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A REVIEW ON LEAN MANUFACTURING FOR SMALL SCALE INDUSTRIES

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Abstract
The study aims to analyze and identify obstacles to implementing lean manufacturing in small-scale businesses. Lean manufacturing is crucial in the current business environment as it reduces costs, improves quality, and meets customer expectations. Implementing lean manufacturing can lead to increased productivity, customer satisfaction, and cost savings. While the effects of lean manufacturing on performance have been studied, the impact on financial outcomes has received limited attention. This research seeks to assess the degree of lean implementation and measure its financial effects. By uncovering the hidden potential in small-scale industries and suggesting productivity improvement approaches, this study will benefit researchers, professionals, academics, and other interested parties. Additionally, the importance of practices like 5S, 7S, Six Sigma, and kaizen will be discussed to enhance understanding and guide improvement efforts.
Keywords: Lean manufacturing, small scale industries (SSI), Six Sigma, 5S/7S, Quality control, Productivity improvement.

I. Introduction

The manufacturing sector's major contributors to job creation are Micro, Small, andMedium-Sized Enterprises (MSMEs). They play a key role in practically every leading industrysector, including the automotive, apparel and textile, and leather industries. Many nations have institutionalized Lean production techniques in their national approach to manufacturing in recognition of the significance of total economic growth of a nation and the need to improve its productivity, competitiveness, and employment generation. Asia's emerging and established nations both benefit from the rise of small-scale industries. Small-scale enterprises have been compelled by the current state of the global economy to implement lean manufacturing (LM) in order to remain competitive [1]. A nation's economic viability is directly correlated with the manufacturing sector's development, so it calls for ongoing improvement to reach excellence across the board. Industries must use current strategies that not only boost productivity but also assist in surviving the fierce market competition in today's environment of challenging company competitiveness.
The manufacturing sector's major contributors to job creation are Micro, Small, andMedium-Sized Enterprises (MSMEs). They play a key role in practically every leading industrysector, including the automotive, apparel and textile, and leather industries. Many nations have institutionalized Lean production techniques in their national approach to manufacturing in recognition of the significance of total economic growth of a nation and the need to improve its productivity, competitiveness, and employment generation. Asia's emerging and established nations both benefit from the rise of small-scale industries. Small-scale enterprises have been compelled by the current state of the global economy to implement lean manufacturing (LM) in order to remain competitive [1]. A nation's economic viability is directly correlated with the manufacturing sector's development, so it calls for ongoing improvement to reach excellence across the board. Industries must use current strategies that not only boost productivity but also assist in surviving the fierce market competition in today's environment of challenging company competitiveness. Lean manufacturing leads to achieve customer satisfaction without compromising to quality. Lean was discovered from Japanese manufacturing industries by John Carrick (1988). The goal of lean manufacturing is to eliminate all needless waste,

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hence the term. Essentially, it aims to streamline the production chain to eliminate anything that doesn't add value or generates waste [2]. A concept known as "lean manufacturing" aims to increase productivity while eliminating waste in industrial systems. Everything that clients don't think adds value and aren't prepared to pay for is considered waste.

Lean manufacturing is the practice of developing and producing physical products using Lean practices, principles, and technologies. In a quick-paced, volatile, constantly changing global market, many businesses are utilizing lean manufacturing principles to decrease costs, stimulate innovation, remove waste, optimize processes, and shorten time to market. Due to its global supremacy in cost, quality, flexibility, and quick response, the lean manufacturing (LM) or Toyota Production System (TPS), pioneered by a Japanese automobilecorporation, Toyota, has been adopted by nearly all nations worldwide. Lean is a production technique that strives to reduce waste while generating greater value for consumers along the whole value stream. The value stream and its optimization are the only things that are considered in this wholly customer-based strategy. Lean principles state that any resource consumption that does not result in value for the user should be changed or eliminated. Lean manufacturing is primarily used to boost output, save costs and lead times, enhance quality, and provide the greatest value to customers. Lean manufacturing has several different definitions [3-5].

The goal of lean manufacturing is to eliminate all needless waste, hence the term. In essence, it aims to streamline the production chain to eliminate anything that doesn't add value or generates waste.

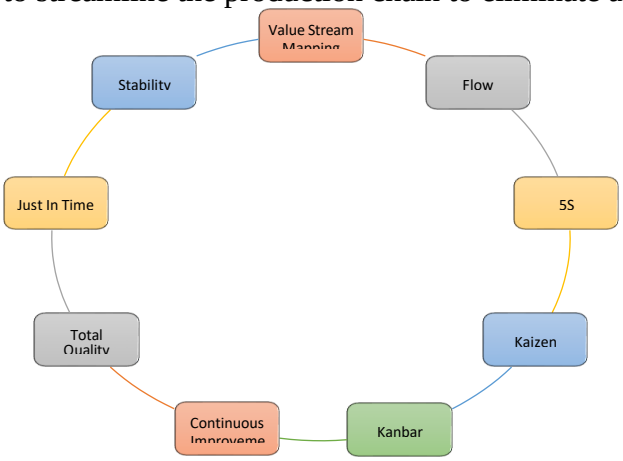

Figure1. Lean Manufacturing

Key Benefits to Lean Manufacture:

Eliminate Waste: Cost, deadlines, and resource constraints are adversely affected by waste. Itadds nothing to the value of goods or services.

Improve Quality: Enhancing quality enables businesses to remain competitive and satisfy customers' shifting demands and desires. You can stay ahead of the competition and maintainquality improvement at the forefront by designing procedures that satisfy these demands and expectations.

Reducing Costs: Storage costs are produced by overproduction or having more materials thanare necessary, and they can be decreased by improved procedures and material management.

Reducing Time: Ineffective working methods waste both time and money, whereas more effective methods reduce lead times and hasten the delivery of goods and services.

II. Techniques of Lean Manufacturing

2.1 Value Streamline Mapping:

The application of Value Stream Mapping (VSM) in the production process is covered in the paragraph. A graphical program called VSM is used to collect data on production process information such as cycle time, lead time, and TAKT time. VSM, on the other hand, is a static procedure that only records a snapshot on a particular day. A fresh approach to doing VSM is suggested as a solution to

this. To determine which future state map is the most ideal, the current and future state maps are modelled into simulation software, and several simulations are run. This approach minimizes the risk of problems when implementing the Include selecting a product family, drawing the current state map, analyzing the current state map for waste and bottleneck processes, eliminating waste and drawing the future state map, simulating the future state map, and finally implementing the selected future state map [6].

The current state map is drawn on a plain piece of A3 paper. Before mapping the current state, some conditions must be met:

- Stage time, Changeover time, Uptime
- Asset Management
- Request from the client
- Supply plan
- Number of workers on each operation
- The total number of working hours, shifts, and breaks.

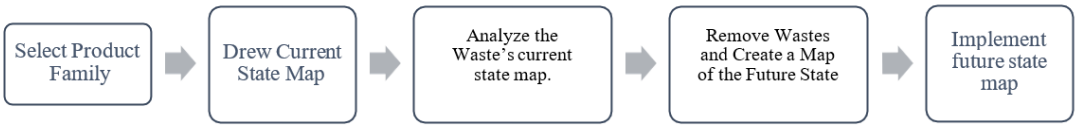

Figure 2. Conventional VSM process [6]

2.2 Just in Time (JIT):

Just in Time (JIT) is a production strategy that aims to eliminate waste in manufacturing by producing the right quantity of raw materials and finished products at the right time and place.The philosophy behind JIT was developed in Japan due to their inherent limitations of space and natural resources. The goal of JIT is to improve profits and return on investment by reducing costs, inventory, and improving quality. Workers in JIT systems are responsible for producing quality parts just in time to support the next production process, and the system should respect the humanity of employees. JIT has been widely adopted in the Japanese automobile and electronics industries and has proven to be beneficial in many industries around the world, improving manufacturing costs, quality levels, delivery responsiveness, and flexibility [7-8]. S

Tools of Just in Time are as follows:

a) Preventive maintenance.
b) Eliminating waste.
c) Set up time reduction.
d) Mixed production.
e) Kanban.
f) Cellular work flow.
g) One piece flow production.
h) 5 S's.
i) Poke yoke.
j) Total productive maintenance.

2.3 SIX SIGMA:

For many businesses, especially factories, suppliers, logistic firms, financial services firms, healthcare providers, and governmental institutions, process improvement has emerged as a key marketing strategy. Quality is a weapon for competition that can lead to enterprises who properly implement its key concepts will benefit significantly. A company hasthe ability to outperform rivals if it can satisfy consumers by enhancing and managing quality.A key component of long-term corporate success is creating an efficient quality plan. For decreasing unpredictability, removing faults, and eliminating waste from goods, processes, andtransactions, Six Sigma is a methodical, endeavor, statistically driven

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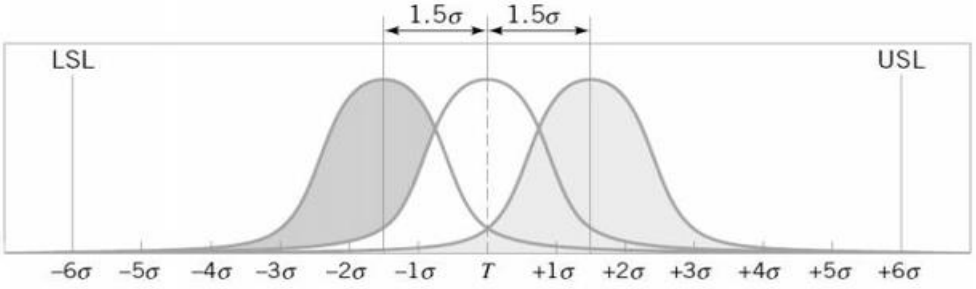
strategy. The Six Sigmaprogrammer is a significant driver for quality and business improvement in today's corporate environment. The fundamentally crucial function that statistical techniques and statisticians must play in a vitally crucial function for statistical techniques and psychologists in this system. We go through the history of Six Sigma, its key elements, how it is often applied in commercial settings, and the part statistics and statisticians play in the process. Also, we address how Six Sigma may affect analysts' studies and instruction as well as the future of thenumbers discipline [9].

2.3.1 Six Sigma Matrix:

The primary goal of Six Sigma is to minimize variation in critical product quality criteria around predetermined target values to the point where failure or faults are highly improbable. With the specification boundaries set at three degrees of freedom on each side of the desired mean, Figure 1a depicts a normal probability distribution as a model for a quality feature. The goal of the Six Sigma idea is to make a product less variable so that the descriptionlimits are at least six standard error from the desired result. At this Six Sigma quality standard,there are around 2 parts per thousand of products that don't meet requirements. According to the Six Sigma approach, it was assumed that even after the process had attained the Six Sigmaquality criterion, disruptions may still cause it to deviate by up to 1.5 degrees of separation from the desired value [10].

2.3.2 A History of Six Sigma:

3 phases of Six Sigma adaptations have existed since the method's inception. Phase I Six Sigma concentrated, mostly in manufacture, on defects removal and fundamental variability reduction. A prime example of Generation I Six Sigma is Motorola. The focus on variance management and defect removal persisted in new gen II Six Sigma, but there was a more significant attempt to link these endeavors to initiatives and tasks that enhanced overallperformance of the company through increased product design and cost savings. As the pioneerof the Generation II phase of Six Sigma, General Electric is frequently mentioned. Six Sigma’s Phase III focus now includes adding value creation for the individual involved as well.



Spec. Limit	Percent inside specs	ppm Defective
±1 Sigma	30.23	697700
±2 Sigma	69.13	608700
±3 Sigma	93.32	66810
±4 Sigma	99.3790	6210
±5 Sigma	99.97670	233
±6 Sigma	99.999660	3.4

Figure 3. Six Sigma Concept [10]

We based our concept of Six Sigma on the field data we gathered and then comparedit to published studies. We start by listing the definitions that were presented to us during the interviews. Lastly, in light of the interviews and indeed the literature, we will give an emergingtheoretical definition. The responder was specifically requested to submit a definition of Six Sigma in each survey, and this definition was then debated and clarified with them.

- The six-sigma strategy serves to highlight producing quantifiable and realizable financial rewards to an organization's bottom line. Without a clearly defined and substantiated bottom-line effect, no six-sigma initiative can be funded. Strong, enthusiastic leadership and the necessary support are of exceptional significance to the six-sigma strategy's effective

Industrial Engineering Journal
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implementation.

- The Six Sigma technique of issue resolution combines the human parts of improvement(change, customer focus, belt system infrastructure, etc.) with the process elements (process management, rigorous tools of process data, analytical method analysis, etc.).The Six Sigma approach makes use of tools and procedures to solve issues in business processes in a methodical, sequential manner.
- In order to install and apply the strategy, Six-sigma develops a system of winners, master black belts (MBBs), black belts (BBs), with green belts (GBs). Six-sigma promotes the value of data and the need for fact-based decision-making as opposed to gut feelings and biases! People are compelled to use measures by six-sigma. Measuringneeds to be taken into account as part of the cultural shift. Six-sigma makes use of the idea of statistical thinking and promotes the use of tried-and-true statistical tools and procedures for defect minimization through approaches such as statistical process oversight and survey commissioned [11] [14].

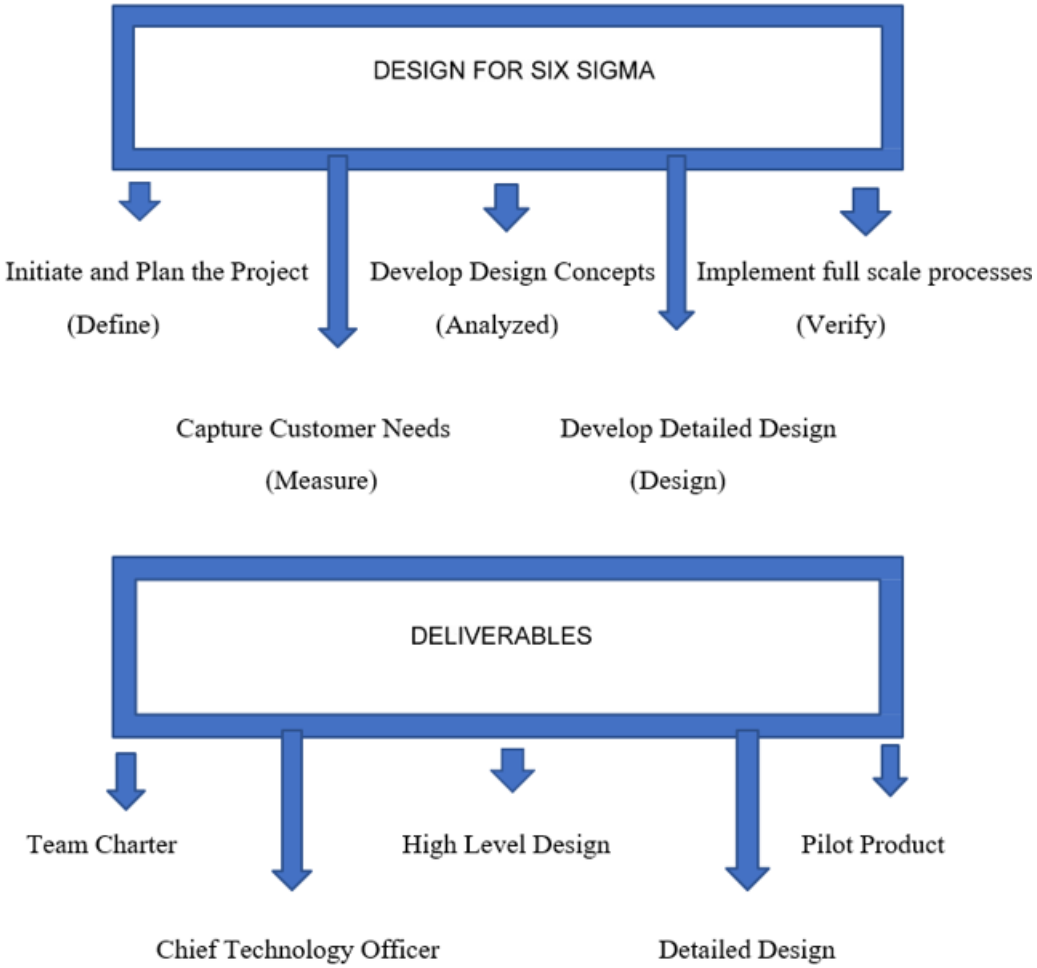

Figure 4. Design Procedure of Six Sigma

2.2 KAIZEN

The Japanese phrase kaizen has gained popularity in several corporate entities.The phrase refers to a method of continuously improving the conventional work style. It is a composite word made up of two ideas: (change)-Kai, and (For the better)-Zen.so kaizen is themixture of these two entities. The phrase is derived from the phrase "Collaborative," One of the key tactics for achieving manufacturing excellence is continued growth, which is seen as essential in the current competitive context. It demands constant work on development from everyone inside the company. Once company and the authorities in Japan understood there wasan issue with the prevailing adversarial managing, they

created Kaizen in 1950. In Japan the industry caused impending lack of workers. Japan worked with the workers to find a solution to this issue. The majority of large enterprises adopted the union contracts backed by the federalgovernment, which included lifelong jobs and rules for redistribution of wealth for the growthof the organization [15].

Kaizen leads to more customer experience, higher safety, quicker delivery, higher production, and higher quality Also, workers report that their jobs are simpler and more pleasant, which boosts employee satisfaction and reduce employee turnover. Results include:

- lowering of waste in areas including stocks, waiting periods, conveyance, moving of workers, skill of workers, excess output, excess quality, and in-processes**.**
- An improvement in the way that space is used, the quality of the products, how moneyis used, interactions, how much can be produced and staff retention.
- Immediate outcomes. Kaizen focuses on innovative initiatives that repeatedly resolve alot of little issues as opposed to huge, money changes. The constant practice of making little adjustments that enhance overall operations and decrease waste is where Kaizen has true strength lies.

2.2.1 KAIZEN COSTING

Instead of increases in the stage of design and creation, Kaizen price efforts concentrate on continuous modest incremental profit margin savings in the production phase. Management will set the cost-reduction goals for the goods during cost accounting. That division's total cost - cutting goal is established for a six-month period of time. Kaizen costingis later developed so at work station company level predicated on discussion and agreement both executives and the worker cell. After reduction objectives are established, the work cell is free to devise whatever strategies necessary to meet them. Often, shop line-controlled product costs are the only expenses taken into account. After 90 days, interim outcomes are measured to see if the station has made progress towards attaining its goal [15-16].

Two things are essential for kaizen spending to be implemented successfully. The work cell should be held responsible to them after the expenditure objective has been agreed. Second, the kaizen process must be trustworthy as well as consistent. For the work cell to consistently try to accomplish their goal and be able to discern the advances made over the length of the year, it has to become part of the culture. On the shop floor, value-added analysisshould be used to help task cells achieve their kaizen goals.

In Industries amount of trash generated during a specific industrial process. In essence, the entire amount of time spends engaging in numerous sales floor processes is dividedinto enhanced quality and non-value-added time. Benefit time which is the amount of time spent converting raw resources into a finished product that increases its value. Semi time is time used throughout the process of change for tasks like inspection, rework, queuing,transferring materials, and waiting that don't improve the final product. The company views this as loss and an unwanted expense. The ideal scenario would be for a product's benefit timeto match its lead-time. In this instance, there is absolutely no production waste. In this instance,there is absolutely no production waste. After the proper concepts and variables are in existence, value-added measurements must be defined in order to accomplish this aim. The aimis to create goals, assess progress towards those goals over a certain time period, and then set new goals, just like in kaizen. Often, this data is reported as a fraction of the time spent in a work.

The core of Kaizen is this. The worker feels driven to uphold safety, quality, low cost, and on-time performance by these straightforward yet fundamental norms. The followingthree guidelines are typically recommended to guarantee that the Kaizen mentality is being maintained and that each person's creativity is being effectively realized:

1. I don't spend a lot of money
2. Don't add anyone
3. Don't add a space

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Kaizen will decrease expenses, space needs, and pulse width. Naturally, as it is ongoing, as soon as one set of issues is resolved, another set of issues arises that need to be resolved. This project start - up in the industrial system being growing increasingly more powerful. Theoutcomes are:

1. Reduced perform by 65%
2. Reduction of the production space by 50%
3. A 45% increase in transaction speed (lead-time)

The Japanese management actively seeks out and considers several recommendations made by staff members, and frequently incorporates these ideas into the larger Kaizen plan. The generally interpreted the efforts of the employees to improve. The fact that each proposalresults in a higher quality after implementation is a key component of the organization [17].

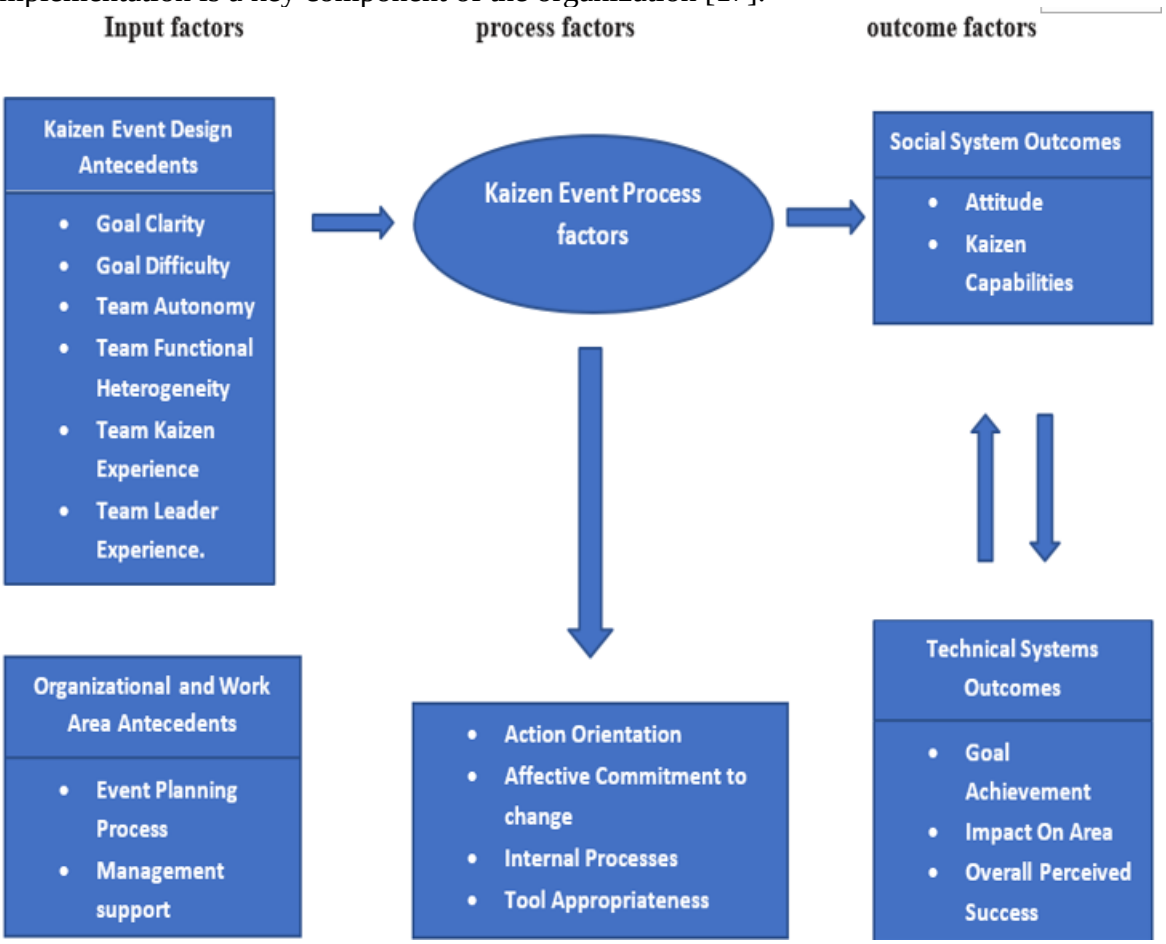

Figure 5. Kaizen Event Process

Many US industries have adopted the lean manufacturing philosophy in the past ten years as a result of the intense global competition they have faced. To keep costs under control during the manufacturing process, many US businesses have relied on conventional standard costing techniques. These systems frequently conflict with the company's strategic goals and are insufficient to support lean manufacturing objectives. In order to promote lean manufacturing and remain competitive, kaizen costing has become a new cost management method and philosophy that is being embraced more frequently. Continuous cost reduction is the main goal of kaizen costing. In order to successfully implement lean production, two goals of this paper were to present financial measuring metrics and to outline a mechanism for setting kaizen expenses. The financial metrics and kaizen costing process that are covered here were developed and are currently in use at Boeing IRC. The Boeing must be able to comparepost-performance indicators with those for future research. Gathered before the adoption of kaizen (i.e., before-and-after measurements) to support the effectiveness of kaizen costing. Close

Industrial Engineering Journal
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coordination between everybody on the work cell group and upper management is essential for the deployment of new financial measurement measures to be successful [17-19].

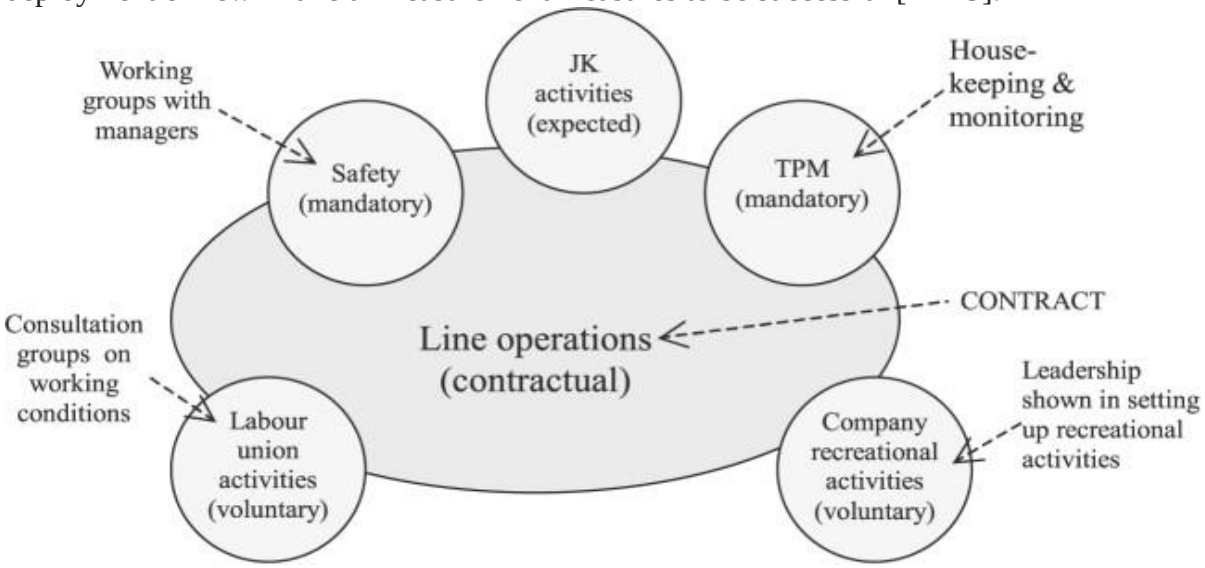

Figure 6. Kaizen

2.3 Workplace organization Technique's for Small scale industries:

Organization consists of:

a) visual management
b) 5S/5C technique
c) Seven S (7S)
d) FMEA Work-out

One of the simplest ways to evaluate an organization's approach to its business andits housekeeping and visual management is to look at how the workplace is organized. When something seems right, it usually is [20].

2.5.1 Visual management:

A safe, clean, organized workplace that promotes open communication, pride in one's work, and constant growth is what Visual Management is all about for its colleagues. Visual Management uses a variety of straightforward, efficient visual information aids to deliver real-time information on workplace status. These help employees comprehend their impact and enhance organizational effectiveness.

Visual Management implementation consists of six phases:

Visual Control Board
Andon
Footprints
Signage
Obey
Hansel

Table 1. Value Management Implementation

2.5.2 5S/5C technique:

5S system is also called a Gemma Kanri. Gemba Kanri, also known as 5S/5C, is a systematic strategy that enables teams to set up their workplace most safely and effectively as possible. The first step entails clearing the workspace of all extraneous items. Depending on how often it will be used, leftovers are then put in a permanent location. The 5Stechnique is used to establish and maintain a tidy,

secure, and well-organized workplace. Organizations can operate more successfully and efficiently by using 5S [21].

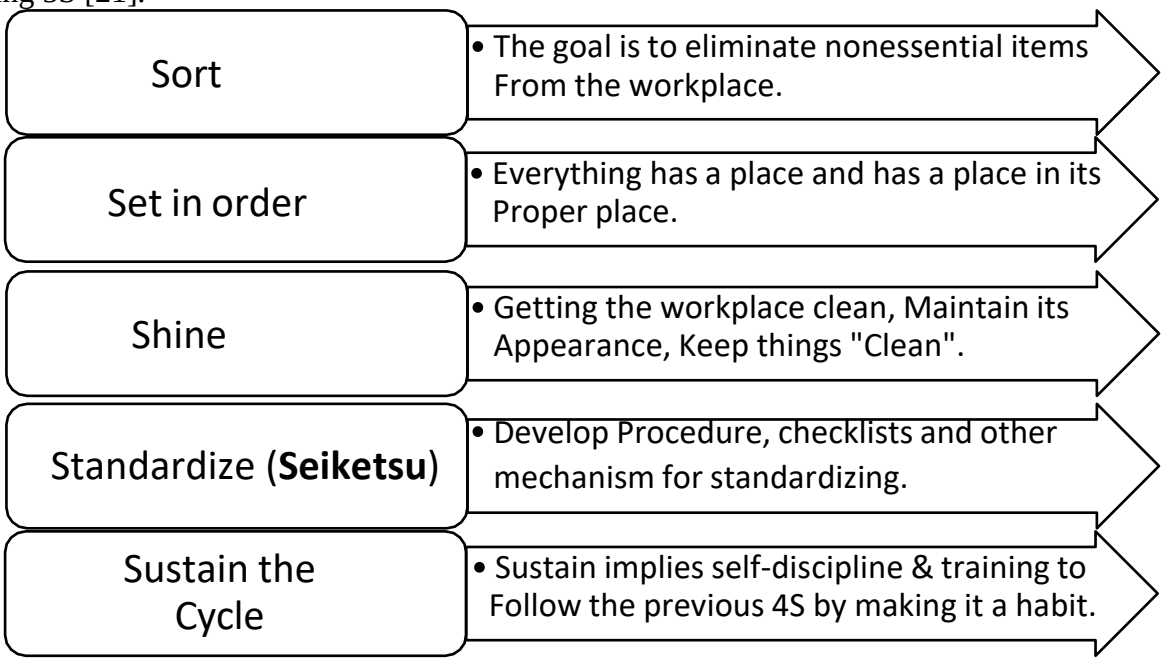

Figure 8. 5S/5C Consists

Benefits of 5S:

- Process improvement through cost cutting Reduction of Stock
- Stock reduction; Better use of the work area
- Search time reduction
- Safety enhancement
- Maintenance and machine efficiency enhancement
- Maintains a clean workplace, easy to check
- Quick information regarding damages (possible sources of damages) is maintained the work environment is improved
- Elimination of the accidents' reasons and the causes of accidents are eliminated

2.5.3 Seven S (7S):

A workplace can be made and kept organized, clean, safe, and high-performing using the 7S process and approach. The seven steps of the 7S implementation are represented in Fig. Shine, Standardize, Maintain, or Spirit, Safety, and Self-Control [22].

Industrial Engineering Journal
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Figure 9. 7S techniques

Benefits of 7S:

- Better communication
- Increased motivation to work
- Better understanding and analysis of issues
- Creates a productive workplace
- Reduces the attitude of boredom towards the work

2.5.4 FMEA Work-out:

FMEA is stand for Failure Modes and Effects Analysis (FMEA) is a systematic method for learning about potential weak points in a design, manufacturing process, product, or service. FMEA is a crucial tool for enhancing the design of both products and processes. FMEA is utilized for design in this section, but it may also be used for system, process, and mechanical design [24-25].

Benefits of FMEA:

- Boost the quality and dependability of products and processes.
- Boost client satisfaction.
- Detecting and removing probable product/process failure modes early.
- Sort product or process flaws by importance.
- The expertise of engineering and organizations.
- Places a focus on problem prevention.

This are Workplace organization Technique's for Small scale industry's visual management, 5S/5C technique, Seven S (7S), FMEA Work-out when we look at a small industry, they need to develop their workplace for increasing their productivity of work, increase client satisfaction, Increased motivation to work etc.

3 Conclusion

The manufacturing sector is looking for ways to lower production costs, remove waste, improve product quality, boost productivity, and raise customer happiness. LM techniques are typically used in industry to get these parameters. Contrary to LM techniques, traditional manufacturing hasn't helped the manufacturing sector develop world-class production systems. As a result, the industrial sector must to strive to apply LM principles, procedures, and equipment in the crucial field of production. Additionally, the manufacturing sector should think about providing personnel with suitable lean

education, training, and professional development. This study showed the importance of Six Sigma, Kaizen, 5S/7S, and FMEA in Small Scale Industries. This study also raised researchers' awareness of the functionof LM techniques and approaches in enhancing production advantages. Lean accounting implementation hurdles can be evaluated further by looking at cultural, technological, organizational, and economic aspects in manufacturing organizations.

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