or elimination of delays of equipment and or materials purchases and management. These recommendations also allow the project managers to prepare more accurate project schedules and bring reliability to the company processes and procedures.

CONCLUSION

Several problems were identified in brainstorming after receiving the answers to the questionnaires. This could mean that several root causes will be determined. Still, the tools used reveal that no matter how many problems can be identified in a company, several root causes will be recognized. This research shows that one root cause affects several areas in the same company.

In conclusion, the recommendations of this research may be simple or bring the perception of no effective or positive results. For example, one of the most essential things in a company is the economic impact, and the recommendations provided will not provide an immediate economic impact. But, if these recommendations are

implemented effectively, they may considerably change the company's performance and give it a competitive position within the industry. So, these recommendations can be implemented with minimal effort and economic investment, and the results may be considered positive for the company.

REFERENCES

- [1] Anon. (2021). *Control de inventario: claves para un mejor servicio al cliente* [Online]. Available: <https://www.mecalux.com.mx/blog/control-de-inventario>.
- [2] Conexión ESAN. (2016). *Gestión de inventarios y almacenes* [Online]. Available: <https://www.esan.edu.pe/conexion-esan/gestion-de-inventarios-y-almacenes>.
- [3] C. Portal. (2011). *Gestión de inventario, stocks y almacenes* [Online]. Available: <https://www.gestiopolis.com/gestion-de-inventario-stocks-y-almacenes/>.
- [4] D. Suárez. (2011). *Gestión de inventarios y almacén* [Online]. Available: <https://www.gestiopolis.com/gestion-inventarios-almacen/>.
- [5] G. Westreicher. (2020). *Control de inventario* [Online]. Available: <https://economipedia.com/definiciones/control-de-inventario.html>.
- [6] Y. Olivo Narváez. (2021). *Optimización de espacio y recursos en el almacén* [Online]. Available: <http://hdl.handle.net/20.500.12475/1113>.
- [7] R. Pérez & I. Torres. (1991). *Diseño de un sistema para el control de producción e inventario en una fábrica de ataúdes* [Online]. Available: <http://hdl.handle.net/20.500.12475/1403>.