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Applying 5S Lean Methodology in Wasef Mutee Furniture Company

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DECLARATION

I declare that no portion of the work referred to in the dissertation has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Author,

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ABSTRACT

With increasing market competition, rising customer quality awareness, the need for better efficiency, less variability, cost reduction, and quality improvements force managers to become keener on continuous improvement and adopt it as the norms of the organizational culture. In this context, lean management discipline is used to effectively and efficiently improve business processes via the effective combination of the different tools of lean.

This research aims to implementing 5S methodology to reduce waste and improve the process at a Palestinian furniture industry: Wasef Mutee Furniture Company. Secondary data obtained via the compilation of relevant literature to establish the effectiveness of lean management, and examine through such literature the main lean implementation framework that manufacturing operations' resembling that of the Palestinian furniture's use towards the achievement of a value driven and waste free business process.

The main challenges and obstacles encountered within the internal processes are identified through the collection of qualitative data, collected through ''field visits'' of the facility in Ramallah. More specifically one specific value stream within the facility's overall structure of departments (value streams) was selected as a pilot and built on the collected data to implement lean tools to identify and minimize incidental work and eliminate waste within the system where possible and as agreed by the facility owner.

Subsequently, evaluation of the conducted interviews with the owner and several carpenters reveal that the main problem facing the company is the lack of space. Analysis of the collected data using the cause-and-effect diagram, Pareto chart, and eight wastes elimination

lean tools indicate that the main concerns are waste excess, plant layout, and the lack of an inventory control system.

The implementation of lean management by the internal stakeholders significantly improved the production process at the company. Specifically the team has been able to minimize several types of wastes namely bottlenecks, excess employee movements, and surplus and obsolete inventory. In addition safety has been enhanced, and plant layout has been improved. Finally, the acquiring of a financial accounting software became apparent for sustaining the newly adopted warehousing managerial procedures.

Keywords*: Lean Management, Eight Wastes, 5S, Pareto Chart, Cause-and-Effect Diagram.*

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Chapter One: Introduction

1.1. Background

"The most dangerous kind of waste is the waste we don't recognize."

(Shingo Shingo)

Imagine a workplace full of clutter and waste which become an integrated part of the organization that the personnel don't even notice the untidiness which hinder the work process. Lean management is the elimination of non-value-added work from the customers' perspective in a business process.

Aside from waste reduction, the numerous benefits of lean manufacturing include, but are not limited to, the increase of product quality, increase of the equipment's efficiency, and decrease of the lead times. Originating in 1978 by the Toyota Motor Corporation, lean management facilitates better communication between various work centers and develops the organizational behavior in a positive manner (Bhamu & Sangwan, 2014). In today's competitive markets, all organizations need to adopt lean management in order to run in an efficient and effective manner as to not only to grow but also to survive (Kumar & Kaushish, 2015).

This research implements lean management in local Palestinian factory called Wasef Mutee Furniture Company (WMFC). An in-depth analysis of the elements hindering productivity is defined. The current process measurements and the data is analyzed in an effort to define

the root causes of the deficiencies. Ultimately, the study seeks to improve the production methods by using different tools in order to sustain the gains by installing innovative process controls.

1.2. Company Profile

WMFC is a custom-made furniture factory specialized in the design and production of home and office furnishings. The family-owned business has been founded in Ramallah, Palestine in 1952 by Nayef Mutee (Wasef Mutee's father) who established Al-Hashimi Furniture Factory. Incorporating new technologies and ideas compatible with modern designs, Wasef Mutee took possession of the woodshop and developed in time to become Wasef Mutee Furnishings, the leading and largest custom-made furniture factory in Ramallah.

Employing over sixty employees, the current manufacturing site consists of two floors. The ground floor has been utilized since 2002 with one thousand square meters. The factory expanded in 2007 into another floor with six hundred square meters. In 2010, the company expanded by opening a large showroom of imported furniture to complement its services.

1.3. Problem Definition

Although the WMFC has an excellent reputation for great workmanship in the region, yet it has a great reputation for delayed delivery time. It is well known amongst not only engineering and design houses, but also amongst potential customers, that it is nearly impossible to have the company meet any agreed upon target completion dates. Various reasons are attributed to this bad reputation.

Even though the shop is categorized as a notable size business, no organizational structure is in place. The company currently employ 65 employees while only four of them are of an administrative position. The organization not only lacks a warehouse manager, but also lacks a warehouse management system & controls; there is no even any space dedicated to inventory warehousing.

It has been noted that the shop floor is jam-packed with a lot of wood scrap, unorganized raw material storage, and faulty machinery which create a waste of the available space and hinder the process flow. All types of woods are stored together unsorted which cause the workers to waste a lot of time sorting and seeking the correct wood for a needed production.

Finally, an important issue that must be addressed is the vast amount of finished goods scattered in the shop waiting for the final stages of the production process: molding and painting. It is evident that the company is in great need of development and improvement in vast areas of its operations.

The lack of historical data prevents the research from utilizing several lean management tools due to the inability to equating measurable improvements. Moreover, WMFC lacks the basic essences of lean management principles. Thus, 5S lean tool has been selected as the preeminent tool in order to eliminate waste and enhance the process flow.

1.4. Research Aim

Increasing customers' demands of delivering quality customized products, in a timely manner, and at valuable prices are demanding producers of the furniture industry to seek lean managerial methods in order to reduce costs and increase production efficiency. This research aims to assist WMFC in implementing 5S methodology, the foundation tool of lean management, to eliminate waste and enhance process flow.

1.5. Research Questions

The research investigates the manner by which to implement lean management in WMFC. The main areas of concern which are aimed to be addressed are:

- How can lean management be part of every employee's daily working routine?
- What are the type of wastes that exists in WMFC?
- What are the lean tools suitable for eliminating the identified wastes?

1.6. Research Objectives

- Identify types of wastes.
- Recommend appropriate lean tools and techniques applicable to WMFC
- Improve process flow
- Eliminate bottleneck
- Increase floor space
- Organize inventory and work area

1.7. Research Expected Outcomes

The significant consequences of implementing waste elimination and process improvements in WMFC are:

1. Improve layout.
2. Efficient internal processes.
3. Floor space savings.
4. Increasing production efficiency.
5. Improving the inventory and warehouse management system.
6. Increasing safety & employee morale: more organized and ordered work place.

1.8 Methodology of this Research

The methodology of this research is divided into three phases: study of existing system, utilization of lean tools, and evaluation of new state.

A detailed study of the existing system is carried out where the research capitalized on the case study approach and progressed to obtaining primary data through a field study of the subject facility, interview with stakeholders, and observations. Several analysis tools such as the eight wastes and fishbone diagram had been utilized to obtain qualitative data identifying the root causes of the problems in order to implement the necessary improvements.

Upon the identification of the wastes to be eliminated, lean solutions, such as the 5S, had been applied. It is noteworthy to mention that although solutions had been developed in the

form of 5S implementation, yet 5S auditing was conducted throughout the duration of the work to evaluate its' progress. The 5S execution was divided into four sub-projects, since the size of the factory was too large to be considered as one requiring an abundant number of employees to be included in the execution of the project. This made the implementation of 5S more efficient.

For the measurement of success and evaluation of the progress, interviews prior and after the implementation of the improvement tools have been conducted. Furthermore, floor check template have been developed to measure the overall organized and cleanliness of the factory.

1.8.1 Thesis Structure

To provide an overview of the structure employed for this thesis, it is useful to outline the chapters comprising this paper:

- **Chapter Two: Literature Review.**

  The literature review exhibits an overview of Lean Management, definition of lean thinking, lean principles, lean tools, and eight wastes.

- **Chapter Three: Research Methodology.**

  Upon distinguishing between qualitative and quantitative research, the research methodology illustrates the manner by which the qualitative data has been compiled relating to lean management, its effectiveness, implementation methods, and the evaluation process.

- **Chapter Four: Gap Analysis.**

Detailed identification of the current process flow, plant layout, and the major problems facing the organization's production are explicitly portrayed in this chapter.

- **Chapter Five: Lean Implementation.**

Implementation of the 5S lean tool in the factory has been validated.

- **Chapter Six: Conclusions and Recommendations**

Consisting of three main sections: Results, Recommendations, and Lessons Learned. All the contributions of the study, executed interpretation, and analysis are illustrated and explained.

1.9 Chapter Summary

A brief summary has been illustrated to present the thesis concept providing a background on the main issues and presenting the research questions at hand. The employed research methods including the target group and the structure of this thesis have been outlined. The following chapter presents an overview of previous work on related literature and studies done to provide the necessary background for the purpose of this research.

Chapter 2: Literature Review

2.1 Lean Management

The foundation of the Just-In-Time system (Later Evolving "Lean Production") were laid by Taiichi Ohno, a Japanese Engineer who studied the traditional mass production system and realized it does not work for Japan's fragile economy (Cheng, and Podolsky, 1996). Considering the fact that having a mass production system would limit variety, an alternative production system to be developed and utilized was imperative. According to Womack, Jones, & Roos (1990), the Just-In-Time (JIT) also called the Toyota Production System (TPS) was a better approach to meet the increasing challenges of survival through focusing on people, plants, and systems.

In the mid 1980's, as Bhasin and Burcher (2006) state, a five year project was launched by researchers in the Massachusetts Institute of Technology (MIT) and was called the International Motor an Vehicle Program (IMVP). The purpose of the project was to assess the performance gab between Western and Japanese Motor Industries in 52 assembly plants in 14 countries. According to Liker (2004), the results of the project were published in a book called "The Machine That Changed the World" by Womack and Jones (1990). The book, as Liker puts it, described the profound revolution achieved by the Toyota Manufacturing system which rapidly replaced mass production. In this book the term "Lean Production" was coined to represent the JIT or Toyota Production System. As Karlsson and Ahlstorm (1996) point out, Womack (1990) realized that Lean Production was not confined to the

manufacturing function of the organization but included product development, procurement and distribution.

A core principle of lean which is rigorously practiced in lean factories is continuous improvement. Continuous improvement, or Kaizen, cannot be achieved radically or during a specific amount of time. Rather, incremental small improvements are made over a long period of time which gradually makes the process better. Some of the common lean tools are Total Productivity Maintenance (TPM), Failure Mode and Effect Analysis (FMEA), 5S, Quality Function Deployment (QFD), Kaizen, Kanban, Value Stream Mapping (VSM) and Mistake Proofing (Dale, 2003; Shah and Ward 2007). Lean production, as Jackson (1996) argues, seeks to significantly reduce manufacturing and production lead time, create higher worker efficiency, greater flexibility, longer machine life, and to bring down inventory levels. This is accomplished by utilizing a Cellular Layout rather than an assembly line in a traditional Mass Production System (Jackson, 1996).

In lean production, the main reason underlying the improvement techniques and tools that are undertaken is the elimination of waste, which as Tie-Jun & Sha (2008) claims is the heart and soul of the system. Wahab (2013) mentions the eight types of waste: transportation, Inventory, Motion, Waiting, Over Production, Over Processing, Defects, and Skills.

2.2 Lean Principles

Kippenberger (1997), in a paper discussing the content of "The Machine That Changed The World", argues that to eliminate waste, lean thinking defines a way to re-specify value, line up value, create actions in the best sequence, conduct activities without interruption, and ensure activities are performed with a high level of effectiveness. In that context, Womack and Jones (1996) specify the five main principles that have become the paradigm for many manufacturing and service organizations. These principles constitute the whole essence of lean and serve as a guideline for implementation when pursued sequentially as follows:

2.2.1 Value

Emiliani (1998) contends that value is specified by the end-user (the customer), and that the product or service must meet the customer's needs or expectations at both a specific time and price. The author adds that specifying value requires understanding what other people want or expect you to be, what they want or expect to hear, what they want or expect to see or to have you say or do. Womack and Jones (1996) state clearly that in order to create value, one should put into consideration that it is necessary to challenge its traditional definition, thus defining it in terms of the whole product and determining the target cost.

As pointed out Kippenberger (1997), managers of companies are misled by outdated definitions of value by focusing merely on what they can make or do rather than what the customer wants. Emiliani (1998) expands on the issue, claiming that the thousands of routine and sophisticated procedures and things that producers do in order to deliver goods are actually of little interest to customers. Kippenberger (1997) adds that managers should

rethink their business on a straight forward product-line basis and engage in objective dialogue with their customers.

2.2.2 The Value Stream

Identifying the value stream, as Emiliani (1998) argues, is to understand all the activities required to produce a specific product, and to optimize the whole process from the view of the end user or customer. Womack and Jones (1990), according to Kippenberger (1997), define the value stream as all specific actions required to bring a specific product (whether a good or service) through the three critical tasks of management of any organization or business: The product Definition Task (from concept definition through design to full launch), the Information Management Task (from order taking through scheduling to delivery), and the Physical Transformation (from raw material to the finished product with the customer). According to Kippenbergher (1997), the concept of value stream mapping means that lean thinking should not be confined to the boundaries of an individual firm, but to look at the entire set of activities that are involved in creating and delivering value.

2.2.3 Flow

After specifying value and identifying the value stream in which activities occur, it is vital to emphasize smooth product flow. This implies that bottlenecks in processes have to be minimized and therefore a smooth flow of activities taking place should be maintained (Elmiliani, 1998). In the traditional batch-queue production system, flow is frequently interrupted due to the enormous number of products passing through every process, thus leading to more Work-In-Process building machines. Ultimately, batches of produces will

have to wait before every process or function until the preceding batch is processed. According to Slack and Chambers (2006), five of the eight wastes directly affect continuous flow: Waiting time (for product in manufacturing or customer in services), Transport, Inappropriate processing, Excess Inventory, and Unnecessary motion.

2.2.4 Pull

The concept of pull, as indicated by Kippenberger (1997), means that operations upstream should not start unless it is in direct response to demand downstream, meaning from the customer. In other words, instead of companies pushing their products to customers in huge amounts and having them stored in warehouses waiting for demand, the customer pulls the product through the plant. This form of small-lot production means that the plant manufactures only what is ordered and when it is ordered.

2.2.5 Perfection

Emiliani (1998) continues to suggest that as organizations accurately specify value, identify the entire value stream, make the value creating steps flow continuously, and let customers pull value, a virtuous circle is ultimately created to enable the pursuit of perfection. Perfection, means that there are endless opportunities for improving the utilization of all types of assets within the organization. Maskell and Bagalley (2006) assert that perfection, as a natural outcome of the four preceding elements of lean, requires sufficient understanding of principles of quality improvement such as TQM. They claim that lean manufactures use both continuous improvement and breakthrough improvement to make ongoing changes in their operations. As appealing as the concept might seem, Emiliani (1998) goes back to

suggest that it can never be fully achieved. However, its pursuit is worth struggling for because it helps maintain constant awareness against wasteful practices.

2.3 Lean Tools and Techniques

Lean Tools are exceptionally significant that many companies start off their lean journey by perceiving lean as a set of 'tools' to implement. Although, the whole managerial approach of an organization must be aligned with the lean philosophy but significant consideration must be given to lean tools and techniques for they are the backbone of lean management.

2.3.1 The 5S

A simple notion that many organizations fail to implement: the idea of everything having its place, everything is in order, limited amount of materials used often, and just enough of what one does use. In the matter that this can be achieved, many of the wastes will be eliminated; not only will employee; safety and satisfaction levels increase but they will be capable of increasing their efficiency for time

2.3.1.1 5S: The Foundation of Lean Management

In alignment with the lean philosophy, the 5S operation model has been accepted as the primary tool of lean manufacturing. It facilitates establishing the system and operational stability required by manufacturing organizations to ensure and maintain successful lean manufacturing succession (Brady Worldwide Inc., 2008). 5S improves orderliness and cleanliness while creating comfort and safe working environment. Although the goal is to

increase labor productivity, the system aims to eliminate all the non-value added actions, such as the wasted time in the processes. 5S is a vital constituent for an organization seeking kaizen and a lean manufacturing site with the primary goal of delivering the right product at the right time to the right customer (internal & external) in the right quantities. It has been envisioned that the 5S is a philosophy which influences continuous improvements in workplace productivity, quality, throughput and safety (Kumar and Kumar, 2012).

According to Ablanedo-Rosas et al. (2010), 5S is the basic tool of running lean and it is a very good way to help the company to reduce the wastes and enhance the profits. Hence, in a lean system, the 5S model is a tool which visually portrays an organization's hindrances and obstacles (Hirano, 1995), 'visual control systems are about improving value added flow' (Liker, 2004). The objective of the 5S is to attain orderliness in the workplace, improving safety and efficiency whilst reducing the product defects rates (Dennis and Shook, 2007).

Benefits of successful 5S implementations include reduced number of searches, improved cleanliness, easier to recognize faults, reduced walking and movement, reduced downtime, reduced safety risks and accidents, improved flow, fewer mistakes, improved workspace visual management and improved space utilization (Chapman, 2005). These benefits bring overall improvements in productivity, quality, cost, delivery, safety and morale (Singh and Ahuja, 2015).

2.3.1.2 The Need of 5S in Today's Industries

In today's competitive markets, industries must increase demand without increasing the selling price of its products. This required both the manufacturing and service organizations

to reduce costs by improving their production efficiency and other related operations in order to enhance their profitability. Therefore, in order to achieve the aforementioned goals, it is necessary to adopt the 5S principles in all types of various industries. The 5S principle has transpired as an effective foundation for improving a variety of aspects in the lean manufacturing advancements increasing the profitability of the organization by removing waste from the manufacturing process and continuously improving the organizations functions. The 5S initiative provides the framework and discipline required to successfully implement a variety of lean manufacturing continuous improvement initiatives in an organization (Singh and Ahuja, 2015).

2.3.1.3 Pillars of 5S

The five pillars of the 5S model are, Seiri, Seiton, Seiso, Seiketsu and Shitsuke, have been translated from their Japanese origin to become the foundation of lean management tools. The 5S initiatives have been referred to as the five keys to a total quality environment (Abdul Aziz et al., 2014). Osada (1991) defines 5S as the baseline for a total quality environment.

Sort, set in order, shine, standardize and sustain, is the beginning of a healthy, comfortable and productive life for everyone at work.

SORT (Seiri)

Keep what you need while losing what you don't need.

In accordance with specific rules or principles', sorting means 'to put things in order – to organize them (Osada, 1991). Initially, a distinction must be made between what is needed and what is not needed in order to create a system that works effectively. This activity helps to eliminate unnecessary items from the workplace enabling the efficient usage of the space. Unnecessary items are stored offsite or disposed of minimizing hazards and clutter.

SET IN ORDER (Seiton)

Everything has its place and is put there after use.

With the aim of having all items set in a designated space or even creating a layout so that people can access what they want with minimum effort. An organization can achieve the aim by prioritizing the necessity and importance of the goods/equipment and by maximizing the easiness of access. "This activity involves ensuring designated locations for all items in the workplace, thereby facilitating employees to have efficient control over the operations and helps employees to meticulously plan materials, supplies, or tools requirements" (Brady Worldwide Inc., 2008). According to Kaushik (2011) setting in order is the method of which an organization arranges tools in a sequence which minimizes the searching time of the tools and items.

SHINE (Sieso)

A clean workplace will ensure a clear vision detecting quality issues rapidly.

This phase includes three basic activities which include cleaning the workplace, maintaining its appearance, and preventing dirtiness. Shining at the workplace eliminates dirt, dust, fluids and other debris (Brady Worldwide Inc., 2008).

STANDARDIZE (Seiketsu)

Implement rules, standards, and a system to keep everything sorted, straightened, and shined.

At this stage, the team develops standard operating procedures to establish improved workplace practices (Osada, 1991). In addition to developing a unified approach throughout the organization, the standardization phase will promote visual standard work instructions such as color coding, flowcharts, checklists, and labelling.

SUSTAIN (Shitsuke)

Maintaining the new situation and continuously seek improvements.

This phase is critical in the understanding and implementation of 5S for it aims to preserve the achievements of attained accomplishment of all the 5S initiatives. "It requires a continuous auditing process for maintaining the performance enhancement realized through 5S program" (Patel and Thakkar, 2014).

2.3.2 The Gemba Walk

Genchi Gembutsu used the Japanese term meaning “going to the real place”, to establish an essential tool of implementing lean management philosophy called “The Gemba Walk”. Its’ foremost purpose is to allow managers and leaders to observe the actual work process, engage with employees, gain knowledge about the work process, and explore opportunities for continuous improvement.

Gemba is one of the core tools of lean management. Liker (2004) suggests that the main idea of Gemba is to go and observe the actual work place and understand how things are done, ask questions, identify the waste in the process, and finely correct the problem. Gemba should be part of company’s culture, manger should do it regularly (Womak & Jones, 1997). As Liker states in his article, mangers should show their employees the respect and interests of their work and listen to their problems carefully (Liker 2004).

The Gemba Walk stresses:

- Observation: the fundamental principle of the method is to provide in person observations.
- Value-add Location: In contrast to discussions being made in a meeting room, the method allows the observing where the work is being performed.
- Teaming: In spirit of Kaizan, the Gemba Walk encourages interactions with the people and the process.

Baugh (2011) illustrates the four steps in conducting a successful Gemba Walk:

I. Identify Your Purpose: Managers should know why and what they are seeking prior to initiating the Gemba walk.

II. Know Your Gemba: To specify exactly what activity they need to thoroughly comprehend.

III. Observe With a Framework: There is a difference between looking around, and observing which is primarily derived from the observational framework. Do you just see what is on the surface? Do you see equipment, people, and material? Does the framework allow the observer to analyze and communicate what one is observing? Whether in the board room or on the shop floor, all work is made up of these components.

IV. Validate What You See: After done with observation, it is time to discuss the conclusion with the one who is doing the job to validate the observation result.

2.3.3 Cause-and-Effect Diagram

Also known as the fishbone diagram and Ishikawa diagram, the cause-and-effect diagram is an effective yet effortless root cause analysis tool used in lean thinking (Koripadu, & Subbaiah, 2014). The head of the fish (diagram) will enlist the conceptualized problem, while the symbolic body of the fish will specify what the problems and challenges are. If a detailed reason for the overall problem is identified, each branch will have its own brand hierarchy and will describe the root cause at the end of the branch. The organization generally analyzes six factors which are mainly contributing to the main defect:

measurement, material, machine, mother nature, man power (personal), and method as illustrated in Figure (1).

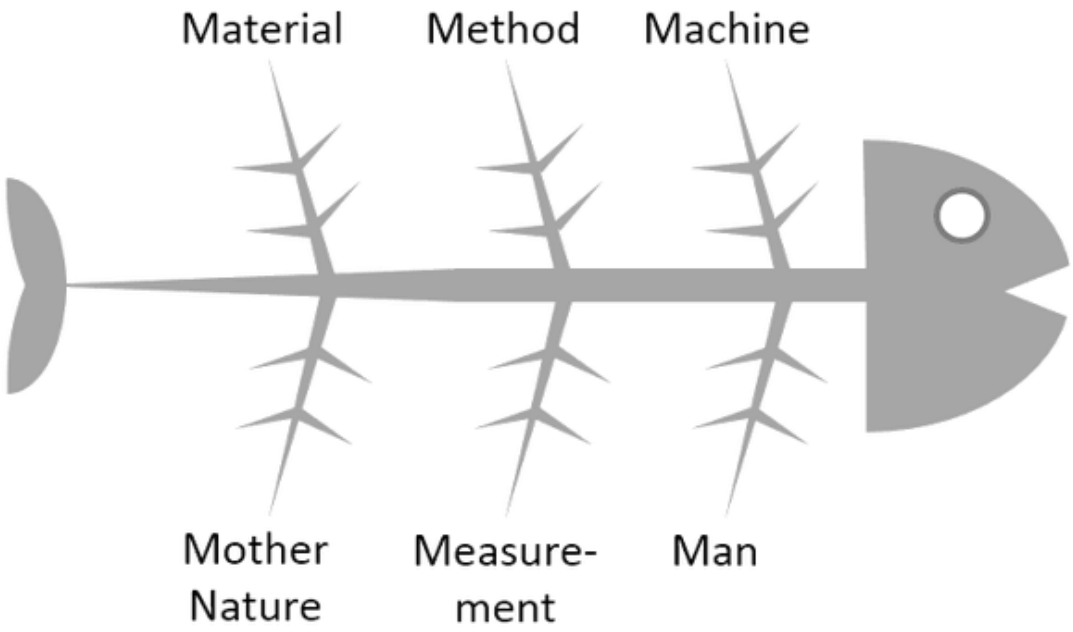


Figure 1 Fish bone diagram (Koripadu, & Subbaiah, 2014)

2.3.4 Voice of the Customer

Voice of the Customer (VOC) is the notion that the wants and needs of the customers are the core to any business or service. Anything done by an organization that does not provide value to the customer is labelled as waste and should be minimized or eliminated. The primary purpose of listening to the VOC is to gain a clear understanding of the customer's wants and needs, and then to translate those requirements into a plan of action (Aguwa, Monplaisir, & Turgut, 2012).

In each industry, there are two types of customers: internal and external customer. External customers are those who use the products of the company and are not directly part of the organization. Internal customers are people who are directly involved in the organization such as the employees themselves. Considering the needs of internal customers will lead to the involvement of people in the continuous improvement (Mcalister, 2015).

The VOC can be obtained by conducting focus groups, surveys, and interviews; nonetheless, this research will solely focus on the interviews.

2.4 Categories of Waste: Muda, Muri, & Mura

Lean can be summarized as the systematic pursuit of perfect value by eliminating all kinds of waste in all organizations' processes (Bandell, 2006). Therefore, all companies who strive to be successful should focus on eliminating waste as well as increasing their value-added activities (Naslund, 2008). During the development of lean management, The Toyota Corporation categorized waste into three types called the 3M's: Muda, Muri, and Mura. Variation in the demand will prompt unevenness: Mura, subsequently exerting pressure on the workers and machines which lead to overburden: Muri. Thus, Mura and Muri lead to waste: Muda (Bicheno & Holweg 2009).

2.4.1 Mura

Meaning irregularity, lack of uniformity, inequality, Mura is the type of waste known unevenness. In an organization with a variation in demand, it is unattainable to achieve a fast uninterrupted flow of production. The unevenness prompted by the variation of demand,

Mura, may be speculated as the root cause of waste in a company (Bicheno and Holweg, 2009).

2.4.2 Muri

The unevenness (Mura) caused by the variations in demand, will exert pressure on the workers and machines which in turn will cause overburden (Muri). Indubitably, the unevenness in the process, Mura, will lead to the overburdening of workers and machines: a type of waste called Muri. Overburdened workers will evidently suffer from work stress and are at elevated risk of being exposed to injuries. Similarly, overloading a machine is unreasonable for when pushed beyond limits. It is evident that not only will the break down time will be increased, but the efficiency and the quality level of the produced work will also be jeopardized. According to Bicheno & Holweg (2009), the overburdening of people and machines simultaneously may result in accumulation of work in process.

The excess burden of workers and machines (Muri) is a waste. Pleasure, comfort, and safety must be part of the organization's culture (Bicheno & Holweg 2009). If both humans and machines are overloaded at the same time, queues can accumulate and eventually the organization will not be able to achieve its' targets (Bicheno & Holweg 2009).

2.4.3 Muda: The Eight Deadly Wastes

Unevenness (Mura) causes overburden (Muri) resulting in waste (Muda). "Variation in the demand is unevenness (Mura). Unevenness in demand will put a pressure in workers and machines which lead to overburden (Muri). Mura and Muri lead to Muda" (Bicheno &

Holweg 2009). A cumulative increase of waste causes even more unevenness. This develops a cyclic problem that can quickly expand if not handled (Feld, 2000). The reduction of waste will be ascertained through the elimination or reduction of the causes of Muda, Muri and Mura, therefore, reducing costs and improving profits.

The main target of lean thinking is still to focus on eliminating wastes in all areas and functions within the system. It is extremely important for organizations to understand the nature of its waste and how to eliminate it, in order to create a successful lean organization (Taylor & Brunt, 2001). Initially, the implementation of lean should start by recognizing the types and the sources of waste in the system.

The 8 wastes according to Jeffery Liker (2004) are listed below:

1. **Transportation**: Whether it is the movement of people, product, equipment, or material in a process, transportation must be minimized for any unnecessary movement will be classified as waste.
2. **Inventory**: Excess raw material and products that are not being processed are categorized as waste. The longstanding caused by the excess inventory might lead to deterioration of the material excreting further financial waste on the organization. However, the waste is not exclusive to a financial matter, but it is further witnessed through the waste of space which the excess inventory occupies.
3. **Motion**: Unnecessary movement by people is a major type of waste. All excess movement must be eliminated by having all tools and other components easily accessible. The layout of the facility should be standardized in order to eradicate double handling.

4. **Waiting**: Any waiting time in the process flow is a major type of waste. This waste includes waiting time of operators caused by other operators for any reason even if the cause of the inefficiency is the operators themselves. Major causes of such a waste are the lack of space, bottlenecks in the process, and equipment failure.
5. **Overproduction:** Whether occurring either by producing more than needed or producing before it is needed, overproduction challenges the efficiency of flow of goods, wastes inventory space, and forms excessive lead-time. Often caused by uncoordinated production planning, overproduction is an enormous waste in all types of businesses. Overproduction makes the flow of goods a challenging practice whilst wasting inventory space and creating excessive lead-time. This phenomenon often appears when production is ahead of demand, piling up the inventory.
6. **Over processing**: This type of waste occurs as a result of more work or higher quality is produced than what is originally required by the customer. A result of non-standardization, over processing causes unnecessary motion and produces defects. The lack of methods' standardization, especially when there are variations between the operators' methods, result in over processing. Process methods should be consistent in order to avoid over processing.
7. **Defects**: A type of waste which cannot be totally eliminated, as we are working with human beings. Defect means wasteful handling, time, and effort, causing rework, scrap, and incorrect information. High number of customer complaints, high inspection level, and broken products are good examples of defects.
8. **Skills:** Employees are the highly valued assets of any organization. At a time when organizations seek to utilize its' assets to the fullest, they seem to ignore a treasured asset:

their employee's skills and creativity. Not tapping into this resourceful asset is a waste that must not be ignored. Underutilizing people's talents, skills, creativity, and knowledge in the improvement of process and practices. Human potential requires clear communication as to what is needed both from management and to management. It requires commitment and support, a culture of trust and mutual respect, and it requires interest and involvement at the workplace

2.5 Production Process Elements

2.5.1 Throughput Time and Bottlenecks

The bottleneck determines the throughput of the supply chain. A supply chain bottleneck (or constraint) is the required resource which consumes the longest time to operate in a supply chain for a particular demand. A phenomenon which is widely apparent in all types of businesses, bottleneck is simply a process in a chain of processes that its limited resources will affect the capacity of the whole chain. It is through lean management where organizations can recognize and resolve bottlenecks that delay work or processes (Modig and Ahlstrom, 2015).

Bottlenecks increase the processing or throughput time of a process. In general, the bottleneck-related process has two features. The first characteristic is usually having a queue just before the bottleneck, regardless of whether the process goes through material, person, or information. The second typical characteristic is when other tasks immediately after the bottleneck should wait. Hence, any organization will maximize revenues by increasing the

efficiency of bottlenecks while ensuring that all other resources are geared at supporting bottleneck operations (Modig and Ahlstrom, 2012).

2.6 Previous Studies

The popularity of 5S implementation has spread throughout various industries. The profuse number of studies conducted in a wide range of organization infer the benefits of implementing this lean managerial tool.

Ashraf, Rashid & Rashid (2017) deliberate the implementation of 5S lean management in R5 Food & Beverage Ltd, a privately owned company in Bangladesh with twenty employees. A producer of various food & beverage items such as bottled water, juice, and candy, the company faced several obstacles in running its operation due to various problems in space availabilities, labor productivity, and workplace cleanliness. The lack of systematic procedures and knowledge regarding the importance of waste elimination were the main reasons underlying these problems. The 5S implementation recovered 28.80 sq. meters of space while providing the company with adequate cost savings. Moreover, the productivity of the factory increased by 38.65% and products' defectiveness decreased by 6.1%.

Another study by Deshpande & Joshi (2016) presents a small scale Indian multiproduct manufacturing company who suffers from protracted lead times. Through an investigation of the root causes, the company found that additional lead time is necessary due to wasted searching times and prolonged setup times. It was concluded that setup time was reduced by 6% and searching times reduced by 18% due to the successful implementation of 5S.

Span Autotech Pvt. Ltd deals in manufacturing of sheet metal components. Kakka, et al. (2015) examines the obstacles Span Autotech faced such as unorganized workplace, obsolete products, missing tools, wasting time searching for raw material and tools, hindrance in material movement, transportation between stations, and an unsafe working environment. 5S implementation in Span Autotech eliminated obsolete products and other wastes, reduced transportation time, and decreased the required searching time for tools and raw materials. Furthermore, implementing 5S made Span Autotech a safe working environment.

Patel &Thakkar (2014) state that the objectives of the research are to reduce the process wastes, streamline the process flow, maintain proper quality controls, improve storage facilities, increase safety levels, and establish process cost savings in the a ceramics manufacturing company. Implementing 5S and Gamba Walk helped to improve space efficiency, establish a safe working environment, significantly limit the margins of error, improvement of inventory control system, and improvement of equipment maintenance and thus efficiency.

Due to cluttered work-stations, excessive scrap accumulation, and work stress generated from large search time for the retrieval of tools, Bikanervala Food Pvt. Ltd search for a solution to be leaner by achieving process standardized, work simplification, safety, and inventory reduction. Kumari, et al. (2018) illustrate the manner by which 5S implementation was the necessitated solution.

The research study conducted by Lingareddy et al. (2013) includes investigations and developments in manufacturing factories due to 5S implementation. The adopted strategy aided to minimize manufacturing process time and increases the available work area. The

solution recognized by the 5S approach minimized waste in the production process and ultimately contributed to the development of the organization. The inspection process was carried out on the basis of the 5S checklist, and the results were analyzed in order to identify major changes such as increased production and quality efficiency while improving safety in the workplace.

Khedkar et al. (2012) study implements the 5S methodology in S.P Plastic Industry MIDC, Nagpur. According to the research, the implementation not only significantly improved safety, productivity, efficiency, but drastically limited possible fraud in the company due to the implemented controls.

Prefab Factory in Amman, Jordan is a manufacturing company of prefabricated buildings. At a time when the company is witnessing a growth in the demand, the pressure to improve work conditions compelled the company to improve their process concurrently decreasing their cost and increase their profit. The plant had an undefined process flow, excessive waste, unorganized workstations, and an unhealthy working environment. This lead to increase in production costs, low worker moral, and product delivery delays. By implementing 5S, Prefab Factory was able to achieve its objectives increasing its effectiveness in manufacturing and assembly work, improving workflow, and enhancing the workplace layout (Al-Aomar, 2011).

In India, the survival and growth of a small-scale industry is highly dependent on innovation capability, operational efficiency, and increased productivity. Lean production is one of the methods which focus on cost savings by elimination of waste. V.M. Auto Manufacturing Company adopted the 5S methodology in order to increase storage space, create standards

and procedure for the factory, reduce non value-added activity, improve safety, and increase work efficiency (Agrahari, Dangle & Chandratre, 2015).

According Journal. I, (2016) lean manufacturing is a method adopted to shorten the time between the customer order and delivery time (lead time) by eliminating non value added activities. SV Engineering Ltd., a leading valve assembly manufacturer wanted to reduce lead-time and increase throughput of high pressure gate valve production. By utilizing value stream mapping, SV Engineering was able to identify the value and non-value added activities. The major predicament was the company's batch mode production manner. Converting to one piece production process flow facilitated SV Engineering Ltd to reduce lead time and minimize the non-value add.

Jebadurai, Rose, & Aattisugan (2017) depicts 5S implementation in a manufacturing company's warehouse facility. In addition to the absence of standards, the main wastes observed in the warehouse are space utilization and the presence of obsolete & unnecessary items. The solution to remove waste through 5S had been adopted. Space utilization improved and unnecessary items have been removed. Not only appropriate cleaning had been done but progressive improvements and sustainability have been observed and maintained through the adoption of a set of standards.

2.7 Lean in the Furniture Industry

Adapting lean manufacturing approach in wood processing is a fairly new concept in the furniture industry. According to Fricke & Buehlmann (2012) only 55% of the companies that are members of the Wood Component Manufacturing Association (WCMA) are

implementing a lean Manufacturing ideology. Moreover, Fricke & Buehlmann (2012) emphasize that 47% of the wood products and furniture manufacturing industry in the state of Virginia, United States of American, have implemented Lean Management at a time when 72% have heard about the concept.

In a wood manufacturing case study, Alvaro, Almeida, and Pereira (2015) portrays the manner by which the Covelo Pinto Wood Company embarked on implementing lean management tools to address several challenges such as high lead time, intermediary stock, waiting times, and transport and handling. As a consequence, several lean tools were implemented such as VSM, 5S, and visual management which resulted in significant reductions in waiting and cycle times, while using product oriented layout and pacemaker process to develop process flow.

An article articulated by Quesada-Pineda (2008) exhibits the manner where various factories utilized lean manufacturing practices to improve and enhance productivity. Due to the adaptation of a lean manufacturing philosophy such as continuous improvement, one piece flow, and waste elimination, Inova Company witnessed an increase in sales of 44%.

By adapting lean management, factories such as Cabtec Manufacturing became more efficient and productive. Implementing the concepts of waste reduction and one-piece continuous flow manufacturing, the company was able to increase its production efficiency by 50 %. Through careful listening to its' internal customers, the company found ways to organize and reuse waste pieces of particleboard (Adams, 2006).

Similarly, Canyon Creek, a wood cabinet manufacturing company, was able to significantly reduce operator travel time, floor space, and work in process by implementing several lean management tactics such as 5S, waste identification, work load leveling, and root cause analysis. The company was able to standardize the work methods and changed the process layout. Furthermore, the company applied the Kanban system for inventory control enhancing its inventory management (www.solutionsforwood.ca).

Lean management is virtually a new managerial concept in the Palestinian market. Thus, rare cases are presented in this field. However, an unpublished Palestinian master thesis by Alhaj Hassan, (2018) has been able to implement lean six sigma in Al-Mimi United Company for Wood and Trading aiding the company in reducing accumulated inactive accessory products and improving the receiving and storing processes. Upon implementing the research, the company's storage area has increased by 70 m^2.

2.8 Chapter Summary

The main purpose of the literature review is not only to portray the various principles, tools, and other elements of research but predominantly to survey previous cases on knowledge sharing. There is a general agreement between all previous studies that implementing lean managerial tools significantly reduce various types of waste and enhance the production efficiency which ultimately lead to cost reduction. Although one study of a Palestinian company has been portrayed yet the similarities of the circumstances may be viewed extensively in most of the Palestinian industries. Due to the competitive nature of the industry, many companies implemented lean management philosophies not in the aim of

cost reduction but principally to improve and enhance productivity, a conception which WMFC critically necessitates.

Chapter Three: Research Methodology

1.1 Overview

The aim of this study is to investigate the implementation of various lean management tools in a WMFC. This chapter explains in detail how the research has been conducted and the reasoning why qualitative research has been selected. Subsequently, the chapter illustrates the manner by which the data has been collected and explicated. This research, is mainly characterized as qualitative, rather than quantitative

1.2 Qualitative Research

Qualitative Research is the 'non numerical examination and interpretation of observations, for the purpose of discovering the underlying meanings and patterns of relationships' (Casebeer and Verhoef, 1997). Qualitative research can further be defined as 'any kind of research that produces findings not arrived by means of statistical procedures or other means of quantification' (Strauss and Corbin 1990). In contradiction to statistical analysis, qualitative research focuses on an in-depth analysis of beliefs, aptitudes, and capabilities. Hence, qualitative methods are concentrating more on the individual than on the general mass (Mayring 2007). According to Gill and Johnson (2005) qualitative research is much more subjective than quantitative research and refers more to meanings, symbols, metaphors, concepts, and characteristics of things. Gill and Johnson (2005) add that it requires interpreting data and analyzing what people say or do. Casebeer and Verhoef (1997) argue that qualitative research follows the inductive approach, rather than the deductive one

employed by quantitative research. Casbeeer and Verhoef (1997) assert that the inductive approach begins by making observations in order to develop hypothesis or a new theory as a result of the research.

1.3 Data Collection

1.3.1 Interviews

Saunders and Lewis (2000) state that the interviews research approach is flexible and allows a researcher to change his direction as changes in new data emerge. Furthermore, the focus in this qualitative research is initially very broad and becomes progressively narrow as the research progresses. Interviews are frequently used when a research is intended to deliver generalizable data (Pole and Lampard 2002). For this thesis, interviews are the suitable method because the interaction allows the investigation of open ended queries to a small sample while exploring individual experiences or opinions regarding the researched phenomenon. Interviews vary, amongst other things, in their degree of structure.

According to Bryman (2008), unstructured and semi-structured interviews mostly focus on the interviewee's opinion and experience, aiming to get rich and in-depth data. Thus, they rather have the characteristics of conversations, trying to deal in-depth with the individual case (Pole and Lampard 2002). Silverman (2000) further elucidates that exploratory studies need to be less structured than confirmatory studies. In a study with a rather small sample size, like this thesis, the focus is not so much on comparing the cases. Thus, the questions do not need to be very standardized and can be rather open. For this thesis the semi-structured interview, as described by Pole and Lampard (2002) seemed to be a suitable method. The

fact that the interviews were not completely structured permitted to talk about the individual opinions and experiences of the expatriates in a non-constraining way.

For the purpose of this thesis, a total of 50 workers and supervisors were interviewed. The interviews have been conducted at the work site, the factory. The average time span of each interview is twenty to thirty minutes. In addition to the workers' interviews, an interview with the owner, Wasef Mutee, has been conducted. The main motive of the conducted interviews is to obtain additional data regarding the work process and other major issues restricting the implementation of lean management at the factory. Further data has been collected through daily conversations with low level employees.

1.3.2 Observation

Observation is a very demanding method yet a common manner of collecting qualitative data. According to Mahoney and Goertz (2006) 'It requires that the researcher becomes a participant in the culture or context being observed'. Participant's observation requires a long period of time of intensive work so that the researcher becomes accepted as a natural part of the culture. Eventually, the observations are ensured as a natural phenomenon. Observations of the factory allow for a thorough understanding of the work processes and different work streams; hence getting an overview of the operation floor.

During the observation, the working process has been carefully documented. Such primary data is valuable because it illustrates the real-life situations, issues and problems that occur daily in a factory. On the other hand, knowledge of the work has been acquired by frequent conversations with the employees. Through informal communication channels, information

and data has been gathered which is not documented officially but has been crucial for conducting the thesis.

Furthermore, through the observation of the process flow in the factory and the execution of a Gemba Walk many problematic matters have been detected such as the absence of a warehousing management system which directly influences the cost structure. These preliminary observations were then supported by conducting interviews which provided deeper insight into the warehouse activities.

1.3.3 Data Analysis

Analysis tools such as the eight wastes, Parteo chart and fishbone diagram had been utilized to obtain qualitative data identifying the root causes of the problems in order to implement the necessary improvements.

1.4 Implementation of 5S Lean Methodology

The research emphasize the use of the 5S methodology model and its different phases. The 5S model is a fundamental tool of lean management which benefits any organization by creating order and tidiness in the workplace.

The 5S Phases

Sort

The main idea in the first phase is to classify the material at a specific site whether they are relevant and functioning for performing a specific task or not. Irrelevant or unnecessary items must be removed after obtaining approval from the authoritative personal.

Several steps must be followed in the first phase. Primarily, a team who will take part in performing this phase must be formed. The team must include workers from the same area. Involving the employees from the initial phases ensures the longevity of the process. The second step is to train the team ensuring that the benefits and steps of the sort phase are clearly recognized. All team members must be aware of the needed procedures and methods by which to perform the sorting phase guaranteeing that the entire area will be thoroughly inspected. The team will examine all the items and mark the items with green, yellow, or red tags. The relevant and functioning items will be marked with green tags. The yellow tags will be used for items which are still functioning but unnecessary for the task at hand. As for the malfunctioning items, they will be marked with red tags. The team will then seek approval of how and if to dispose or relocate the yellow and red tagged items.

It is essential that prior to initializing the phase one of the 5S model, numerous pictures must be taken in order to document the improvements to be implemented. These pictures will be used to compare the new workplace environment: not only will the pictures aid in visualizing the improvements made but they are constructive in reminding the team of their achievements.

Set in Order

Upon disposing all unnecessary items, it is time to start organizing the area with the aim of increasing the work ergonomics and the overall process flow. During this phase, the newly designated areas will be labelled with special markings to indicate what each area is assigned for. Furthermore, specialized racks or cabinets with visible guidance may be installed in order to organize the items further making the materials and tools easily accessible and organized. This phase is usually the most time consuming phase of the entire 5S program.

Shine

This phase consists initially of cleaning the work space. It is essential that the employees should perform this phase in order to value the actual process. A maintenance schedule will be drafted in order to maintain the cleanliness. It is beneficial to maintain the working area in the same manner on a daily basis. This will aid in recognizing any malfunctioning machines & tools, excess items, and factors harming the working safety.

Standardize

A set of procedures detailing the manner of which the area should be maintained on a daily basis will be listed in this phase making abnormalities visible. The responsibilities of each employee will be clearly detailed in their job description in order to facilitate the standardization.

Sustain

It is only when cleanliness and standardized order become part of the work habit and the organizational culture as a whole that the system will be sustainable. Well defined responsibilities and regular managerial audits will greatly ensure sustainability. The core importance of this phase is to not solely maintain the current environment but to continuously seek improvements.

1.5 Monitoring and Evaluation

Sustainability of the 5S lean tool is aimed at continuous improvement, thus a floor check template has been developed to measure the overall organized and cleanliness of the factory. Furthermore, the measurement of success and evaluation of the progress were validated by conducting interviews prior and after the implementation of the improvement tools.

1.6 Chapter Summary

This chapter illustrates in depth the research methodology. The qualitative data has been collected through interviews, and observations, upon which, the necessary data analysis tools to be utilized are exhibited. The 5S lean management model illustrates the various stages that must be implemented. Finally, ensuring the improvements' sustainability and the implementations value, the evaluation and monitoring has been explicated.

Chapter 4: Gap Assessment

4.1 Background

Although the principles and practices of lean management have been widely adopted in many industries, they are in principle new schools of thoughts to factories in Palestine. It is evident that WMFC lacks any notion of lean management; a matter which is significantly affecting the work flow of the company and the satisfaction of all stakeholders including the customers. There are several issues which must be addressed that are hindering the ability of the company to perform efficiently.

The first matter is the factory layout. The current manufacturing site consists of two floors. Aside from certain specialized machinery, each floor has its tools except of the sanding, polishing, and painting process where they are located in the ground floor. However, the lack of direct access between the two floors severely restricted the movement of goods and created major delays in the work process.

Although the carpentry is a leader in its field, yet no formal financial and/or accounting managerial software systems are in place, and no costing structures are identified. Except for minor manual documents and filings, there is a lack of a formal database which does not allow the investigation of any statistics and reporting. No formal managerial procedures (production planning) are established including the lack of warehousing management controls/systems and/or personnel.

The lack of a suitable inventory management system is a pronounced financial burden on the institution and a major source of waste and space unavailability. Not only is the inventory data lacking but the organization lacks the position of a warehouse supervisor, the matter which leads to several interruptions in the production process. Furthermore, there are inefficient and undesignated storage areas.

Aside from the several obsolete raw materials which are scattered in the floor space due to the lack of inventory control, wood scrap is witnessed throughout the production area. Wood scrap is a major space obstacle. On one hand, management refuses to dispose it, while on the other hand, the carpenters are not utilizing it: thus, the scrap keeps accumulating consuming the much-needed floor space.

The lack of space is a major hurdle in the production facility. Aside from the scattered raw materials and wood scrap and the fact that the area is not being exploited efficiently, there are several unused tools & machineries witnessed throughout the area.

The thesis idea has arisen from an actual need for process improvement of WMFC to cope with the growing demand and the growing pressure to improve work conditions. In time and due to increased demand, the plant suffered from undefined process flow, excess waste, unorganized workstations, and unhealthy work environment. This has translated into increased production cost, low workers morale, and delays in products delivery. Hence, the thesis is aimed at defining the production process, removing/reducing process waste, cleaning the production environment, and organizing workstations.

4.2 Data Collection

There are several methods of collecting primary data. Descriptive research through the voice of customer (VOC) and observations have been obtained.

Voice of customer (VOC) has been perceived in order to start identifying improvement opportunities. Customers could be classified as internal or external. In this research, internal customers' voice known as the voice of the employee (VOE) represented by carpenters and top managers have higher level of attention than external customers and will be articulated through personal interviews.

Observational data goes beyond numbers and statistics providing valuable form of information. A method of significant importance in collecting observational data is the Gemba Walk for it allows to gain valuable knowledge about the actual production process, work flow, and the materials being used.

4.2.1 Voice of Customers

The VOC has been perceived through personal interviews with several carpenters and top management for they are the most technical, attainable, and low cost qualitative data collection methods. Although the interviews were unstructured with no set of predetermined questions, the collected data were directly documented after each interview. Aside from the owner (general manager), fifty employees were interviewed providing an opportunity to interact with most of the internal stakeholders allowing the investigation of open ended queries while exploring individual experiences and opinions regarding the researched

phenomenon. Several challenges and complications have been revealed during the interviews of the manger as well as the carpenters in the factory by inquiring about the work process.

4.2.1.1 Interview with Owner/General Manager

Through the interview of Mr. Wasef Mutee, general manager and owner, numerous difficulties were noted confirming the nonexistence of lean management principles in the organization. It is of major concern to the management that they no longer can meet any set deadlines and cannot comply with any project management tools. Management is complaining for the numerous amounts of orders, yet they are neither refusing to accept any new work, nor committing to long delivery time.

It has been reported that the lack of management systems are complemented with the lack of sufficient managers forcing the decisions to be centralized and decreasing efficiencies. The manager is concerned with the fact that no data can be collected and thus no information regarding costs may be calculated. The manager cannot report the number of labor hours dedicated to each project.

The building structure seemed to be a major grievance of the general manager. In order for the production process to be efficient, the material handling needed to be well-organized. Due to the fact that the plant is laid out in two different floors, this causes several complications. Moreover, the available space does not fulfil the number of projects being accomplished. Unavailable space was also reported in regards of lack of inventory warehouse of neither raw materials nor finished goods. A major phenomenon that disturbs

the general manager is the non-readiness of the customers to accept the finished projects, forcing the company to store the finished project in undesignated areas.

When questioned about the wood scrap, the manager reported that he had several ideas of utilizing it. At one point, he insisted on using the scrap to manufacture small items such as side tables and sell them in the showroom. However, further discussion with the manager, he realized that the time needed to produce such items is always better invested in completing the undergoing projects. There is no idle time of machineries to allow for such work. At the same time, management believes that the wood scrap is too valuable to throw away, but they realize that they are problematic as they are not being utilized by the carpenters.

Additionally, the general manger complained about the behavior of the employees. There are too many absences reported and the management feels that the employees hold no loyalty to the organization. Upon further discussion in the interview, it was soon to realize by management that the underlying cause of such a problem might be the lack of lean management in the organization. When asked if he believes that the employees' attitude will change if the workspace is tidy and the production process is proficient and well-organized, he inevitably answered: "Yes, of course"

4.2.1.2 Interview with Carpenters/Employees

What qualitative study seeks to convey is why people have thoughts and feelings that might affect the way they behave. The main advantage of interviews stems from their capability to offer a complete description and analysis of a research subject**,** without limiting the scope of the research and the nature of participant's responses (Collis & Hussey, 2003). Interviews with the employees are useful for gaining valuable insights.

It is not peculiar that the majority of the employees reported the same difficulties. Employees feel overburdened with the amount of work but not in a petulant manner. They are however disturbed with the lack of space, and the cluttered and unsafe workstations. A major bottleneck of which they complained about was the painting process for the work in process which tends to stay in their workstations for a lengthy period.

The building structure is also considered of major disturbance. The employees often need to transport the heavy projects by hand between two separate floors through a road. Another waste of time is the time needed to search for tools for there are no designated areas for storage. As for inventory, the employees feel that they will significantly shorten the process if there are proper inventory measures and a warehouse manager. In this manner, they will not be wasting time obtaining the needed raw materials.

In regards of the wood scrap and other unused material, the employees converge on the fact that no one other than the general manager can decide what to do with the waste. Due to the fact that he is constantly busy, the waste just keeps up. There are even several items when asked what they are, the employees were not able to recognize them.

4.2.2 Observation

4.2.2.1 The Gemba Walk

A gemba walk has been conducted to further investigate the causes of the above mentioned problems. During which, precise and in-depth questions have been asked about the process being observed and tasks' time duration & distances have been measured in perspective of needed paces. Mainly, valuable knowledge has been gained about the actual production process, work flow, and the materials being used. Asking the employees why they do things the way they do allowed them to suggest various process improvements.

One of the biggest opportunities for improvement has been discovered during the walk where the work in process changes departments such as from the production line to the finishing line. Projects were either being transported by the employees who complained from the heavy load, or work in process had to wait for the company's logistic truck to transport the goods from the production line to the finishing line. By following the flow of value, many obstacles have been exposed.

In conclusion, the principal impediment concluded from the Gemba Walk validated the data collected from the voice of customers which is the lack of floor space availability. Thus, supplementary investigation is essential in determining the causes of such an obstacle.

4.3 Data Analysis

What qualitative study seeks to convey is why people have thoughts and feelings that might affect the way they behave. The research seeks to represent the voices of the internal stakeholders so that they can be interpreted and reported on.

4.3.1 Pareto Chart

A Pareto Chart (80/20 principle), a problem solving technique used to prioritize potential causes of the problem and aids in identifying improvement opportunities, has been developed to illustrate the findings. The 80/20 principle indicates that 20% of causes are resulting in 80% of the problems. Therefore, by focusing on these 20%, one will notice a dramatic change (Ultsch, 2002).

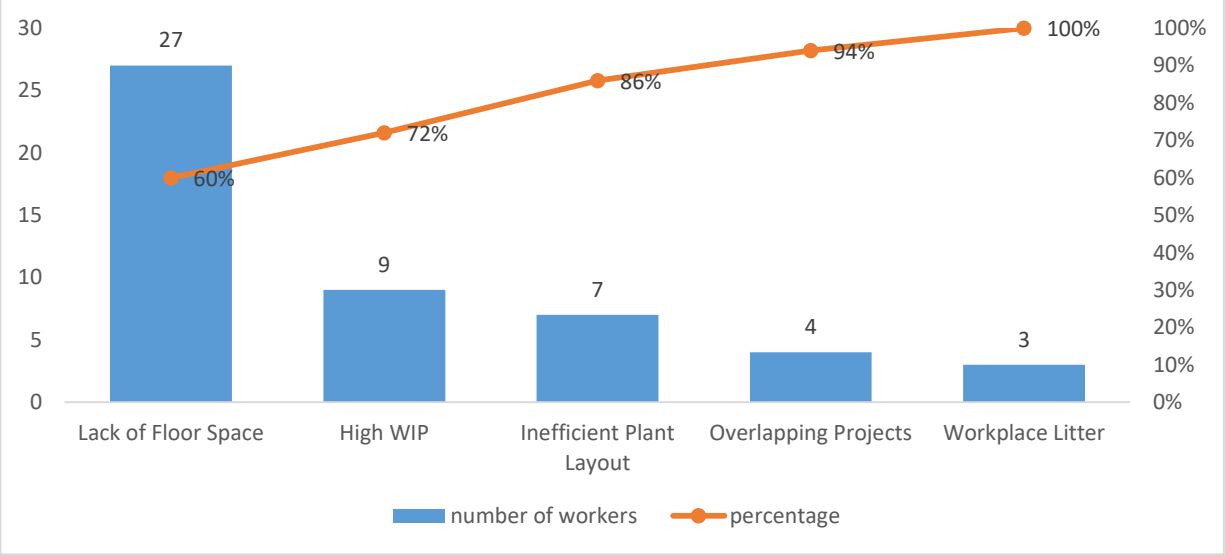


Figure 2 Pareto Chart

According to the illustrated Pareto Chart (Figure 2), 27 out of 50 of workers reported that floor space is the major delinquency, while 9 out of 50 indicated that the work in process is, and 7 out of 50 criticized the plant layout. A total of 86% reported the lack of floor space, stagnant work in process, and the plant layout are the major hurdles of the production process.

4.3.2 Cause–and-Effect Diagram

After the thorough observation of the factory's first floor and understanding of its' process flow, cause-and-effect diagram has been sourced to categorize and graphically display all potential causes of the main problem which is the unavailability of floor space. Thus, personal interviews with managers & carpenters, and inquisitive observations were held in order to collect all potential causes for unavailability of floor space.

As shown in the following Figure 3, the cause-and-effect diagram summarizes and categorizes all potential causes of floor space unavailability based on the five main categories: method, machines, manpower, material, mother-nature (environment). Using this categorization, the diagram represents a model of suggestive presentation for the correlation between the problem and its multiple causes. This five categories-based diagram helped to investigate the problem's causes and to identify the most critical areas where data should be gathered for further studies (Ilie & Ciocoiu, 2010).

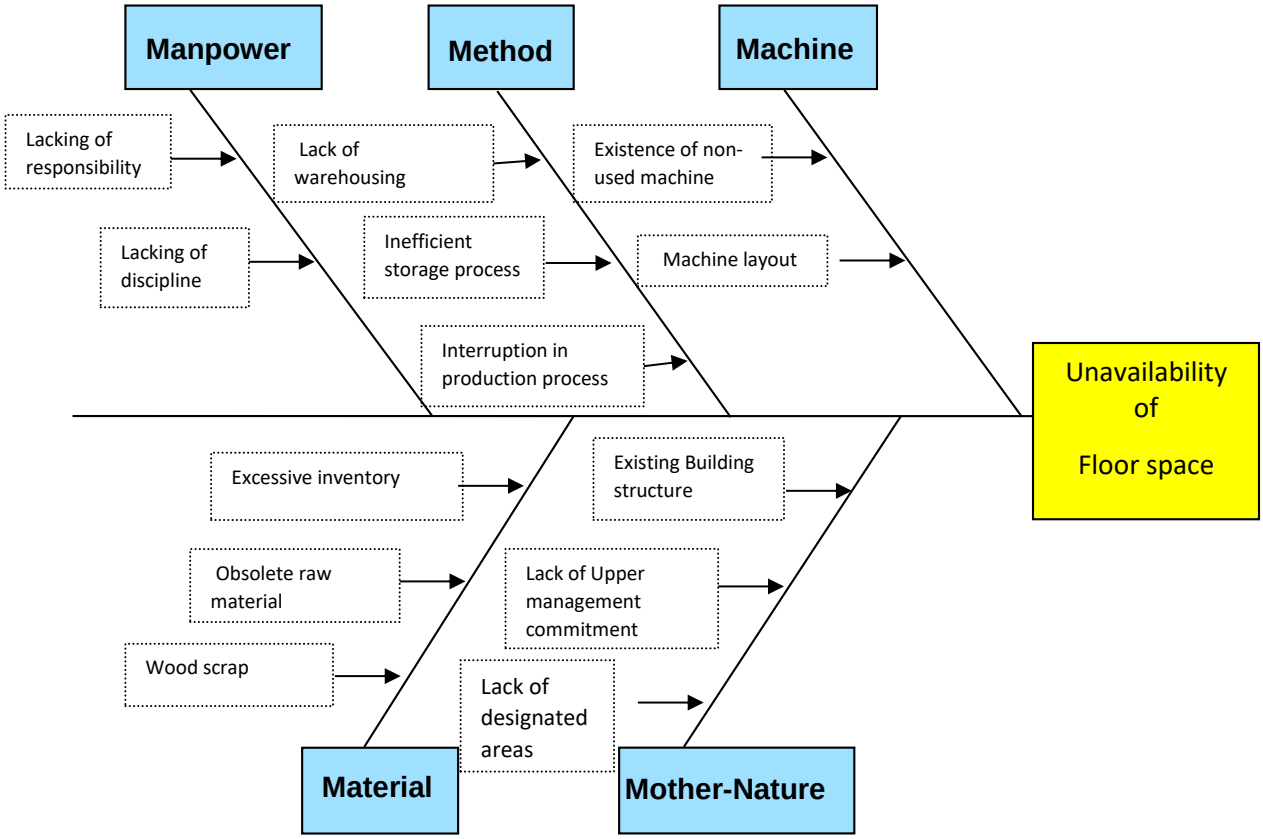


Figure 3 Cause-and-Effect Diagram for Unavailability of floor space

Upon the examination of all potential origins of the main problem, the unavailability of floor space, and the display of the major causes, management as well as the employees concur on dividing the sources into three categories:

- Plant layout
- Inventory management
- Waste
    - Wood scrap
    - Unused tools & machines

- Defective or returned finished goods
- Places

4.3.2.1 Plant layout

The importance of a layout would be better appreciated if one understands the influence of an efficient layout on the manufacturing function. Operating efficiencies, such as economies in the cost of handling materials, minimization of production delays, and avoidance of bottlenecks all these depend on a proper layout.

The current plant layout is not assisting in creating a smooth production flow; therefore, the layout can be seen as a limitation of efficient material flow. The factory has a basic layout divided among two floors: ground floor and first floor. Although each floor has separate tools and machineries, but as previously mentioned, some machineries are shared amongst the two floors: the most important of which is the finishing station which consists of the sanding and painting (located on the ground floor). The link between the floors is 72 meters through the main traffic road. As a result, the material is being transported outside the factory and frequently not utilizing a suitable carrier method such as the company's delivery truck.

Moreover, due to unavailability of floor space, there is no inventory storage of the accessories used in the first floor's production lines. They are stored in the ground floor. Each time the carpenter needs an accessory, he needs to travel a total distance of 170 meters to collect the needed component. From observation, this is performed on average three to four times per day.

Table 2 illustrates the distances required during various stages in the production process of kitchen cabinets before the implementation of any enhancements:

Table 1 Initial activity based distances

Step	Activities	Distance (meters)	Number of Move / Day	Total Distance Travelled per Day in Meter
1	Work station to accessories warehouses	85	4	340
2	Accessories warehouse to work station	85	4	340
3	Wood warehouse to cutting	5	13	65
4	Wood cutting to edge banding	14	3	42
5	Edge banding to body assembly	10	3	30
6	Body assembly to rubbing and polishing	72	1	72
7	Rubbing and polishing to painting	3	1	3
8	Painting to rapping and shipping	3	1	3
	Total Distant Travelled			**895**

4.3.2.2 Lack of Inventory Management System

The lack of a suitable inventory management system is a pronounced financial burden on the institution and a major source of waste and space unavailability. No inventory data is available regarding any material and on several occasions, orders had been made to suppliers for materials which are otherwise available in the factory.

A warehouse supervisor, who is not available, is not only essential for inventory control but is critical in any cost control process. The raw materials are readily dispersed to any carpenter in the factory and in the matter that an error in production has been made, no record of it will be noted, for the carpenter can take another wood panel without any permission. In no manner, will management acknowledge the true cost of any project. Accumulations of various inventory materials utilize a lot of space in the factory:

- Raw Materials (Wood)

Upon the arrival of the wood raw materials, five carpenters have to halt production, unload the truck by hand, carry each panel, and lay the goods inside the factory in an unorganized manner. Limited designated area for warehousing is available for the wood panels and thus they are spread next to the machineries throughout the factory creating an immense movement hurdle not to mention a safety hazard.

Furthermore, the wood panels are not sorted according to types or in any specific manner. Therefore, the carpenter generally needs to devote on average twenty to thirty minutes sorting and preparing the raw material to initiate any project.

- Component Parts

Accessories are stored in two separate unorganized areas amongst the two separate floors of the factory. In one measured occasion, it took a carpenter a total travel distance of 170 meters to collect the needed component parts from different areas to finalize a project: an occurrence which has been occurring on average 3- 4 times a day by the same personnel.

Due to the lack of a purchasing system associated with inventory management, many component parts are purchased in large quantities. The product life cycle of such accessories is relatively short for the company, which distinguishes itself in the market by being a leader in utilizing innovative components. This results in large storage of unused and outdated components which are occupying a lot of space.

- Work-in-Process (WIP)

As mentioned earlier, although the separate floors have their own machinery, yet they share some needs amongst them. The main matter is the painting station which is present in the ground floor. The work in process must be transported from the first floor to the ground floor in order to be painted. This is normally done using the company's delivery truck which needs four workers and on average two hours to transport WIP. In the matter that the truck is unavailable, the WIP will remain in the first floor waiting to be transported. This creates a massive difficulty in space availability.

Moreover, the project must be sanded prior to painting. This is also being executed in the ground floor near the painting station. Due to the fact that kitchen cabinetry are manufactured in the first floor, they take up a lot of space in the painting preparation area and thus they are only being transported when space is available in the sanding area of the ground floor. Thus, this bottleneck causes the WIP to continue in occupying the space in the first floor on average between ten to twelve days.

- Finished Goods:

It is implausible for a custom-made woodshop to have space availability complications due to storage of finished goods. However, in this case, it was observed major space occupancies of final goods. The most frequent cause of such a phenomenon is the un-readiness of the customers' construction site to receive the finished goods. In other cases, the company will not make delivery of the final goods to the customer due to failure to make the payments. On a different note, there are substantial amounts of stored finished goods due to customers' decision to change the design during the installation stage. At one instance, furniture which dates back to over twenty years ago is still being stored. No one but the owner has the authority to make decisions regarding these final goods which became overlooked by him for they are irrelevant to the daily business of management.

4.3.2.3 Floor Space Waste: Area Mismanagement

Due to the fact that the production line follows a large number of processes, it's inevitable that, over time, elements of that process develop non value added waste that hamper the efficiency of the process flow. Figures 4 & 5 illustrate below the types of waste occupying the floor space:

Figure 4 Plant layout for first floor

Designated in orange, the wood scrap was scattered in the floor space occupying 26 sq. meters while the purple area marks the space utlized by wood panels 25 sq. meter. Returned finished goods area, marked in light blue, occupy 12 sq. meters and the goods had been placed in the work floor space for a very long time with no prospects from upper management on what to do with them. The pressure tanks take up an area of 2.5 sq. meters, marked in dark blue. Moreover, there were a couple of outdated and obsolete machines which are not being used that useed up 3.5 sq. meters of the space. There were some partitions marked in yellow

that were hindering the work process. Finally, the 2.7 sq. meters area, marked in green, had been originally designated as a kitchen; yet, it has not been used for that purpose.

The first floor also includes a storage loft fully designated for the storage of waste. As detailed in Figure 5, the total area of the tree lofts consists of 85 square meters area which store returned finished goods, outdated (obsolete) and broken accessories, and unused machineries such as an old compressor.

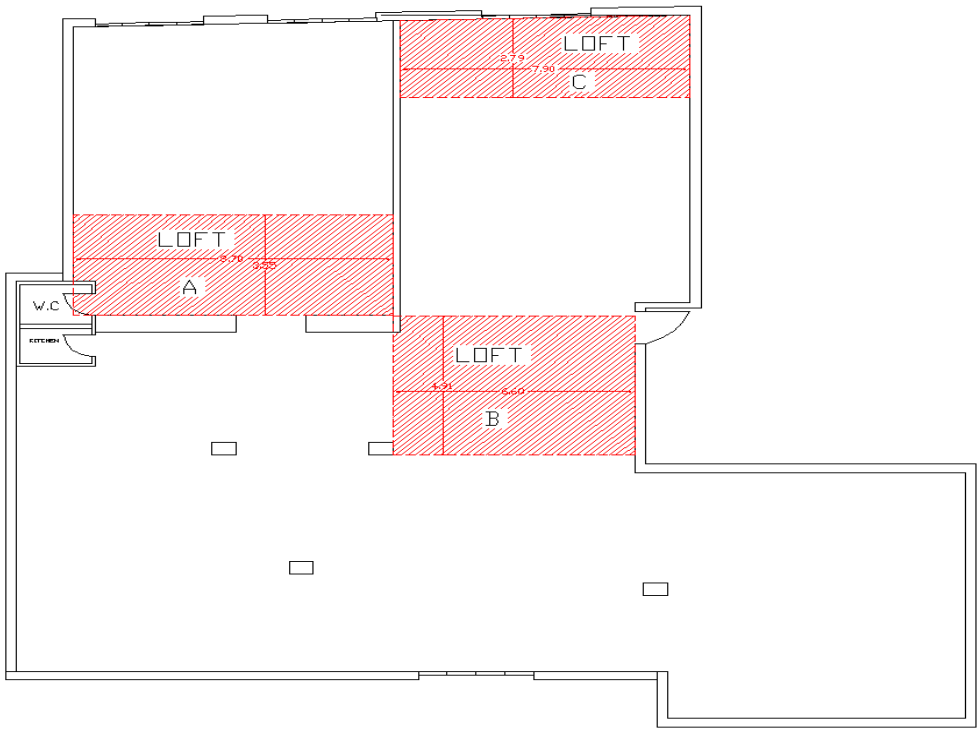


Figure 5 First floor storage loft

As illustrate in Figure 4, the waste can be classified into four categories. The first type of waste consuming the largest amount of space is the wood scrap. Defective or returned finished goods are the second largest types of waste in regards of area consumption. Unused

tools, accessories, and machinery are the third type of waste. Finally, there are certain areas in the plant which are categorized as area waste due to the fact that they are not being used for their designated purpose.

Wood scrap

Within the factory wood scrap is classified into two types:

- Wood offcuts: occupy approximately 26 sq. m
- Sawdust

The factory is specialized in customized furnishings and thus there are no standardization of the raw material. Carpenters cut the wood panels according to various measurements, a matter which produces a lot of wood offcut. There is no preliminary planning on the best manner to cut the panels in order to minimize waste. The carpenter basically takes panels and initializes the work.

Moreover, the carpenter lays the wood offcuts against the wall next to the machines in an unorganized fashion restricting the movement around the machines, as illustrated in Figure 6. The wood offcuts are not accounted for and it is a tedious job for the carpenter to sort the offcuts when needed. Instead, the carpenter just takes a new wood panel. Eventually, this will increase the amount of waste and decrease the availability of floor space.

Figure 6 Wood Scrap[1]

As with any carpentry, sawdust is a major waste produced during the process and one which can neither be eliminated nor limited. The only matter to consider is a collection system of the saw dust which will reduce the cleaning time. However, this seems to be in place of the current factory. The collected sawdust is sold to third parties.

Returned/Defective Products

Returned and defective products are a major issue in the factory as they are occupying 12 sq. m from the shop floor space. In case a customer refuses the receivable of a finished product, the carpenter returns the product and places it in any available floor space which he might find available. It is noteworthy to mention that not only the company lacks an inventory system which tracks the returned goods quantity but the employees are not pursing any decisions from top management on what to do with the returned goods. Thus, they remain

[1] *All photos had been taken and used for the purpose of this research with the consent of Wasef Mutai, owner of Wasef Mutai Furniture Company.*

as a hindrance in the work area. Some products had been placed in the same location for over ten years. Figure 7 illustrate returned finished good.

Figure 7 Retuned finished good

Idle & Damaged Machinery, Tools, & Products

While conducting the Gemba walk, it was observed that a couple of significantly large unused machines, occupying 3.5 sq. meter, were placed against the wall. Upon investigating the matter, it appeared that they were no longer in use due to the fact that they were outdated and had been replaced by new technologically advanced machines. It was evident that the area was not utilized efficiently due to the placement of such idle machines.

It is noteworthy to mention that also during the Gemba walk, many broken tools were noticed scattered all over the factory, as shown in Figure 8. The carpenters are so accustomed to them being there that they don't recognize them as waste in their surroundings.

Other wastes that were noted are broken accessories scattered in the storage loft and under the work tables, as illustrate in Figure 8. The carpenters do not possess any authority to

dispose or even mark them as waste. When upper management does not take any decisions regarding their utilization or disposal, the waste just keeps up.

Figure 8 Broken tools and accessories

Unused areas

Another issue that was observed, is an area in the first floor consisting of 2.7 sq. meters which had been previously been used as a kitchen, as illustrated in Figure 9. For several years, they are not using this kitchen for they are only using the one located in the ground floor. Thus, the area is considered to be a waste of space.

Figure 9 Unused Kitchen

4.4 Types of Waste in the Kitchen Production Process

This study primarily focuses on the kitchen cabinetry production line for it is the most produced item of the factory. Thus, implementation of lean management and waste elimination in the main production line will have the most influential impact on the factory as a whole. Initially, the general conditions of the working areas were considered. Subsequently, the operating procedures were carefully observed. The production subsystems

are illustrated in the process flow chart shown in Figure 10:

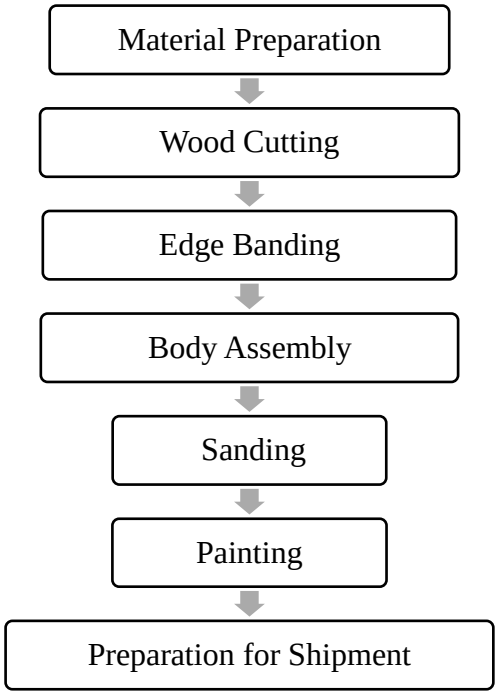


Figure 10 Kitchen process flow

Subsequently, the above mentioned process's activities were analyzed according to various types of waste using the **eight waste of lean modular** shown in Table 3:

Table 2 Eight waste in kitchen production process

Activity	Transportation	Inventory	Motion	Waiting	Defect
Material Preparation	Lots of Material movement	1.Unorganized place 2.High inventory level 3. Obsolete products	Lots of motion to allocate the required inventory	Waiting for material	Damage goods from source
Wood cutting		Unallocated spaces for different type			Scrap and Rework
Edge Banding					
Body Assembly		High WIP	Searching for tools	No space to assemble	
Sanding	Lots of movement between floors	High WIP		Waiting for available worker and space	
Painting				WIP waiting	
Wrapping and Shipping					

Waste reduction is a major concern in today's industrial environment. The above illustrated eight waste table states that transportation, inventory, and waiting time are the three major wastes significantly affecting the production process' efficiency and availability of floor space. Subsequently, motion and defect are of significant importance.

Transportation

Due to the plant layout, there is a substantial transport amount not only of the work in process but of the raw materials as well. Frequent movement is necessary of the material and the personal that are forced to continuously waste time travelling between the various departments laid in two separate floors and connected through the main road.

Moreover, the frequent unavailability of the company's truck to transport the work in process to the ground floor causes the product to remain in the first floor for a notable amount of time preventing the carpenter from initiating the assembly process or starting a new project. It is noteworthy to mention that although there are 12 production lines and two painting stations, the main cause of the delay is the sanding process which is time consuming. Any interruption in the process is a key factor in the accumulation of work in process reducing the availability of floor space.

Inventory

Unorganized storage and lack of an inventory system will increase the inventory level of raw material. With no set forecasts of the actual needs, the company normally has a high level of accessories' inventory. In a company is known to be the market leader in installing up to date accessories, this causes the company to stock a lot of obsolete raw materials which in turn utilize a lot of space. Furthermore, damaged inventory is also high due to longer storage time.

In the material preparation process, the efficiency is limited due to the unorganized inventory space. The process's efficiency will increase if the inventory storage is adequate.

The work in process is also considered a type of inventory. The high level of work in process inventory between stations, especially the body assembly and sanding processes, is intolerable.

The wood cutting process produces wood scrap which is a type of inventory. There is a lack of an allocated space for sorting and storing the wood scrap. The carpenter does not waste time by looking through the pile of wood scrap searching for appropriate fragments. Instead, the carpenter uses new wood panels. Thus, the wood scrap inventory just keeps up wasting space.

Motion

In the material preparation process, the carpenter is compelled to make lots of motions in collecting the needed raw materials to initiate a project. However, the major waste of motion is due to the chaotic nature of the factory; carpenters spend a lot of time searching for the needed tools throughout the various processes.

Waiting

A lot of time is being wasted in the material preparation due to the unorganized workplace and lack of sorted inventory and lack of inventory system.

A major hindrance of the process' time efficiency is the waiting time for the sanding and painting procedures. The lack of space prevents the employment of new labor for the manual time intensive task of sanding, creating a major bottleneck in this process. The work in process remains in the assembly station until space becomes available in the sanding and painting processes. Consequently, due to work in process accumulation, space becomes scarce delaying the assembly process which prevents the initiation of new projects.

Defect

The lack of a quality control system allows the company to accept damaged goods from the source due to the lack of quality assurance procedures. The defective materials are thus recorded as major waste in the material preparation activity.

Wood cutting produces a great deal of waste such as wood scrap which the carpenter sets against the wall next to the machines in an unorganized manner.

4.5 Chapter Summary

This chapter discusses in details the techniques followed in collecting and analyzing the data in order to prioritize the major hurdles facing the company. Apparently, the identified key measures are expected to improve the availability of floor space and reduce the process time. The current performance of the factory has been assessed in regards to these two major key measures.

Chapter 5: Implementation of Lean Management

5.1 Preface

Upon interviewing most of the workers in the factory and due to the limited time of the research project, it was decided to work on implementing lean management philosophies on the first floor of the production plant with minimal improvements on the ground floor. The carpentry activities of the first floor is specialized mainly in kitchen, home decor, bathroom vanity, and walk in closet.

It has been concluded from the gap assessment that the major hurdles limiting the availability of floor space and directly affecting the efficiency of the process time are the accumulation of waste, the plant layout, and the lack of an inventory system. The initial implementation phase had to commence with the waste elimination which in turn elucidates what needs to be performed in the plant layout and aids in establishing a sustainable inventory system.

5.2 Implementation of the 5S Tool

An imperative waste elimination method followed in an organization applying lean management is the 5S model. The implementation of the 5S system in an organization helps in eliminating waste (MUDA), improving workplace and productivity, frees up floor space, increasing the employee satisfaction, and most importantly increasing safety.

5S offers the organizations a foundation for continuous improvement by developing standardized working methods. It creates a visual factory that allows for quick determination of the workplace status.

In preparation to implementing 5S, a team must be selected which consists of workers who are responsible for the area and a project leader/manager who has the authoritative power to make critical decisions in the factory. The implementation of 5S requires the understanding of all the employees, supervisors, and managers related.

Prior to selecting the teams, a preliminary informative introductory session had been scheduled with all of the employees in order to explain the benefits of implementing the 5S model in the organization and the procedure to be executed. The level of employee involvement and the required dedication had also been clarified. In conclusion, the teams had been selected not solely based on the recommendations of the general manager but also based on their interactions during the preliminary explanatory sessions. Selecting the team members in this manner has been extremely beneficial in obtaining the dedication needed in implementing 5S. It was evident at the end of the session that this had been the initial spark of changing the organizational culture and behavior in the company.

Due to the magnitude of the implementation, it was not feasible to implement the 5S model in the organization as a whole. Instead, the implementation has been separated into four different projects:

I. Storage Lofts

II. Warehouse

III. Wood panel/scrap

IV. Waste of space

5.2.1 Project I: Storage Lofts

5.2.1.1 Background

As illustrated in Figure 5 the first floor includes three storage lofts which have been fully designated for the storage of waste and unused items: Loft A 31 sq. meters, Loft B 32 sq. meters, and Loft C is 22 sq. meters. In total, as shown in Table 4 the lofts consists of 85 square meters area which store returned finished goods, outdated (obsolete) and broken accessories, and unused machineries such as an old compressor.

5.2.1.2 Goal

The goal of this project is to eliminate the waste from the storage lofts and use the space for active purposes.

5.2.1.3 Sort

Before eliminating anything, photos are taken from the current situation. Upon that, all the items have been sorted and separated. The sorting phase did not consist of any traditional tools; instead, all items have been sorted according to its function: accessories, returned products, and machines.

Table 3 Area occupied by type of waste

Type of Waste	Area (sq. m)
Obsolete accessories	29
Broken accessories	21
Returned product	28
Machines	7
Total Area	**85**

The team then agreed on the best manner by which to dispose of the items in each category.

- *Obsolete Accessories*: Due to the lack of any inventory management system and inappropriate purchasing forecasting, the company does not utilize the inventory efficiently. Upon gathering the obsolete accessories together Figure 11, the general manager contacted various suppliers and offered them the items at a discounted rate. Due to the great standing of the customer supplier relationship which the company enjoys, many of the suppliers returned the marketable accessories at the full selling rate crediting the company and allowing it to purchase new ones. Other truly outdated

Figure 11 Example of absolute accessories

accessories were relocated to a storage facility outside the factory awaiting further action.

- *Broken accessories*: The absence of a quality control system, accessories with missing parts continuously piled up in the storage loft. The carpenter constantly stored them in the aim of eventually reforming them Figure 12. The team assigned one carpenter to reform what is repairable from the broken accessories which subsequently were stored in the storage loft for reuse. All other unrepairable parts were gathered and sold by weight to a recycled metal goods collecting company.

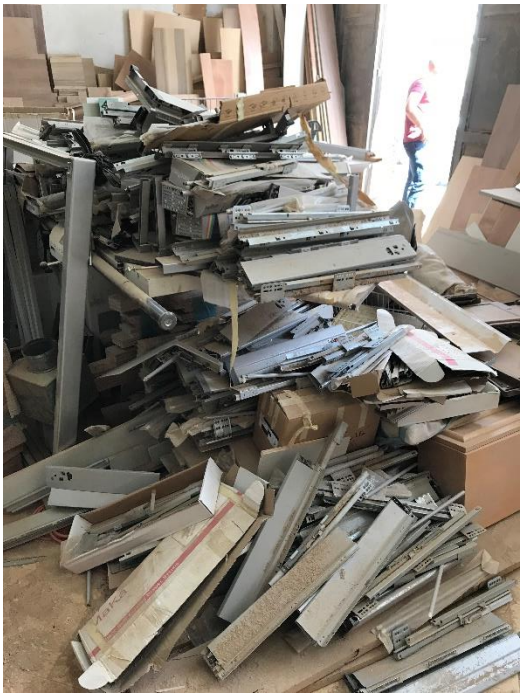


Figure 12 Broken sliders gathered to be reformed

- *Machines*: A few damaged machines Figure 13 have been stored in the loft mainly consisting of an old compressor which has been sold to a carpenter who is employed in the company and other broken equipment which have been disposed of.

Figure 13 Left portrait is an example of an old machine while the right portrait is the old

- *Returned Products*: During the sorting phase Figure 14, the team leader noticed a lot of tables and chairs parts that were unknown to him. After investigation, he soon realized that these products were customized to a business which closed prior to the delivery date. The irony of the matter is the delivery date was over twenty years ago. Several unfinished furniture items such as beds, doors, and closets have been gathered outside the shop and sold to carpenters. All other items have been disposed of.

Figure 14 Reject goods: Chairs, Cushions, Rooms, Dressers, and Doors

5.2.1.4 Shine

Once all the tasks involved in the sorting phase have been completed, the storage loft were completely emptied and thus the cleaning process has been initiated even from all the built up wood dust. The classification of all the cleaning activities has been assigned to the warehouse manager as illustrated in Appendix (1). The completion of this phase was concluded by the decision of general manager and the team on the best manner to utilize the new clean 85 square meters of space as discussed in the following phase.

5.2.1.5 Set in Order

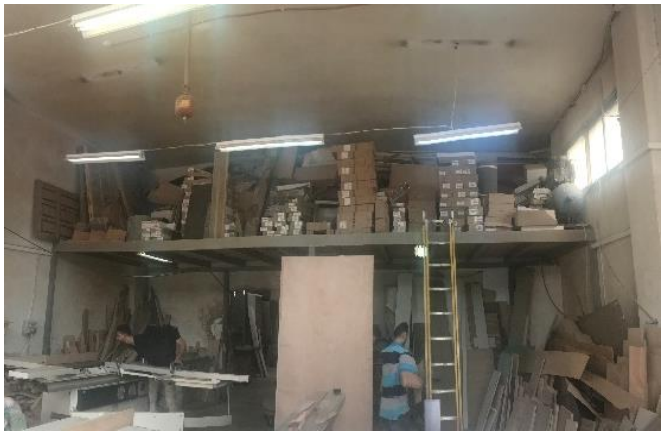
After sorting and shining the storage lofts, three decision were devised:

1. Dismantle storage loft C from its place and reassemble it next to storage loft B
2. Close the sides of storage loft B and C by constructing new wood sidings and designated the space to storing accessories for the first floor production. No shelves have been installed due to the fact that all the accessories are received in carton boxes and thus no warehousing shelving is necessary. Loft B has been assigned for small sized accessories while Loft C for the large types.
3. Designate storage Loft A for raw materials which are rarely used such as rare types of wood, decorative items which are not usually requested by customers, and accessories which usage are extremely limited.

Figures (15, 16, 17 & 18) illustrate the new improvements which have been implemented in the storage lofts.

Storage Loft A:

BEFORE



AFTER

Figure 15 Implementing 5S in Storage Loft A

As illustrated, in Figure 15 the excess waste of broken accessories and returned goods have been removed while remaining obsolete accessories have been relocated to another external storage facility. The project team dedicated the new storage area for rarely used inventory items.

Storage Loft B:

BEFORE AFTER

Figure 16 Waste removal from Loft B and the new wall siding

Upon the removal of all the waste from Loft B and a thorough shining, new wood siding has been installed in preparation of the new warehousing of large sized accessories as shown in Figure 16.

Storage Loft C:

BEFORE

AFTER

Figure 18 Implementing 5S in Storage Loft C which has then been emptied and then ready to be dismantled and reassembled next to Loft B

BEFORE

AFTER

Figure 17 Reassembling Loft C next to B and the installation of the new siding

The implementation of 5S in Loft C has been concluded in two separate events. The first event is the removal of all the waste and the second phase is the dismantling of the loft and

reassembling it next to Loft B and closing its' siding in preparing it for a new inventory space of small accessories as illustrated in Figure 17 and 18 respectively.

5.2.1.6 Standardize

The responsibility of standardization has been assigned to the newly appointment Deputy General Manager. Ensuring the first 3S's are implemented properly. More importantly, no longer does any carpenter have any access to inventory. Instead, a day prior to initializing any project, the carpenter will submit an order sheet by which the newly appointment warehouse manager will prepare and forward the listed accessories and other needed raw materials to the station Appendix (3).

Finally, due to the raw material's high turnover, the warehouse manager has dedicated thirty minutes per week to ensure the adherence of the employees to the newly drafted procedures which are aligned with the 5S principles.

5.2.1.7 Sustain

Sustaining the work done so far is the final step in the implementation in order to ensure that the process is to be maintained.

In order to maintain and improve the factory performance, audits are to be conducted by the general manager on a monthly basis. A review of the checklist will be performed to ensure the sustainability of the 5S tool, as shown in Appendix (2). Moreover, biweekly meetings are to be held between the general manager and the warehouse manager to discuss any issues

which might arise and most importantly to converse on manners by which to continuously improve the warehouse management system performance.

Finally, in order to continuously emphasize the importance of the 5S tool, before and after pictures are displayed throughout the factory.

5.2.1.8 Results

Shortage of space is a major dilemma in the company. Upon implementing 5S in the lofts, the team immediately realized the importance of such a tool for it recreated 85 sq. meters of new warehousing area to be dedicated to the storage of accessories which are to be used in the first floor production projects.

5.2.2 Project II: Warehousing

5.2.2.1 Background

This project focuses on two main areas in the company used for warehousing. Consisting of 50 sq. meters, the first area is the main storage facility of accessories and materials needed for the factory's production department located in the ground floor. Located next to the accountant office, the second storage area, of 26 sq. meters, stores the highly valued accessories and materials. Although the general manager realizes the materials' high value, yet there are no controls in place to prevent unauthorized personal from accessing the area: all carpenters haves access to the warehouses.

5.2.2.2 Goal

The storing of accessories in an efficiently accessible manner and implement an adequate inventory control system to the main warehouse.

5.2.2.3 Sort

In order to apply any notable measures to the warehouse, the 5S tool has been executed. The selected team commenced by sorting the items and as discovered in the storage lofts, many obsolete and broken accessories had been discovered. By sorting the accessories to active and inactive types, the team consulted with the general manager to find the most suitable solutions for disposal. All inactive accessories have been eliminated by reforming the broken accessories and selling the damaged ones to a metal recycling company while allocating the remaining inactive accessories to the storage facility outside the factory for further decision. A total area of 21 sq. meters has become available for use. As for the active items, they will be accounted for and restocked in the warehouse according to the new system.

5.2.2.4 Shine

Upon eliminating all of the wastes, a thorough cleaning has been performed by the selected team. Subsequently, cleaning responsibilities have been assigned to the newly appointed warehouse manager as illustrated in Appendix (1).

5.2.2.5 Set in Order

The active accessories have been separated according to the production area upon which they are to be utilized. The first collection which is to be used in the first floor production area

has been relocated and stored in the storage loft (B & C) of the first floor. This decreased the personnel travel time significantly for they no longer need to walk to a separate floor to gather the needed inventory. As for the second collection which is to be used in the ground floor production area, they have been reorganized on newly constructed shelving system which has been installed in order to systematically organize the area allowing the accessories to be stored in a resourceful manner encouraging an efficient work flow.

Figure 19 and 20 are illustrations of implementing 5S in the main storage facility:

BEFORE

Figure 19 Main storage before 5S

AFTER:

Figure 20 Main storage after 5S

Figure 19 is a clear illustration of the manner by the accessories have not been stored in any efficient manner. However, Figure 20 portrays the work implemented during the set in order phase, as the project team members installed a shelving system for storing the accessories. The warehouse manager can now easily access and locate what is need eliminating the time wasted in searching for these accessories and making available more storage space.

In regards of the accessories located in the other storage area next to the accountant's office, the items had been relocated to the secured main storage area making available 26 sq. meter for a different use. It is noteworthy to mention that a lock has been installed on the main storage area denying access to all personnel and the newly appointed warehouse manager has sole access to the area.

Figure 21 and 22 are illustrations of implementing 5S in the area storing the exclusive accessories:

BEFORE:

Figure 21 Area being designated to store exclusive accessories

AFTER:

Figure 22 The new office space utilizing the area in previous figure

Figure 21 is a clear illustration of the manner by the accessories have not been stored in an inefficient manner. However, Figure 22 portrays the two offices that were formed after the space became vacant due to the relocation of the accessories to the main warehousing facility.

5.2.2.6 Standardize

Without proper supervision or the absence of any set standards, it is eminent that the warehouse will turn into clutter in no time. Thus, a new warehouse manager position has been created in the organizational structure. Aside from ensuring that the first 3S's will be continuously implemented, the new manager is able to prepare the needed inventory for a new project ahead of time decreasing the required time in the work process more specifically the set up time. Furthermore, the manager is able to monitor the stock levels of the items avoiding the creation of obsolete items and limiting the financial burden of high inventory.

Moreover, although the company uses a digitalized financial accounting system, yet they failed to implement the warehousing modular of the system. A trainer has been employed to train the employees on the warehousing modular. A new stock card had been initialized for each item and the inventory has been accounted for in the system. It became effortless for all managers to monitor the stock levels of all the items in the company. Additionally, new managerial procedures have been created including standardized forms to facilitate the ordering of raw materials from the production personnel. It has been recommended that for further development, the company will track the inventory disbursement of all the items according to each project. This will allow for better costing discovery and therefore improved pricing system increasing the competitiveness of the organization.

5.2.2.7 Sustain

Sustaining the work done so far is the final step in the implementation in order to ensure that the process is to be maintained.

It was essential to train the newly appointment manager on the understanding of the 5S principles and procedures. The general manager will regularly audit the checklist compliance, (Appendix 2) and conduct biweekly meetings with the supervising personal to ensure the adherence to the 5S scheme and discuss further improvements. Furthermore, the displayed before and after pictures are becoming a core representation of the organizational behavior.

5.2.2.8 Result

A major enhancement has been witnessed in the development of this project. Aside from the minor fact that an area of 26 sq. meters has been cleared and now a greatly demanded new office space occupies the area, the major focus is the creation of an inventory management system and the staffing of a new warehouse manager.

5.2.3 Project III: Wood Panels & Scraps

5.2.3.1 Background

It is evident that wood panels are the main raw material in a factory. Due to the lack of any standards, the wood panels are scattered randomly all over the wood floor. Not only they are not sorted according to types or in any specific manner, but the carpenters have access to

any amount and type which they want. Furthermore, the carpenter generally needs to devote on average twenty to thirty minutes sorting and preparing the raw material to initiate any project**.**

In a company where space is highly demanded, the wood panels occupied about 25 sq. meter while the wood scrap occupied around 26 sq. meters from the production floor space. The carpenters are accustomed to placing the wood scrap randomly more often restricting the movement around the machines creating a safety hazard.

For accounting purposes, the wood scrap are not accounted for and their costs are not allocated appropriately. The main reason for not disposing the wood scrap is for carpenters to use them when they need to cut small pieces. However, more than often, carpenters are not searching through the wood scrap for it is a tedious job and rather cut the needed pieces from new wood panels.

5.2.3.2 Goal

Creating an efficient stacking system for wood panels and decreasing the inventory of wood scrape.

5.2.3.3 Sort

- Wood panels

Generally, the duration of the sorting phase for this kind of project requires one working day. However, due to the magnitude of the work entailed, it was not feasible to finalize this

project's phase in a single working day for it necessitated three working days. The team commenced the project by separating the wood panels into two different groups:

- *Active wood panels* which henceforward are separated according to the type of wood.
- *Inactive wood panels* which are damaged panels mainly due to inappropriate storage conditions. The team reformed the panels by cutting the damaged parts, and reserved the usable fragments which subsequently were sorted and stored with the wood scrap.

- Wood scrap

As previously mentioned wood scrap creates a working hazardous for the employees and if a carpenter attempts to utilize the wood scrap, the process work flow will be negatively impacted due to inappropriate storage conditions. Moreover, wood scrap consumes fairly sizeable areas in a company where space is a limited resource. The team initially sorted the wood scrap according to types and sizes. However, any piece measuring less than 15 cm in length of width of any type of wood except for sandwich panel wood has been disposed of. The reason why the small pieces of sandwich wood is not being disposed of is because they are cut into 9 cm pieces and used as the integral toekick of kitchen cabinets. Furthermore, the general manager informed the station managers that any wood scrap being formed from cutting maple, beech, and MDF wood panels are to be benefitted for solid painted kitchen cabinet panels.

5.2.3.4 Shine

A fundamental aspect of this phase is the involvement of most carpenters and not just the team in this phase of the project. The majority of the carpenters worked together in cleaning the site and preparing the areas for the set in order phase. Their involvement is critical not only to the success of the implementation but in the sustainability of the project. Cleaning schedule has been developed to classify the cleaning responsibility as illustrated in Appendix (1).

5.2.3.5 Set in order

- Wood panel

In a previous project, storage loft C has been dismantled and relocated. Hence, the group's consortium determined that a new vertical shelving system must be installed in the specified area to maximize the storage capacity of the sorted wood panels, as shown in Figure 23. Moreover, upon examining the newly efficient shelfing system and the space which became available upon shining the area, the general manager agreed to invest in a forklift in order to load and unload the wood panels. It is noteworthy to mention that in order to enhance the process flow, the wood panels are not only stored according to types in the newly established shelves but also according to frequency of use. Finally, the shelves have been labelled to specify the type of wood panels to be stored in each section.

BEFORE

AFTER

Figure 23 The implementation of 5S on wood panel

- Wood scrap

Upon sorting all the scattered wood scraps in the carpentry according their types and sizes, they are stacked accordingly in designated areas of the production floor. Each area is specified to certain type of wood which has been clearly marked. Moreover, it is noteworthy that the wood scrap are stacked vertically and according to sizes in order to make it feasible for carpenters to retrieve any wood scrap.

BEFORE

AFTER

Figure 24 The implementation of 5S on wood scrap

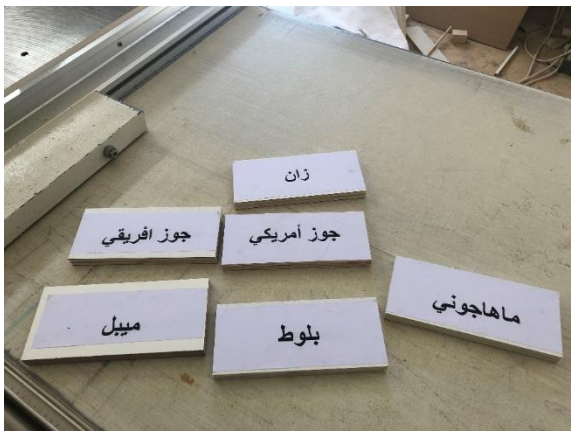


Figure 25 Labels for wood scrap and wood panels

5.2.3.6 Standardize

Labels were made and hang above each designated area to specify the type of wood panel and wood scrap to be stored underneath. Procedures for maintaining the orderliness of the workplace has been drafted and adhered to. For example, a procedure regarding the usage of the circular wood panel saw has been instilled: the produced wood scraps are to be sorted and stored in the specified areas according to type and size after each usage while a cleaning schedule is to be performed on a weekly basis.

Finally, work instructions regarding the manner by which to keep the place organized became available for every carpenter has set roles and responsibilities.

5.2.3.7 Sustain

Sustaining the work done so far is the final step in the implementation in order to ensure that the process is to be maintained.

Station managers received a thorough training and developed a full understanding of the 5S procedures. The general manager conducts an audit checklist of the wood panel's storage

fitness to the 5S standards on a monthly basis, while it is the worker gaffer's responsibility to equivalently perform the audit on the wood scrap, Appendix (2). Moreover, monthly meetings are held between the general manager, warehouse manager, and worker gaffers to discuss the adherence to the procedures and implementation of further improvements. Finally, the displayed before and after pictures are becoming a core representation of the organizational behavior.

5.2.3.8 Result

Once occupying major floor space in the factory, the wood scrap currently occupies only 7sq. meters. Consequently, the wood panel's storage space decreased to 18 sq. meters. The significant matter is the efficient manner by which the carpenter can retrieve the needed wood whether from the new shelving system of the panels or from the sorted and labeled scraps.

5.2.4 Project IV: Workshop Area

5.2.4.1 Background

A cluttered working environment is negatively affecting the employee morale and significantly decreasing the work flow efficiency. Once the three other projects have been concluded, it was time to initialize the main project which is the whole working area in general. All types of wastes (wood scrap, defective products, broken & obsolete items, and excess inventory, furnishings, tools), and even garbage are cluttering the work space. Additionally, the work floor layout must be altered in order to enhance the space availability and dedicate each area to separate work stations.

5.2.4.2 Goal

Originate a change in the organizational behavior by implementing 5S in the production floor space and partitioning the floor space into segregated manageable work stations.

5.2.4.3 Sort

Due to the scale of this project, the sorting phase of this project has not only been time consuming but challenging at the same time.

A. Waste: Although several of the items may be classified as waste but in this section waste has been defined as the following:

- Wood Scrap: the sorting and actions taken regarding wood scrap are performed in the same manner as previously handled in preceding projects.
- Defective products. Once again, many defective products have been witnessed scattered in the production floor area occupying 12 sq. meters of space. Many of the products are sought-after and thus were sold to the employees while the remaining others have been discarded.

- Broken & Obsolete Items: Several broken and obsolete accessories Figure 27 were noted in the work floor. However, the main focus of this phase is the removal of a pressure tank from the production floor. The tank has been relocated to the roof of the building. Not only did this increase the efficiency of the compressor but also expanded the availability of space by 2.5 sq. meters. Furthermore, other large size machines occupy 3.5 sq. meters of space, an edging machine, and also a boring machine have been bartered with a machinery supplier for exchange of future maintenance service needs of the existing machinery.

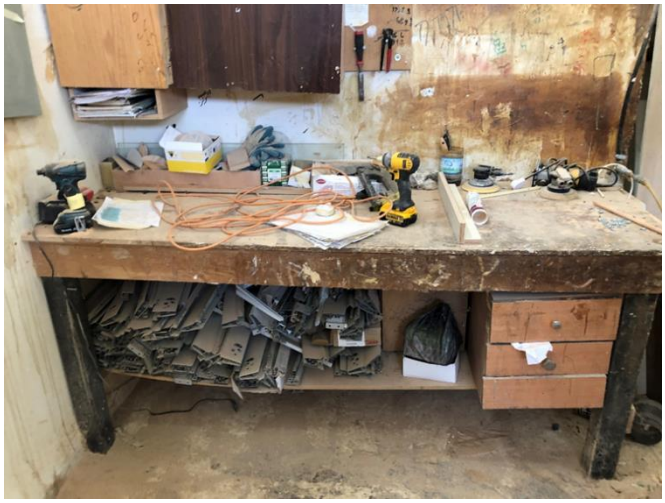


Figure 27 Broken accessories

- Excess Inventory: Due to the lack of a warehousing management system, raw materials have been scattered in several areas. Several materials have been

deemed obsolete. Likewise, the lack of inventory control allowed excessive items such as nails and sandpaper to pile up in the floor space as illustrate in Figure 28.

Figure 28 Excessive Nails and Banding Material

B. Furnishings: Several broken and obsolete tables have been removed from the area as shown in Figure 29. Files, consisting of work orders and projects' details, have been piled on workbenches are often misplaced or teared. Upon sorting all of the documents, a new filing cabinet has been designated next to the work stations to house all of the paperwork.

Figure 29 Cabinet removed and discard

C. Tools: While the obsolete tools have been disposed of, the broken tools have been gathered in one area and the maintenance crew repaired what is repairable and discarded the others as illustrate in Figure 30. Moreover, scattered tools such as clamps were gathered in order to prepare them for other phases of the 5S tool.

Figure 30 Broken Tools

D. Garbage. It was ironic to witness such large amount of garbage scattered in the work floor, however, with such a cluttered working environment, it was even more ironic that it was expected. Empty boxes, used silicon tubes, and used sandpaper were collected by all and disposed of.

Figure 31 Used sandpaper, empty boxes and silicon

E. Work Floor Layout: A space of 2.7 sq. meters which was originally built as a kitchen was no longer being used by the employees. Thus, the team decided to remove the building structures to expand the space. No external contractors were used for the demolishing and the area preparation have been performed by the selected team. It is noteworthy to mention that several partitions have been removed in order to make the area more accessible improving the process flow.

5.2.4.4 Shine

After sorting and removing not only the unnecessary items, the unused machinery, and the pressure tank, but also the kitchen's building structure, most of the employees thoroughly cleaned the area and the machines removing all of the dust and ensuring that the machines are in great working condition. Subsequently, cleaning responsibilities have been assigned to carpenters to classify the cleaning activities as illustrated in Appendix (1).

5.2.4.5 Set in order

In order to divide the workplace into separate work stations, the partitions were removed and the machines had been repositioned. The designation of new work stations involved the installation of new racks and stacking shelves in preparation of setting in-order all of the equipment and tools in an accessible manner Figure (32, 33 & 34) . Moreover, an area has been marked to temporary place returned goods in order for the general manager to make a decision of the ultimate manner to dispose or recycle them.

BEFORE AFTER

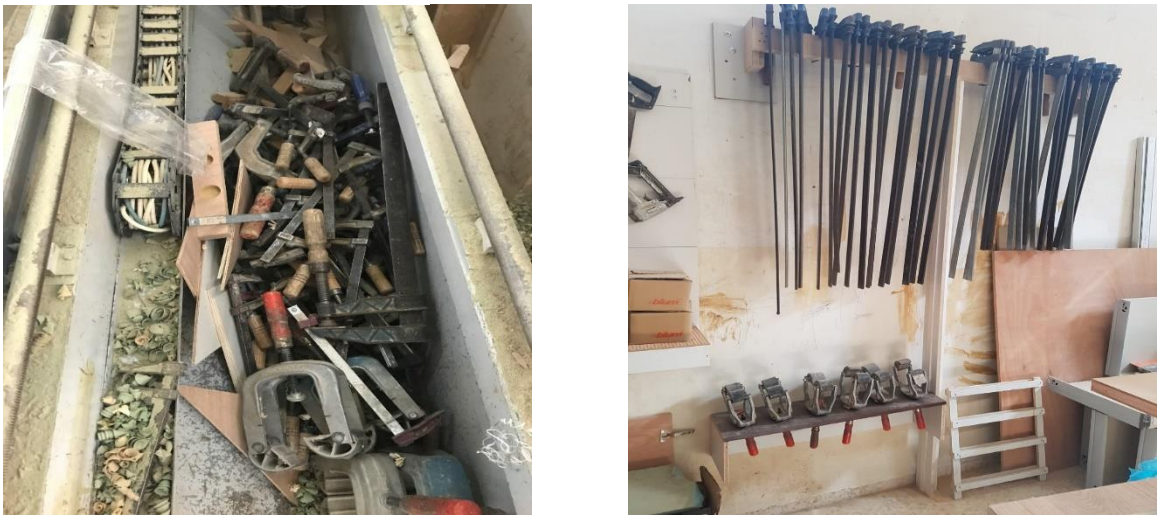


Figure 32 Setting in order various tools

BEFORE

AFTER

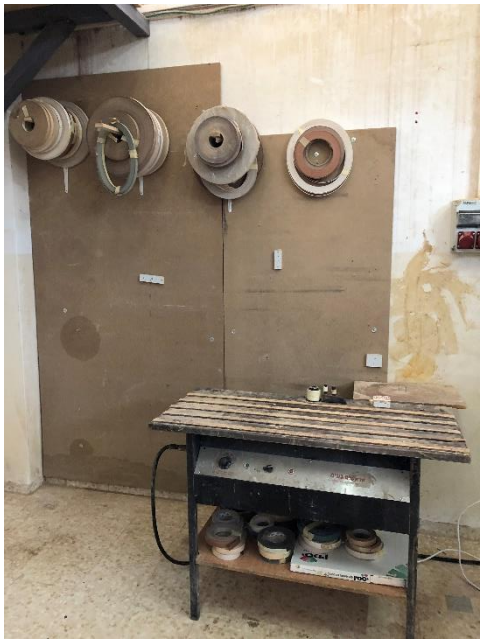


Figure 33 Efficient storing of edging material

BEFORE

AFTER

Figure 34 Removal of the pressure tanks

5.2.4.6 Standardize

A major change in the managerial hierarchy has been set: the workplace has been divided into separate work stations where each station has a newly appointed station manager. Job responsibilities have been formed to define the duties and obligations of each station manager. Moreover, procedures for maintaining the stations according to 5S standard have been drafted where the compliance to which is the responsibility of the station manager. Finally, the newly constructed shelves and cabinets aided in keeping everything sorted and in the proper designated place.

5.2.4.7 Sustain

Sustaining the work done so far is the final step in the implementation in order to ensure that the process is to be maintained.

The station managers received a thorough training and developed a full understanding of the 5S procedures. Audit checklists are performed on a monthly basis by the manager (Appendix 2). Moreover, monthly meetings are held between the general manager, warehouse manager, and worker gaffers to discuss the adherence to the procedures and implementation of further improvements. Finally, the displayed before and after pictures are becoming a core representation of the organizational behavior.

5.2.4.8 Result

Even though the changes seem small, these changes have increased the overall safety and atmosphere within the organization. The work flow has become more efficient, as all the materials and equipment have their own, named spot. Due to the implementation of 5S, bottlenecks in the areas without instructions, has now been eliminated, together with reduced walking to complete tasks.

5.3 Consequences of 5S Implementation

While conducting the gap analysis three main affairs had been revealed:

- Plant layout: a limitation of an efficient process flow.
- Lack of Inventory Management system: a pronounced financial burden and a major source of waste and space unavailability.
- Process Waste: several non-value added waste hamper the efficiency of the process flow.

The following section will illustrate the manner by which the implementation of the 5S tool addressed these impediments.

5.3.1 Plant layout

The implementation of 5S in the general working area had significant improvement on the availability of space. A brainstorming session had been conducted which included the team who originally performed the 5S implementation and the general manager in order to draft and decide on ideas of the ultimate manner by which to utilize the new available spaces.

Of the most significant utilization of the newly available space is the establishment of a station on the first floor. Prior to the implementation of the 5S tool, the work in process (WIP) had to be transferred from the first to the ground floor through the 72 meter traffic road. This matter was causing WIP to pile up in the first floor. The newly available space made it possible to establish a sanding and surfacing station for the rather massive WIP, the kitchen projects, who in turn will be transferred to the final process: the painting station.

Prior to the implementation of 5S, carpenters travelled on average three to four times a day a distance of 170 meters through the main traffic road to collect needed components for the projects. A new warehousing area has been designated in one of the newly available spaces to store the needed accessories which is located 8 meters from the work stations.

Due to the division of the two floors, a limitation of efficient material flow exists in the company. Upon the realization of the importance of an efficient process flow, a decision has been made to install an industrial elevator to link the two floors instead of using the main traffic road to transport the goods in progress. A significant improvement had been witnessed on the build-up of WIP, and it is noteworthy to mention that no longer must the company's truck be made available for such a tedious matter.

In order to further illustrate the improvements in the plant layout, the Table (5) has been drafted to demonstrate the manner by which the total travel distances required during various stages in the kitchen cabinets production process decreased by 732 meters:

Table 4 activity based distances before and after implementing 5S

	Prior to 5S implementation			**After 5S implementation**		
Activities	Distance (m)	Action per Day	**Total Distance per Day**	Distance (m)	Action per Day	**Total Distance per Day**
Work station to accessories warehouses	85	4	**340**	8	1	**8**
accessories Warehouse to work station	85	4	**340**	8	1	**8**
Wood warehouse to cutting	5	13	**65**	5	13	**65**
Wood cutting to Edge banding	14	3	**42**	14	3	**42**
Edge banding to Body assembly	10	3	**30**	10	3	**30**
Body assembly to Rubbing and polishing	72	1	**72**	3	1	**3**
Rubbing and polishing to painting	3	1	**3**	4	1	**4**
Painting to rapping and shipping	3	1	**3**	3	1	**3**
Total Traveled Distance			**895**			**163**

5.3.2 Inventory

In order to prevent waste, the implementation of 5S tools and lean management is essential in any warehousing management system. Prior to the implementation, the company lacked any warehousing principles.

The impact of the 5S's implementation is highly visible in the factory not mainly through the elimination of waste but through the image of the newly constructed storage shelving system of the wood panels and the establishment of the warehousing designated areas. Waste reduction has not only been performed on material but on time variances and labor efforts as well. The purchasing of a new forklift eliminated the unnecessary time exhausted by at least five workers in unloading raw material receivables.

Upon setting everything in order, it has become an essential component of sustainability to hire a warehouse manager to supervise any procedures to be implemented. No access to raw materials is granted to any of the employees. Instead station managers are to submit order sheets to the warehouse manager prior to the initializing of any project significantly increasing the efficiency of the carpenters for they are no longer wasting time retrieving raw materials. Currently, a stock card is well maintained in the company's financial management software. Thus, the manager can check the stock level of any inventory instantly and set reorder points. The inventory management system eliminated the waste created by obsolete products and allowed the lower stock level yielded in an increase of assets liquidity and improved working capital.

The implementation of 5S yielded in the implementation of a new warehousing management system which in turn significantly affected the costing structure of the company. With inventory controls, management can calculate the exact raw materials used in each project. In short, the warehousing management system cost control drastically improved the company's capability of products' pricing and thus increasing its' market competitiveness.

5.3.3 Waste

It is undisputable that the implementation of 5S is vastly apparent all throughout the company with the elimination of non-value added waste that significantly hampered the efficiency of the process flow. The 5S tool significantly affected all types of wastes in the company, but the following will focus on the major hindrance of the process flow according to the eight waste of lean modular findings:

Transportation: The personal's travel time wasted between the first and the second floor is no longer an issue for a storage facility has been made possible due to the implementation of the 5S tool. Furthermore, the installation of the industrial elevator eliminated the need to wait for the company's truck availability to transport the goods from the first to the ground floor. Thus, no interruptions in the process are noted causing no accumulation of work in process.

Inventory: The most significant implantation of the 5S tool has been the improvement in the warehousing managerial standards as previously discussed earlier in the chapter.

Motion: The setting of order of all the tools and the cleanliness of the factory significantly reduced the waste of motion which was evident due to the previous chaotic nature of the factory.

Waiting: Not only did the sorting of the accessories and other raw materials diminished the waiting time but it is no longer the responsibility of the carpenter to prepare the needed materials for any project. The new warehouse manager will prepare all needed items significantly altering the waiting time of the carpenters. Moreover, the implementation of 5S allowed the development of a new sanding and surfacing area in the kitchen production floor eradicating the bottleneck in the process and permitting the initiation of new projects.

Defect: the development of quality standards and the implementation of new inventory and warehousing procedures limited the receipt of any defective products. Furthermore, standardization regulated the production of wood scrap and maintained it in a manner which is efficiently accessible.

Skiles: Upon finalizing the 5S implementation process, the general manager realized the managerial talents which the carpenters possess and thus decided to shift the decision making modular of the company from a centralized to decentralized especially regarding matters pertaining to waste. Prior to the implementation, the carpenters were not able to make any decisions regarding the waste, while currently the station managers have the responsibility to make such decisions.

To further illustrate the matter, an eight waste of lean modular has been performed after the implementation of the 5S tools as shown in Table (6 & 7).

BEFORE (Gap Analysis)

Table 5 Eight waste in the kitchen production process before implementing 5S

Activity	Transportation	Inventory	Motion	Waiting	Defect
Material Preparation	Lots of Material movement	1.Unorganized place 2.High inventory level 3. Obsolete products	Lots of motion to allocate the required inventory	Waiting for material	Damage goods from source
Wood cutting		Unallocated spaces for different type			High Scrap and Rework
Edge Banding					
Body Assembly		High WIP	Searching for tools	Nos pace to assemble	
Sanding	Lots of movement between floors	High WIP		Waiting for available worker and space	
Painting				High WIP waiting	
Wrapping and Shipping					

AFTER:

Table 6 Eight waste in the kitchen production process after implementing 5S

Activity	Defect	Waiting	Inventory
Material Preparation			
Wood cutting	low Scrap and Rework		
Edge Banding			
Body Assembly			low WIP
Sanding			low WIP
Painting		Low WIP waiting	
Wrapping and Shipping			

It is evident from the comparison of Table 6 and 8, the extent upon which waste has been eliminated in various phases of the production process. The majority of the issues have been resolved while other intervals have transformed from high waste alert to low.

Moreover, Figure (35) floor plans illustrate the manner by which the implementation of the 5S affected the company:

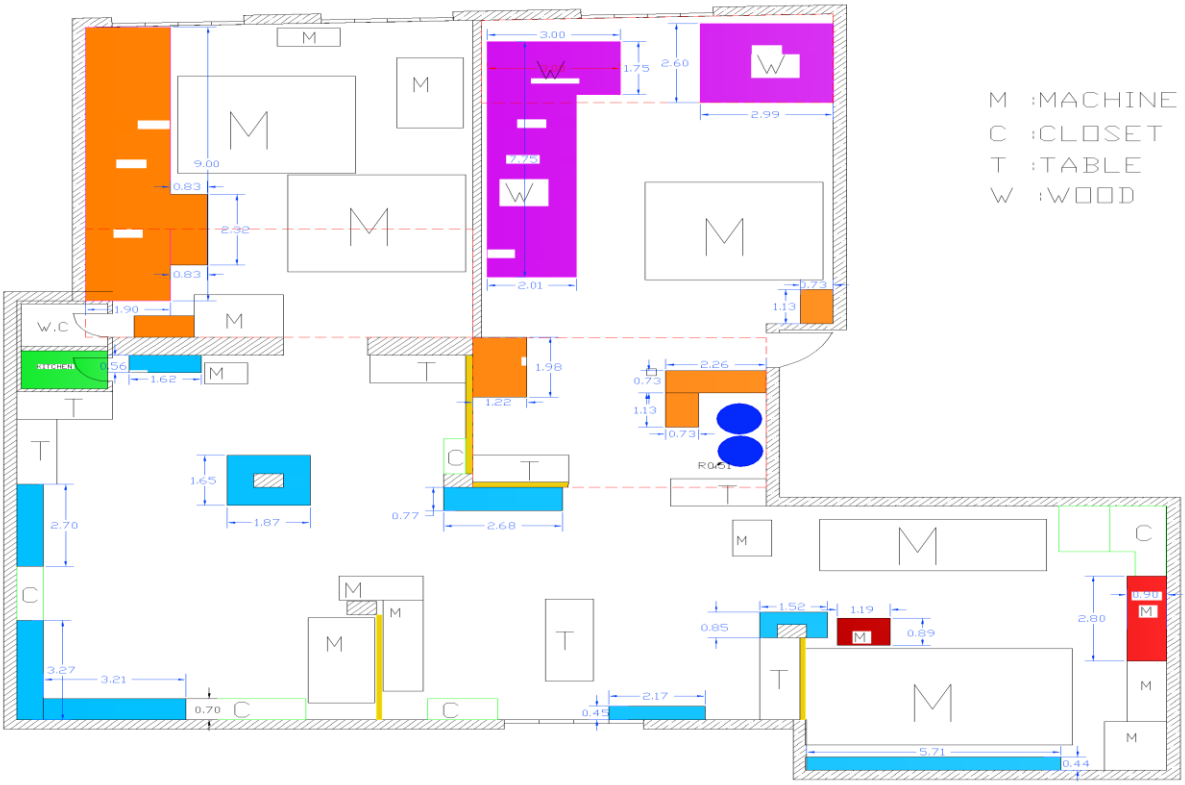


Figure 35 Floor plan before implementing 5S

Designated in orange, the wood scrap was scattered in the floor space occupying 26 sq. meters while the purple area marks the space utlized by wood panels 25 sq. meter. Returned finished goods area, marked in light blue, occupy 12 sq. meters and the goods had been placed

in the work floor space for a very long time with no prospects from upper management on what to do with them. The pressure tanks take up an area of 2.5 sq. meters, marked in dark blue. Moreover, there were a couple of outdated and obsolete machines which are not being used that useed up 3.5 sq. meters of the space. There were some partitions marked in yellow that were hindering the work process. Finally, the 2.7 sq. meters area, marked in green, had been originally designated as a kitchen; yet, it has not been used for that purpose.

Figure (36) illustrate the new layout after the implementation of the 5S tool:

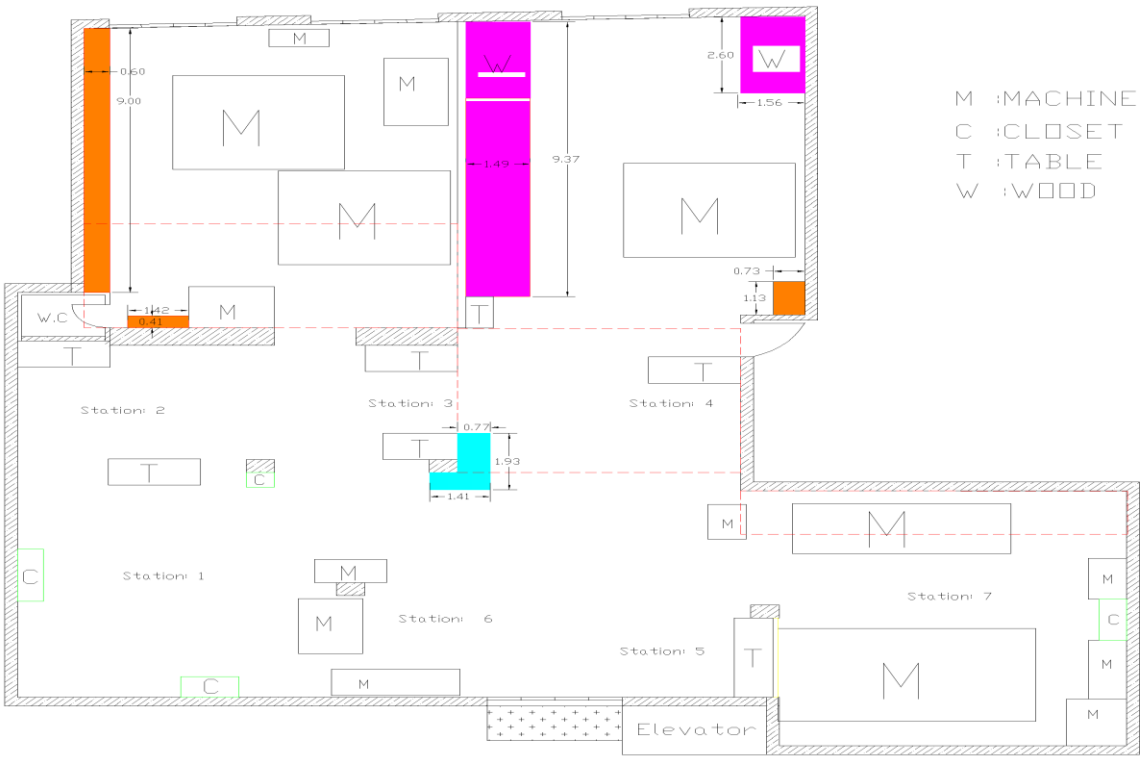


Figure 36 Floor plan after implementing 5S

Table 7 Available area after implamenting 5S

Activity	Area Prior to 5S Implementation	Area After the 5S Implementation	Available Area
Wood Scrap	26	7	19
Wood Panel	25	18	7
Pressure Tanks	2.5	0	2.5
Returned Furniture	12	1.60	10.40
Kitchen Structure	2.7	0	2.7
Obsolete Machines	3.5	0	3.5
TOTAL NEWLY AVAILABLE SPACE			**45.10**

Not only has the area of the wood scrap, marked in orange, has been reduced from 26 sq. m to 7 sq. m but the manner by which the wood scrap is currently being stored significantly reduced the time needed to access any needed amount. Although the layout space of the wood panels, marked in purple, has not significantly improved, but the new shelving system allowed for vertical storage and material can be easily retrieved. The total newly available space, 45.10 sq. meters, which account for 7.5% of the total floor space allow for the utilization improvement of the area for various activities facilitating an enhanced process flow.

5.4 Chapter Summary

This chapter discusses in details the implementation of the 5S tool on the first floor of the production plant with minimal improvements on the ground floor. However, upon finalizing the implementation, the company in general and not solely the first floor witnesses a drastic change. The implementation has been initialized in four different projects. The first project is the storage lofts where waste has been eliminated and the new available space has been utilized to store raw materials such as accessories. The second project is the development of warehouse management system. The third project is the organization of the wood panels and wood scraps where an efficient stacking system has been installed. The final and fourth project is the reduction of waste in the workplace which has been concluded with a change in the organizational behavior of the company. The implementation of the 5S significantly affected the plant layout, instilled an inventory management control system, and reduced various types of waste in the company.

Several investments have been made in the implementation phase ranging from minor activities such as trivial construction (demolishing partitions) to major actions such as the installation of an industrial elevator and the acquisition of a fork lift. Ordinarily, the return on investment must be measured in order to indicate to quantify the benefits made to the company. However, the majority of the improvement investments made in WMFC have been deemed essential in any optimal production facility. For example, it is unacceptable to use the main road to travel between production floors and thus the return of investment of the industrial elevator will not be measured in time or cost savings but more importantly in employee morale and safety. Subsequently, for a small workshop it is not customary to have

an asset such as a forklift, but for a company consisting of 60 employees and 12 production lines, a forklift is an essential part of the business for loading and unloading as they are performed on a daily basis. Finally, if return on investment is deemed necessary, the most valuable return of 5S implementation is for WMFC to maintain its market competitiveness. WMFC was beginning to lose its' market appeal due to its inability to deliver products in a timely manner. As mentioned in an earlier chapter, WMFC market image was becoming synonymous with flawed delivery time prior to the implementation of the lean management tools. Thus, in conclusion, if one is to measure the return on investment of the 5S implementation, the most valuable return is WMFC maintaining its' marketing appeal by regaining consumers' trust in delivering high valued products in reasonable prices.

Chapter 6: Conclusions & Recommendations

6.1 Introduction

It is not a simple assignment having a Palestinian business owner agree to allow a consultant yet a graduate student to implement any improvement strategies to a successful business operation. It is simply not in the Palestinian business culture to accept any external advisors interfere in the daily management of the operations. However, the catastrophic working conditions at WMFC and the need to improve the image of the company regarding delivery time made the persuading task seem effortless. The company's reputation is characterized with superior quality yet many potential customers are reluctant to work with the company due to the company's inability to meet delivery dates.

The research investigates the manner by which lean management has been instigated into WMFC organizational culture in order to facilitate a positive change. Upon identifying and analyzing the elements impeding productivity, various tools have been utilized to significantly improve the company's production processes, throughput time, eliminated wastes and bottlenecks, and implemented standards and process controls to ensure the longevity of the implementation.

6.2 Conclusions

The main expected outcome of the project is to improve the production process efficiency in the first floor production area, especially the kitchen cabinet manufacturing unit. Benefits include a more organized workplace and activities in order to streamline operations, simplify floor control, and develop a lean management approach in the organizational culture. The major hurdles limiting the availability of floor space and directly affecting the efficiency of the process time are the accumulation of waste, the plant layout, and the lack of an inventory system.

The implementation has been segregated in four different projects critical to prepare the company for 5S application:

1. Storage Lofts: waste has been eliminated and the new available space has been utilized to store raw materials such as accessories.
2. Warehouse management system: the development of inventory control is keen to sustain a profitable organization.
3. Stacking System: the installation of a stacking system to organize the wood panels and wood scraps in an efficient manner.
4. Waste Reduction: the decline of waste in the workplace has been concluded with a change in the organizational behavior of the company.

The execution of the 5S tool in the above four mentioned projects, the company significantly reduced various types of wastes, the plant layout has been enhanced to improve the process

flow, and the instilling of an inventory management control system significantly aided in the sustainability of the implementation.

The 5S tool has been adopted to eliminate waste. The main advantage of the 5S implementation is the amount of floor space savings allowing for the development of various tasks such as a new painting preparation station which aided in eliminating a bottleneck in the process. The total area exploited is 177 sq. m. Another main issue is the improvement of the process flow by reducing excessive motion; carpenters will no longer need to focus on divergent tasks such as locating tools. Moreover, the level of safety has been significantly increased due to the cleaning and organizing the workstations for several potential hazards are identified and removed. Thus, the workers became more satisfied with their environment and the employee morale increased.

Of the major improvements in the plant layout is the realization for a need to a direct access between the two production floors in order to eliminate the need to use the main road and reduce travel time. An industrial cargo elevator has been installed significantly reducing the material travel flow and eliminating several wastes such as the time utilized by the company truck and employees to transport the goods to the ground floor. Furthermore, the work in process painting station bottleneck has been eliminated.

The implementation of 5S lean managements promoted the establishment of designated storage areas. The acquiring of a financial accounting software became apparent to sustain the new warehousing managerial procedures.

The overall benefits to the company can be summarized as follow:

- Work in process (WIP) reduced.
- Reduction of set up time.
- Total Area saved around 177 sq. meter.
- Reduced activity based travel distance by 732 meters.
- Reduced time to access inventory.
- Reduced material flow time.
- Implemented an inventory management system.
- Created a raw material warehouse.
- Installed a cargo elevator.
- Purchased a forklift to achieve more efficient material handling

With the improvement of process efficiency and the removal of bottlenecks, the company is regaining consumer trust by delivering the quality products in a reasonable time. The implementation of lean management in the company significantly improved the process allowing the company to better estimate the projects' lead time and is capable of meeting the set target dates. The employment of assistant General Manager and warehouse manager are significant changes in the managerial system but the formation of station teams and station leaders evolved the organization structure which aided in sustaining a lean management system and encouraged continuous improvements.

6.3 Recommendations and Future Work

Based on the implementation evaluation interviews and brainstorming sessions conducted with the general manager and the team, herein within recommendations the company can pursue to further improve the process flow:

- In order to effectively sustain all the implementations and to continuously improve the efficiency of the process, the appointment of an expert Quality Assurance Manager has been advised. The job responsibilities would further entail not solely the monitoring of the various aspects of the 5S process, but training the employees about the importance of the 5S implementation as well.
- The acquisition of a CNC sawing machine with software which will calculate the ultimate manner to cut a project's wood panels in order to minimize wood scrap. Furthermore, the company will be able to input a 2D or 3D drawing of which the sawing machine will ultimately cut the needed pieces according to the desired design in the most efficient manner to accelerate the efficiency of the process flow and minimizing waste.
- The embracing of a project based reward or incentive employee program to further improve productivity and profitability. Since the carpenters had been divided into workstations, it has been discussed to award the employees a share of the profits of each project including holding them accountable for any defective goods.

- The implemented inventory management system and the new procedures which have been set allow the company to collect valuable data of which they can utilize to enhance the costing and pricing structure and further improve the efficiency.

6.4 Closing Remarks

Lean Management is all about reducing waste. This involves the implementation of 5S tool which ultimately increase the process flow efficiency. The teamwork approach gives rise to achieving the desired results proficiently and rapidly but more importantly allow the instilling of lean management philosophy into the organizational culture.

Lean Management has enabled WMFC to eliminate waste in the production of the kitchen cabinetry production line. Wasef Mutee is seeking to extend the implications of lean management by incorporating its' values in the organization as a whole. The successful implementation of lean production at a production division in WMFC will form not solely the benchmark for the systems introduction at the whole company, but a mere significant case study for the Palestinian manufacturing industry.

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APPENDIX

Appendix (1) cleaning responsibility schedule

Cleaning activity	**Responsible person**	**continuously**	**Daily**	**weekly**		
Floor plan cleaning	Housekeeping boy	**X**				
Station	Station manager		**x**			
Storage	warehouse manager			**x**		
Wood scrap	All carpenter			**x**		
Wood panel	Warehouse manager			**x**		

Appendix (2) 5S Checklist

Work Area: . . . . . Date: . . . . . .

5S Leader: . . . . . 5S Auditor: . . . . . .

S1 - Sort - SEIRI:

✔ / x

1. No unnecessary items are left or stored in the workplace.	
2. All machines are in use.	
3. All tools are in use.	
4. Standards for eliminating unnecessary and returned finished goods exist and are being followed.	
5. unused equipment and machinery removed from the area	
6. Is there any obsolete inventory (wood panel, accessories)?	

S2 - Set in order - SEITON:

7. Locations of tools and equipment are clear and well organized.	
8. Locations of accessories, wood panel and wood scrap are clear and well organized.	
9. Labels exist to indicate locations, and shelves.	
10. Are storage places for tools and equipment designated and marked?	
11. Are returned goods placed in there designated area?	

S3 - Shining - SEISO:

12. Floors free from dirt and dust.	
13. Racks, cabinets and shelves are kept clean.	
14. Machines, equipment and tools are kept clean.	
15. Stored items, are kept clean.	
16. Cleaning assignments are defined and are being followed.	

S4 - Standardize - SEIKETSU:

17. Information displays, signs and other markings are established.	
18. Procedures for maintaining the first three S's are being displayed.	
19. 5S checklists, schedules and routines are defined and being used.	
20. Everyone knows his responsibilities, when and how.	

21. Regular audits are carried out using checklists and measures.	

S5 – Sustain - SHITSUKE:

22. 5S seems to be the way of life rather than just a routine.	
23. Success stories are being displayed (i.e. before and after pictures).	
24. Rewards and recognition is part of the 5S system.	

Comments……

Appendix (3) Raw Material Order Sheet

نموذج طلبات	
إسم النجار:	إسم المشروع:
نوع العمل:	
المطلوب:	
العدد:	

- المرحلة الثانية: إعادة تنظيم المخزن الرئيسي و ترتيبه بطريقة تُسهل الحركة والاستخدام. كما تم التخلص من المواد الخام التالفة و الغير مستعملة أيضاً، والإستثمار في برنامج لإدارة المخازن مع تعيين موظف مسؤول.
- المرحلة الثالثة: إعادة تنظيم ألواح الخشب المستخدمة في التصنيع وترتيبها حسب النوع، كما تم التخلص من زوائد الاخشاب التي لا يمكن إعادة إستغلالها و ترتيب الجزء الآخر حسب النوع .
- المرحلة الرابعة: تنظيم كامل لأرض المصنع و التخلص من المآكنات التالفة والبضائع الراجعة.

بعد إتمام جميع المراحل تم توفير مساحة تكفي لإنشاء محطة أخرى مسؤوله عن تجهيز البضائع للمرحله النهائية وهي الدهان، بالإضافة إلى توفير مساحة أخرى لإنشاء مكتبين، وإنشاء مصعد صناعي للوصل بين طوابق المصنع. نجح أعضاء الفريق في الوصول إلى النتائج المرجوة، إلا أنهم حتى اللحظة يسعون إلى التحسين المستمر.

ملخص

مع زيادة المنافسة في الأسواق المحلية وزيادة وعي المستهلك لجودة المنتج، أصبح من الضروري على المصانع تحسين كفاءة الأدآء وتوفير منتج ذو جودة عالية بأسعار مناسبة. و بناءً عليه، يسعى مصنع واصف مطيع للأعمال الخشبية مُمَثل بمديره العام "واصف مطيع" و جميع العمّال بالتعاون مع قائدة البحث "لونا طنوس" لتحقيق الهدف.

مصنع واصف مطيع هو مصنع للأثاث المنزلي والمكتبي مُكَّون من طابقين منفصلين و يعمل به أكثر من 60 نجار. سيتم العمل على تحسين الطابق الأول للمصنع مع بعض التحسينات البسيطة للطابق الثاني في هذه الرسالة.

في البداية قامت قائدة البحث بالإجتماع مع المدير العام للإتطلاع على أهم المشاكل التي تواجه المصنع بشكل عام، و من ثم قامت الباحثة بعدة زيارت للمصنع و تدوين الملاحظات وإجراء مقابلات مع العمال ومناقشة الأمور والمشاكل التي تواجههم أثناء عملية التصنيع.

وبناءً على البحث و المناقشه بين الباحثة و المدير العام، تم تحديد المشاكل الأساسية التي تواجه المصنع و التي تتضمن:

- انعدام برنامج خاص لإدارة المخازن.
- عدم توفر مساحة كافية لإتمام العمل بشكل أفضل ووقت أقل.
- تراكم البضائع الراجعة و زوائد الخشب المستخدم في عملية التصنيع.
- تراكم المنتجات الخشبية الغير جاهزة بين مراحل التصنيع.
- عدم و جود بيئة منظمة و آمنة في المصنع.
- إنعدام الترتيب و التصنيف بين ألواح الخشب المستخدمة في التصنيع.
- وجود ماكنات على أرض المصنع غير مستخدمة في عملية التصنيع.

وعليه تم تشكيل فريق عمل مكون من خمسة أشخاص بمرافقة الباحثة للقيام بتطبيق منهجية (5S Lean Tool) على المصنع.

بدء المشروع التحسيني للمصنع بجلسات توعيه بين العمال و الباحثة، حيث قامت الباحثة بشرح كامل عن آلية البحث واهميتها. ومن ثم تم تقسيم العمل في المصنع إلى أربع مراحل .

- المرحلة الأولى: التخلص من البضائع الراجعة والتالفة الموجودة في ثلاثة مخازن علوية (سدّه) حيث أنّ مساحة هذه المخازن تساوي 85 متر مربع. و عليه فقد تم توفير هذه المساحة لإستغلالها كمخزن للمواد الخام الخاصة بالتصنيع لهذا الطابق.