DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF BUSINESS ADMINISTRATION
BUSINESS ADMINISTRATION PROGRAM
MASTER'S THESIS

5S APPLICATION INTEGRATED INTO ERP SYSTEM IN A GARMENT MANUFACTURER

Ayten PAZARKURAN

Supervisor
Prof. Dr. Aşkın ÖZDAĞOĞLU

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Ünvanı, Adı, Soyadı	Üniversitesi	İmza
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Müdür

DECLARATION

I hereby declare that this master thesis titled “5s Application Integrated Into ERP System In A Garment Manufacturer” has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials in this thesis benefited from the mentioned resources in the reference list. I verify all these with my honour.

23.07.2024

Ayten PAZARKURAN

ABSTRACT

Master's Thesis

5s Application Integrated Into ERP System In A Garment Manufacturer

Ayten PAZARKURAN

Dokuz Eylül University

Graduate School of Social Sciences

Department of Business Administration

Business Administration Program

The rising production philosophy is undoubtedly lean production. One of the most common and preferred methods among lean production techniques is the 5S technique. Many factories are working towards becoming visual factories. However, unfortunately, there are still businesses that cannot implement lean production techniques and 5S practices. There is a huge lack of practice and knowledge, especially in the textile industry. In addition to these problems, the use of ERP is an application that is desired to be disseminated and integrated into the textile industry. Unfortunately, issues such as the scarcity of scientific research on lean production and ERP in the textile industry and limited application examples create limited information. Therefore, there are still gaps in the literature. This research aims to show the improvements that can be achieved by supporting 5S work in the textile industry with the ERP system and to close the literature gaps. In this study, 5S visual studies were carried out and it was also aimed to maintain digitalization by using the ERP system. The application results showed that a significant improvement was achieved at the end of the project. The main problem at the beginning of the project implementation was that material losses were high and employees lost a lot of time searching for materials. The total material search time was 6136 seconds (102.26 minutes), which decreased to 3493 seconds (58.21 minutes). At the end of the application, the total material search time decreased by 43%. And material loss is 99.9% prevented.

Keywords: 5S, Lean Manufacturing, ERP System, Lean Techniques, Digitalization, Lost Time.

ÖZET

Yüksek LisanTezi

Bir Hazır Giyim Üreticisinde ERP Sistemine Entegre 5s Uygulaması

Ayten PAZARKURAN

Dokuz Eylül Üniversitesi

Sosyal Bilimler Enstitüsü

İngilizce İşletme Anabilim Dalı

İngilizce İşletme Yönetimi Programı

Yükselen üretim felsefesi şüphesiz yalın üretimdir. Yalın üretim teknikleri arasında en yaygın ve tercih edilen yöntemlerden biri 5S tekniğidir. Pek çok fabrika görsel fabrika olma yolunda çalışıyor. Ancak ne yazık ki hala yalın üretim tekniklerini ve 5S uygulamalarını hayata geçiremeyen işletmeler var. Özellikle tekstil sektöründe büyük bir uygulama ve bilgi eksikliği var. Bu sorunların yanı sıra ERP kullanımı tekstil sektöründe yaygınlaştırılması ve entegre edilmesi istenen bir uygulamadır.

Tekstil sektöründe yalın üretim ve ERP üzerine bilimsel araştırmaların azlığı, uygulama örneklerinin sınırlı olması gibi konular ne yazık ki sınırlı bilgi yaratıyor. Bu nedenle literatürde hala boşluklar bulunmaktadır. Bu araştırma, tekstil sektöründe 5S çalışmalarının ERP sistemi ile desteklenmesiyle sağlanabilecek iyileştirmeleri göstermeyi ve literatürdeki boşlukları kapatmayı amaçlamaktadır. Bu çalışmada 5S görsel çalışmaları yapılmış olup aynı zamanda ERP sistemi kullanılarak dijitalleşmenin sağlanması da hedeflenmiştir.

Uygulama sonuçları, proje sonunda önemli bir iyileşme sağlandığını gösterdi. Proje uygulamasının başlangıcındaki temel sorun, malzeme kayıplarının yüksek olması ve çalışanların malzeme ararken çok fazla zaman kaybetmesiydi. Toplam malzeme arama süresi 6136 saniye (102,26 dakika) iken 3493 saniyeye (58,21 dakika) düştü. Uygulama sonunda toplam malzeme arama süresi %43 oranında azaldı and malzeme kaybı %99,9 oranında önlendi.

Anahtar Kelimeler: 5S, Yalın Üretim, ERP Sistemi, Yalın Üretim Teknikleri, Dijitalleşme, Kayıp Zaman.

5S APPLICATION INTEGRATED INTO ERP SYSTEM IN A GARMENT MANUFACTURER

CONTENTS

CHAPTER TWO

LITERATURE REVIEW

CHAPTER THREE

METHODOLOGICAL FRAMEWORK

ABBREVIATIONS

ERP	Enterprise Resource Planning
5S	Seiri, Seiton, Seiso, Seiketsu, Shitsuke
SMED	Single Minute Exchange of Dies
JIT	Just in Time
TPM	Total Productive Maintenance

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

In today's technology environment, price reductions and quality increases have necessitated an emphasis on cost and quality factors. Lean Production combines production techniques, management principles, and continuous development to overcome challenges and move forward. It involves identifying flaws and problems in the current system and striving for perfection. Lean manufacturing refers to the procedures, techniques, strategies, and initiatives used by businesses around the world to decrease essential and non-productive tasks, activities, and behaviours in the workplace. (Garvin, 1988:40)

In today's market conditions, companies are one step ahead of their competitors. Every application you will undergo is of great importance. "Order and order", which is of great importance in both business and daily life, has become a necessary practice in market conditions where competition is constantly increasing. From the moment they are born, people are taught that they must be tidy and clean and that they must put their lives in order in order to live a good life. people's lives They make an effort to keep the items they use and their environment tidy and clean throughout their lives. (de Oliveira,2020:48)

Lean manufacturing occurred during World War II in Japan. This is an awareness that stems from the poor economic conditions and development efforts after World War II. After the war, Japan, where natural resources were limited and labor and capital resources were insufficient, had to learn to use resources as cheaply as possible in order to maintain its economic life. These needs played a major role in the development of lean production, which is also defined as a philosophy. (Price, 1994:66)

Cleanliness and order, which are a part of our daily lives, are essential in workplaces. It is implemented using the 5S technique. 5S is a systematic technique that enables employees to participate in workplace cleanliness and order, as well as creating and maintaining a perfect working environment in businesses. Consisting of basic and systematic procedures, the strategy maintains workplace order and ensures that all necessary materials are available on-site. To avoid misunderstanding, clear the business of unnecessary materials, classify the necessary resources according to the business, increase employee motivation by providing a clean working environment, and increase staff motivation by providing equipment. (Gupta, 2015:81)

An inspection was carried out in the warehouse before the project. In the ERP system, materials were randomly selected in the warehouse stock report, and warehouse personnel were asked to find the selected materials and prove that the quantity shown in the warehouse was correct. During the search phase of the selected materials, a time study was kept for each product. There are a total of 4 personnel working in the warehouse and the materials each personnel is responsible for are different. Materials are assigned to warehouse personnel on a customer basis, and each of them is responsible for providing their customers' materials and keeping them ready in the warehouse for production. The required materials must be delivered to production in full when the production of the main product begins.

As a result of the inspection, most materials were not found and a significant amount of time was lost in the search department. And one of the most important problems observed is that it is a person-based operation. But what is essential for efficient production is a system-based the flow. One of the main reasons why the person-based system creates errors is that other warehouse personnel in the warehouse, when asked about the location of the relevant products, state that they do not know.

This situation has shown us that if the relevant personnel do not come to work, time will be lost while searching for materials if materials are needed for production, and production will be disrupted, and perhaps even production will not be able to start because all the necessary materials cannot be found. There have been situations where production was disrupted due to the existing material being available in the company, but stocks remained due to the same order being placed many times.

The warehouse's materials are not in order and there are no certain standards on the shelves. Some materials do not even have shelves and are piled up in a messy manner. With the 5S studies carried out, it is aimed to find each material quickly, reduce time wastage, and in case the responsible personnel is not at the workplace, any person can quickly obtain the necessary material without the need for help by viewing the shelf information from the system. (Richards, 2017:105)

The first step of the project was determined as warehouse counting, and then all stock items in the Accessory warehouse and fabric warehouse were counted. In this way, current stocks have emerged.

All data in the warehouse counting are simultaneously defined in the ERP system. When counting the warehouse, a shelf and place are determined for each material. The designated shelves are defined in the ERP system in the same way. The main purpose of matching the warehouse exactly with the ERP system and carrying out all activities in the warehouse simultaneously in the ERP system is to minimize the process of searching for materials that do not provide added value to the product by creating a dynamic, fast system.

CHAPTER ONE
LEAN MANUFACTURING

1.1. LEAN MANUFACTURING CONCEPT

Companies have been competing in the global environment since the date they were established to maintain their competitiveness and sustain their existence. They constantly aim for the lowest cost and high quality. Besides these intended benefits, speed is a very important factor. The most important supporter of companies to compete and sustain their existence is to follow global innovations and keep up with them. One of the ways to progress most efficiently is to adopt the lean production principle. (Porter, 2011:250)

Some of the most important factors that form the basis of the lean production approach are preventing waste, continuous improvement, and increasing efficiency. It is also known as the Toyota production system, and its originator Taiichi Ohno evaluated waste as activities that consume resources but do not create added value. In other words, waste is actions that increase costs but do not provide benefits. Any cost that the customer is not willing to pay is a waste. (Hosseini et al, 2015: 261)

Lean production techniques reduce cycle time and unnecessary costs while increasing customer satisfaction, performance, and quality. Thanks to lean production, non-value-added activities that do not create value for the customer reduce speed, and increase costs can be identified. In addition to the benefits mentioned, lean production will also reduce inventory costs by minimizing the stock holding rate. As like says ‘’ It’s not necessary to change. Survival is not mandatory’’ (W. Edwards Deming, 1982:108).

Lean manufacturing consists of eight principles, each representing different purposes.

1) Elimination of unnecessary and non-value-added activities and elements
2) Zero failure
3) Sequential workflow
4) Multifunctional materials / Groups
5) Reduction of hierarchical levels

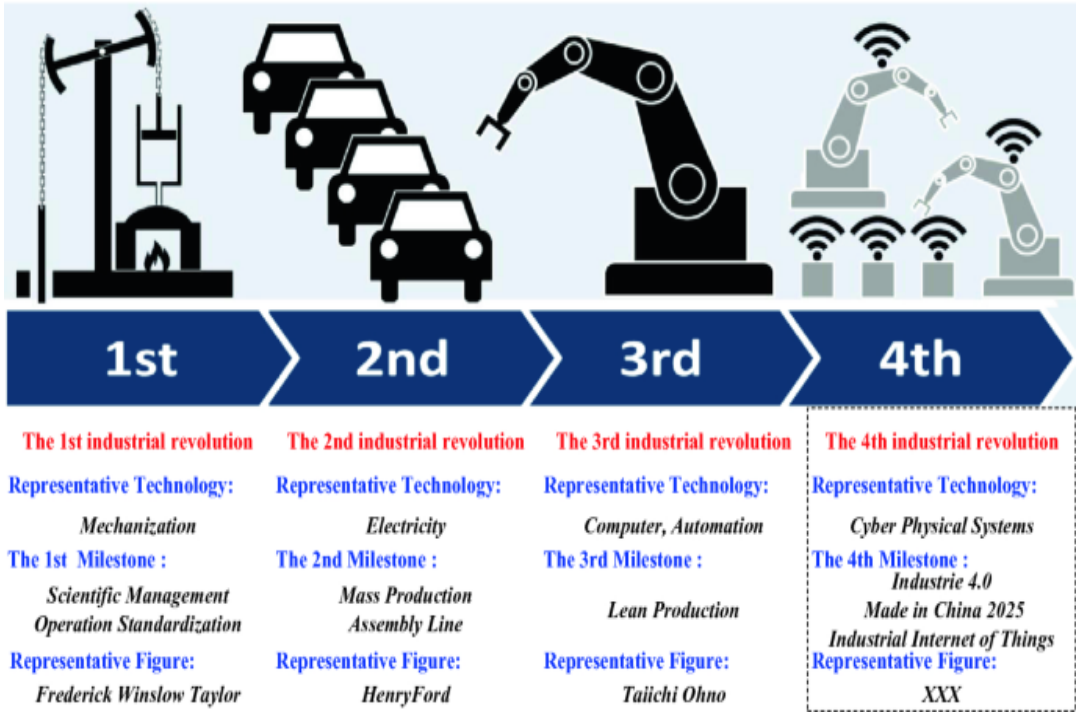
6) Group leading

7) Horizontal information systems

8) Continuous improvement

Some companies have difficulty applying lean production principles in the past and today, but many strive to achieve successful results and continue the application. There have been 4 industrial revolutions and the lean production philosophy emerged in this process. The picture below explains industrial revolutions. (Bamber & Dale, 2000:295)

Figure 1: Four İndustrial Revolutions And Related Milestones For The Manufacturing Modes



Source: R. Zhao and H. Sang, 2019.

1.2. LEAN MANUFACTURING FEATURES

The concepts of lean production and lean organization have been used very frequently in recent years and are becoming a growing phenomenon. The lean approach of a system or mechanism tells us that that system is an active and effective living system. The lean manufacturing system eliminates any bulkiness, unnecessary movement and effort, and unneeded load, focusing exclusively on value-added operations and required parts. It is a system that does not consume unnecessary energy, time, and workload. From the eliminations mentioned above, we should deduce that the lean system is not simple, but on the contrary, it is an improved and developed system. (Holweg,2007:422)

The lean production system is a system that provides cost advantages because it eliminates activities such as unnecessary movement, transportation, workload, and process stages, provides a faster cycle time, obtains more output with fewer resources, and prevents waste of movement and time. The production system's simplicity implies that it is devoid of superfluous hassles; it means that production factors, transportation, and time waste are kept to a minimum. (Lewis,2000:963)

Compared to mass production, lean production uses much less resources and energy. In addition, compared to mass production, lean production uses much less resources and energy. In addition to finished product stock, semi-finished and intermediate stocks are undesirable elements. Minimizing costs in lean production is one of the main goals, as mentioned before. One of the methods applied for this is to minimize direct labor. The basis of minimizing costs is essentially minimizing fixed expenses. When past studies on lean production are examined, it is seen that everyone who implements the lean system is satisfied with the results. The lean system has brought a new approach to production. Lean production is not just a set of techniques but a management style. However, there is a generally accepted and undoubted idea that lean production has brought a new perspective to the production system and brought original techniques. (Williams,1992:322)

Lean manufacturing does not only protect the manufacturer or the customer. It supports both sides with its techniques. It provides satisfactory results and benefits for both the manufacturer and the customer. It aims to ensure that everyone wins and is

satisfied. Components of lean thinking, customer focus, and knowledge. Its orientation is to eliminate waste, create value, and be dynamic and continuous (Kaymakcı, Ö.,2012).

One of the most important concepts according to lean manufacturing is value and waste. Value is the benefit provided to the consumer in the form of a product or service that meets their wants, is available at their chosen time and location, and is willing to pay for their business. Customers determine value, while producers generate and sustain it. Value-creating activities have a direct impact on consumer satisfaction. Activities that do not provide value do not promote consumer happiness; instead, they merely use resources, which is waste. (Simboli, 2014:178)

Waste refers to actions that use resources without producing any value. Defective goods require rework, manufacturing created without demand and eventually collected in stockpiles, unnecessary process steps, the transfer of people and products from one location to another, and prior phases. Products and services that fail to fulfil the expectations of employees and consumers who are left waiting in the following phases due to incomplete work are a waste. (Pongrácz & Pohjola, 2004:147)

The seven wastes are Taiichi Ohno's classification of the seven primary wastes commonly observed in mass production:

Overproduction occurs when more is produced than is required by the next process or client. The most harmful sort of garbage since it adds to the other six.

Waiting: Operators standing idle as machinery cycles, equipment breaks, essential parts do not arrive, etc.

Conveyance is the unnecessary movement of components and products, such as from one processing step to another, when the second step might be positioned immediately adjacent to the first.

Processing: Performing unneeded or inappropriate processing, usually due to poor tool or product design.

Inventory: Having more than the minimal stock required for a properly managed pull mechanism.

Motion: Operators performing strenuous or needless motions, such as seeking for components, tools, paperwork, etc. (Yarbrough et al, 2022:7)

Corrections include inspection, rework, and scrap. (Christoph Roser, 2015)

Seven Wastes is also Japanese called Seven G. We can be successful in reducing this waste; they would get big advantages in the competitive business area. In addition to these seven wastes, with observation companies can recognize more wastes in the production area. Therefore, being in the production area and walking is so critical. Waste is caused by disadvantaged working techniques, extensive preparation periods, ineffective procedures, a lack of training, insufficient maintenance, long distances, and a lack of leadership. (Soliman, 2023:4)

The lean manufacturing method includes aims and factors such as separating waste and value, stopping doing non-value-added work and reducing the time used for this work, focusing on reducing flow time, producing in small batches, reducing model return losses, separating different products on the production area, reducing wait time, decreasing unnecessary walks, avoid failures, supporting workers to be multitasking, find the root cause and avoiding. (Ahmad, 2022:1502)

When these goals can be reached by lean manufacturing methods, cycle time and waste will be reduced. As an additional benefit to them,

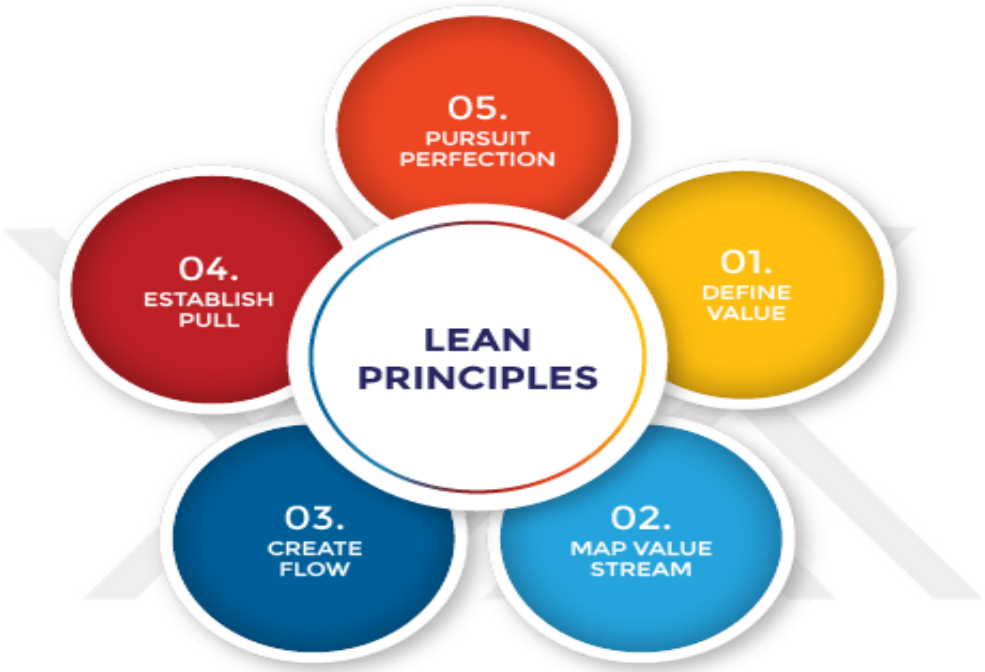
- Delivery time is shorter.
- Money returns accelerate up
- Stocks decrease
- Resource utilization efficiency improves.
- Costs decrease.
- Working capital requirements reduce.
- The ability to track quality improves. (Sundar,2014:1879)

1.3. LEAN MANUFACTURING PRINCIPLES

Lean production has been taken up by several companies as one of the most significant ways to ensure competition and continuity. Lean manufacturing has enabled businesses to increase output, reduce expenses, improve quality, and enhance profits by adhering to five key principles: identify value, map the value stream, create flow, pull, and pursue excellence. (Alves et al, 2012:235)

The five lean manufacturing concepts originated in Japan. In James Womack and Daniel Jones' book Lean Solutions, the five principles identified by the authors appear as important principles. (Womack et al, 2007: 65)

Figure 2: Lean Principles



Source: Doanh Do, 2017, 08.02.2024, https://theleanway.net/The-Five-Principles-of-Lean.

1.3.1. Value

Value is a notion that can only be defined by the end-user and has value when presented in terms of a specific product (a good or service, and frequently both) that meets the needs of the consumer at a certain price and time. The manufacturer creates value. The first step towards being lean is also the first principle of lean production that determines value. Businesses must determine what customers value and how their goods and services align with those values to proceed with this stage. Here, the value necessitates:

- Creating goods that satisfy consumer demands
- Eliminate any features that don't precisely fit these specifications.

Wasteful actions that may be necessary for undesired qualities should be eliminated by corporations by creating products to satisfy specific demands. A strategy that can assist firms in determining value is called Design for Six Sigma. (Kujala et al, 2009:72)

Businesses can methodically define, measure, and analyze what their customer's desire by utilizing Six Sigma. After that, businesses can create unique items for their clients. The first step towards being lean is also the first principle of lean production that determines value. If the factory or company is defined as a system, then the customer alone determines "Value" for Lean Thinking, which seeks to eradicate all waste in the system. (Schroeder, 2008: 60)

Value is defined as what the buyer is prepared to spend. Finding out what the client's true needs—or if they are hidden—is crucial. Users may have trouble expressing their needs or desires at points. This is particularly typical in the case of new items or technologies. You may determine what consumers find useful by using a variety of methods, including site data mining, population statistics, inquiries, and discussions. You can find out what customers want, how they would prefer the good or service to be supplied, and how much they can afford by employing these methods of inquiry. (Anderson, 1998:42)

1.3.2. Map Value Stream

The second lean manufacturing principle is to map the value stream. The value stream encompasses the whole life cycle of the product, from design to delivery. A value stream is the sequence of tangible acts necessary to obtain a specific product (a commodity or service, or a combination of the two). Value streams are what provide value for customers. Lean emphasizes value flow processes above all else. More value may be produced and obtained for consumers as value stream procedures are refined. Waste can be recognized, and action plans can be formed to eliminate waste by concentrating on value streams (Ozcelik and Erturk, 2010:57).

To establish a win-win partnership between businesses, the entire supply chain must be viewed as a value stream (Jones, and et al, 2003). A value stream consists of three different kinds of activities:

1. Value-added activities: These are precisely what the client requests. We are assembling components on an assembly line.

2. Activities that are not value-added but are nevertheless required: These are tasks that the customer does not particularly want to perform, but they are necessary given the state of the business and cannot be quickly eliminated.

3. Activities that can be quickly deleted and do not provide value for the consumer are referred to as non-value-added and unnecessary activities. That includes all forms of delays, rework, preparation, and needless travel.

While the former should be minimized, the latter should be completely eradicated as it is sheer waste. You can guarantee that consumers are receiving precisely what they desire while also lowering the expense of creating that good or service by cutting down on and getting rid of pointless procedures or stages. (Jum'a, 2020:6)

1.3.3. Flow

Ensuring there are no hiccups or pauses in the progress of the other stages is the next step to take after eliminating the waste from the value stream. Cutting down stages, rearranging manufacturing procedures, distributing the burden, establishing multidisciplinary divisions, and providing staff with multitasking and adaptable learning is some tactics for making sure profitable operations go efficiently.

To prepare for the next phase of lean thinking after the value has been properly established, the lean company has thoroughly drawn the value stream map for a particular item, and the actions that result in waste have been removed. This is an amazing advancement. Ensuring the flow of steps that provide value is the remaining task. But this phase necessitates total reorganization. There is a widespread belief that all work in an organization should be categorized and related activities should be completed in an identical area. Employees may now complete related activities in groups, which makes management simpler and appears to be more effective. The tools and machineries are also active. However, all of this "efficiency" results in a large amount of inventory, concealed flaws, lengthy lines, and wait periods between procedures. (Chen, 2010:203)

Henry Ford was the initial person to understand the strength of flow. He achieved a 90% reduction in labor required to construct simply through utilizing an ongoing flow throughout the last part of the line. However, it was a unique situation because they had been utilizing identical components over an extended period and in large quantities when creating. Utilizing a constant supply in settings where consumers often desire a wide range of items in tiny quantities was the true problem. Taiichi Ohno accomplished this by shortening machine setup periods and appropriately configuring the devices in order to place them next to one another, allowing value to flow continually. Through step-by-step analysis, this theory seeks to pinpoint every component of waste that impedes and complicates each operation. Following the VSM tool's identification of the wastes, the business must make sure that the following steps in each process go without a hitch. Therefore, principle flow is in charge of it. Supervisors must closely monitor every assignment, and they must ascertain the cause of any snags. (Drucker, 2003:36)

1.3.4. Pull

Pulling, to put it simply, is the result of activities at earlier phases in the chain not producing any goods or services in the absence of a need from the client process on the subsequent side of the chain. Nevertheless, the practical implementation of this regulation involves some additional complexity. The easiest approach to comprehend pull sense and, to some extent, its challenge is, to begin with the need of the consumer for a certain product and work from there again down each step until the good or service is delivered to the client.

If not the most significant waste in every manufacturing process is thought to be inventory. Limiting stock and job-in-process objects and preserving the availability of necessary assets and knowledge to facilitate effective workflow is the aim of a pull-based system. Put another way, a system based on pulling enables just-in-time manufacture and delivery, in which goods are produced in precisely the right amounts and at precisely the right time. Pull-based systems are invariably developed with end users' demands in mind. You may make sure that the goods supplied can meet

consumer demands by adhering to a value chain while proceeding forward through the manufacturing chain. (Mentzer et al, 2001: 1-25)

Because lean manufacturing designs, plans, and produces the product that the client requests at the appropriate time and with the necessary features, it enables genuine value and success through its pull principle. As opposed to creating a sales forecast and carrying out the production, it offers the advantage of providing the items that the customer requests at the desired time. The main purpose of this process is to change the fact that the product is pushed for sale not at the time the customer demands, but without being equipped with the desired features. The customer can use the product at any time and with the features he/she wants. In this way, satisfaction will increase. Moreover, demand will have a much more stable structure when customers are sure that their expectations will be fully met, and manufacturers give up discount campaigns to dispose of products that are left in stock because no one wants them (Womack and Jones 2010: 24).

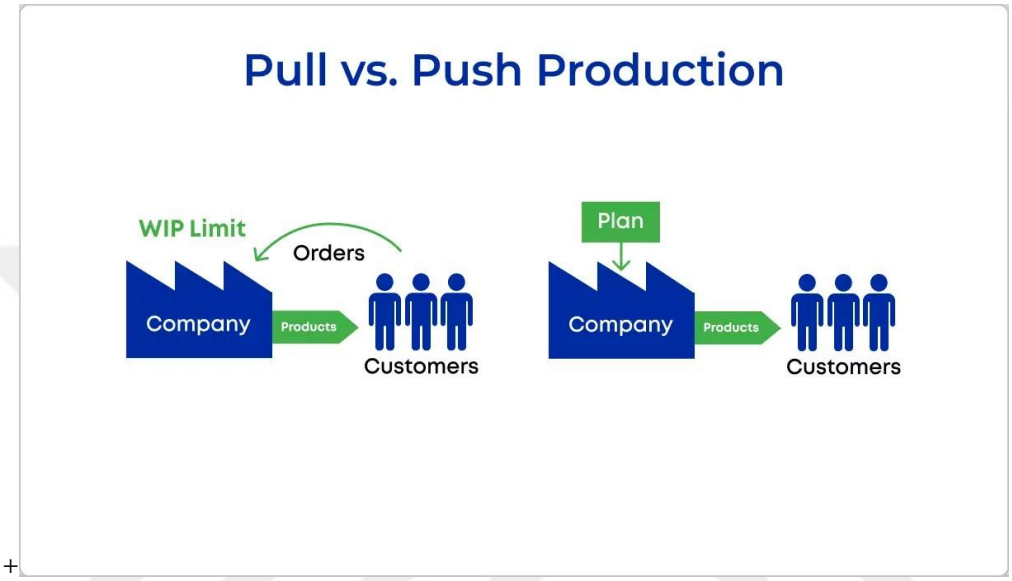
In pull manufacturing, every process is both the supplier and the customer of the one before it. Therefore, to implement the pull system in production, small quantities must be produced using the Kanban system, and at the right points, single-piece flow must be switched. Additionally, in order to implement the pull system in the delivery of goods, the number of batches must be reduced, warehouse layouts must be smoothed, and parts must be grouped and rearranged according to their size and frequency of use. It may be feasible.

Once a push approach is used, a business focuses its output on expected demand, which may not match the real demand. Such a disparity may result in unforeseen financial shortfalls. (Toneva, M, 2024). Establishing a pull system is encouraged by the Lean principle, once a smooth flow of work has been established. The concept is straightforward: only begin fresh tasks when you require it and your workforce has the resources. Your objective ought to be to provide the value that those you serve genuinely want and refrain from producing anything in excess, such as overproduction.

To put it simply, team managers or leaders generate tasks and then allocate them to team members via a push system. To put it another way, labor is forced onto those who will be carrying it out. Conversely, anything that requires to be performed

in a pull system is kept in a standing order. When an associate has nothing else to work on, they will move to the front of the line and select the item that has the greatest priority for them to work on. The workers retrieve the tasks and start working on them.

Figure 3: Pull system production vs. Push Production



Source: (Michaela, Toneva. 01.06.2024, https://businessmap.io/lean-management/pull/what-is-pull-system.)

This is when the push system gives way to the pull system. Whereas the latter depends on client needs, the former follows a set timetable (Russell et al, 2008).

1.3.5. Pursuit Perfection

The greater the degree to which precisely businesses can describe value, and assess every aspect of the value stream, achieve the sequence of actions that generate worth for goods, and allow consumers to obtain value for their company, the nearer they will get to comprehending excellence, the 5th and final principle of lean methodology. Because, despite producing a product closer to consumer needs than ever prior businesses are gradually coming to accept that the process of decreasing workforce, cost, time, space, and mistakes will never cease. (Hubbard, 2014:10)

Letting the flow of value quicker always exposes the Muda that is buried in the flow of value, and the more forcefully you pull, the more obstructions to the flow appear visible and destroyable. Dedicated team members who have direct touch with customers are continually looking for methods to better define value and optimize pull-through flow. Furthermore, while Muda removal appears to necessitate the development of novel techniques and product conceptions, in certain circumstances the innovations and ideas introduced by the solutions are simple and suitable for rapid deployment.

Waste is prevented by completing the initial four phases:

1) Identifying value,

2) Mapping the value stream,

3) Establishing flow, and

4) Implementing a pull mechanism.

Nevertheless, the fifth step toward excellence is especially crucial. It integrates lean ideas and continuous improvement of processes into the organization's culture. Each worker must aim for excellence in providing goods that meet the expectations of their customers. The corporation must be a learning organization, always striving to improve. The most essential of the Lean Manufacturing Principles urges organizations to strive for excellence. Although the pursuit of excellence appears straightforward, it is sometimes one of the most challenging ideals to properly adopt in the workplace. The pursuit of excellence compels businesses to constantly improve their methods, which frequently necessitates a transformation in workplace culture. Fabrizio, & Tapping, 2006: 71)

Kaizen, a concept of continuous improvement, may help firms adapt by cultivating a culture in which employees strive for excellence. Kaizen focuses on creating modest, incremental changes. Over time, Kaizen will lead to increased efficiency, lower costs, increased production, and higher-quality goods.

Because the system is not stocked, ongoing improvements may be made to the items created each time. This prevents waste by correcting faults and making changes before the product builds up. It is impossible to be perfect. However, further work on this line is required to attain better results. Perfection must be aspired for in order to perceive what may be done and achieve far more than under regular circumstances.

While organizations preserve their concept of excellence, they will envision the product designs and business technology that will be needed. One of the most significant impediments to rapid development is that existing process technologies are inadequate for the objectives of a lean enterprise. Producing things more flexibly in small batches and flow. Knowing fully will give guidance to individuals who produce innovative ideas and equipment. (Zhou, 2016: 457)

1.4. LEAN MANUFACTURING TECHNIQUES

Many scholars believe that the lean manufacturing system is an integrated production system that necessitates the use of numerous production methods. Furthermore, they suggest that the simultaneous deployment of these distinct techniques should result in improved operational performance due to their diversity. Despite demonstrating that they are complimentary and interconnected, they claim that. Lean manufacturing has been provided with exceptionally reasonable implementation techniques that allow all of its aims to be satisfied. The most creative and noticeable characteristic of lean manufacturing is that its ideas and aims are backed by effective procedures rather than just theoretical concepts. (Alves, 2015:5325)

Lean production procedures are methods that complement one another and strive for a similar goal. As a result, when utilized in combination, it produces better effects. As a result, using one or more of the lean manufacturing approaches outlined below will provide several benefits.

Some of these techniques are listed below.

1. Just in Time (JIT)
2. Kanban
3. Single Minute Exchange of Dies (SMED)
4. Jidoka
5. Poka -Yoke
6. Six Sigma
7. Kaizen
8. Total Productive Maintenance
9. 5S

1.4.1. Just in Time (JIT)

Just-in-time manufacturing (JIT) is the process of transporting necessary supplies to the required places at the appropriate moment. JIT aims to meet the required level of demand from internal and external customers now it is requested. The American Production and Inventory Control Society define JIT generally as a method centered on the constant elimination of waste to achieve excellence in a manufacturing organization.

It envisions the ability to manufacture a product with the specified attributes in the required quantity and time. It serves as one of Toyota's two key pillars. A production system that achieves Takt Time by establishing Continuous Flow after attracting and leveling client demand (Pull); it is a Just in Time manufacturing system. JIT, like Jidoka, the second key pillar of the Toyota House, attempts to bring issues to light. Kiichiro Toyoda adopted the just-in-time technique in the 1930s to separate from the American automobile industry, and Taiichi Ohno established the manufacturing system in the 1950s. JIT is a precondition for stockless operations. (Gudenau, 2018:25)

To ensure just-in-time production, the following terms and conditions must be met.

- Constant and uninterrupted output must be assured.
- To avoid having too much inventory, supply should be separated into lots.
- Production orders must be replicable for the same production.
- Staff should have alternate production knowledge.
- The delivered goods must arrive on schedule, not early or late.
- High-quality items must be manufactured.
- Minimum and sufficient stock should be maintained.
- Production should be separated into small batches, as needed.
- Preparation and setup times must be rapid and at the lowest cost.
- You should operate with dependable and trouble-free vendors.
- Preventive, repair, and maintenance tasks must be performed successfully.
- A pulling method should be employed for material transportation across departments.
- Continuous improvement in output must be assured.

- There should be no abnormal workflows.
- Group technology should be implemented.
- The Kanban system should be implemented.

The setting up of this system is divided into five phases.

1- Time spent processing: It is the amount of time spent processing during manufacturing.

2- Control time is the amount of time needed to produce the required level of quality.

3- Time required for transportation: The amount of time needed to move the item.

4- Waiting time: The amount of time the product has to wait for components.

5- Semi-finished and finished goods are stored throughout the storage phase in preparation for processing or shipping. (Wazed,2010:820)

Promoting the active engagement of all organization members in the improvement approach is one of the fundamental tenets of overall quality management. Engagement is crucial for "continuous improvement in quality" as well as raising worker motivation. This notion dictates that proposals made by employees must be valued, listened to, and rewarded. Because, if workers are involved in the decision-making process, they are more likely to execute them carefully. To design items for cost-effective manufacture, available manufacturing equipment and procedures must be evaluated. To improve the production flow and make workplace arrangements, adjustments are made to reduce or remove material flows. Programs are designed to guarantee staff involvement. Studies are conducted to get correct data. Paperwork is decreased because too many copied reports become obsolete with time and ineffective for decision-making. Waste is decreased. We aim for continuous development in all sectors. It is also vital to reduce superfluous inventory.

1.4.2. Kanban

The first need of just-in-time manufacturing is to send information to work centres about when and how many components will be produced. In conventional production systems, this requirement is satisfied by distributing completed orders for work across all job centres. Every job centre has its push production control system. It depends on the idea of dispatching parts to the following work centres without regard for whether the following procedure is capable of handling the part. This typically results in stock buildup. The first need of just-in-time manufacturing is to send information to work centres about when and how many components will be produced. In conventional production systems, this demand is satisfied by distributing prepared work orders to all work centres. Push production control system is one. (Schonberger, 1982:5)

Taichi Ohno, the initial developer of the tensile manufacturing method, established it at Toyota Engine Company in 1953. This technique was inspired by Taichi Ohno's observations of the material movement in American supermarkets. In the supermarket, each consumer selects his preferred amount of the product from the shelves, places it in his cart, and pays at the exit. The consumer then takes the purchased item home. Meanwhile, when the number of items on the shelf decreases, store personnel refill them. (Wada, 1998:69)

When buying, the consumer considers the number of people in his household, the capacity of his refrigerator, and the number of days he will eat it. After all, no one likes to buy more of a product than they need. Ohno suggested that this technology may potentially be used in manufacturing. In the supermarket, each consumer selects his preferred amount of the product from the shelves, places it in his cart, and pays at the exit. The consumer then takes the purchased item home. Meanwhile, when the number of items on the shelf decreases, store personnel refill them.

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would assist in reducing intermediate inventories produced between operations, as well as changes in intermediate stock levels. However, Kanban has unintended and difficult consequences for some businesses. For instance, this may be used to illustrate organizations whose delivery time exceeds their production time, as well as companies whose client needs vary regularly even after agreements have been reached.

To accomplish the zero-stock aim, the JIT methodology requires reducing inventory levels at each step of production (raw materials, semi-finished items, and completed goods). To do this, material movements inside the firm must be viewed from a fundamentally new viewpoint. Just-in-time manufacturing is described as creating just the necessary components in the quantities and time frames required. The key to realizing just-in-time production. The goal is to build a timely information system for all processes, including when and how much they will generate. This function is performed by the kanban framework in a JIT context. Kanban is the Japanese term for a sign or card. (Cook, 1996:12)

The following operation takes what it requires from the prior one. He obtains the parts when and, in the quantity, required. Similarly, the prior operation generates as much as the subsequent operation draws. Kanban is a method for running this system. The system is solely reliant on a worker from the following manufacturing stage travelling to the previous phase and "pulling" the number of pieces needed for his manufacturing station at the time. (Kaymakci, 2012: 55)

To adjust the manufacturing rate to reflect changes, timetables must be amended and sent back to the appropriate components. Because these plans take a long time, in push systems, modifications are accomplished by storing stock between operations. As a result, it is unavoidable to operate with large intermediate inventories to continue output in traditional systems. Just-in-time manufacturing systems, on the other hand, are very visible. Pull systems are frameworks in which succeeding processes demand and pull parts from prior processes only in the amount and time required and are hence also known as demand-pull systems. In pull systems, just the final production plan is supplied to the process.

Just the result specifies the item will be created, when, and in what amount, ensuring that this process only uses the parts it requires from prior processes. However, without the part extraction from the following step, manufacturing at the previous

stage will not be possible. Consequently, each at this level will generate just in time to fulfil the demands of the subsequent stages. Kanban cards are used by all need centres to draw their needs. This system is managed using various cards at each level, from the final assembly line to components manufacturing workplaces, inventory warehouses, and vendor firms.

Kanban, which is utilized during production based on the "first in, first out" concept, is always included in the collection kanban, whether they are full or empty. The Kanban system seldom regulates the rate of output. Its primary goal is to remove waste and enhance the manufacturing system. Kanban cards are used by all need centres to draw their needs. This system is managed using various cards at each level, from the final assembly line to components manufacturing workplaces, inventory warehouses, and vendor firms. (Qi, 2017:9)

1.4.3. Single Minute Exchange of Dies (SMED

The term SMED refers to mold changeover times in single digits.

It denotes a decrease. It is a method designed to shorten mold or type change and adjustment times from 0 to 10 minutes using SMED. Moulded change over time must be reduced to guarantee that just-in-time manufacturing (JIT) and Kanban systems operate together. Key principle: The procedures to be conducted before, during, and after mould change are completed as fast as feasible utilizing automation and 5S techniques. (Salwin,2019:9)

It reduces waste in the production process by ensuring a rapid and error-free transfer from one product to the next. This quick switching across items is the key to reducing the number of orders, accelerating process development, and increasing flexibility. The main argument put forward by those who support working with stock is that mould adjustment and replacement timeframes are seen to be rather lengthy. Higher stock volumes are required to maintain machine productivity and lower cost per unit component when mold change and adjustment durations lengthen. Correction timings are viewed as unchangeable data in many firms, and all modifications are occasionally. (Novis, 2008:523)

The fact that type switch adaptation periods are excessively long is one of the main factors driving mass production enterprises to this manufacturing approach. They desired the adjusted type to run for a long time in order to reduce or offset the time or efficiency lost during the adjustment phase, or put another way, the cost. On the other hand, this option offers the chance to lower unit costs and boost productivity. Businesses saw long type change adjustment periods as an unchangeable reality, hence producing a product in large quantities was deemed necessary.

The greatest indication that this problem is one of the main barriers to lean manufacturing is the fact that it takes half a day. Mold change and adjustment times need to be reduced as soon as possible to effectively use lean manufacturing techniques. This approach is termed mold altering in a minute since perfection is always the aim. When feasible, production parts are designed to be utilized in several products, hence reducing the diversity of materials needed. Mold change and preparation times can be decreased with two operators instead of one if there is enough manpower and room. Variation may be minimized via standardizing Set-Up procedures. Configuration remedial action may be started to shorten these intervals by using the approach (time study) to monitor the processes and their durations. Standardizing best practices in accordance with the designated times can be used to develop instructions. (Bhasin, 2015:128)

When a consumer requests a product, stock work provides it to them if it is available; if not, the customer must wait until the next production. In the increasingly competitive world of today, customers dealing with inventory results in lost business as customers opt to wait instead of purchasing the goods from another supplier. Zero inventories are the aim of lean manufacturing. Here, type presents the most challenge to operating without stock. It is imperative to minimize or do away with change setup times. Because the necessary product may be produced at the desired time, production with small batch sizes is opened and customer satisfaction is guaranteed. The SMED approach is the most popular and successful way to shorten adjustment times. The SMED technique, which was created by Shigeo Shingo, is regarded as the most crucial lean manufacturing approach. (Tekin, Arslandere, Etlioğlu, Koyuncuoğlu, & Tekin, 2019:6)

At its most fundamental, lean aims to reduce model changeover time. Without quick model changes, one-piece flow and consumer attraction systems are not feasible. But cutting down on model changeover time will need more than just making little adjustments to individual machines. Potential application of manufacturing molds. It must be standardized and have as many common characteristics as possible (height, breadth). The potential of the models getting out of service should be considered by the teams in addition to the mold durations. Teams should now develop daily maintenance plans for the molds as part of TPM (Total Productive Maintenance), and operators should get daily maintenance and control instructions along with a checklist (Byrne, 2015:8).

The manufacturing system and the business both profit from the SMED approach in different ways. For instance, production and storage capacity gains coincide with a rise in cash flow. Goods in hand. The expense of transportation is substantial and efficiently reduced. Because mixed production may be created, it makes it feasible to operate without stock and prevents defective and spoilt items from being stored in stock. Production capacity is raised via enhanced and shorter machine cycle times. Mold change times are shortened, but mistakes made in the process are also removed, raising the product's quality. Accidents at work are declining. Changes in the mold may happen faster, allowing for flexibility and quick response to unforeseen shifts in client needs.

It entails changing the mold in under a minute, gathering the necessary tools and parts, and then replacing, adjusting, and placing the components. SMED timeframes are decreased due to factors including increased competition, lower batch sizes, shorter lead times, more frequent model turnover, and reduced manufacturing stock. (Fernandes, 2022:8)

SMED technique is based on very simple principles. Shingo first divided mold change operations into internal and external operations. Internal activities are those that are limited to being carried out when the machine is not in use. Internal tasks include things like attaching the mold to the apparatus and taking it out. External operations are those that can be carried out without the machine stopping. External operations include things like taking out the old mold and adding the new mold. Prior to SMED: Differentiating between external and internal configuration.

Step 1: Distinguishing the internal and exterior configuration.

Stage 2: Transitioning from an internal to an external configuration

Stage 3: Every setup operation is managed and enhanced individually.

Generally speaking, the SMED technique doesn't call for significant financial outlays. Improvement efforts and the development of problem-solving abilities yield significant advantages. While financial investment is typically not needed for the first or second stages, the third stage may call for certain unique investments. The materials and requirements needed for the model return are identified during the division of internal and external activities. It is also verified that all equipment and materials are in good operating order and that they are all located in the proper locations. (Da Mota, 2018:43)

1.4.4. Jidoka

Jidoka, which translates as "autonomous" or "non-human" in Japanese, is a tool used in the lean manufacturing method. This tool may be used for automatic error detection methods and manufacturing lines that stop on their own. Jidoka offers a way for a process to halt in case of a potential error or malfunction and to notify operators when action is necessary. Jidoka's primary goal is to minimize or avoid manufacturing line mistakes. (Pinto, Matias, Pimentel, & Govindan, 2018:4)

As a result, stock levels are decreased, and quality is raised. Because Jidoka stops mistaken transactions from happening again and gets rid of the root causes of errors, it also lowers the costs of the business. The automated mistake detection systems of Jidoka are among its most significant characteristics. These systems find errors automatically. When a production line malfunctions, these systems instantly identify it and shut it down. This lowers waste and aids in the early detection of manufacturing faults. (Shook, & Marchwinsk,2014:20)

Jidoka alerts the machine or operators to an unusual circumstance. Recognizing this circumstance when it arises and giving the option to cease working right away. One of the most well-known and often applied implementations of the Lean manufacturing system is the Jidoka approach. The most straightforward instance is when a procedure is automatically terminated due to negativity or inconsistency. Any

device or operator that recognizes an unfavourable or unusual circumstance intervenes in the system and puts a halt to it. Jidoka is based on four main ideas. Find any irregularities, put an end to abnormality Permit to detect issues, and keep human and machine labour apart. The Jidoka method aims for zero mistakes. Because the rate of waste in manufacturing companies is the primary source of waste. Wastage is the primary source of mistakes. Because of this, the foundation of Jidoka is error prevention. To do this, he suggests the following guidelines. An explosion or a faulty repair makes the product useless, necessitating reprocessing. Here, "error" is the crucial word. In theory, waste and repairs do not happen if errors are not made. Consequently, the Jidoka technique's goal needs to be mistake prevention rather than waste and repair prevention. The system must be designed for this. (Guzman, 2024:63)

The most important thing with the aim to avoid mistakes, and the most challenging, of the Jidoka principle is stopping production is the first thing we should do when we recognize we made a mistake. Otherwise, waste production rises quickly. Production must be halted while we wait for the mistake to be fixed. Jidoka techniques are based on three fundamental ideas.

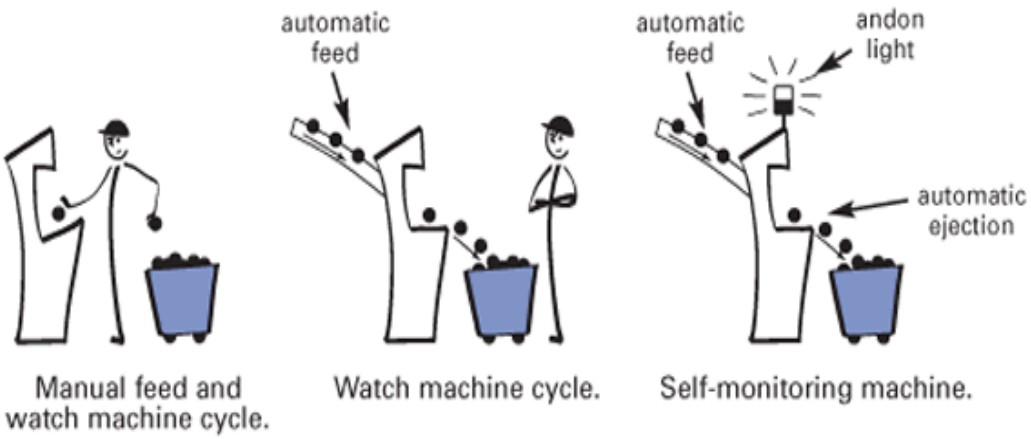
1. Stop production as soon as an issue is detected: By making a few straightforward changes to machine designs, it is now possible to automate human control procedures.

2. Providing feedback and acting quickly to fix and avoid errors: When an issue happens, report it to the source and take action to stop it there, as opposed to including an item to control order at the end of production, which is the typical trend.

3. Distinguishing between human and machine labor: An employee pushing a part in a press while holding it signifies that both human and machine labor are involved. But as soon as the task that must be completed by a human.

Jidoka is referred to as automation or automation that includes human intelligence. Based on the jidoka technique, aims to separate human activities from machine activities. Working operators must be able to control multiple machines and intervene when they see an error. This can only become a reality with increased autonomy. Romero, Gaiardelli, Powell, Wuest, & Thürer, 2019: 3).

Figure 4: The evolution toward Jidoka



Source:(Balamurgan, 2020, 20.4.2024).https://www.slideshare.net/slideshow/jidoka-an-improvement-tool-of-lean-232719797/232719797

1.4.5. Poka Yoke

When we examine the words Poka Yoke in their dictionary meaning, POKA means carelessness, absent-mindedness, and YOKE means elimination. Quality is the most basic and important idea in lean production. Whether or not a company chooses to implement lean manufacturing, quality is the most important idea. Quality awareness is required for the implementation of lean production. However, the definition of quality varies between businesses and, as a result of different aims and objectives; the idea of quality becomes less serious than it should be.

Every organization has a different waste rate. Additionally, the ignition tolerance range varies. While some businesses believe their waste rates are extremely low, other businesses may have higher waste rates. In lean production, the discount rate should be very low, and the target should be zero error. Every below-average product produced has a cost. Moreover, this expense is not an expense that the customer will accept to pay and that does not add value to the product.

In a production system, if the product does not meet the required standards and cannot be trusted to have the features and quality the customer expects, quality control

must be carried out at the end of each production run. The truth is that the quality control phase is an optional activity that adds little value to the product hampers production and increases costs. The need for control and the inability to rely on the calibre of the products produced are the driving forces behind quality control. Defective products also cause additional costs such as labour days, depreciation, and unnecessary machine usage.

Several factors can cause poke-yoke to occur, including inexperience, negligence, sabotage, carelessness, miscommunication, lack of focus, and lack of standards. It aims to achieve zero error output without the need for additional control elements by utilizing various auxiliary and error-preventing tools and tactics against human factor conditions. For this reason, if necessary, additional mechanisms can be added to the workbench used or changes can be made in the design of the product. Fault isolation is known as Poka-Yoke in Japanese. The basic idea of poka-yoke, or autonomy, is to ensure that no defective parts are made by detecting and preventing errors as soon as they occur, rather than waiting for errors to occur. Poka-Yoke is very easy to use. All that is done is to automatically detect when there is a problem with the machine's operation or condition and then install devices that will cause the machine or process to automatically shut down. (Stewart & Grout, 2001:417)

When the machine stops, it immediately alerts workers to a malfunction by ringing a bell or turning on a warning light. At this stage, the process involves collaborating with engineers and employees to identify the source of the error and quickly implement the necessary corrections. So the problematic component moves on to the next step. Not only is the error completely prevented, but its root cause is also found and corrected, ensuring it does not occur again.

1.4.6. Six Sigma

The letter sigma comes from the Greek alphabet. It is used to express deviation in mathematics. In lean production, it is used to describe how far a process or situation is from perfection. Six Sigma consists of 5 stages and these stages are processes supported by statistical methods. These steps are the steps taken for a defect-free

product. Briefly speaking, these 5 stages consist of definition, measurement, analysis, improvement and control. (Gygi& Williams, 2012:146)

1) Definition: This is the step where the points that need improvement are identified and the project to be implemented is identified and defined.

2) Measurement: This is the stage where the current situation is measured, the necessary data is collected, and the methods to be used in measuring the work to be carried out are determined. In this part, documentation of the data is very important.

3) Analysis: This is the step where the current situation analysis is made, the point to be reached at the end of the project is determined, the steps that need to be implemented for this purpose are determined, and the development points are determined.

4) Improvement: This is the stage where the improvement steps identified in the analysis phase are made and simpler techniques are applied.

5) Control: This is the stage where the project is controlled with the necessary methods after its completion and its benefits are observed.

Companies can benefit from many benefits with the 6 Sigma Method. Chief among these are.

- Reduction in error rate
- Customer Happiness
- Reduction of non-value-added cost
- Productivity increase
- Decrease in stocks

It can be considered as an example. (Goshime, Kitaw, & Jilcha, 2019:698)

1.4.7. Kaizen

Kaizen, in other words, continuous improvement, is an important technique of lean production. Kaizen should be adopted as a lifestyle rather than a technique or method, and it is. Continuous improvement is adopted by the Japanese philosophy in daily life. It is the application of the philosophy of getting better in the production system. To be successful in continuous improvement, it is important to have a lifestyle and progress slowly but effectively. One of the aims of the Kaizen technique is to

support and encourage the participation of all employees. It is the continuous development and maintenance of the continuous improvement process. Kaizen is an approach that accepts that there is always more perfection and that the final result is never reached. In Japanese, “kai” means change and “zen” means good, or better. As can be understood from here, kaizen means more perfection, more development and continuous improvement. Kaizen also says that lifestyle should constantly improve. (Gupta, 2014:29)

1. The staff is the focus and is focused on them. The emphasis is on whether the work they do can be made more efficient, productive effective, and improved.

2. Equipment and machines are observed. Corrections, developments and field arrangements are provided.

3. Education is important, and the practices required for education are emphasised. Approaches and processes that restrict education are prevented.

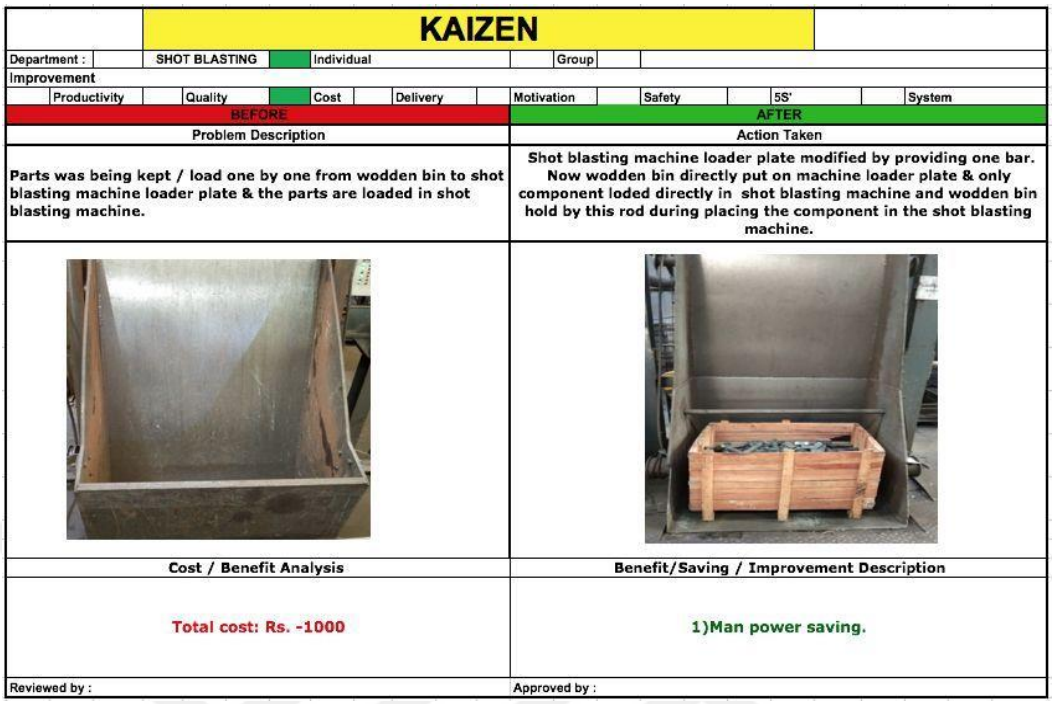
4. Innovations are given importance and innovative activities and practices that are important for the new and simple philosophy are implemented. For this step to be valid, the first 3 conditions must be successful.

It is a corrective action based on kaizen. There is always a better system and corrective actions are constantly ongoing. Feedback is important in this process and Kaizen is also based on this. Kaizen starts with small steps but gets bigger and bigger. The most important factor here is teamwork and group awareness. Kaizen work is done in groups. The groups are headed by a team leader.

As stated before, Kaizen is an approach to continuous improvement with small steps. That is, the improvements made should be small or large but ongoing. Kaizen focuses on the process, not the result, because there is always a more perfect result and to improve the result, it is necessary to manage and improve the process.

One of the most important and common kaizen projects is the before and after kaizen work. These are improvement works that are carried out for problems that come mostly with the suggestions of the employees, are discussed in meetings and different employees bring ideas, the personnel responsible for the improvement work are determined and are easy to explain with photographs showing the before and after on a single-page form. (Berger, 1997:112)

Figure 5: Before and After Kaizen Form



KAIZEN												
Department :		SHOT BLASTING		Individual			Group					
Improvement												
	Productivity		Quality		Cost		Delivery		Motivation		Safety		5S'		System
BEFORE									AFTER						
Problem Description									Action Taken						
Parts was being kept / load one by one from wodden bin to shot blasting machine loader plate & the parts are loaded in shot blasting machine.									Shot blasting machine loader plate modified by providing one bar. Now wodden bin directly put on machine loader plate & only component loded directly in shot blasting machine and wodden bin hold by this rod during placing the component in the shot blasting machine.						
Cost / Benefit Analysis									Benefit/Saving / Improvement Description						
Total cost: Rs. -1000									1)Man power saving.						
Reviewed by :									Approved by :						

Source: (Bhoraniya, N. 2018, 28.04.2024.) https://www.nikunjbhoraniya.com/2018-/11/kaizen.html#comments

1.4.8. TPM (Total Productive Maintenance)

Total productive maintenance is a lean production technique that aims to increase the efficiency and effectiveness of machines and equipment in the factory and at the same time minimize machine-related errors. Maintenance Systems go through different processes over time, such as fault maintenance, protective/preventive maintenance, predictive maintenance, and productive maintenance, and today they are considered efficient maintenance. In essence, total productive maintenance is to extend machine life, keep and protect equipment in optimal conditions, reduce depreciation ensure faster return on machinery investments, and ensure occupational safety. (Niazi, 2014:87)

Total productive maintenance, like Kaizen, is a technique that progresses with the joint participation of employees. Thanks to total productive maintenance, the efficiency of the equipment increases, which in turn supports the increase in the

efficiency of the entire company. In total productive maintenance, the maintenance services that the equipment will need throughout its life cycle are planned. This system reduces scrap rates significantly. In the lean production philosophy, one of the wastes is waiting, but waiting forms the basis of total productive maintenance. Because it is necessary to stop and wait for a certain period for maintenance. However, the time spent on maintenance is not wasted because faulty production, safety problems, and scrap rates that will occur by working with poorly maintained machines are prevented. In the total productive maintenance technique, parts waiting for production are produced and then maintenance is not carried out; when maintenance is required, all machines are stopped and maintenance is carried out. Because in Total Productive Maintenance, what matters is the completion of the maintenance. Since the pulling system forms the basis of lean production, there will be no accumulation during the machining process. Therefore, a malfunctioning machine causes the entire system to stop. (Phogat, & Gupta, 2019:29)

Employee participation and seriousness are very important in total productive maintenance. The worker must take responsibility for the machine and be its guardian. As a result of total preventive maintenance, the number of malfunctions, time loss due to malfunctions and machine downtime are reduced. Effective use of machinery and equipment is ensured, and the productivity of the production system increases.

Some steps must be followed for total efficient maintenance, and if we want to express these steps in a certain order,

1. First of all, machine cleaning and inspection
2. Identify machine problems and errors
3. Determine the maintenance and personnel to be performed
4. Teach the maintenance techniques to the machine personnel.
5. Teach correct maintenance techniques to every working maintenance personnel.
6. Implement the 5S system and adopt area cleaning
7. Monitor overall Equipment Effectiveness and promote group work

When a factory operating according to lean production principles is observed, visuality comes to the fore in almost every part of the factory. In almost all areas of the factory, texts, minutes and graphics displayed on panels next to the lights, machines

or lines can be seen. All important operations and achievements in the factory are documented and exhibited. Similar practices are seen within total productive maintenance. In the total productive maintenance system, the practices, results and studies carried out to increase incentives are exhibited in the production area. Minutes kept solely on the computer are not sufficient. It is ensured that its employees also see it. The basic principle of lean production is not to forget any mistakes, to consider all mistakes and provide solutions, and then to care about and reward successes. There are different methods of providing visualization for total productive maintenance. Total Productive Maintenance generally proceeds by placing visual panels next to the machines so that the personnel can see them and provide constant stimulation. (Narayan,2004:71)

CHAPTER TWO
LITERATURE REVIEW

This study concentrated on the effects and benefits of 5S in manufacturing organizations, particularly in the textile industry. This chapter focuses on the literature and gaps in lean manufacturing in the textile sector, 5S, and enterprise resource planning in textile companies. According to this study, ERP and Lean manufacturing are linked and assist each other in some way, and successful applications increase efficiency while decreasing costs. Furthermore, workers prefer to work in clean environments, therefore labor efficiency improves.

2.1. LEAN MANUFACTURING PRINCIPLE

The principle of lean manufacturing was first introduced by a Japanese automobile company shortly after World War II. Toyota's genius mechanic, Taiichi Ohno, established the Toyota Production System, which is the basis of the lean framework. (Womack et al., 1990). Toyota and other Japanese corporations pioneered the concept of lean thinking as a new approach. Lean is an extensive collection of ideas, practices, tools, and methodologies aimed at eliminating waste, synchronizing labor flows, and managing variability in production flows. (de Koning, Verver, van den Heuvel, Bisgaard and Does, 2006:21).

The main historical occurrence of Lean can be explained as reducing and eliminating wastes from production. Some engineers, like Frederick Taylor, Henry Ford, Frank and Lillian Gilbreth, and others, provided methodologies (Diaz Heisor, 2013:17).

Reducing waste is not the only aim of Leaa. Lean manufacturing also aims to decrease costs and increase productivity and employee efficiency. Lean approach can help reduce costs while increasing profits. Of course, it is quite difficult to eliminate expenditures and reduce them to zero, but significant solutions are willing to appear. According to many Engineers and idea owners (Altarazi & Abushaikha, 2018; Salhieh, Womack, et al., 1996:42), the main wastes are:

1. Excessive production.
2. Errors.
3. Waiting
4. Movement
5. Stock
6. Carriage
7. The excessive processing.

Despite this input, Lean knowledge focuses mainly on the beginnings and subsequent growth of the TPS—most of the methods and techniques created by Toyota company.

2.2. INTRODUCTION 0F 5S

In Japan around the beginning of the 1980s, Takashi Osada developed the 5S approach. Regarding who created the 5S concept, there is still a great deal of uncertainty in several literary works. (Mercy, 2018). The five stages of the 5S are Seiton, Seiri, Shitsuke, Seiso, and Seiketsu. These words mean "sort," "set in order," "shine," "standardize," and "sustain" in English. 5S has been clarified as a visual factory (workplace) by literature. These steps are intended to improve maintenance, increase productivity, and offer continuous improvement in every area of a business's operations (Hirano,1995: 30-50). According to some, 5S approaches are gaining favour as an approach for maintaining a visual factory while reducing time loss and insignificant motions (Deshpande et al, 2015,56). According to Bayo-Moriones 5S is a system in which waste gets reduced and productivity and quality are maximized by maintaining an organized work environment (Bayo-Moriones et al, 2010:6).

Although there is no conclusive evidence that 5S is the primary technique for running lean, it can significantly cut waste and increase profits (Hunglin,2011:48). In the Japanese manufacturing system, there are four main activities and four of them begin with ' S'. (Breyfogle, 2008:102) Those are;

1. Seiri (sort)
2. Seiton (set in order)
3. Seiso (shine)

4. Seiketsu (standardize)

Following that, a fifth activity named Shitsuke (sustain) was introduced, and the group is now known as 5S (Hunglin,2011). The platform allows the development of an integrated management system through the use of total productive maintenance (TPM) (Bamber et al. 2000.73).

When these five processes are implemented effectively and consistently, workers become more productive and efficient, and more eager to work while waste and non-value activities decrease.

Kobayashi et al. (2008) distinguish between 5S as a philosophy or approach and 5S as a technique or instrument by comparing the frameworks offered by Osada (1991) and Hirano (1995). From Osada's (1991) approach, 5S is a strategy aimed at organizational development but on the other hand, Hirana (1995) presents 5S as one of the biggest industrial tools against competitors.

2.3. THE 5S COMPONENTS

Table 1 summarizes the many modifications. This research utilized the English counterparts of Hirano's 5S methodology.

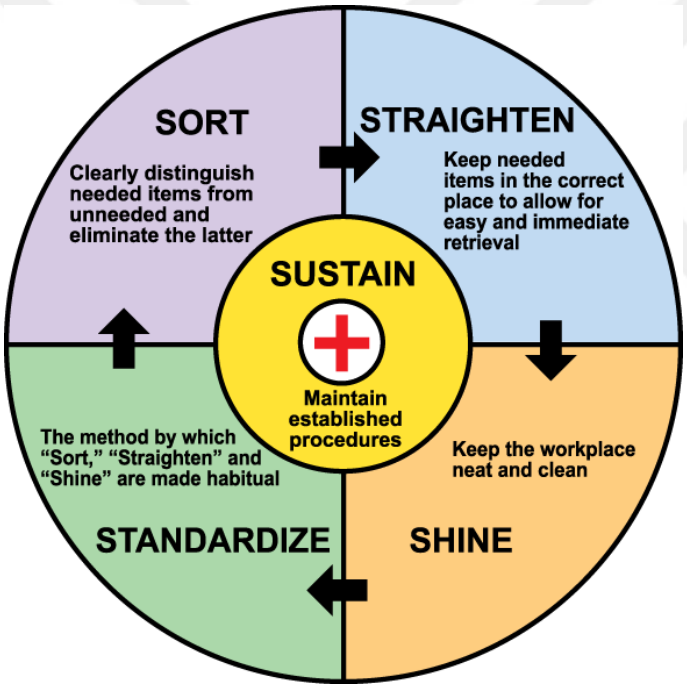
Table 1: 5S Components, Equivalents, and Aim

		Other Variations			
Japanese	English 5S	5C[a]	ONCSD[b]	CANDO[c]	Aim
Seiri	Sort	Clean out	Organization	Clean up	Remove unwanted items from the work area
Seiton	Set-in-order	Configure	Neatness	Arranging	Visual workplace – assign every item a place
Seisou	Shine	Clean & check	Cleaning	Neatness	A clean workspace
Seiketsu	Standardize	Conformity	Standardize	Discipline	Standardize and maintain work place procedures and processes
Shitsuke	Sustain	Custom & practice	Discipline	Ongoing improvement	Audit, communicate, and train employees until it becomes a habit

Source: O'hEocha (2000, p. 321). b Osada (1991, p. 25-32). c Massey and Williams (2005, p.331).

Before implementing the 5S, a corporation needs to understand what the 5S are and why they exist. Many firms prioritize 5S while implementing lean practices. Here are several established explanations for this: 5S is simple, straightforward, and captures people's attention. However, there is no rule to determine where to begin. Begin implementing 5S when there is a reasonable point inside an organization. Figure 1 is a view for employees to understand 5s application goals. Before implementing 5S, a firm leader should explain the concept and how it will be used, as with any new initiative.

Figure 6: 5S



Source: "5S in the office," by Beyond Lean (BL), retrieved from http://beyondlean. WordPress. Com? s=5, 23.03. 2024.)

5S application provides several benefits for companies. Here are five ways that your business may profit from 5S systems:

1. Optimized Organization: One of the five pillars of workplace organization is to reduce the amount of time spent looking for, determining how to use, and

returning objects. Parts and tools are organized according to the 5S principle so that they are conveniently accessible and used.

2. Efficiency: The 5S method motivates businesses to increase efforts to remove waste from the production process and ultimately boost a company's bottom line. This is accomplished by enhancing products and services, hence reducing costs.

3. Increased Storage Density: Standard 5S deployment leads to considerable savings in the square footage of space required for current operations. The strategy entails removing unneeded objects from industrial facilities, freeing up space for more productive usage.

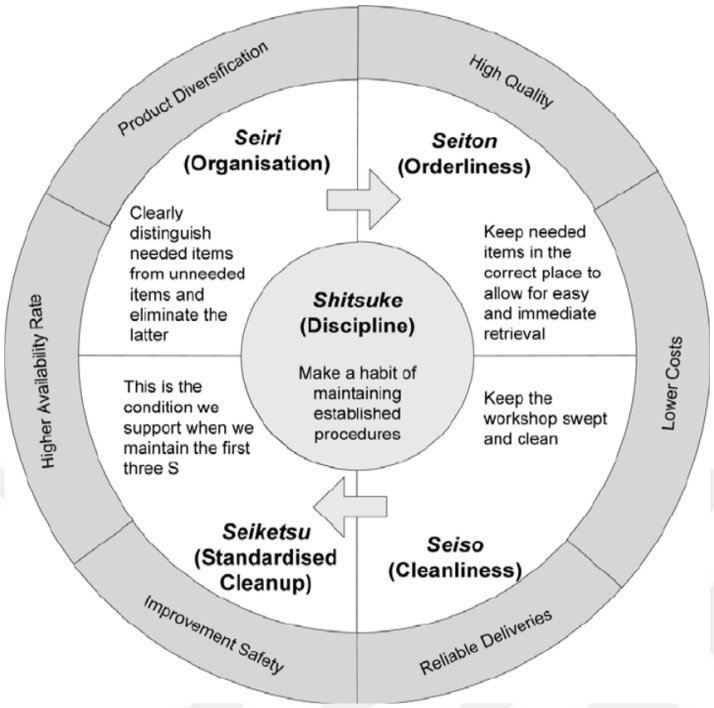
4. Increased Safety: The term "waste" to be eliminated is broad, encompassing everything from carrying superfluous inventory to waste of harmful situations, such as a box of supplies left in a frequently visited location, which might cause a worker to trip and get harmed.

5. Increased workplace morale: One of the system's primary goals is to make it a habit to adopt correct procedures and discipline in order to minimize backsliding. This technique increases the odds of avoiding gloomy, unclean, and unorganized environments, which can lead to decreased employee morale.

While manufacturers prioritize consolidation and optimal space usage, more and more businesses are turning to lean approaches like 5s to create flexible production environments. Organizations that continue to strive for increased efficiency guarantee that their businesses have a strong chance of success. (Lista, 2014:68)

All 5S steps are connecting each other. The practice of 5S has been heavily affected by variances in theory, nomenclature, and translations, as mentioned. According to Kobayashi et al. (2008), Hirano focused on the first two components of 5S. Every component of the 5S system is interconnected, with shitsuke (sustainability/discipline) at its centre. The relationship between the components is shown in Figure 2.

Figure 7: The relationship Between 5S Components



Source: Hirano, 1995.

2.3.1. Seiri (Organization, Sorting, 整理)

The first phase of sorting involves removing undesired or unnecessary things from the workspace (Hutchins, 2007:34). In other words, according to Breyfogle (2010), categorizing objects as used or non-used is beneficial for companies and organizations. Briefly, the Seiri tool's main goal is to eliminate all unnecessary items from the workplace and separate all of them into two different parts, used and un-used items. When researchers or workers are separating the items, they use the red tagging method. Sorting improves tool search efficiency, reduces cycle time, and keeps the environment of work clean (Sharma & Singh, 2015:14).

Red tagging specifies all unnecessary and degraded items in the work area. In this way, the company workers can determine unrequired items. Objects that are infrequently used are relocated to a more orderly storage space away from the work area. Entirely unnecessary items are removed from the organization (Peterson and

Smith, 2001:11). These steps support to removal of broken and disposed items from the working space (Harrington, 2000:58). Thanks to that, workers can find items and materials that they need, can find easily and immediately.

If the Seiri phase is completed, the organization will be able to use the work area more efficiently because any unneeded materials may be noticed using this method. Cleaning is also important in this step because in the case of dirty and messy working conditions, determining the items may not be easy.

When Seiri, the first stage in the 5S technique, is properly executed, there will be less uncertainty in the workplace, and communication will be improved, resulting in increased morale and motivation (Korkut, et al, 2009:67). During the performing of the Seiri Phase, the researcher and the team should ask some questions below.

1- Are unnecessary and unused materials causing the disorganized and dirty area?

2- Is there any place for these unused and disposed-of materials?

3- Materials that will be used in the project are organized or messy?

4- Are all materials in the work area organized, classified, and lined up?

When sorting and organizing work areas, the upper-level questions should be answered, and these answers need to direct the project. While the work is being carried out, unnecessary materials in the work area can be labelled and sorted with the help of a red label (Michalska and Szewieczek, 2007:48).

The main goals of the “Sorting “phase are.

- Reduce time spent seeking an item by removing superfluous items.
- Reduce the possibility of distraction from unneeded things.
- Simplify inspections. Increase the amount of available and usable space.
- Increase safety by removing obstructions. (5S methodology. (2011, May), Wikipedia, 02.03.2024, https://en.wikipedia.org/wiki/5S_(methodology))

One of the most crucial phases in the sorting process is determining the disposal and unnecessary material selection requirements and criteria for their proper elimination. When determining the criteria, someone needs to oversee managing the team. Because, during the selection and elimination of materials, some conflicts can occur.

The most important key of this step is unquestionably visualization and pictures. Rather than talking and documenting with words, pictures need to be taken. When finalized the project is finalized, pictures will show the improvement significantly.

In this step, all team members' names must be documented, and encourage they must be encouraged to join this part. All goals and conditions need to be explained very carefully and in detail to each of them. Team members have to know the work area, effect factors, and safety conditions to make correct decisions. Tasks and responsibilities have to be explained to everyone in this step.

2.3.2. Seiton (Orderliness, Set in Order, 整頓)

This step is the second part of the 5S system. Seiton means that set in order. It aims to improve workplace productivity through real-world solutions. Tangling all goods in the firm will improve workflow. All tools should be positioned in a spot where they may increase workflow and be easily found for the job (Hunglin Chi, 2010:89).

Seiton's purpose is to arrange goods methodically in the workplace. Someone "Streamline" is also used for calling Seion rather than set in order. After removing any extraneous objects from the workplace during the sorting process, materials must be organized based on utilization areas and necessities. The item which used more than one other needs to be in a place where it is more comfortable to access. One of the main goals of the Seiton step is to make it easier to find items for everyone and decrease searching time. In this phase, nonvalue-added time decreases significantly. Because in this stage, each item's location is identified and placed. Everyone may effortlessly and quickly verify these identifications. (Wani & Shinde, 2021: 186)

Visual audit and evaluation criteria are important in this phase. Everything must be placed, coloured, numbered, organized, visualized, marked, and labelled. This tool helps workers to understand and notice easily. Once this process is implemented and items have been sorted and appropriately placed in zones, order-picking time will be reduced, and inventory management will be improved (Pascale, 2013:29)

The Seiton step is also critical for workplace ergonomics and safety. Because while the team works in the area, they can identify nonconformances and risky circumstances. In general, this step takes the longest time in the entire process and the majority of project completion time is contained set is the order phase. Because most of the things mentioned are practised in this phase. Examples include labelling, tagging, marking, and placing.

As mentioned before, visualization of the workplace is one of the most important things in this step. Painting the floor, identifying the places with colours and specified transport ways, clarifying storage places of materials, etc. is needed to be examined successfully. Figure 8 shows how to place specifications and transport ways identifications can be shown.

Figure 8: 5S Walking and storage places paintings and labels

Source: 10.05.2024,https://www.erbaytrafik.com/fabrika-ici-cevresi-is-guvenlik

Implementation of 2S (Seiton) has some rules and steps;

It ought to carry out the division of items and identify where they will be stored. Utilize items shall be categorized as:

- In nearby availability (first-degree sphere).
- Accessible (second-degree sphere).
- Within the reach of the hand range (third sphere).

To assess the workplace using the 2S rule, consider the following control questions:

- Are the positions (locations) of the principal routes and storage areas properly defined?

-Are items divided into categories based on their intended use?

-Are all transport pallets stored at suitable levels?

-Is anything kept in the region of the fire-resistant devices?

-Are there any irregularities or fissures on the floor that may hinder the operator's movement?

Spaghetti diagrams may be a valuable tool for placing items. Materials should be in the most accessible and easy-to-reach, safe areas in the work area using the spaghetti approach. (Majewski, 2019: 65). When the material has been placed, it needs to stay in this place as defined. The main purpose of this approach is to find items in 30 seconds. Table 2 specifies the distance that the device should stay based on its frequency of usage.

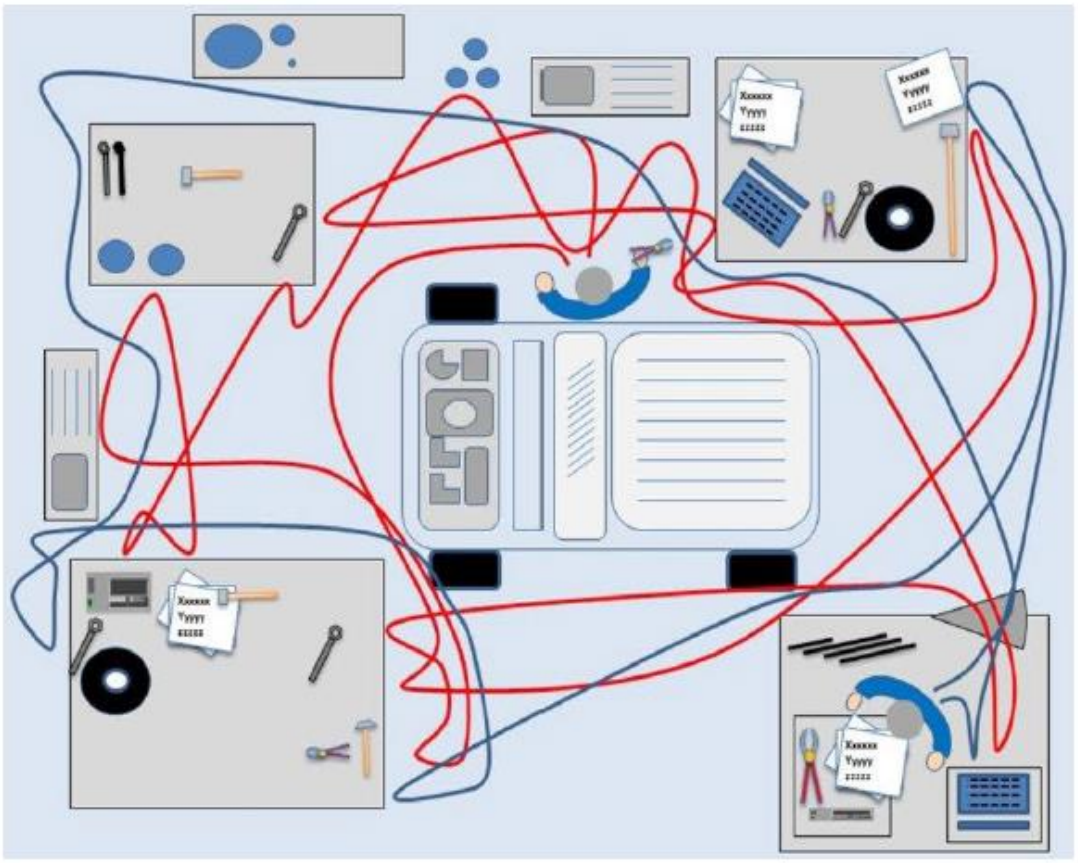
Table 2: Distance Specification According To Frequency

Unnecessary	Should be thrown away
One in a year	Keep in the far distance
Less than one in a month	In the place or somewhere close
Ones in a week	Keep close in where to use
Every day	Keep it somewhere it can be found within 30 seconds of where it is used.

Source: Created by the author.

According to the spaghetti diagram, items should be in places where safe and suitable for workflow. When workers start working with this method, their effectiveness, motivation, and productivity will increase, and the waste of time will decrease. In order to implement this method effectively, the researcher should make observations. When the researcher can select the correct area for observation, he or she can define the workflow clearly and understand workers' motions. Taking the essential actions for bottleneck and walking waste detection components. (Daneshjo, Rudy, Malega, & Krnáčová, 2021:43). Picture 9 shows the spaghetti method application system.

Figure 9: Spaghetti Diagram



Source: Latestqaulity,2018, 07.01.2024, https://www.latestquality.com/spaghetti-diagram/#

2.3.3. Seiso (Shine, Sweep, 清掃)

Seiso removes, cleans, and reviews the workplace, equipment, and machines on an ongoing basis (5S methodology. (2011, May), InWikipedia , 02.03.2024, https://en.wikipedia.org/wiki/5S_(methodology).Cleaning the workplace is significant for seeing any defects and unnecessary materials, abnormalities, and problems. Cleaning significantly decreases problems, failures, and und rework while increasing effectiveness, safety, and productivity.

Everything in the workplace like tables, materials, machines, tools, common workplace, and manufacturing area needs to be responsible for cleaning. Regular cleaning is significantly important for eliminating the source of dirty and unused materials in the area. Every item in the workplace should be observed and checked during the cleaning process. In addition, presently available information, intelligibility as well as an understanding of presented data, etc. should be checked by the responsible.

The operator’s and personnel’s sustainable controls about cleaning and organizing are indispensable. Because the main effective activity of these steps is to sustain the cleaning on a regular period, when aiming to keep this activity as a behaviour, someone should be responsible for controlling the cleaning activities of workers. Operators should have a schedule of cleaning activities. (Mitropapas, 2020:58).

When implementing the Seiso step, workers should follow the steps below.
The initial phase in implementing the Seiso rule is to renovate the workspace. The assumption is that "the primary cleaning" requires a precise assessment of the application of two preceding rules. The Seiso principle is used daily to keep the workplace clean and tidy. It is carried out by the operator of the designated workplace. To estimate the work environment's cleanliness by the Seiso, consider these three monitoring inquiries:

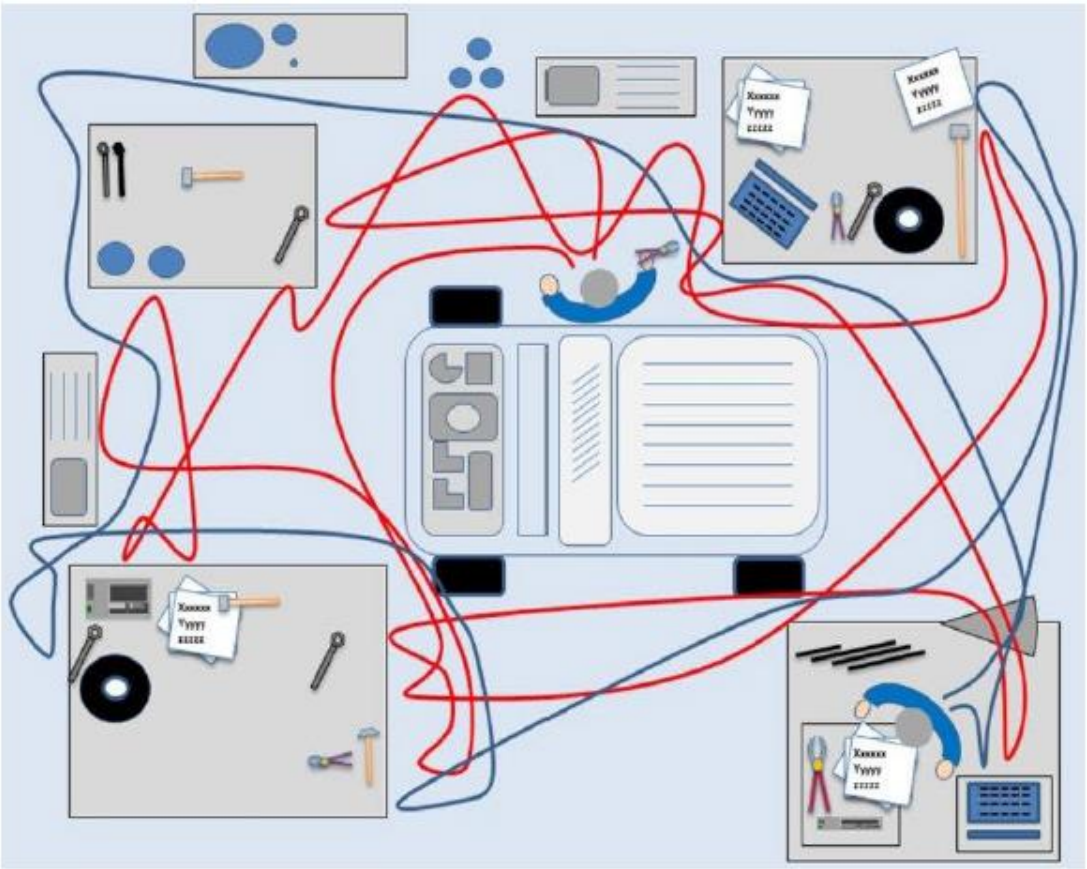
- Are there any oil marks, dirt, or metal remnants near the equipment or on the ground?
- Is the equipment being used clean?
- Are the cables and valves clean, or are going to they need to be repaired?

- Are the oil line exits not blocked with dust?

- Are the sources of light clean?

Cleaning is an always clean and well-maintained activity that ensures the environment, materials, and equipment are clean and designed for the aim of preservation and protection, according to the working. Picture 10 shows that a responsible operator or worker cleans his/her assigned area of responsibility.

Figure 10: Operator Cleaning His Responsible Area



Source: https://world-class-manufacturing.com/5S/seiso.html

Goals:

- Improves manufacturing efficiency and safety, minimizes waste, and eliminates mistakes and faults.
- Make the workplace safe and easy to work in.

- Keep the workplace clean and pleasant to work in.
- When in situ, somebody unfamiliar with the surroundings must be able to notice any difficulties within 15 meters (50 feet) in 5 seconds.

Implementation:

- Assign a part of a group to determine the area for cleaning.
- Take notes on what are the needs
- Clean the workplace and equipment on a daily basis, or at another suitable (high frequency) cleaning period.
- During the cleaning process, inspect the workplace and equipment. (5S methodology. (2011, May), Wikipedia, 02.03.2024, https://en.wikipedia.org/wiki/5S_(methodology).

Cleaning or shine might be understood and evaluated differently by people because everyone expects different levels of being clean. Therefore, the team and leader should determine rules and criteria for cleaning. It might be daily, hourly, or maybe weekly. Thus, the main criteria are the specified rules in this cleaning step.

In summary, we need to determine and set the rules and criteria for cleaning responsibly and rules. We should have the aim and standards to be achieved. The most important key of this phase is to sustain the rules and have a behaviour (attitude) on cleaning.

2.3.4. Seiketsu (Standardize, 清潔)

Seiketsu is the 4th phase of 5S. is to guarantee that what was achieved in the previous three phases becomes a company culture that can be perpetuated.

The main purpose of this step is to standardize the process with the use of previous steps. The Seiketsu step is derived from the Seiso step which makes the workplace clean, shiny, and tidy. The seiketsu step determines the standards for cleanliness. The idea of this phase is to create the standards. Seiketsu provides the potential and realistic to live up to that ideal. Seiketsu is the process of developing procedures as well as establishing and controlling the execution of standards in order to maintain good results. (Wıkurendra,2022:147)

The key motivations of Seiketsu are; Sustaining the increased attitude achieved throughout Seiso. Pleasure about the activity and workplace. Trying to keep cleanliness from Seiose because if the workplace becomes dirty and untidy, it means that efforts and results coming from Seiso have been lost and wasted. The maximum time per worker to clean is 5 minutes in a day generally. The behaviour should be daily cleanings rather than bşg cleanings before the control.

In order to sustain cleanliness, the company should follow some requirements;

1. Eliminating the source of the dirt
2. The type and standards of daily cleaning should be determined.
3. The type and standards of weekly cleaning should be determined.
4. The cleaning types and methods should be specified and separated as to which type should be more frequently or seldom.

Most of the researchers and those responsible defend that Seiketsu should contain standardization more than cleaning. Because just cleaning up is not enough for significant solutions. Some believe that the two concepts Seiri ("sort") and Seiton ("set in order") require a similar focus. When completing the Seiso step, the researcher should be recognized some ideas. (Basu, 2021: 142)

To consistency and sustain the Seiketsu step, users must ask and answer a few fundamental questions.

1) Assignments ought to be distributed in each work area.

2) Everything around it must be clean.

3) Take apart the machines, clean them thoroughly, and arrange them visually.

4) Agree on how to clean and where to store cleaning supplies.

5) Determine the needed supplies.

6) The order of duties must be followed.

7) It should be determined how frequently cleaning and inspections will be performed.

8) What is the main source of pollution?

9) Can the root cause of pollution be removed?

To sustain and set the standards, the cleaning should be done daily for the determined time range. Daily cleaning tasks need to be no longer than 5 minutes because the main purpose of these daily tasks is to make these actions a routine for the

workers. Standards and decisions ought to have been recorded in a methodical manner in order for them to be long-lasting and accessible to everybody.

Daily cleanings are not enough to sustain the cleaning. To control and observe weekly tasks, the responsible worker should create plans that need to be more planned and organized. The Responsible should ensure that everyone completes their weekly tasks. Each region of operation should have its own set of documents with clear instructions describing the job descriptions. Checklists are useful for controlling daily and weekly tasks competing. Every responsible worker should sign the checklist.

Figure 11: The Checklist Of Manufacturing Area

Source: https://citoolkit.com/wpcontent/uploads/templates/5s_audit_checklist_manufacturing.pdf

In addition to daily and weekly cleaning tasks, less often cleanings also should be carried out. These actions included more details, planning, and attention. Like the weekly control checklist, this clean-up action has to involve control lists and signs. The company has to have a scheduling method to ensure that tasks are effectively completed. This schedule and control system can be manual or digitalized. This control list has to be simple and easy to understand for everyone. Because everyone needs to

remain on their task when seeing this list. One person has to be responsible for controlling the task list. (Woods, & Buckle, 2006: 63)

It comprises duties such as maintaining a good environmental order for visual management and 5S standards, as well as organizing, settling, and cleaning personal things. However, clean tools and equipment retain their effectiveness for an extended period. As a result, machines that run for longer periods have a lower error rate and require less time and effort to fix. It serves the aims of establishing management standards to assist 5S, offering visual management to highlight flaws, and colour coding. For the following purposes:

1. Work, maintenance, defective, and active indicators are prepared.
2. Marking is supplied with danger zone signs.
3. The marking is done with thermal labels.
4. Work zones are marked with directional signage.
5. The marking is done with voltage labels.
6. Open and closed direction labels are implemented.
7. Fire extinguishers and signboards aid in emergency preparedness.
8. Accident-prevention warning signs are implemented.
9. Steps are taken to reduce noise and vibration.
10. The 5S calendar is developed.
11. Park and garden landscaping is carried out.

As mentioned before, one of the most important things about the Standardize step is visualization. The principles should be visualized. All of the information and documents should be collected together and be visual to understand easily through everyone. Posters can be effective for visualization. While using posters or other visual tools, they need to be easily recognized, easy to understand and eye, and eye-catching fast. These visual tools should include rules and key messages. From every corner of the area, these posters should be seen by everyone from everywhere. The picture below shows the visualization of standards with posters. (Yau,2024: 108)

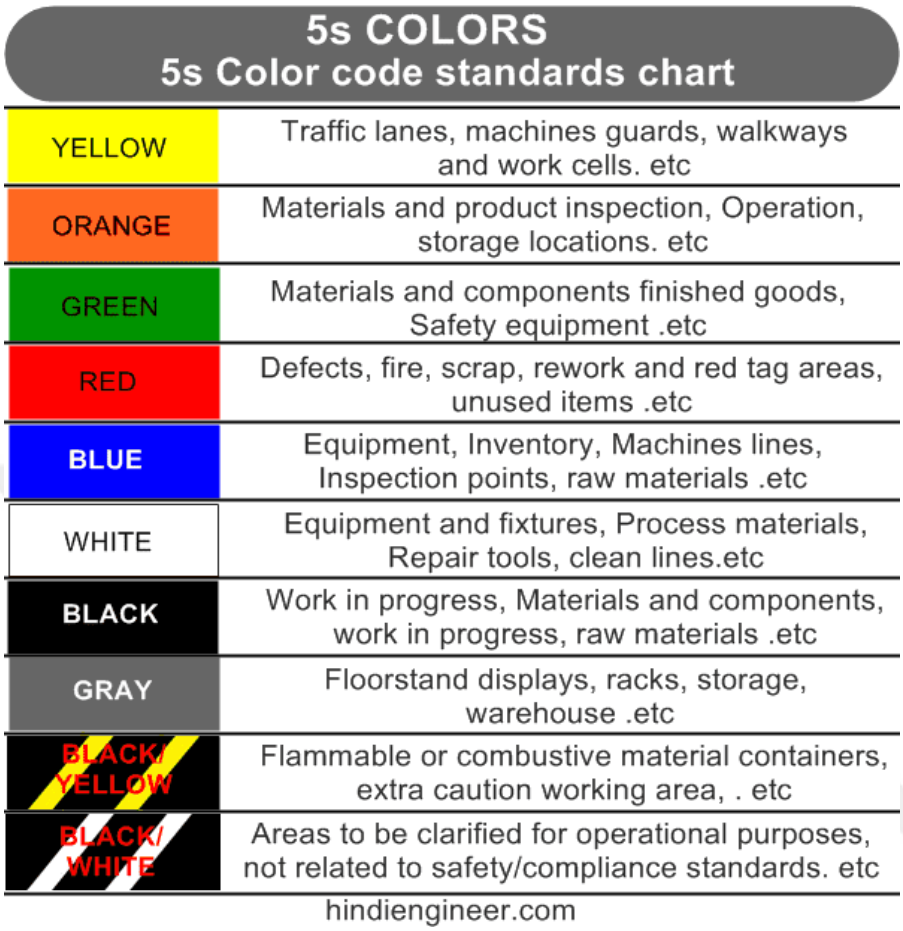
Figure 12: Visualization of Principles

Source: 06.11.2023, https://www.5s2kaizen.com/seiketsu-poster/

One of the visual tools is colour coding. This tool is very common and effective for visualization. In hospitals, factories, schools, etc. Color coding is used. Generally, companies that apply 5S rules separate garbage by colour. This method also supports Zero waste and recycling with 5S visualization. Red, yellow, black, green, and blue are the most common ones in colour coding. Black represents general garbage in not only the Japanese approach but also in French. By this colour coding separation, workers and visitors can separate the items easily and avoid the dirty. (Pandey,2015: 34)

The colour coding system is an effective tool for standardization. In the ‘set in order step colour coding also can be implemented. However, the responsible researcher should control the effectiveness, and trustworthiness of the application and compare them. When deciding to implement colour coding, quick and intensive meetings for education can be important. Because for sustaining the results, everyone should understand the method and the aim. Colours and meanings of colours (representing what) can be selected by the team or workers. This approach may be more encouraging for everyone. Because joining in decision-making steps can be an incentive for the 5S idea.

Figure 13: 5S Color Codes



Source: Alone Mayur, 2024,14.12.2023, https://www.hindiengineer.com/

To standardize the 5S application, unregular and unexpected visits to the area are essential and important. The lead should not only look for mistakes but also should control the process without interruption and measure the performance. These controls should encourage the workers to develop 5S applications. This person who will lead the controlling process should have good communication skills, be positive, have high knowledge of the process, and be able to motivate others. This person should be a bridge between management and workers. (Block,2016:12)

2.3.5. Shitsuke (Sustain, 躾)

It is a series of studies that links four phases and covers all processes. The sustain step also covers educating the workers and maintaining the process.

In addition to ensuring continuity in all business processes; It also includes steps such as training employees, creating corporate loyalty, announcing improvements, running campaigns, and rewarding work groups (Gapp et al., 2013: 566).

Everything must be maintained to support development. Sustaining, the team means that every worker should continue to clean, prevent getting dirty, and care for the factory's appearance. They must view this procedure as a form of responsibility because as employees begin to accept responsibility as an attitude, the efficacy of the process improves. The team leader should follow a positive attitude while educating the team ama sustaining because the team must adopt it within oneself and do it of one's own will.

Shitsuke is the final step of 5S and covers the fifth phase. Shitsuke means Sustain and by Sustaining it means sustained discipline. Shitsuke word is very common in the Japanese language. Sustain discipline can be separated in different ways. For example, sustained discipline may be evaluated at a personal level, cultural level, company level, group level, etc. In the 5S approach, we can evaluate the sustain at the Group level, personal level, and management level. Responsibilities and results should cover both managers and workers. In case one of them is not following the sustainable methods or applications, it means that this phase needs to be fixed. (Shaikh, 2015:26)

Managers should encourage the workers and 5S team to keep sustainable steps in progress. When the management team encourages the workers, they can follow some approaches.

- Develop and promote inspection and accreditation initiatives, officially ensuring that the latest regulations have been embraced and applied.
- Create regular cleaning processes (Seiketsu) and periodically examine the norms.
- Perform audits to verify that standards are fulfilled.

- Dedicate time and resources to less-frequent cleanups.
- Supply education, place to store, materials for cleaning, new components, and other tools as needed to meet requirements.
- Educate new personnel in the 5S processes while clarifying the fundamentals.
- Share the 5S ideas to the workers regularly, maybe by building and maintaining boards that stress one or more aspects of the 5S program. (Olofsson, O, (2015:43)

Starting training is essential when it comes to initiating and propagating the 5S fundamentals. This training can cover leadership development, increasing and discipline of workers on 5S, and new approaches to the work area. The time and contents of training can be determined by the 5S team. The workers should be trained through their interests and skills because every worker's knowledge level and abilities are different. The management team also should be chosen according to the team and their responsibilities. Training and a high level of knowledge are quite critical for the sustaining phase not only on a technical level but also on a management level. This training should be understandable level and need to eager them for learning.

Regular meetings are essential for sustainability. In these meetings, a one-topic approach can be more effective and attractive. In these topics, the leader should select more easy-to-understand interesting, and less technical ones. This meeting should be short to prevent participants from losing interest. In these meetings, presentations should be done. Every member of the team needs to join in this meeting. Because most efficient brainstorms are carried out in this kind of meeting. The meeting should focus on practical solutions and perspectives because workers may not be interested in theoretical approaches and methods. In these meetings, team members can examine the newest technologies, methods, applications, etc. This topic can be a guide for them. Even the latest scientific studies and their results can be examined in this meeting. Maybe understanding these documents can be not easy for workers but the leader can explain these studies understandably and focus on root results. (Székely, & Vom Brocke, 2017:56)

To sustain phase works, management and workers should share the responsibilities and be a good team. Although the team and management work

together, the management team should take more responsibility for encouraging the workforce and planning the meetings, applications, responsibility diversity, etc.

The management team needs to set standards. These standards should include tasks, schedules, and responsibilities. These standards should cover prior steps. One of the important keys of this standard is audit. These audits support workers to follow their responsibilities. After these audits and training, certification programs and certification are encouraging and supportive. Therefore, the management team should be involved in the certification of the standards. (Cleland, 1996: 78)

Keeping the existing workers is important but while keeping them following the standards, the management team should educate new employees explain the procedures to them and make them follow them. Meanwhile, managers should follow resources and provide them. Support continuous improvement by embracing comments on issues such as better places to keep equipment, more efficient work sequences, and how to prevent producing dirt in the first place (Olofsson, 2015:28).

From a worker's perspective, employees should follow their responsibilities and cry out for their tools. Meanwhile, workers need to have high morale and be successful in their tasks. Workers need to suggest their ideas during the project because every new idea supports the development. In addition, if they can help each other in the work area during the tasks it would be better because they can increase the visualization.

Shitsuke step has several benefits from different perspectives.

- Creating employee motivation.

Maintaining a sense of collaboration and achievement can be lost when standards are not met. Happiness would plummet if workers began to assume that management did not follow through on tasks. Dropping back into a filled place of employment would undermine the pride that comes with having a clean and orderly atmosphere. Continuing to listen to staff recommendations. (Elmore, 2002: 58)

- Continuous productivity improvements are related to:

Less damage on machinery owing to increased cleanliness and regular visual inspections. Constantly placing tools in the appropriate places: the most commonly used are closest to hand; no need to play "hunt the hammer" since it is kept correctly. Clear communication, especially on signs that identify where equipment is housed,

what risks preventing, and what paths to follow for preventing transferring machinery. Clear communication on bulletin boards and in libraries, since outdated documents are eliminated or filed away. There is less needless clutter in the storage space, making it easier to find essential equipment or materials. It is faster to transfer materials about the shop since there is no needless clutter on the shop floor. Proper tools are more effective than patched or makeshift ones. Clearer job instructions lead to higher quality and more consistency. (Nallusamy, 2016:124)

Reduced amounts of airborne pollutants (dust). Falls and safety hazards were decreased or removed during the Seiri stage. Properly kept equipment: Covers are installed; leaky seals or gaskets are identified and replaced. Visual examinations detect the beginnings of cracks or corrosion, and these issues are swiftly remedied. Seiri reduced bending and twisting to collect low things, resulting in fewer injuries from repetitive uncomfortable actions. Seiri changed the heights of the seats and workbench, resulting in fewer injuries from awkward work situations. (Olofsson,2015: 71).

2.4. LEAN APPROACH IN TEXTILE INDUSTRY

This research was carried out in a textile garment manufacturing company, therefore previous research on the textile sector has been examined in this section.

The textile production business is using technology to reduce costs and meet customer demands for high-quality goods. These have decreased waste, enhanced overall efficiency, and promoted sustainability in the textile business, requiring lean manufacturing approaches (Guruprasad and Chattopadhyay, 2013:28).

In 2006, Akcagün conducted a study on a manufacturer of men's shirts (Akcagün 2006). The researcher made a time study on a specified garment. The main focus was the assembly line and he designed the assembly line through this results. When he organized the area, he used 5S techniques. As a result of this research, he increased the efficiency by 11%.

Brahmadeep and Thomassey rely on growing the use of automated methods in planning, as this reduces costs while increasing delays. (Thomassey and Brahmadeep, 2014,13).

Ayna conducted Kaizen studies at a knitted fabric manufacturing facility to reduce costs and cycle times. After several successful implementations, Ayna decreased the cost by 8%. (Ayna, 2021,42).

Some researchers use lean methods to reduce lead time and cost while increasing efficiency. (Hamja, Maalouf & Hasle, 2019,25).

Lean production organizations reaped multiple advantages, such as increased operational efficacy due to reduced worker effort, time spent storing, and process modification (Womack et al., 2007:5).

One of the researchers declares that companies that apply lean manufacturing technologies have an upper hand in the global economic context (Tourki,2010:186).

It is critical to implement these approaches at the firm level and analyze performance metrics. Leaders and administrators are hesitant to employ untested processes because they have doubts about their success rate (Sahoo and Yadav, 2018:55).

Because of its simplicity and familiarity, the 5S method may be easily implemented in a wide range of businesses. It has also proved to boost corporate success in terms of market share and customer happiness (Nallusamy, 2016.80).

CHAPTER THREE
METHODOLOGICAL FRAMEWORK

3.1. BACKGROUND

In today's competitive environment, the most important thing is not only to respond at the right time to customer requests and to offer great quality at a low price but also to adapt to the current situation's competitive demands and changes, and even to be a pioneer. For this aim, companies should identify roadmaps and development points to achieve this goal.

Companies experiencing tough competition can benefit from the digital revolution. As a result, to compete sustainably, businesses should observe and apply digital necessities. Companies in this competition have just two ways out: undertake digital improvement projects and continuously improve applications have to be part of the company or be ready for the end of the firm.

Companies must improve their effectiveness and efficiency. In its most basic form, efficiency is how firms transform inputs into outputs, and the degree to which something is successful in producing the desired result is referred to as its effectiveness. Companies can improve their effectiveness and efficiency in several ways. Lean manufacturing methods are one of the most popular and effective ones.

Lean manufacturing is a method that does not allow for waste, errors, non-value-added costs, or internal activities. The goal of the lean manufacturing system is to improve quality while lowering costs and enhancing delivery performance by increasing speed and decreasing flow time. Lean manufacturing is a global phenomenon that is being implemented all over the world right now.

There are many employees in the textile industry who work in filthy, uncomfortable, and untidy work environments in small, traditional companies. Finding the necessary tools is difficult and time-consuming due to the untidy working environment. Searching for materials for a long time is one of the biggest wastes of time and disrupts the production schedule. Furthermore, it is an unnecessary activity for production that adds no value to the product and employers are not eager to work in this kind of place thus this situation affects the employer’s efficiency.

Version Tex, like other small and medium-sized businesses, was dealing with this problem. As a result, the corporation began to find a solution to this problem. Audits were conducted throughout the company, and the warehouse was in disarray. Finding production materials is either impossible or takes an extremely lengthy period. For these reasons above, the company decided to implement the 5S methodology in the warehouse.5S was the best and most necessary solution for the warehouse.5S is a technique for making work environments tidier and more ideal for efficient working by using five tools: sort, straighten, shine, standardize, and sustain.

3.2. STUDY OBJECTIVES

The primary goal of this study is to conduct necessary warehouse improvement points to increase efficiency and effectiveness. Additionally, it will increase the company's knowledge of lean manufacturing and ERP.

5S technique’s aim in the warehouse was to make a tidier workplace and decrease the unnecessary time for looking for materials which is an activity that does not add value to the product. With this 5S application, workers start to work happier than before because bad work conditions and dirty areas make workers unwilling to work.

It is important to remark that, the aim of this project is not to give very detailed information about lean manufacturing and 5S, the aim is to give a significant example and solution for textile companies who live with these kinds of problems in the company.

3.3. THEORETICAL FRAMEWORK

The theoretical framework of the study is based on the combination of lean manufacturing approach and methods, applications with 5S phases, and improvements. This supports finding difficulties, problem-solving methods, develop new strategies for failures and difficulties. In addition to these benefits, analyzing results, evaluating the performance of applications or methods, and operational efficiency are being supported. The impacts of the research can be examined. The

framework guides the research's evaluation and analysis: contributing to a greater awareness of how integrating 5S with warehouse optimization might lead to achievements in the textile sector.

3.4. STATEMENT OF THE PROBLEM

Textile manufacturing is expanding significantly both globally and in our nation. This expansion provides benefits as well as opportunities for advancement. Companies in the industry must adapt to new technology and techniques to remain competitive and sustainable. Reduced costs, increased operational efficiency, and the ability to satisfy client add-ons are all critical aspects of preserving competitiveness. Following and implementing innovative approaches has become inevitable in achieving the stated goals and maintaining competition.

Aside from the numerous advantages, lean manufacturing and 5S applications face other challenges. Examples include inexperience, managerial weaknesses, a lack of technology, and insufficient investment activities. As a result, the 5S strategy is not being implemented and maintained efficiently. In addition to all of these potential difficulties, previous applications and experimental pieces of evidence are limited. In the case of companies that are eager to implement continuous approaches in textile companies, they are challenged with a lack of information. Because empirical shreds of evidence are limited, companies can not see the potential achievements in effectiveness and increased performance, etc.

For these factors, this research studied an organization that had difficulties using 5S principles due to a lack of expertise, as well as the advantages, benefits, and processes that would be acquired if the 5S technique was followed. This study aims to answer the following questions,

- What advantages do 5S enhancements in the warehouse provide in the textile industry? What are the potential gains?
- What are the achievements of implementing the 5S method in the Warehouse on various performance metrics like time study, worker efficiency, and willingness, reduction in the number of lost products, and cost reduction?

- How companies can implement the 5S method in their company and what are the process and steps?

By answering these questions, the research intends to give perspectives and practical recommendations to firms considering the integration of 5S. The study's findings will contribute to the pool of knowledge, guide decision-making processes, and assist textile industry experts who are unfamiliar with lean manufacturing, eventually driving improvements in warehouse efficiency and performance.

3.5. AIM OF THE RESEARCH

Lean manufacturing is obviously one of the necessities of the future based on literature and successful projects (Taiichi,1988). In case, companies do not implement necessary development and improvement projects, they have to face their end. In today's competitive area, they have to minimize the cost, and unnecessary applications and maximize effectiveness and profit. Lean manufacturing is the most effective tool for this aim.

The main and most important goal of this research was to increase warehouse worker efficiency and decrease lost time in material finding and preparation for production. The 5S approach was appropriate for this goal, but workers and management were unaware of it and had no information about it. Therefore, the first phase of the goal is to tackle the lack of knowledge problem and inform them.

3.6. SIGNIFICANCE OF THE RESEARCH

The benefits of lean manufacturing substantially impact a company's efficiency and effectiveness. However, in the textile industry, lean manufacturing processes are not widely used, and most companies need to be made aware of the benefits. This kind of successful project can be encouraging and a pioneer for the other textile manufacturers. Because of a lack of knowledge and insufficient examples, companies are not eager to implement lean manufacturing methods.

Typically, companies view lean tools as an additional cost without examining the results. Therefore, if this type of implementation is successful, other organizations

will be convinced after seeing the effects on employee efficiency, lower material costs, and shorter production times. So, This research can prove that lean manufacturing methods like 5S can be beneficial about cost, profit, employee efficiency, productivity, employee satisfaction, etc.

This research included not only the 5S application but also information about ERP systems. This study will serve as an example for other businesses in terms of the benefits, advantages, and how they may incorporate ERP systems into their warehouse operations. ERP systems are not widely used in Turkey. Only 28% of Turkey's employees use ERP. Research shows this 28% of employees' first reason for using the ERP system is a decrease in the stock quantity (Yegül and Toklu, 2004; 3).

As a result, this research may be used to persuade the remaining 72% to employ ERP systems in their businesses and illustrate the road map for integrating the ERP into the warehouse. Furthermore, company managers and engineers can be aware of the benefits of ERP systems on staff efficiency, stock quantity reduction, higher level of control, and reduction of unvalued time and effort.

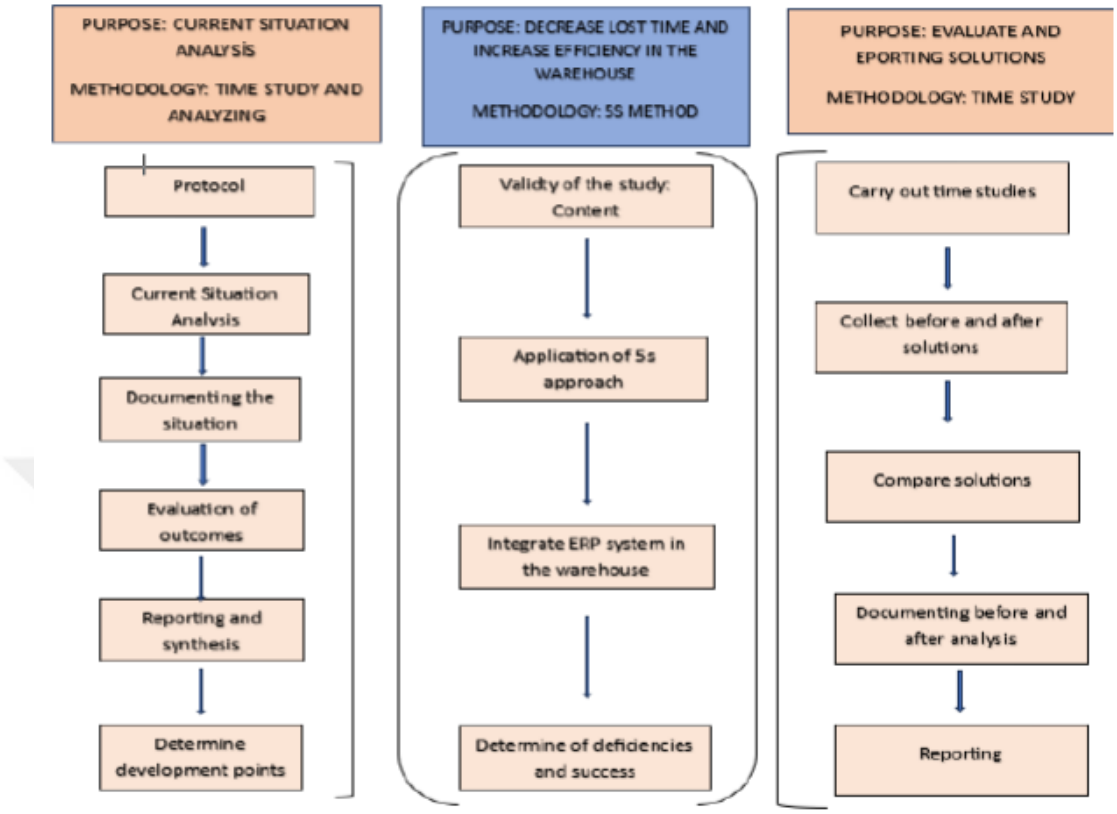
Hence, this thesis is critical in filling this research gap and providing a deeper understanding of lean manufacturing and ERP benefits in textile manufacturing factories. Another benefit of this research is that it provides a successful example with outcomes and explains the roadmap with strategies for developing the process by utilizing a literature review. Companies might become aware of 5S and ERP in this manner.

3.7. THE METHODOLOGY OF THE RESEARCH

Lean manufacturing, 5S, and enterprise resource planning are the main topics of this application's tools and investigations, which are supported by time studies. The state of global competitiveness, the growing need in manufacturing regions for Lean manufacturing tools, and the indisputable advantages of the Lean approach were the most important considerations for selecting this topic.

The goals of the research, the techniques used, and the procedures taken in application for this work are shown in the Picture. The table in Figure 14 explains the roadmap and study steps clearly.

Figure 14: Roadmap And Study Steps



Source: Created by the author

3.8. TIME STUDY AND ANALYSIS

The warehouse was disorganized, and employees were unwilling to work there. Finding production materials was not only time-consuming but also nearly impossible. The current state of the warehouse has been documented and photographed. Following this photography step, time studies (method) were carried out. This time study used 50 production materials in total to examine the problem and estimate lost time. The results of this time research step were thoroughly analyzed, and it was determined to construct a roadmap.

Four people are working in the warehouse, and each individual is in charge of a separate set of materials. resources are assigned to warehouse people based on

customer, and each is responsible for providing their customers' resources and maintaining them ready for production in the warehouse.

On February 6, 2023, a warehouse inspection was performed. In the ERP system, 50 materials were chosen at random from the warehouse stock report, and warehouse personnel were requested to locate the materials and establish that the number represented in the warehouse was right. A time study was kept for each product during the search phase of the selected materials. There are 5 different customers' materials used in this study. As a result of the inspection, 14 out of 50 materials were not found. The rest of the 36 metariels' time study measurements are in Table 3 below.

Table 3: Time Studies

PROCESS NUMBER	PROCESS	PROCESSING TIME
1	Getting GW zip	158 sec
2	Getting GW button	Could not find
3	Getting GW bobbin	72 sec
4	Getting GW weaving label	215 sec
5	Getting GW brand label	Could not find
6	Getting GW size label	247 sec
7	Getting GW carton label	69 sec
8	Gettin GW locked the rope	310 sec
9	Getting GW buckram	105 sec
10	Getting GW metal logo	200 sec
11	Getting GW fastener	213 sec
12	Getting MI button	190 sec
13	Getting MI lanyard	Could not find
14	Getting MI binding	540 sec
15	Getting an MI price sticker	Could not find
16	Getting MI size label	575 sec

17	Getting an MI carton label	135 sec
18	Gettin MI locked the rope	309 sec
19	Getting MI buckram	355 sec
20	Getting the MI metal logo	Could not find
21	Getting JK zip	138 sec
22	Getting JK button	70 sec
23	Getting JK bobbin	45 sec
24	Getting JK weaving label	257 sec
25	Getting JK brand label	Could not find
26	Getting JK size label	Could not find
27	Getting JK carton label	85 sec
28	Gettin JK locked the rope	42 sec
29	Getting JK buckram	65 sec
30	Getting JK metal logo	220 sec
31	Getting JK price sticker	Could not find
32	Getting PD size label	75 sec
33	Getting PD carton label	Could not find
34	Gettin PD locked the rope	55 sec
35	Getting PD buckram	Could not find
36	Getting PD bobbin	140 sec
37	Getting SS zip	273 sec
38	Getting SS button	Could not find
39	Getting SS bobbin	186 sec
40	Getting SS weaving label	57 sec
41	Getting SS brand label	155 sec
42	Getting SS size label	Could not find
43	Getting SS carton label	96 sec
44	Getting SS to lock the rope	114 sec
45	Getting SS buckram	Could not find

46	Getting the S&S metal logo	94 sec
47	Getting S&S size label	70 sec
48	Getting S&S carton label	126 sec
49	Gettin S&S locked rope	80 sec
50	Getting S&S buckram	Could not find

Source: Created by the author.

The acceptable time average was 0-60 seconds for each material. The main purpose in this case was to specify all materials in the warehouse because time study results did not seem appropriate. Only 8% of 50 materials were between 0-60 seconds. 24% of 50 materials were found in 60-120 seconds on average, but the order quantity of production was not equal, implying that some of the materials were lost. 40% of 50 meters took more than 120 seconds to find and 28% of 50 meters could not find. This means that these 14 materials must be reordered.

Before situation photos of the warehouse below in Figure 15.

Figure 15: Before Situation

Source: Created by the author

This type of problem increases nonvalue costs and time, resulting in a loss of profit for the organization. In addition, this disorganized warehouse causes delays the production means stopping production because of missing materials. After reviewing the warehouse condition, it was determined to immediately begin mending and improving the procedure.

3.9. 5S METHODOLOGY

This thesis' technique was action-based. The idea for this study came about in April 2022 because researchers were looking for thesis topics while simultaneously developing the circumstances of the employer company. The researcher prepared a presentation explaining the topic, including potential project outcomes and benefits. The researcher offered the concept to management at the end of May. Positive feedback and comments were received.

Because the researcher did not have a 5S team, the first step was to form a qualified and agile team. Warehouse personnel were unquestionably the most appropriate and necessary workforce. Because they were major participants in this study and have expertise in the warehouse working procedure. In this team, there were 5 people. One of them was a researcher and the others were warehouse workers. After creating the 5S team, the second step was training about 5S and ERP. One of the researcher's goals was to integrate an ERP system into a warehouse to sustain the project's results. The ERP system was employed in the company, but it was not widely and efficiently used. Furthermore, the majority of the system's tools were not being used, and they were unaware of their existence. Because of these reasons, the researcher gave training about what is 5S system and how they can carry out 5S projects, and how they can use the ERP system more efficiently not only to sustain the 5S project but also to keep stocks more correctly.

The project was split into two sections: the 5S application and the ERP integration. Because the entire project was so complicated and time-consuming, separating steps was beneficial to the team. The team worked together from the start of the project to the end. The researcher was always working with and leading the

team. The researcher takes photos, time studies, and worker feedback during the process to measure success and document the process.

3.10 COMPANY INFORMATION

This research has been carried out in the Garment Textile company which has been in the apparel industry in Izmir/TURKEY for over 26 years, established in 1995 with a 3500 square meter area, which included production lines, design, planning, sourcing, sampling, cutting, finishing, a quality control (QC) department, and collaborating with numerous subcontractors.

Their main products are women's woven blouses, dresses, skirts, jacks, and trousers. They have more than 15 customers. The company employs 120 people and has an insourcing capacity of 40.000 PCs per month. Outsource capacity between 80.000 to 120.000 PCs per month. This sample company's primary market is European countries and servicing to 6 different countries. There are 30 white color workers and 1 of them is Industrial Engineer. This sample company is the customer of first choice because of quality satisfaction and location.

3.11. 5S APPLICATION STEPS

In this research global 5S steps are used. As a quick reminder, there are Seiri (Sort), Seiton (Set in order), Seisou (Shine), Seiketsu (Standardize), and Shitsuke (Sustain). This step's goal is listed below.

Seiri: Remove any unnecessary materials from the work area.

Seiton: Visual area - assign a location to each item.

Seisou: Clean and tidy work area

Seiketsu: Standardize and uphold uniform workplace policies and practices.

Shitsuke: Audit, interacts with, and train staff until it becomes second nature and keeps the development sustained.

Osada (1991) classified the approach into three categories: sort and arrange cleanliness and discipline. According to Chapman (2005), the successful implementation of 5S generates a disciplined, tidy, and well-organized work

environment. The reader can find the aims of the 5S stages and the essential meaning of the 5S above. Below, 5S cycle steps are shown in Figure 16.

Figure 16: The 5S Cycle

Source: Creative Safety Supply, 18.02.2024,
https://www.reativesafetysupply.com/5s-cycle-floor-sign/

3.11.1. The Application of "Sort "Step

After analyzing the situation of the warehouse, the researcher decided to implement the 5S project in the Version Textile's warehouse. The first step of this project was Sorting. Because current situation analysis showed that, the warehouse was completely disorganized and untidy. The warehouse had virtually lost its primary purpose and had become a storage facility for old, unused, waste, and obsolete materials.

The aim of the ‘Seiri’ step in this research is to take anything out of the work area that isn't necessary. Mark all of the things and then remove or replace them in another workstation. Field analysis shows that most of the materials in the warehouse are unnecessary and unusable. As a result, locating the correct materials for production at the right time is difficult and time-consuming. Furthermore, workers may become perplexed as to whether the material is correct.

The researcher and team first chose to count warehouse materials. Because the number of the materials was unknown, this was the most important phase for identifying necessary materials, correct quantities, and specifying them for separate manufacture. The crew was able to notice the old, superfluous, and out-of-place goods this way. The researcher divided the work for the team. As previously said, each worker has their clients and is responsible for keeping their stock in the proper place at the right time. As a result, to remove incorrect materials, everyone has been held accountable for their customers' materials.

The aim of this phase and what to do were explained to team members again. The planned length of the event will be determined, and the plan thoroughly explained to all participants. Everyone begins to observe the area and determines the most important and least important locations based on their criteria. The goal was to draw attention to this project and stimulate brainstorming. After everyone has finished observing the field, everyone shares their development and problem-solving ideas, and all ideas are recorded by the researcher. The red tagging is examined by the team members. The computers have been given for each team member to keep documents. The researcher takes photos of the warehouse constantly. Because one of the best confirmation and comparison tools in 5S is photos. Team members and others can see developments from pictures easily.

Figure 17: Before And After Photos

Source: Created by the author

The 5S team is in charge of red tagging, and all items should be easily identified for tagging before executing. It entails inspecting everything in the work area (warehouse). There is no separation on red tagging. Everything in the workplace is involved in this action even dirty papers on the floor, waste materials, cables, production materials, etc. Red tagging has several steps:

1. Firstly, the team members have to be selected and should identify specific areas for red tagging.

2. Determine criteria for the tools for eliminating or staying.

3. The team should observe the area and start red-tagging tools and materials but, when they are tagging them, they have to keep documents about the found date of the material, who found it, the aim of the tool, etc.

4. Red tagged materials show removed from the area to the ragged red items holl.

5. The team members should observe the items for a while to see if they were used or if they were simply unnecessary.

When carrying out red tagging, they should use red tag paper as below:

Figure 18: 5S Red Tags

Source : 31.05.2024, https://www.compliancesigns.com/blog/improve-your-5s-red-tag-program/

3.11.2. The Application of "Set in Order "Step

The second phase of the 5S application is the set-in-order step. Firstly, the team must remove all unnecessary and disposal materials from the area before proceeding to the set-in order step. One of the most important things about this step is, that them has to complete the sort of phase before starting this step. In this step, the team takes the materials which they think are essential for production or warehouse. They need to place these materials in suitable places.

Standardization is so important and indispensable for this phase. All materials that are decided to stay in the warehouse, located in meaningful and useful places. The

team must be sure that, these meters are located correctly and fit for purpose. The set-in order is intended to create a standard and consistent method of storing and retrieving tools and materials. There are some keynotes about how they can store items; 1- If the items are connected, keep them in the same location.

2- Prioritize the items based on usage frequency and thoroughly locate them. For example, top priorities should be visible.

3- Placed the items by seeing physical conditions to easily reach them by workers.

Items that workers frequently use should be placed near the workers. One of the goals of this step is to reduce the number of unvalued moves. As a result, the priority of materials on usage is critical. The Set in Order step employs multiple techniques to achieve its objectives, including one which is shadow boarding.

Following several meetings, the team determined that the best and most effective method of placing items is to separate them by customer and production number. Because the production model number is used when the purchasing specialist places the order. As a result, using these articles makes it easier to identify materials. However, some materials are not purchased for specific production; instead, they are always used; thus, these items are separated based on customers or usage goals. Customer-based placement is shown in the picture.

Figure 19: The Production İtems Were Sorted İnto Boxes Based On The Customer

Source: Created by the author

3.11.3. The Application of “Shine “Step

It is time to begin the third phase of research after completely defining unnecessary objects, disposing of materials, and materials that are in the wrong position and placing them correctly. With this step, the study's purpose is to establish a tidy and clean warehouse. Some issues may arise during the shining step. As a result, the crew must use extreme caution. This step focuses on keeping the workplace clean and tidy. As a result, the primary goal of the researcher was to clean the warehouse, but this was only the first step in the shine process. This should be the goal of workers to sustain this action.

At the beginning of this phase, the team cleaned the whole warehouse because the area was so dusty and dirty. This situation was unacceptable to researchers and team members not only because dirty workplaces are bad for workers and appear bad, but also because the textile business generates a lot of fabric and yarn waste, which can be hazardous to one's health. Some safety issues show up and the researcher made chances on them. For example, some heavy boxes were in high places which are not so strong closets.

The major goal of this phase is to change the workers' mindset and encourage them to clean the warehouse daily. Every day, the employees must tidy their assigned areas. Mess, indiscipline, inefficiency, blunders, and work accidents are all caused by dust, grime, and trash in the workplace. When employees make it a habit to clean, their search time for materials decreases since the space becomes more visible.

This warehouse has cleaning responsibility for the area, which is separated from the customer's materials. The goal of this decision is to prevent the loss of necessary materials and to accept responsibility for any undesirable circumstance caused by a lack of information. The researcher initially controlled the cleaning daily, but after a few months, she switched to a weekly basis.

3.11.4. The Application of “Standardize “Step

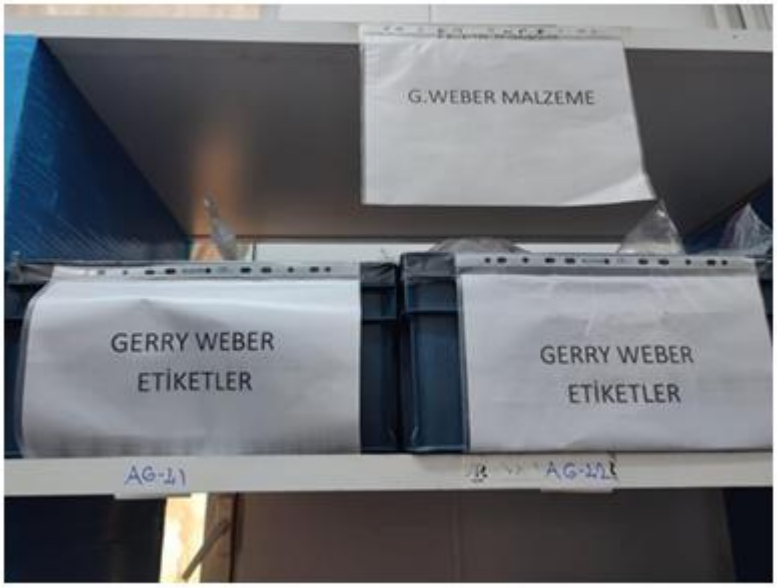
Completing the steps (sort, set-in-order, and shine) of 5S, is key to Maintaining efficiency and requires permanence. As a result, this stage is critical for the team. The primary purpose of this phase is to maintain the developments and improvements made in the previous three levels. To that end, the team determined to have weekly meetings to keep an eye on the warehouse situation and intervene as soon as possible. In addition, the team established standards, regulations, and responsibilities for each stage and area. The rules must be simple to understand and permanent. If the team fails to standardize the rules and applications, the benefits will be lost almost very quickly.

The researcher investigated how she could sustain and standardize the warehouse's improvements. During this research, the researcher observed the warehouse for a few days and discovered that the customer-based shelving system needed to be fixed systematically and effectively since the staff did not adhere to the rules and procedures. Because the workforce had not used these approaches in many years. As a result, the researcher decided to improve the ERP system and integrate it with the warehouse. The main purpose of this choice was to build and improve a control system and to push employees to follow the rules and the system.

The researcher met with the ERP system provider company multiple times to transform the SQL system into an ERP program. The main requirement for this SQL system was to create an easy-to-use and basic display. Workers were not educated, and complicated systems appeared to be a waste of time and difficult to understand. After almost 1 month the ERP system was completed.

The second step of the process involved assigning numbers and codes to shelves. When assigning codes to shelves, customers' names, the floor of the shelf, and the column on the floor. The main goal of this chosen numbering system was to grasp the customer's material position, shelf, floor, and column at the same time while minimizing wasted time and unnecessary work. The picture of shelves shows the coding example.

Figure 20: The Numbering System Example From The Shelf

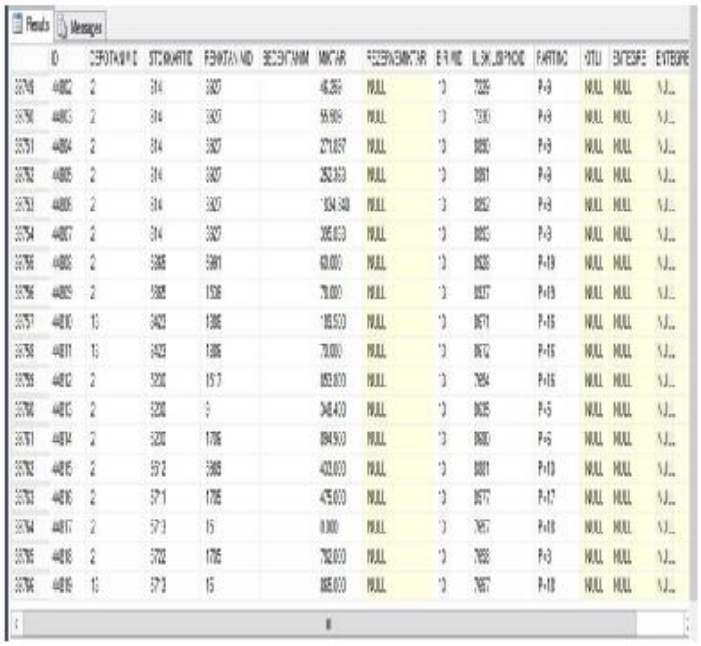


Source: Created by the author

This shelf, for example, belongs to Gerry Weber's accessory, and the sticker's code is AG-41. It indicates that Gerry Weber's stickers can be found for workers in the warehouse's accessory area (A), on Gerry Weber's client shelf (G), on the fourth floor (4), and in the first column (1). The idea for this type of numbering originated from the researcher and team. They believe that the simplest and most straightforward method was used. The warehouse stock report tool in the ERP system could have been more effective. The researcher inserted a shelf column into the stock report. This column made use of the coding system. Anyone who wants to check any material from the warehouse can easily find the location. Thanks to this improvement in case workers do not come to work, anyone can know the place of items.

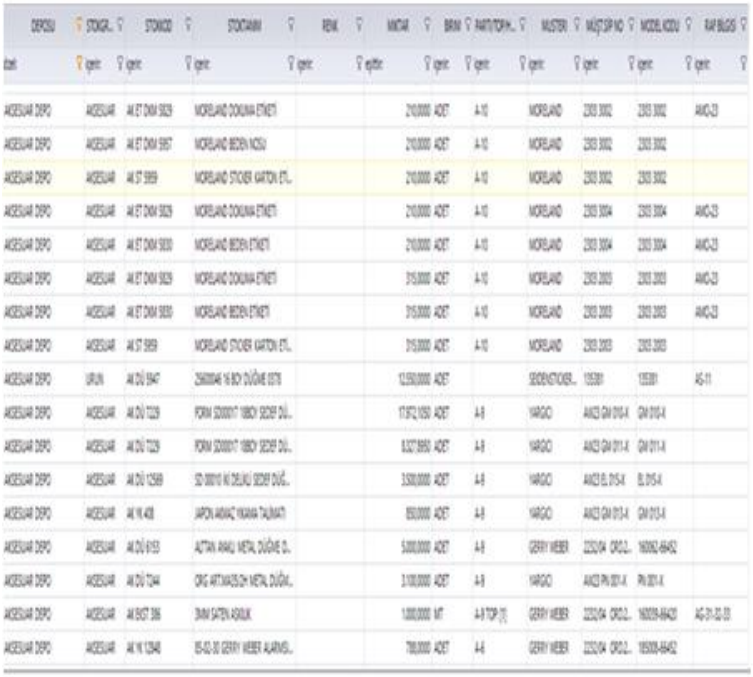
The picture shows the SQL system’s column used in Version Textile.

Figure 21: SQL System's Backup



Source: Created by the author

Figure 22: SQL System Screen From Worker's Computers



Source: Created by the author

The A-number system is another form of material coding method. These codes are associated with materials used in manufacturing. This material is located outside the workers' room and is awaiting production. All materials are placed in a box labelled with the customer's name. This method reduces production time while reducing material searching loss and avoiding unfond materials. The picture shows how production materials keep with this method. Even the responsible worker of this production is not available at this time, anyone can control the place of materials from the ERP system and find the location.

Therefore, this study focused on systemic functioning by reducing human-oriented information flow. This approach definitely reduces wrong decisions due to a lack of information and helps to work systematically and programmatically.

Figure 23: Accessories That Are Ready For Manufacturing Are Separated From Production Numbers

Source: Created by the author

In the warehouse, 2 types of stocks were located. Accessories and fabrics. Fabric's part was all the same except the name of the coding. Because the fabrics were located in fabric palettes. Therefore, in the ERP system location of fabrics was called 'P'. All palettes are given numbers from 1 to 36. and the number stickers are pasted

above the floor near the palette. Because the management was very prejudiced for this investment and needed to be convinced to invest, the procedure employed in Version was quite basic and underdeveloped. Although this method was not invented, it solved the problem and aided in the identification of locations. Pictured in 22 demonstrates how this palette numbering was carried out. This set of numbers was easy to see from workers during the work.

Figure 24: Numbers Of Palettes On The Floor

Source: Created by the author

Obviously, this application was not enough. The researcher entered these data points into the ERP system, but when manufacturing began, it was critical to identify the correct fabric. Because they recently utilized incorrect fabrics in production, and customers had an axe to grind about it. Version Textile loses money due to the additional costs of faulty manufacture and garment stock from inappropriate fabric. As a result, the researcher created a folder structure. All palettes have fabric samples in this folder to compare if they are using the correct fabric or not. Furthermore, fabric warehouse workers often left their jobs, thus maintaining the system and being connected to the technology rather than individuals was crucial for Version Textiles. The picture shows the folder system from the Fabric part of the warehouse. This solution was very useful for solving these problems and increased workers' efficiency. Also, it was a huge development for lack of knowledge.

Figure 25: Before and After 5S for Folders

Source: Created by the author

3.11.5. The Application of "Sustain "Step

The final step of 5S is sustained. The main purpose of this step is to keep and sustain these improvements and applications. The researcher must be confident that the applications will be sustained. The outcomes of the 5S application were shared with all management and employees. The final audit was carried out in the warehouse at the beginning. The results were satisfying for the researcher and management. Results will be shared in the results section.

The audit team included a researcher, a business manager, and an auditor from a consulting firm. The auditor was important for this study because she could evaluate the results objectively and had several examples from other manufacturers. This study included 50 different items from various worker responsibilities and customers. At the end of the study, they were all given successful solutions.

The team and researcher agreed to hold weekly meetings to discuss previous and potential warehouse developments. Because this application had to run continuously. However, it was insufficient for this phase because the workers were not familiar with this type of project, and it was so close to returning to old habits that the researcher abruptly implemented monthly audits.

3.12. ERP SYSTEM INTEGRATION

As mentioned in the previous sections of the study, the ERP system has critical and significant benefits in this project. Because it has an important place in the continuation of the 5S studies carried out. The main material and method for the continuity and protection of the implemented order is to use the 5S system efficiently and effectively.

There is an ERP system that has been purchased within the company but cannot be used correctly and effectively and does not serve its purpose. The number of personnel who can use the system within the company is low and insufficient. There are materials and stocks entered the ERP system, but almost all of them are incorrect and incomplete. The codes of most materials in the warehouse are not in the system. The entered materials are not correct in quantity because the incoming materials were not entered on time, and the quantity reduction processes for the materials used in production were not done in the system.

In the ERP phase of the project, first, meetings were held with the personnel responsible for the ERP system (Supplier Company). In these meetings, issues such as how to make the system more efficient and the modifications that needed to be made were discussed. Training was organized for the use of the ERP system. There is a serious lack of information about the use of the ERP system. For this reason, first the project manager, that is, the researcher, received the necessary ERP training. After the researcher received the necessary training, he made the necessary changes to the system. He made the system suitable for the factory and easy to use. After the researcher started to use the system effectively and correctly, he trained 4 more production personnel, especially the warehouse personnel, who could support them

and substitute when necessary. In total, 8 personnel and the researcher received ERP training and started to use the system effectively.

Shelf information and code information have been added to the ERP system. These codes are equivalent to the codes used in the warehouse. When a new product arrives from a supplier, the warehouse personnel first enter the incoming material into the system and determine which shelf to put it on in the warehouse. After defining the shelf in the ERP system, the material is placed on that shelf, preventing the possibility of the material being lost. While the ERP system is almost not used at the beginning of the project, it is used effectively at the end of the project and has become a very important function for the sustainability of the project.

3.13. RESULTS

The audit was essential once all processes were finalized, and the project was completed. The researcher decided to audit the team. The audit team consisted of three people: a consultant, a researcher, and a business manager. The researcher was in charge of conducting time studies and keeping notes. The consultant reviewed time studies before the 5S project and observed that the results were extremely disappointing, affecting production cycle time and material costs significantly. The first step in comparing before and after outcomes was to conduct time studies of workers while searching for certain materials. The materials were identical to the initial audit materials, allowing for easy comparison.

The researcher felt satisfied with the before and after images because the improvement was obvious. Before the implementation of 5S, everything was unorganized and cluttered, and this made staff unwilling to work. Furthermore, they had lost control and were unable to resolve the problem without assistance. The warehouse was shown to be fixed, although time studies and finding rates were the main measuring keys. Before sharing the 5S, time study solutions were shared. Following 5S time studies, time studies are greatly improved, and lost materials are 100% fixed. It took 6136 seconds (102.26 minutes) to determine the GW customer's production materials location, and that was just for identification. Material quantity control, durability, and inspection times are not included. Materials were not in control

before placement. Following 5S applications, the team chose to examine materials before positioning them.

One of the most serious issues was the separation of materials from the same manufacturing. For example, the button logos were divided by size, which posed a major obstacle for workers. Because they did not separate them when the materials arrived from the supplier, and when production began, it took a long time and production was stalled. Firstly, they separate them into ERP systems, because of this move; they need to separate the boxes by specific needs (for example size issue in this case). And it made it easier to find during production.

The researcher and consultant review the before and after pictures before beginning the time study audit. Because all extraneous products had been removed, the warehouse appeared to be much cleaner and tidier than before. Each material was separated and placed. Before the photos, the warehouse had no rules or standards for placement or cleaning. This application established standards. Following the 5S application, all materials were separated by the customer, and everyone began to understand which materials belonged.

The company no longer has a lost material problem because of this approach being taken. Because of the lost material, the corporation was forced to incur additional costs that did not add value to the product. For example, during the initial check, the metal logo of MI customers hadn't been found before production. This implies they'll have to reorder the metal logo. Metal logo costs 0.40 cents. This means that the textile version lost 0.40 delivered for each product, which is not included in the order cost. This order's quantity taken as an example was 4500 units. This means that Version Textile lost 1800 € because of this issue. But this is not the only problem that occurs because of lost materials, also the company facing with could not delivering the order in dealt time to deliver. It is a very big problem for Version Tex because in case of delayed delivery, the customer is requesting a turnover loss discount, and this cost is not a small budget.

Because everything had been left off, certain parts of the facility were left ineffective owing to disorder. This 5S initiative addressed the issue of empty areas and made them usable. They can store more materials and keep everything together thanks to this application because they had been split somewhere due to this being

disorganized and inert capacity. The image in number 23 illustrates how this project transformed ineffective areas into effective ones.

Figure 26: Disorganized and Ineffective Shelf From The Warehouse Before 5S

Source: Created by the author

Figure 27: Organized And Effective Shelf From The Warehouse After 5S

Source: Created by the author

3.13.1. Time Studies After Project

Measurement was required after the project was completed. At the beginning of the project, the measurement tool was time studies. As a consequence, over time studies have been conducted to determine whether or not the project was successful. At the start of the study, 28% (14 items) of 50 materials could not be found, however, after the 5S project, this problem was completely resolved. Because, after all, when the material arrives from the suppliers, the workers enter it into the system before locating the items. The system and the real circumstance were completely the same, therefore forgetting the location or locating randomly was avoided.

With this system, workers can check the place from the ERP system very quickly and find the materials just in time. Finding materials has become very fast with these solutions. As mentioned before, the total material searching time was 6136 seconds (102.26 minutes) and this time decreased to 3493 sec (58.21 minutes). The total time for searching for materials decreased by 43% at the end of the application. And lost materials before production avoided 99.9%.

Table 4: Final Time Studies

PROCESS NUMBER	PROCESS	PROCESSING TIME
1	Getting GW zip	45 sec
2	Getting GW button	58 sec
3	Getting GW bobbin	25 sec
4	Getting GW weaving label	60 sec
5	Getting GW brand label	75 sec
6	Getting GW size label	85 sec
7	Getting GW carton label	69 sec
8	Gettin GW locked the rope	87 sec
9	Getting GW buckram	53 sec
10	Getting GW metal logo	126 sec

11	Getting GW fastener	40 sec
12	Getting MI button	74 sec
13	Getting MI lanyard	119 sec
14	Getting MI binding	52 sec
15	Getting an MI price sticker	25 secs
16	Getting MI size label	98 sec
17	Getting an MI carton label	57 sec
18	Gettin MI locked the rope	33 sec
19	Getting MI buckram	189 sec
20	Getting the MI metal logo	74 sec
21	Getting JK zip	118 sec
22	Getting JK button	67 sec
23	Getting JK bobbin	32 sec
24	Getting JK weaving label	84 sec
25	Getting JK brand label	149 sec
26	Getting JK size label	37 sec
27	Getting JK carton label	34 sec
28	Gettin JK locked the rope	53 sec
29	Getting JK buckram	28 sec
30	Getting JK metal logo	75 sec
31	Getting JK price sticker	59 sec
32	Getting PD size label	97 sec
33	Getting PD carton label	73 sec
34	Gettin PD locked the rope	58 sec
35	Getting PD buckram	64 sec
36	Getting PD bobbin	46 sec
37	Getting SS zip	75 sec
38	Getting SS button	108 sec
39	Getting SS bobbin	54 sec

40	Getting SS weaving label	39 sec
41	Getting SS brand label	85 sec
42	Getting SS size label	106sec
43	Getting SS carton label	70 sec
44	Getting SS to lock the rope	47 sec
45	Getting SS buckram	103 sec
46	Getting the S&S metal logo	32 sec
47	Getting S&S size label	41 sec
48	Getting S&S carton label	76 sec
49	Gettin S&S locked rope	36 sec
50	Getting S&S buckram	103 sec

CONCLUSION

This study aims to digitalize the business while eliminating unnecessary movements, time losses and unnecessary items by applying 5S studies in a textile manufacturer factory that produces women's woven garment products. One of the main problems experienced by the researcher while conducting this study was the lack of investment in the project and the limited use of resources. At the same time, the lack of knowledge of the personnel constituted an important constraint during the project process. This study aimed to show that efficient results can be obtained with limited resources.

While this study was being carried out, the aim was to reduce time losses and cost increases due to lost materials by making the warehouse, which had gone beyond its purpose, more visual and functional. At the same time, it was aimed to increase the willingness to work and to create awareness by making the working environment of unhappy and unmotivated personnel more organized. While this study was being carried out, the team also faced problems such as limited investment resources and lack of information. After this study, investment activities can be increased, and a more visual and ergonomic working environment can be created.

5S studies have been done in the textile sector before and contributed to the literature. These studies still shed light on the benefits of 5S to textile companies today. This visual warehouse study, it is aimed to provide benefits in the evaluation and maintenance part from a different perspective by including the ERP system in the 5S project.

First of all, it was decided to carry out a 5S study by giving brief information about the 5S project with the current situation analysis carried out with the staff, managers, and consultant, and touching on important points about its reasons and advantages. At the meeting held, it was decided that the application area of the project would be a warehouse. The main purpose of the application is to reduce time losses. Because it became apparent from the observations that the employees were wasting a lot of time looking for things in the warehouse.

This situation both disrupted production and reduced employee productivity.

In the enterprise where the project was carried out, initially 7 people, including 1 consultant, 1 engineer, and 5 personnel, took part in the project. At the time the project was carried out, nearly 150 personnel were working in the company. The lean production philosophy was not widespread in the company, so the first step of the project was to transfer the lean philosophy to the company.

One of the most important points that motivate employees is that the gains they will obtain because of the project are clearly understood and they understand and accept that they will work more effectively. In addition, since the basis of 5S is visual, the idea of a visual and clean workspace has motivated the staff a lot. Because the current situation was quite dirty and messy. For this reason, personnel are not satisfied with their work area.

The 5S approach, which started as project-based training, turned into a widespread practice within the company over time and was developed and disseminated by employees day by day. Especially in the company warehouse, neatness and order have become very important criteria. One of the important factors that motivated the employees was that the visuals to be used and the arrangements to be made while carrying out 5S work were determined and carried out by the employees themselves. 5S to employees in this regard

Examples of applications within the scope were given and they were asked to examine them and adapt them to their work areas as they wish. In the "sustain" phase of the work, they were asked to produce solutions that would warn and support them to make the 5S philosophy permanent in the business, as far as they learned. In this context, the development and use of the ERP system has become a generally accepted and enthusiastic method.

The participation and motivation of the employees in this regard made a significant contribution to the success of the 5S application. As employees embraced the 5S philosophy, their work increased day by day and became a system that would continue continuously.

The following criteria are effective in the success of the 5S work implemented in the business: can be said:

- Strong support from senior management to 5S activities,
- Providing incentives and rewards,

- Strong communication and cooperation among employees in the business,

- Evaluating the employees' approaches to the 5S philosophy and their potential through one-on-one interviews with employees before working in the business.

- Planning the activities to be done before starting the work and continuous recording of observations by preparing relevant application and control plans and control charts,

- Theoretical and then practical pieces of training with visual materials on 5S

- Unhappiness with the disorganization of their staff and their positive approach to this project.

Measurements were necessary when the project was completed. At the start of the project, the measurement instrument was time studies. As a result, throughout time, research has been done to establish whether the initiative was effective. At the outset of the study, 28% (14 items) of the 50 materials could not be located; however, after the 5S project, this issue was totally rectified. Because, after all, when materials come from suppliers, workers enter them into the system before locating the products. The system and the real situation were identical, therefore forgetting the position or locating randomly was avoided.

With this technology, workers may easily verify the location from the ERP system and locate materials on time. With these solutions, finding materials is much faster. As previously stated, the total material search time was 6136 seconds (102.26 minutes), which was reduced to 3493 seconds (58.21 minutes). The overall time spent searching for content dropped by 43% at the end of the application. Furthermore, 99.9% of materials wasted before manufacture and newly arrived ones were avoided. As a result, in the study conducted

- Unnecessary parts have been eliminated
- Necessary materials placed in the right place and separated
- Materials are classified
- Working environment cleaned
- Cleaning has become a routine habit
- Standardization was made and supported with visuals
- Methods were developed to continue the work carried out

- Employee training has been provided and continues to be provided
- Control and audit logic has become a habit within the company
- Lost times have decreased significantly
- Employee productivity and desire increased

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