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Storage Equipment for Woodstock Assembly Line

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Abstract

This addition storage design proposal aims to improve the efficiency of the Woodstock production line by reducing cycle times through the implementation of new storage equipment and material handling systems. The current process is plagued by delays and inefficiencies in material handling, leading to longer cycle times and reduced productivity. The proposed design is expected to reduce cycle times by up to 10%, resulting in increased productivity and cost savings. In the proposed design for storage equipment and material handling, worker safety is of utmost importance. The use of tin shoulder, scissor, and air pressure gun can pose potential hazards to workers if not properly managed. Therefore, the design will incorporate several safety features to mitigate any risks. Overall, the new storage and material handling system will help the Woodstock production line remain competitive in the market and better serve customer demands.

Keywords: - Manual material handling, material handling, cycle time, storage equipment

1. Introduction

1.1 Background

The manufacturing industry has been hit hard by the COVID-19 pandemic, which has led to production restrictions and closures due to its high reliance on the workforce and complex supply chain. However, companies can still innovate and pivot to overcome these challenges by making process improvements, managing their supply chains better, and investing in automation and information technology. This is crucial for their survival in these difficult times. The automotive industry is a vital contributor to the economies of both developed and emerging nations, and its performance can impact a country's economic development. Before the pandemic, the automotive industry was expected to grow steadily. WSA Engineering Sdn. Bhd. is a top supplier of automotive parts to Proton, Perodua, and other automakers in Malaysia. They have two product categories: automotive parts and interior design services. They have produced headliners, door trims, and floor carpets for various automotive components. Their main customers include Proton, Perodua, Honda, Hyundai, Toyota, Volkswagen, and Volvo. Additionally, they have also produced commercial carpets for interior design sectors, which have been used in the interior design of various buildings.

Due to the high demand for automotive parts, particularly D51A, this study aims to design a storage equipment for Woodstock assembly line while analyse its impact for the line. Storage equipment in manual material handling can significantly improve production efficiency. By utilizing appropriate storage equipment, workers can store and access materials quickly and easily, reducing the time spent searching for materials and improving productivity. Efficient storage also helps to prevent damage or loss of materials, reducing waste and costs. Additionally, storage equipment can help to organize materials and create more space in the work

environment. This reduces the risk of accidents and injuries due to cluttered or cramped working conditions, improving overall safety in the workplace.

1.2 Objectives

1. To identify the problem regarding storage equipment in workstation.
2. To design the material handling new storage equipment (Manual Handling - Storage Equipment) in WSA Engineering Sdn. Bhd.
3. To analyse the impact of storage equipment for Woodstock Line

1.3 Production Plant Layout

The most appropriate production layout for manufacturing large quantities of standardized goods or services is the assembly line, also known as repetitive manufacturing. This involves producing the same item multiple times in order to achieve a specific production rate. The assembly line is typically a dedicated production line that operates continuously throughout the year, producing identical products. The speed of the production process can be adjusted to meet the specific needs of individual customers.

1.4 Process Flow Headlining P213A

There are 5 workstations in process forming of headlining. The technique on the assembly line has been chosen based on the bike timetable. Fig. 1 below shows the product that being produce at Woodstock line.

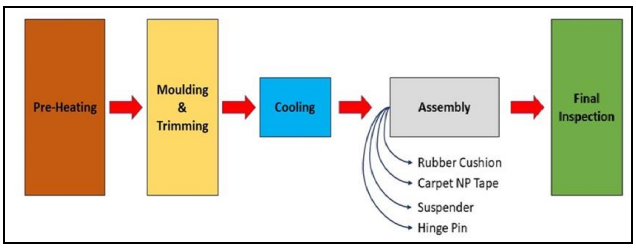

Fig. 1. Product produced at Woodstock line

2. Literature Review

2.1 Material Handling

Material handling is a critical component of any manufacturing process, and recent research has focused on improving the efficiency and safety of these operations. One study by Song and Lee (2021) examined the impact of various material handling methods on productivity and efficiency in manufacturing operations. The authors found that automated material handling systems were more efficient than manual methods, particularly for high-volume production processes. The use of automated systems also reduced the risk of worker injury and improved overall safety in the workplace. Another study by Etebari et al. (2020) investigated the impact of material handling on supply chain management. The authors found that effective material handling systems can improve supply chain efficiency by reducing lead times, inventory costs, and transportation costs. The study also emphasized the importance of integrating material handling systems with other supply chain technologies, such as warehouse management systems and transportation management systems.

In a study by Yao et al. (2021), the authors developed a simulation model to optimize material handling in manufacturing operations. The model was used to evaluate the impact of different layout designs and material handling methods on production efficiency and overall costs. The authors found that an optimal material handling system could reduce production costs by up to 23%. Finally, a study by Yousuf et al. (2021) focused on the role of material handling in sustainable manufacturing. The authors emphasized the importance of reducing waste and improving resource efficiency in material handling operations, and highlighted the potential for automation and other technologies to improve sustainability.

2.2 Manual Material Handling

Manual material handling refers to the process of moving, lifting, and carrying materials and products by workers, without the use of automation or mechanical equipment. This process can be physically demanding and can increase the risk of work-related injuries. Recent literature has focused on improving manual material handling practices and reducing the risk of injury. A study by Park et al. (2020) investigated the impact of a manual material handling training program on worker safety and productivity. The authors found that the training program improved worker knowledge of safe material handling practices and reduced the number of work-related injuries. The training program also led to improved productivity and efficiency in manual material handling tasks.

In another study, Chung et al. (2021) investigated the impact of ergonomic interventions on manual material handling tasks. The authors found that ergonomic interventions, such as adjusting workstations and providing lifting aids, reduced the risk of musculoskeletal disorders and improved worker comfort and productivity. A review by Ayoub and Mabrouk (2021) highlighted the importance of effective manual material handling practices in the healthcare industry. The authors emphasized the need for healthcare workers to use proper lifting techniques and to have access to appropriate lifting equipment. The review also emphasized the importance of training programs and ergonomic interventions in reducing the risk of work-related injuries in healthcare settings.

In a study by Kim et al. (2021), the authors developed a wearable device to monitor worker posture and movements during manual material handling tasks. The device was designed to provide real-time feedback to workers and supervisors, with the goal of improving worker posture and reducing the risk of injury. The authors found that the device improved worker posture and reduced the risk of musculoskeletal disorders. Finally, a study by Lee et al. (2020) investigated the impact of age and experience on manual material handling tasks. The authors found that older workers and less experienced workers were more likely to experience work-related injuries during manual material handling tasks. The study emphasized the need for targeted training and ergonomic interventions to reduce the risk of injury in these populations.

2.3 Cycle Time

Cycle time is an important metric used in manufacturing to evaluate the efficiency of a production line. In woodstock production, cycle time refers to the time it takes to complete one cycle of production, from the start of one piece of wood entering the production line to the completion of one finished woodstock product. This metric is important because it directly affects the overall production capacity and can be used to identify opportunities for process improvement.

In a study by Li et al. (2020), the authors evaluated the impact of different production factors on cycle time in a wood-based panel manufacturing plant. The study found that the type of wood material used had a significant impact on cycle time, with thicker and harder woods resulting in longer cycle times. Additionally, the study found that equipment maintenance and production speed were important factors in reducing cycle time and increasing production capacity. Another study by Wang et al. (2018) investigated the impact of automation on cycle time in a wood furniture production line. The study found that implementing automated material handling systems and robotic equipment resulted in a significant reduction in cycle time and increased production efficiency.

In a more recent study by Alam et al. (2021), the authors evaluated the impact of lean manufacturing principles on cycle time in a wood furniture manufacturing plant. The study found that implementing lean manufacturing practices, such as reducing waste and optimizing production flow, resulted in a significant reduction in cycle time and increased production efficiency.

2.4 Storage Equipment

Material handling is an essential aspect of many industries, including manufacturing, construction, and warehousing. Various tools and equipment are used in material handling operations, including scissors, shoulder, and air pressure guns. Efficient storage and management of these tools and equipment are crucial to enhance productivity and reduce the risk of injuries.

Scissors are commonly used in cutting operations, and they come in different sizes and designs. According to the Occupational Safety and Health Administration (OSHA), scissors should be stored in a secure and easily accessible location to prevent accidents. Wall-mounted scissor racks are a popular storage solution, as they allow easy access and minimize the risk of injuries. Scissor racks come in various designs, including magnetic racks and sliding racks, depending on the size and number of scissors to be stored (OSHA, 2019).

Shoulder and air pressure guns are used for lifting and moving heavy loads, and they require specialized storage equipment. Shoulder gun holders are designed to hold the gun securely, and they come in various sizes and shapes, depending on the type of gun. The holder should be mounted in a location that is easily accessible and does not obstruct other operations (Sentry Protection Products, 2021).

Air pressure guns are commonly used in material handling operations, and they require specialized storage equipment to ensure their safety and longevity. According to the Canadian Centre for Occupational Health and Safety (CCOHS), air pressure guns should be stored in a clean, dry, and secure location to prevent damage and accidents. Wall-mounted gun holders and cabinets are popular storage solutions, and they come in different sizes and designs, depending on the number and size of guns to be stored (CCOHS, 2021).

In conclusion, the storage and management of scissors, shoulder, and air pressure guns are crucial aspects of material handling operations. Proper storage equipment, such as wall-mounted racks and gun holders, should be used to ensure the safety and longevity of these tools. Employers should also ensure that their employees receive adequate training on the safe use and storage of these tools to minimize the risk of accidents and injuries.

2.5 Impact and advantages of material handling

Material handling is an essential component of manufacturing operations as it ensures the smooth flow of raw materials, work-in-progress (WIP), and finished goods within the factory. Material handling is defined as the movement, storage, and control of materials within a manufacturing facility (Muther, 2011). Effective material handling techniques and equipment have a significant impact on the overall efficiency and productivity of a manufacturing plant.

a. Advantages of Material Handling

i. Improved Efficiency: Material handling equipment and techniques improve efficiency by reducing the time and effort required to move materials within the factory. Automated equipment such as conveyor belts, robotic arms, and AGVs (Automated Guided Vehicles) can perform material handling tasks more efficiently than manual labor, reducing production cycle times (Srinivasan et al., 2020).
ii. Cost Reduction: The use of material handling equipment such as conveyor systems, forklifts, and pallet jacks, reduces labor costs and improves material flow within the factory. Automated equipment reduces labor costs and reduces the risk of workplace injuries, which can be costly for the company in terms of medical bills, workers' compensation, and lawsuits.
iii. Increased Safety: Proper material handling equipment and techniques enhance workplace safety by reducing the risk of workplace injuries. Automated equipment reduces the risk of injuries caused by manual handling of heavy loads and repetitive motion injuries (Muther, 2011).
iv. Improved Quality: Efficient material handling processes and equipment can improve product quality by reducing product damage, contamination, and defects. Automated equipment such as robotic arms and AGVs can handle materials more precisely and delicately than manual labor, reducing the risk of product damage (Srinivasan et al., 2020).

b. Impact of Material Handling

i. Production Cycle Times: The use of material handling equipment reduces production cycle times, resulting in increased productivity and reduced lead times. Automated equipment such as conveyor belts and AGVs move materials faster and more efficiently than manual labor, reducing production cycle times (Muther, 2011).
ii. Inventory Management: Effective material handling techniques improve inventory management by ensuring the smooth flow of raw materials, WIP, and finished goods within the factory. Automated equipment such as pallet jacks and forklifts can move materials more efficiently, reducing inventory holding costs and improving inventory control (Srinivasan et al., 2020).
iii. Capacity Utilization: Material handling equipment and techniques enable manufacturers to utilize their production capacity more efficiently. The use of conveyor systems, robotic arms, and AGVs ensures that materials are moved quickly and efficiently within the factory, reducing bottlenecks and idle time (Muther, 2011).
iv. Customer Satisfaction: Efficient material handling processes and equipment can improve customer satisfaction by reducing lead times, increasing product quality, and ensuring on-time delivery. Effective inventory management and material flow ensure that products are delivered on time and meet customer quality standards (Srinivasan et al., 2020).

Effective material handling techniques and equipment have a significant impact on the efficiency and productivity of manufacturing plants. Proper material handling equipment and techniques reduce labor costs, increase safety, improve product quality, and reduce lead times. Automated material handling equipment such as conveyor systems, robotic arms, and AGVs provide significant advantages over manual labor in terms of speed, precision, and efficiency. The impact of effective material handling includes improved production cycle times, inventory management, capacity utilization, and customer satisfaction. In conclusion, material handling plays a vital role in the success of manufacturing operations, and manufacturers should invest in proper material handling equipment and techniques to optimize their operations.

3. Methodology

3.1 Observational Research

Observational research is a type of research design that involves observing and recording the behavior of individuals or groups in their natural environment. This research design is often used to gain insights into behavior that cannot be studied using experimental methods. In an observational research study, researchers observe and record behaviors, actions, and events without manipulating any variables (Loria, Sancho & Ruiz-Olabuénaga, 2021). Observational research is a valuable tool for researchers in various fields as it allows them to gain insight into real-world behaviors without interfering with them (Gelso & Hayes, 2018). However, observational research also has limitations, such as potential biases and limitations in generalizability. Nonetheless, the insights gained from observational research can provide a foundation for future research and inform practical applications. Fig. 2 below shows the overall research methodology for this study.

Fig. 2. Overall research methodology

3.2 Data Collection

Based on observations and survey, the most significant problem that needs to be solved is in the Woodstock assembly line which requires improvement in safety and material handling at the area. Efficient material handling and safe working practices are essential for industries such as the Woodstock line, which produces Package Tray Trim for Perodua Myvi (D51A). However, accidents can still occur if proper procedures are not in place. One such risk factor is inadequate storage for sharp and hot items, which can cause injuries if left lying around.

Fig. 3. Woodstock line and targeted area

In addition to this, another risk factor is the improper setup of tools for assembling the Package Tray Trim. The tools, which include a shoulder, scissor, and air pressure, need to be set up carefully and correctly to ensure safe and efficient operation. If not set up properly, workers may take the wrong actions, leading to accidents and injuries as can be seen in Fig. 4.

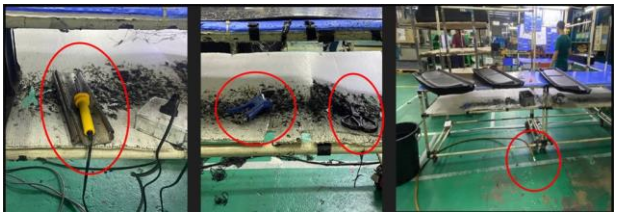

Fig. 4. Woodstock assembly table condition

4. Discussion

The Woodstock line must implement appropriate storage practices for sharp and hot items, such as labeling and organizing containers, to reduce these risks. Additionally, workers should receive sufficient training on how to set up assembly tools correctly as well as how to use them safely and effectively. Worker training properly can lower the risk of accidents and increase productivity. Making new shoulder, scissors, and air gun storage equipment can benefit industries that use these tools for material handling and assembly operations in a number of ways.

First off, having specialized storage equipment made just for these tools can keep them well-organized and accessible. Workers won't have to waste time looking for the right tool, which can help save time and increase productivity. Second, using the right storage tools can help keep the tools from getting damaged, extending their lifespan and lowering the frequency of replacements. Inadequate tool storage can result in loss or damage, which can cause production to be delayed and increase costs for the business. Thirdly, the safety of workers can be enhanced with storage equipment made for these tools. The storage apparatus can be made to allow for proper labeling and grouping of tools according to their use and any potential dangers, like hot or sharp edges. This can lessen the likelihood of workplace accidents by preventing employees from inadvertently using the incorrect tool or coming into contact with hot or sharp surfaces. This gave rise to the concept of designing a tool storage system, as shown in Fig. 5.

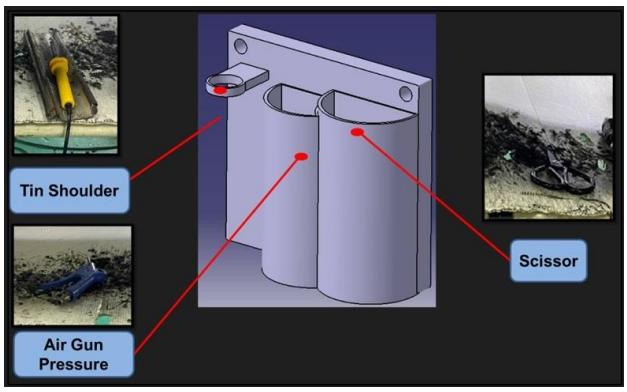

Fig. 5. Design for storage equipment at Woodstock assembly workstations

A typical style of container used to store a variety of substances, including compressed gases, liquids, and powders, is cylindrical storage equipment made of stainless steel. Due to their strength and resistance to corrosion and other forms of damage, these containers are frequently used in industrial and laboratory settings.

Cylindrical stainless steel storage equipment is a great choice for safely storing scissors, shoulder, and air gun pressure. A variety of equipment can be stored safely and effectively in these containers, which can also be equipped with specialized fittings and valves. For instance, a pressure relief valve can be added to a stainless steel storage container in the form of a cylinder that is intended to hold air gun pressure in order to prevent overpressurization and ensure secure storage. Similar to this, special racks or compartments can be added to a container made to hold scissors safely in order to safeguard the blades and ensure proper handling. Overall, stainless steel storage equipment in the form of cylinders is a great option for securely keeping scissors, air gun pressure, and shoulders. These containers can be tailored to meet particular storage needs and offer durability and corrosion resistance.

4.1 Before Improvement Made

The workers at Woodstock line had to spend a significant amount of time searching for tools before storage equipment was implemented on the assembly line. It took them over 5 seconds to locate a single tool. When you consider that the production line churns out approximately 200 pieces per day, this lost time quickly adds up. In fact, workers were wasting around 1,340 seconds or roughly 22 minutes per day searching for tools. This was an inefficient use of time and impacted the overall productivity of the operation. Table 1 shows the collected cycle time to find the equipment tools before the implementation of storage equipment.

Table 1. Overall cycle time of process including to find equipment tools (before)

No.	D51a Package Tray Trim	Time Measurement Cycle Time Process			
		1	2	3	Average
1	Pre- Heating	64s	66s	63s	64.3s
2	Molding & Trimming	86s	87s	84s	85.6s
3	Cooling	126s	125s	122s	124.3s
4	Rubber Cushion Assy	37s	34s	39s	36.7s
5	Carpet NP Tape Assy	30s	29s	28s	29s
6	Suspender Assy	68s	65s	67s	66.7s
7	Hinge Pin Assy	36s	37s	38s	37s
8	Searching for Tool	6s	9s	5s	6.7s
9	Final inspection	57s	58s	55s	56.7s
	TOTAL				570s

4.2 After Improvement Made

The implementation of storage equipment on the assembly line helped to alleviate this issue by providing a dedicated location for tools to be stored. This made it easier for workers to locate the tools they needed, reducing the time spent searching and increasing overall efficiency. This completely erase the time taken to search the tools. Table 2 shows the Cycle time to find the equipment tools after the storage equipment being made.

Table 2. Cycle time overall process (after)

No.	D51A Package Tray Trim	Time Measurement Cycle Time Process			
		1	2	3	Average
1	Pre- Heating	64s	66s	63s	64.3s
2	Molding & Trimming	86s	87s	84s	85.6s
3	Cooling	126s	125s	122s	124.3s
4	Rubber Cushion Assy	37s	34s	39s	36.7s
5	Carpet NP Tape Assy	30s	29s	28s	29s
6	Suspender Assy	68s	65s	67s	66.7s
7	Hinge Pin Assy	36s	37s	38s	37s
8	Final inspection	57s	58s	55s	56.7s
	TOTAL				563.3s

5. Conclusion

The study begins with the importance of proper equipment for material handling and storage. This is crucial in industries that store compressed gases or liquids in specialized containers. To ensure safety and efficiency, storage equipment must be designed for the substance. Procedures boost production, which is the second point. This streamlined Perodua Myvi package tray trimming process increased production. This emphasizes the need for well-designed procedures that optimize workflow and minimize time and effort.. To reduce injury and ensure equipment safety, proper training and safety procedures should be implemented. Proper storage equipment helps identify equipment. In industries that require equipment storage, this is important. Using easy-to-identify storage equipment saves time and reduces errors during equipment retrieval. By emphasizes problem-solving when identifying material handling and storage issues, its

creating workflow-optimizing and cycle-time-reducing solutions requires creativity. The sixth point emphasizes new design to reduce cycle time and motion. To maximize efficiency, material handling and storage practices must be evaluated and improved. Seventh, a new storage design reduces operator movement. This underscores the importance of designing material handling and storage practices to minimize movement and reduce injury and accident risk.

Finally, the Woodstock assembly line's 5S implementation indirectly addresses material handling and storage efficiency. Sorting, organizing, cleaning, standardizing, and maintaining a workplace is the 5S principle. This method can create a tidy, productive, and safe workplace. The study concludes that manufacturing material handling and storage must be efficient. It emphasizes proper equipment, well-designed procedures, user and employee protection, creative problem-solving, new design, and 5S. These practices improve workflow, productivity, and safety in businesses.

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