IMPLEMENTING LEAN MANUFACTURING IN FMCG TO REDUCE WASTE

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQURIMENTS FOR THE AWARD OF THE DEGREE OF

MASTER OF TECHNOLOGY
IN
PRODUCTION ENGINEERING

Submitted by:

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I, Prabha (2K17/PIE/10) of M.Tech (Production Engineering), hereby claim that the undertaking project dissertation titled " **IMPLEMENTING LEAN MANUFACTURING IN FMCG TO REDUCE WASTE**" that is submitted by me to the department of Mechnical Engineering, Delhi Technological University, Shahbad Daulatpur, Bawana Road, Delhi in partial fulfilment of the requriment for the award of the degree of Master of Technology, is authentic and no longer copied from any resources without proper citation. The work has not formerly formed the basis for the award of any diploma, Degree Associateship, Fellowship or different similar identify or popularity.

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ACKNOWLEDGEMENT

The mission has finished in time because of the contributions made by many individuals who furnished the fuel source for this project to soak up complete tempo. I am able tp like to explicit my honest gratitude to all the ones who've at once or in a roundabout way have lent their assisting hand on this task. I experience honored to be on the receving quit of the support from them. Without them, the real implementation of this venture could now not have been feasible in any respect.

I owe a debt gratitude to my project mentor Dr. Rangamath M. Singari (Head, Department of Design) for incorporating inside me the concept of a major project and supporting me in task and for being there on every occasion. I wanted his importance guidance and help.

I additionally thank my organisation, Delhi Technological University for provision of library and net facilities which helped inside the-timed finishing touch of this assignment. Without our mentor and the group, this project could have lacked in great of results and thus their aid has been essential.

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ABSTRACT

Applicable lean tools have been used in this report. In this report, in various faster growing industries like FMCG, pharmaceuticals; hospitality, manufacturing etc are used. Value stream mapping is the tool with priority over others in identifying the waste . It is a lean tool which helps to translate both information and flow of data through which those processes that are not adding any positive value in our study can be easily eliminated.. This report is an effective effort to find out the waste production during manufacturing of a perishable goods in discrete manufacturing system. To categories the factors that are responsible for the 80 percent of waste , the Pareto chart has been used . Here a vital role is played by Ishikawa diagram for finding of their possible causes and effect. Kanban, Kaizen, and FIFO are the other contemporary lean tools used for future state map processing. Through the future state value stream map the result obtained states the changeover time of various processes, the cycle time near to the takt time, improvement in lead time and total cycle time of the manufacturing process.

KEYWORDS:- Takt time, Value stream mapping, Kaizen, Kanban, FMCG

CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of symbol and description

Symbol	Description
VSM	Value stream mapping
Tt	Takt time
C/T	Cycle time
C/O	Changeover time
Pe	Process efficiency
P/T	Process time
lt	Lead time

CHAPTER 1 INTRODUCTION

Lean manufacturing is an idea , developed by Toyota. A method to systematically recognize the waste generating factors in the organization and to remove the waste through continuous improvement and harmonizing the product flow at the pull of the customer is called as Toyota production system . Waste is a material which sums no value to the product as per customer point of view . The motive of lean is to remove this non-value adding process and material from the system. It is mostly used in industries to meet customer demands with least produce of waste .

The system which helps to detect the waste and try to maderate the effect of factors causing waste is called lean manufacturing system . It works with the combination of all the employees . The contribution of each employee in the oganisation helps to make the implementation of tools to become successful . Now , the lean is used with six sigma to reduce the inconsistency in process.

Nowadays , the items sold quickly and for direct use to the costumers are Fast-moving consumer goods (FMCG) or consumer packaged goods (CPG). The family things that we are buying while shopping in the groccery store or drug store is being sheltered by the industry of Fast Moving Consumer Goods .The advise of 'Quick moving' makes the things rush to leave the racks . It has a tendency to be high in volume yet low in costly things. These essential things are the items that we utilize the whole day. The most brand names that we go over every day is holded by the multi- million dollar divisions.

The lean manufacturing helps to carry out the process in the sequence to identify the waste and then find new solution to reduce the waste and increase the productivity nad reduce the cost.

The main principal of lean system is that the reduction of the time via removing the waste, also continous improvinf the process. High competition between the industries forcing the organisation to expand the quality, decrease the time, and also the reduction in the cost. By adopting a lean sysem in various industry helps to progress the value of product, diminish time, increase the productivity, and most important satisfaction of the customer increased.

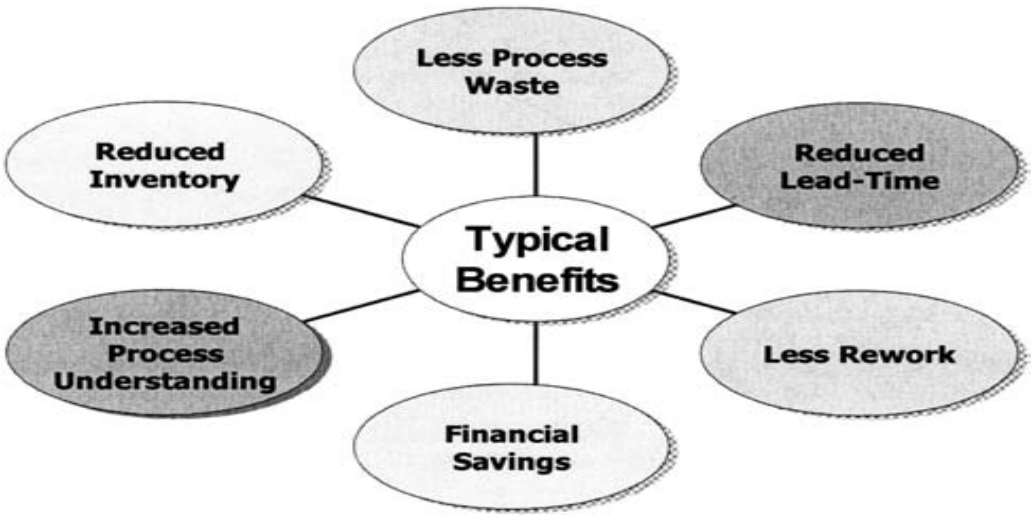


Figure 1.1 Benefits of lean[20]

FMCG organizations , recognized by their capacity , gives the items to the purchaser that are deeply requested, while adding up an suggestion with trust and dependability. For example, the cleaning and clothing that are utilized as a part of family items , over the counter preparations, sustenance things and individual care products which makes up most of the FMCG business.

The nourishments that disposed to decay are perishable . They rot or wind up risky , if not kept refrigerated at 40 F° (4.4 °C) or beneath or solidified at 0 F° (- 17.8 °C) or below. Cases of nourishments that must be kept refrigerated for security integrate meat, poultry, dairy items, and every single cooked extra. The bacterial growth is moderated by refrigeration and by solidification it gets stopped .

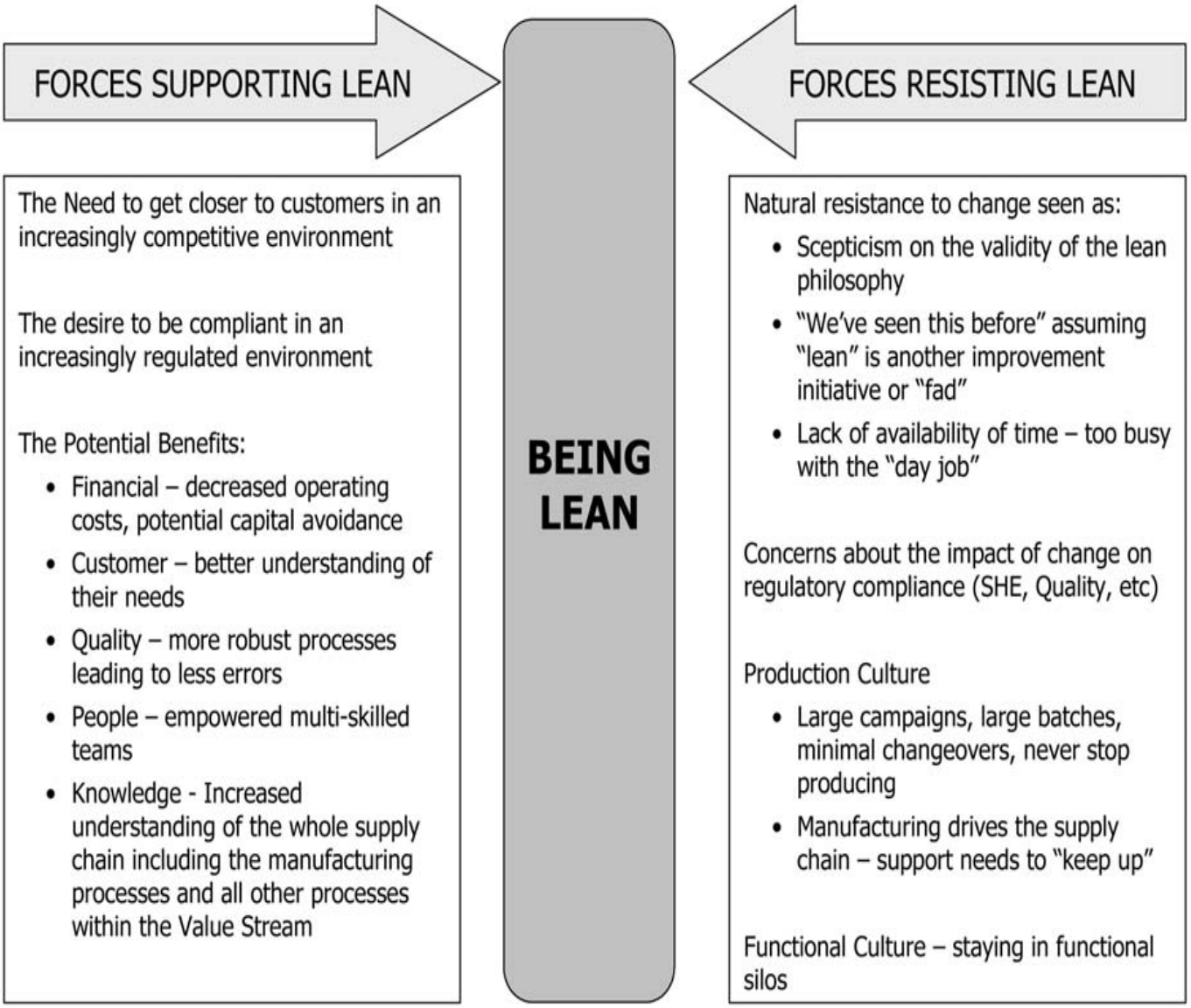


Figure1.2 .present forces of opposing also driving of change in 'lean'.[20]

The perishable products produced by FMCG's are short live so the feasting should be fast . It is very difficult to have large catalogues of these items in house and to manage the production control to meet the costumer demands .

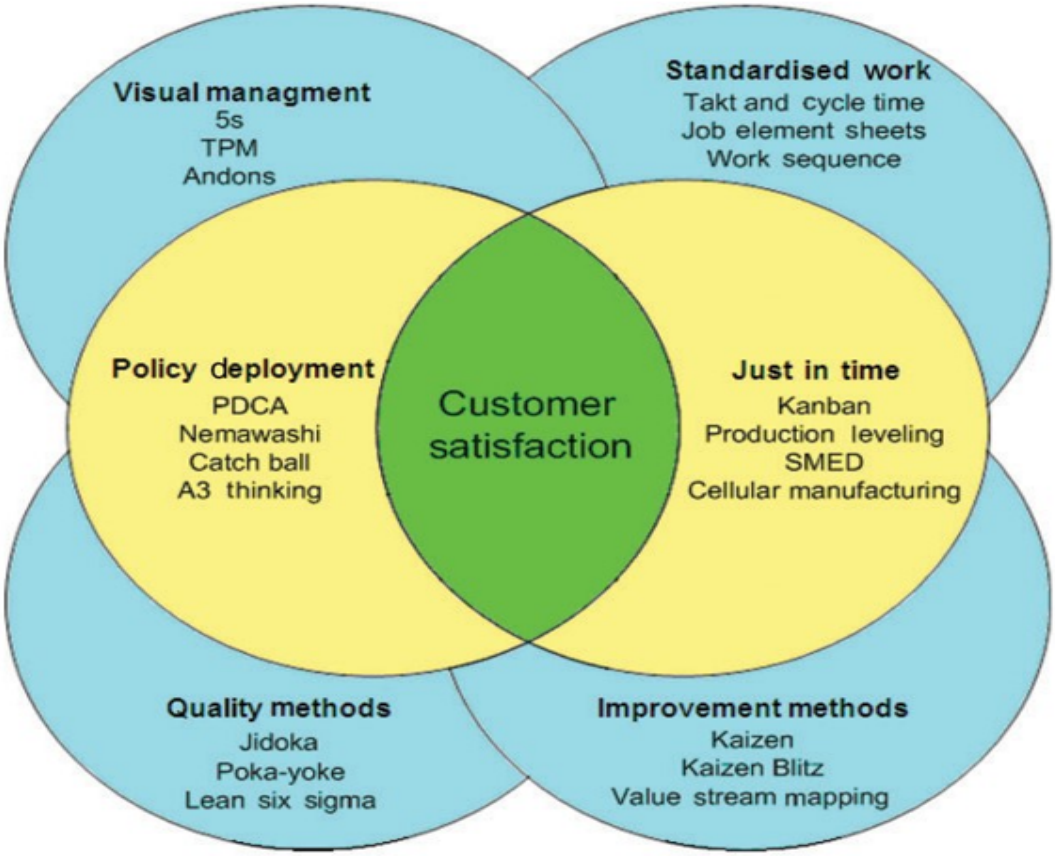


Figure 1.3 Present model of lean tools used and principal[13]

1.1 OBJECTIVE

The objective of this report is to implement the lean tools in the distinct process of a FMCG. Firstly , the focus of the project is to map the discrete process of the value addition which will help to determine the factors causing waste in the value stream . Secondly , by evaluating the blockage process and calculating various time like cycle time, changeover time etc. Thirdly , the factors causing almost 80 percent of the waste can be find out using pareto chart . By finding out the possible reasons of the factor using cause and effect diagram , the major factor can be evaluated .

The FMCG which we target is Bikanerwale . At the manufacturing plant , we value stream map the process of producing sweet like rasbhari rasogolla at and then we find the possible factors which are underwriting for the production of waste in the process. The application of the lean tools requires the data obtained by physical remark . At the end a future value stream map is try to obtain so as moderate the effects of factors causing waste.

1.2 SCOPE

This report addresses the scope of VSM in perishable goods at the production line to identify the waste occur at each step of value addition. Using the lean tools employment, the factors causing waste in the process is determine and their possible causes is evaluating. A future value stream map is set to mitigate the effect of factors and diminish the production of waste.

1.3 TECHNIQUE AND TOOLS EMPLOYED

The following various tools are employed for the finding of factor and mitigating their effects are

a) Takt time (tt)
b) Pareto chart
c) Value stream mapping (vsm)
d) Kaizen
e) FIFO lane
f) Process efficiency
g) Supermarket Kanban pull system
h) Cause and effect diagram

The physical observation is recorded and various calculation and visual understanding is attained through MS Excel software.

Kaizen System

Kaizen is a word which refers to continous enhancement, here continous improvrment means the involvment of everyone that involve in a particular project i.e, empolyee, manager, caption etc. and every one have to involve in a activities who are the part of the project. So that the problem can be find out easily and evey one should work on it so that the solution can be find out easily and quickly. Just in time (JIT) is the extend form of the Kaizen it also include the continous improvement. The main three pillars of the kaizen on which it is based are standardization, waste elimination and housekeeping according to Rawabdeh (2005). Kaizen system is consist of two disputes kai and zen which meant kai- to change, zen- better so Kaizen means ‘ change’, continuously for betterment.

JustInTime (JIT)

JIT is the important tool of lean system to obtained a final product. It helps in sucessful implementation and execution of the processJust-in-Time refers to rigit product reach at the right time when requried. JIT helps in reduction of the time and also helps to increase the production. The main aim of JIT is that the product should reach the right dwelling at the right time. It helps in reducing the lead time, decrease in lot size.

Material Requirement Planning (MRP)

MRP tool that helps in converting end product into the thorough form of the raw materials. Inexactitudes in the solidpreparation causes lots of errors which include lowering the productivity, increase in the inventory of non-added valued product. It helps in to calculate the rough idea about the requriment of the product needed and avoid the chance of making wrong planning of manufacturing.

Kanban

Kanban means movement of the materials to different workstation using the kanban cards. The parts delivered to the production line when requried and only supplier can deliver parts so that parts shortage is not their, this is the essential requriment of the kanban system. Kanban system is paly a important role for the smooth material flow.

5S

5S system consist of sorting, organizing, cleaning, standardizing and sustaining. The 5S methodology increase the level of safety, scrubbing of work area, increase productivity, and helps in maintenance. 5S is the initial method for the companies clean and standardized.

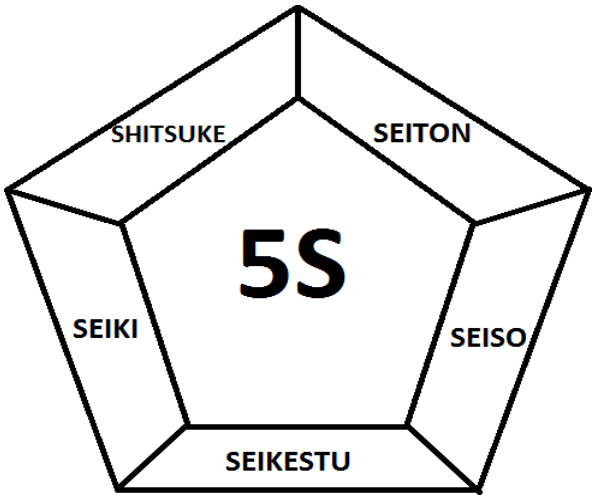


Figure 1.4 5S's [21]

Waste elimination

The main objective of the lean system to abolish all the waste. According to the customers the product that are not accumulation any worth to the product are the unused so there is the requriement to remove those waste. These waste are identified and can be removed by using the lean tools. The non-added valued product in the process are the waste from the customer point of opinion, so their is the need to remove those process which are not giving any input to the system. The lean tools which are used are kanban, kaizen, 5S, Preventive maintenance schedules these tools are castoff to recognize and eradicate the waste from the industries.

Table 1.1 Lean manufacturing tools[30]

Tools	Remarks
Standardized work	Jobs are broken down into elements and examined to determine best and safest method for each.
Workplace organization (5S concept)	Sort (Seiri), Set-in-Order (Seiton), Shine (Seisco), Standardize (Shitsuke), Sustain (Seiketsu).
Visual factory	Information is made available and understandable at a glance.
Point-of-use-storage (POUS)	Locate all parts, raw materials, tools and fixtures as close as possible.
Quality at source	Error proofing devices are used for example Pokayoke
Teams	Departmental barriers are eliminated and replaced with cross-functional teams.
Kanban	An information system that controls (Pulls) required parts in required quantities at the required time.
Kaizen	Japanese word for continuous improvement
Quick changeover/single minute exchange of dies (SMED)	A system that allows the mixing of production without slowing output or creating higher costs from waste setup.
One piece flow	To minimize work in process, operators focus on completing one part through the operation before starting next part.
Cells	Proper placement of machines
Total productive maintenance (TPM)	Consists of a company wide equipment maintenance program that covers the equipment life cycle and requires participation by every employee.
Value stream mapping (VSM)	VSM is a method of visually mapping a product's production path, including materials and information flow, from dock to stock. It takes a holistic look at the activity required (both value added and non-value added) to move a product from raw material to customer.
TAKT time	TAKT is the rate at which the customer requires the product and is computed as TAKT time = (Available work time/Customer demand) per day.

CHAPTER-2 LITERATURE REVIEW

2.1. INTRODUCTION

Lean manufacturing is helpful for removing waste by its various tools. In lean the waste is divided into three types called as 3M . The three types are MUDA, MURA and MURI.. In its common words, lean systemrefer to the movement of the product through aal the process, reducing the waste from all the process, reduce the process time and achieve a continous development. The lean philosophy works on the pull system and continuous improvement (Kaizen). A grouping of non value added and value added actions are called value stream that make the product move from intial to the final state, so that final product can be obtained. The product so obtained defects free and customer satisfaction is obtained [2].

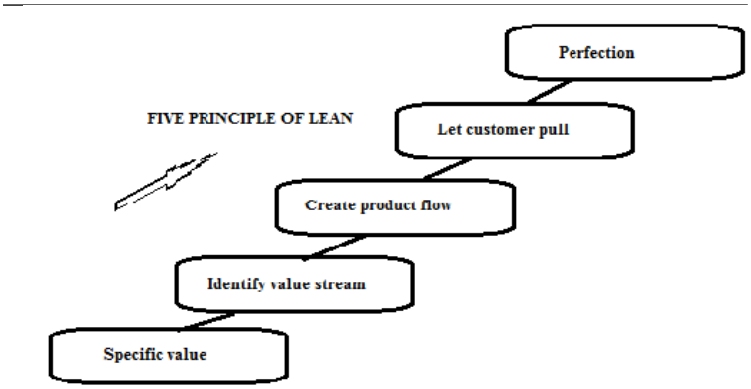


Figure 2.1 Five principal of lean [21]

2.2. MUDA, MURA, MURI : 3M's

MUDA, a type of waste which consists of eight kinds, out of which eight seven are presented by Toyota production system.These are as follows : Waiting, Overproduction, Inventories, Transport, Motion Non-utilized Talent, Defect and additional preparing. As Memory aiddevice , DOWNTIME [31] is the primary letter of these squander frame acronym . To distinguish and expel squander from your procedure there are various instruments accessible , which incorporate Poka Yoke, Kanban, Takt Time, SMED.

LMPDimension	Definition

Supplierfeedback(SF)	This means that the feedback is received from the customer and sent back to the company for futher improvement.
JustInTime(JIT)	It means that the product is supplied to the company at the requried time , correct quantity and also the correct place.
Supplierdevelopment	Thismeansthatthesimilarity manufacturerand supplier capability levels.
Customerinvolvement	Here the customers need is understanting and tryto rectify their problem
Pullsystems(PS)	In this system products are produced according to the customer requriment through different process.
Continuousflow(CF)	This means that the product is flow withod any disruptions andstoppage and the product is flow continously.
Setup timereduction(STR)	Here the main aim is to reduce the set up time so that the variation in the product can be obtained from the given resources.
Totalproductive/preventive maintenance (TPM)	This refers to avoiding machine and equipment breakdowns through active maintenance schedules and procedures.
Statistical processcontrol(SPC)	Thisreferstothedevelopmentofahigh-qualityculturewherethedefectsfromoneprocessshould not get percolated to the subsequent operations.
Employeeinvolvement(EI)	This refers to the commitment, participation, and empowerment of the employees towardthe development of the organisation

Table 2.1 Dimension of lean manufacturing practices[17]

DEFECTS are the items or administrations that are moved to the following procedure step,however not fit to the client specs. In a creation domain, an item could be deform that does not work appropriately, or an item when touches base at the client becomes fragmented. In an IT framework an imperfection in an office domain could be a mistake, it stops proceeding of the procedure , or notwithstanding sending a wrong connection inan E-mail.

Deformities as a rule prompt adjust or potentially additional work, to ensure the client gets the items or administration he requested [31].

OVERPRODUCTION means to give more than the client needs now. This is awaste since possessions are now put resources into items or administrations , after the present procedure step [17] it will not be taken as a report . One case in progress is delivering parts that are required further downstream of the workstation, nevertheless when they will be required precisely than it will be doubtful . In the workplace state , the contribution of electronic tickets for change demands for IT or designing can be thought about overproduction, when the divisions that are accepted by the resource are limited but they do not have the given capacity to yield . To push the following number of solicitations into the framework is generally done by general population who require IT changes , trusting they will be executed, investing energy in the following process. Overproduction is also named 'the mother of all waste', since it prompts every single other sort of waste on the grounds that the item or administration travels through the whole procedure with both esteem including and non-esteem including exercises. [2]

Name of the third waste and incorporate parts is WAITING , messages and SAP activities that areholding up to be finished on the shop floor, in some individual's letter drop or in the ERP framework. What's more, shouldn't something be said about all the individuals that are sitting tight for one individual toward the beginning of a gathering? These are all non-esteem including times all the while, specifically expanding the lead time and forestalling stream. Holding up time can be interrelated to stock. At whatever point items are sitting in stock, they are in fact holding up to be prepared. Similar holds for E-sends holding up to be perused or replied. This is the reason inventories on the esteem stream delineate estimated in holding up time.

NON-USED-TALENT integrates worker information and aptitudes not being utilizedto their maximum capacity [27] [31]. For example, a high talented specialist needs to do work that is moderately simple, or is firefighting all the time as opposed to concentrating onpersistently enhancing the long run. Another case isn't welcoming the master of a workstation to the esteem stream mapping occasions and in this way neglecting to utilize his contribution to recognizing the issues inside that esteem stream. This could prompt a whole

administration group concentrating on the wrong issues to understand, doing everything over again at a later stage.

TRANSPORT incorporates all developments of item between workstations, printedmaterial between divisions, or computerized forms between various people. The item moves around without all things considered being modified, which implies it expands the lead time and even worker hours when a physical item is being transported, without making value to the client.

INVENTORIES are the items or administrations that are holding up at a workstation, inan E-mail account or in the ERP framework to be finished. There is an unmistakable connection with holding up here, since items are really holding up to be chipped away at in a stock. The more parts are sitting tight for a similar task, the more one specific part needs to sit tight. Once more, holding up times straightforwardly increment the lead time of an item or benefit and thusly make the association slower in reacting to client request. Besides that, physical stock costs cash: Material costs, devaluation costs, physical space costs, administration costs, protection costs, and the expenses of conceivable redundancies or harm.

MOTION depicts the development of individuals and machines without really dealingwith the item or administration. For example searching for the correct screwdriver to fix a tighten generation or hunting down a record for 10 minutes on the nearby drive to send it in the connection of an E-mail in an office domain. By the way that it requires investment to achieve that part or navigate different envelopes on your PC, movement has a reasonable connection with overburden (muri) too. Parts that are put high up a rack or down close to the floor prompt ergonomic difficulties for the worker. Movement is one of the squanders that ought to not generally be expelled to zero. Taking out the most troublesome movements of a man's work cycle may be a change regarding ergonomics, yet taking out all development may negatively affect wellbeing.

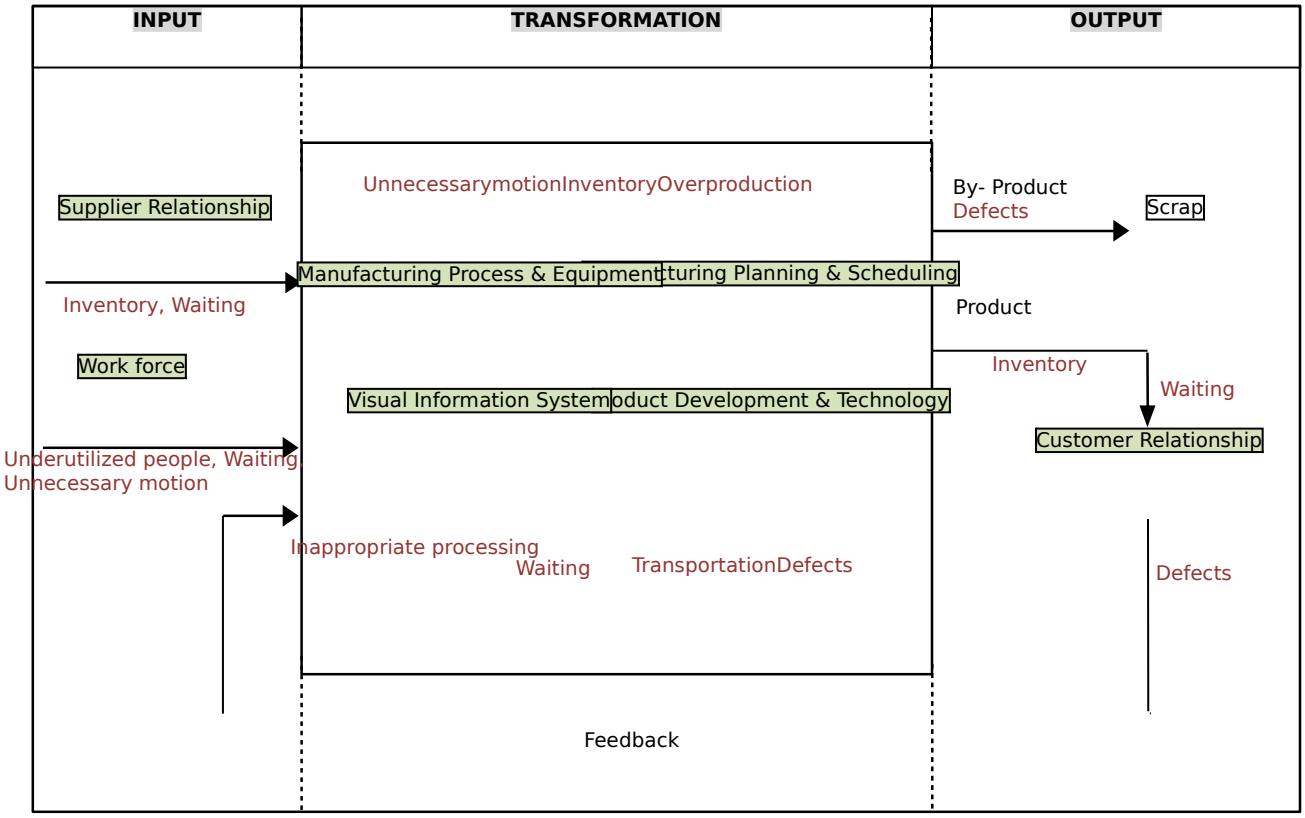


Figure 2.2 Lean dimensions in a manufacturing system and its relation to wastes[33]

EXCESS PROCESSING, implies doing additional things that the client isn't requesting.This could incorporate working in item includes or including more frill that the client does not by any means require, yet in addition the modify that is important to repair abandons. Including bundling materials for inner transport (between various floors, divisions or even destinations) which are then expelled again are additionally illustrations or abundance preparing. In the workplace condition, excess processing implies adding more pages to a file then important or creating a style template for presentation.

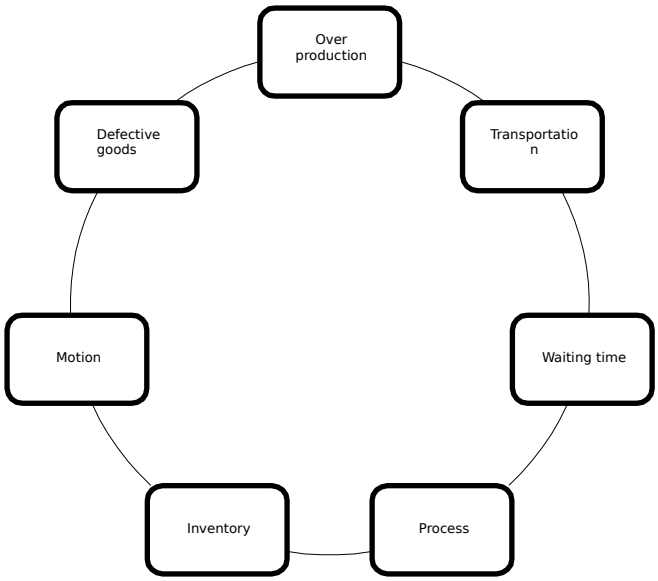


Figure 2.3 MUDA (seven waste) [21]

MURI, overburden, can come about because of Mura, and from expelling excessively Muda(squander) from the procedure [31]. Whenever administrators or machines are used for over 100% to complete their errand, they are overburdened. This implies breakdowns with regards to machines and non-appearance with reputes to workers. To improve the consumption of machines and ensure they work suitably, safeguard and self-sufficient support can be executed. To foresee exhausted representatives, security ought to be the focal point of all procedure outlines and all standard work activities.

MURA, variability occur in the system due to variation in client demand, cycle time of differentoperator, uneven production strategy, non-standardized work, poor value component will lead to mura which have further leaning to create muri and hence muda [2].

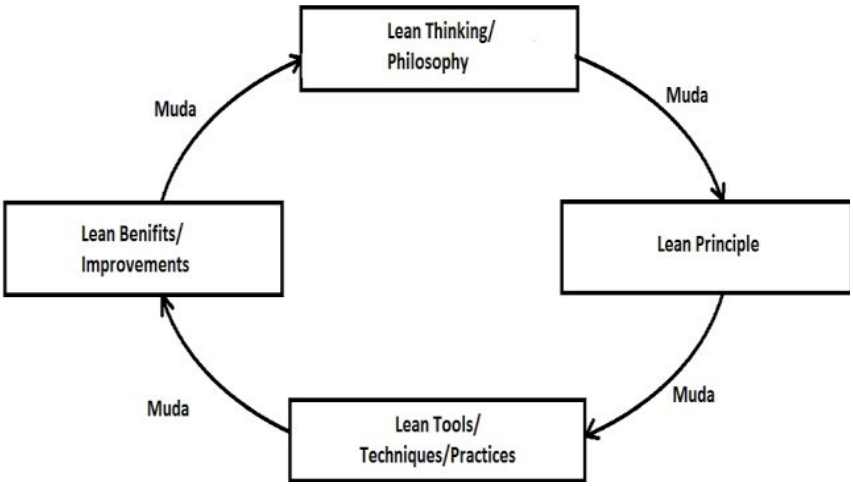


Figure 2.4 Features of Lean [21]

2.3 Review related to Lean Manufacturing

The term 'lean production'was coined by Womarck et al in 1990. The Machine that changed the World. Lean production (also termed as 'lean manufacturing' or just 'lean') refers to a manufacturing paradigm which is based on the ultimate objective to constantly minimize waste to maximise flow.

To cut or to get rid of the waste and non-value-added activities from the process (Alukal, 2003),Toyota along with the help of Taiichi Ohno and Shingeo Shingo has introduced a system . It refers that lean manufacturing has been described as one help to get rid of unnecessary processes to align processes in a continuous flow, and to use resources in order to solve problems in a never-ending process. Lean manufacturing has many different strategies and activities that are related to most industrial engineers. In its common words , lean manufacturing is : making the product flow through the proces; stopping waste (eliminating non-value adding activities), decreasing the entire manufacturing lead time (including administrative and physical processes) for a product and continuous improvement (Hancock and Matthew, 1998).

The main objective of lean manufacturing is to eliminate waste in human effort, inventory, time to market and manufacturing space to become highly amenable to customer demand while producing quality products in the most efficient and economical manner. This

approach cores around the elimination of waste. Waste can be initiated at any time and anywhere and it can in many forms . In policies, procedures, process , product designs, and in operations , the waste can be found hidden . It does not add any value to the product but only consumes resources . Waste was termed by Russell and Taylor (1999) as any material excluding the least amount of equipment, effort, materials, parts, space and time that are essential to add value to the product.

Lean manufacturing is the combination of both mass and craft production : Providing an wide range of products and more challenging work (Womack et al. 1990) with an ability to decrease costs per unit and completely improving the quality . It has been make out beyond doubt that the substantial cost and quality advantages are with the organizations who have learned lean manufacturing methods as campared to those who are still practicing traditional mass production (Fleischer and Liker 1997)

Monden (1993) gave a major involvement in the internal manufacturing context . He recommended a new form of classifying operations into three inclusive categories .These categories are non-value adding (NVA), non-value adding (NNVA) and value adding (VA). This scheme stretched to different places and it proved to be more inclusive . Further avenues are being explored by Value stream and lean initiates such as using the theory of constraints, system dynamics, simulation, mathematical and expert system-based approaches. The major point of their work is the same: To ensure its perceptible in the pipeline in different industrial scenarios and how to reduce listing , and country-specific conditions. The principles of good repetition for material flow engineering and system design methodologies is very important work of Towill (1997) . Other important works by Towill (1996, 1999) are also often reported regarding the design principles of supply chains.

One-piece flow, visual control, Kaizen, cellular manufacturing, inventory management, Poka yoke, standardized work, workplace organization and scrap reduction to cut manufacturing waste (Russell and Taylor 1999) are the tools used by Lean manufacturing .

Throughout the years, to help value stream many lean manufacturing have been developed and many more are being proposed every day (Schonberger 1982, Dillon 1985, Womack et al. 1990, Sako 1992, Lamming 1993, Barker 1994, Liker et al. 1995, Cusumano and

Nobeoka 1998, Liker 1998, Childerhouse et al. 2000, Feld 2000, Taylor and Brunt 2001). VSM tools were promoted by Rother and Shook (1999).

According to Bhasin and Burcher (2006) lean is consider as a philosophy more than the strategy. For the lean employment supplier involvement is a most important factor. However, for obtain the best result in the lean manufacturing continous improvement is the best method (Kaizen).

From the point of view Yan-jiang et.al.(2006), lean manufacturing has some motivation power which helps in continous improvement in the organistion.

Lyonnet et.al applied lean manufacturing in different companies by using a different methodologies. They come up with a idea that single piece, pull system are least used method in the organisation.

According to Dhamija et.al.(2011), they found that the the organisation which are using lean manufacturing are requried very number of material to complete their work ,require very less human intervention for the completion of work. The organisation who adopated the lean syestem their first prioty is the customer satsifaction and give them a good quality of product and services.

Rose et.al.(2011) Work on the 17 lean practices which can be suited for the small scale industries and also for the medium scale industries. They give the idea thst lesn process should be done in continous way. Inconsistency will make the industries lack back and can not maximum profit from lean system.

According to Bhuiyan and Baghel (2005), they make a research on the kaizen process (continous process). Kaizen uses different method to obtain the best result for the improvement of the organisation. These method innclude the six-sigma, lean manufacturing, balance score card and lean six-sigma.

From the author Hopp and Spearman (2004) paper they work on a kaizen . By using the Kaizen method we can achieve a great level of pull production by eliminating the variability in the process/system and so that helps to reduce the number of waste in the industry.

Wong et.al (2009) state that the best lean manufacturing tools for the waste reduction are the continous improvement and the waste education for easy understanding for all the manufacturers.The most important thing is achieved is the cost reduction by reducing all the waste factor. They also work on Kaizen and 5S and found that these tools are also beneficial for the improvement of the organisation. They work on small and large scale industry and compared them and found that the large sacle industry gives better result on the implement of the lean manufacturing.

Motwani(2015), he done the case study of the automative industry where lean system is used. The industry uses the socio-technical systems(STS), so that the it can increase the customer satisfaction, services, reduce cost and increase the profit and productivity.

Mc adam et.al.(2014), they they apply lean and six sigma into the medium and small industry. They give the conclusion that lean is considered on the measurement and the sixgma is about the driven of data.

Bouami (2015), he proposed that how the waste can be reduce using the lean manufacturing and present the model based on the cost. The model help the makers to take decision about the cost minimization and also how to reduce the waste from the organisation.

Nordin et.al (2010) work on the Automative industry. They found that the kaizen and 5S are the two main lean tools that are the driving force in obtaining the the best result in an organisation.

Lean approach to supply chain improvement and value stream management has been designed by Hines (1999) . An attempt to expand VSM across the whole supply chain from steel through steel service.

Centre to first tier component manufacturers has been made by Brunt (2000). To demonstrate the benefits of a lean system pictorially , the current and future state maps have been highlighted and a discussion on method of constructing action plan has also been done .

Explaning the involvement of service management that can decrease costs and focus on customer value (Adams and Willetts, 1996) is done by the Lean communication provider .

Daultani et.al.(2015), in their paper they implement the lean manufacturing and present current and the final state of lean manufacturing in the healtcare and give the conclusion that healthcare had a different challenges for the lean implementing.

The effort to develop a lean logistics strategy from VSM is made by Gallone and Taylor (1996). A case study of a big automobile manufacturer who participated in LEAP project has been presented. Current and future state maps were established with the objective of reducing lead time according to customer requirements. The implementation of the future state map attained lead time reduction from 64 to 55 days.

Benefits of VSM summarised by Rother and Shook (1998) are as follows:

1. It helps you to visualize more than just the single process level (e.g. assembly, welding) in production.

2. It helps you to not only see your waste but also its source in the value stream.

3. The process of manufacturing to supply chains, distribution channels and information flows are told by it .

4. A common language for conversation about manufacturing processes is provided by it .

5. Links Production Control and Scheduling (PCS) functions such as production planning and demand forecasting to production scheduling and shop floor control using operating parameters for the manufacturing system, for example, TAKT time (this is the production rate at which each processing stage in the manufacturing system should operate).

6. By designing the production system based on the complete door-to-door flow for a product family helps to form the basis for implementing the lean manufacturing .

7. For strategic planning to deploy the principles of lean thinking for their transformation into a lean enterprise , a campany is provided with a ‘blueprint’ .

2.4 LEAN TOOLS

Table 2. 2 Lean Tools (source: Wilson L “how to implement leanmanufacturing” [34])

Lean Tools	Remarks
5S	It is the workplace structure so that minimum time and waste is produce for getting a work to be done
Jidoka (Autonomation)	It is also known as automation with human touch. The machinery is made ergonomics so as to optimize operation
Just-in-time (JIT)	It is based on producing after customer put an order. Highly automation and good organization culture is require for implementing this
Kanban (Pull System)	It is applied in an organization by using kanban cards using this the product generation occur through customer pull.
Kaizen (Continuous improvement)	It provide employee empowerment and their ability to tackle daily issue so that an environment of continuous squander elimination is created.
Standardized Work	Disposes of waste by reliably applying accepted procedures.

	Structures a benchmark for future change exercises.
Single Minute Exchange of dies (SMED)	It empowers to create consistently without or with least downtime all the while. It additionally diminishes the changeover time definitely
Takt Time	It determines the rate at which consumption of the product is going on in the market. It is a very useful remedy to make a benchmark for the pace at which production to be done
Poka-Yoke (Error Proofing)	This tool implement the basic features so that the possibility of having a mistake can be mitigate
Value stream mapping (VSM)	It's a tools which is used for physically mapping the value addition process in the organization. It provide opportunity for the improvement in the existing system by mapping the current state.

2.5 Tools rating

Table2.2ToolsRating(S.S.Mahapatra&S.R.Mohanty,2006[30])

S.No.	Ideas/Tools/Techniques	Score	
		DM	CM
1.	Takt Time	4.750	0.000
2.	Error Proofing (Poke Yoke)	4.000	2.400
3.	Single Piece Flow	3.800	2.750
4.	Work Standardization	3.750	2.200
5.	Visual Management	3.700	3.200
6.	Waste Identification and Elimination	3.400	3.250
7.	Workplace Organization (5S)	3.350	3.500
8.	Material Pull System	3.300	2.600
9.	Overall Equipment Effectiveness (OEE)	3.125	3.100
10.	Total productivity Maintenance (TPM)	3.050	4.400
11.	Kaizen 'Blitz' Events	3.000	2.750
12.	Value Stream mapping (VSM)	3.000	3.510
13.	Automatic line stop when part defective (Jidoka Autonomation)	2.600	3.750
14.	Policy Deployment	2.500	2.300
15.	Changeover Reduction (SMED)	2.050	3.800
16.	Process Mapping	2.000	2.800
17.	Cellular Manufacturing	2.000	3.500
18.	Quality Function deployment (QFD)	1.850	2.500
19.	Multipurpose handling	1.500	2.100
20.	Six Sigma	-	3.500

CHAPTER 3- RESEARCH METODOLOGY

Lean tools are made for effective usage of the resources although, tools are of similar in nature and quite generic to understand, application of selected group of lean tools and their sequence must be consider sensibly in a specific circumstance depending upon external and internal operating condition [Mahapatra and mohanty, 2007].

3.1 METHODOLOGY OF IMPLEMENTATION

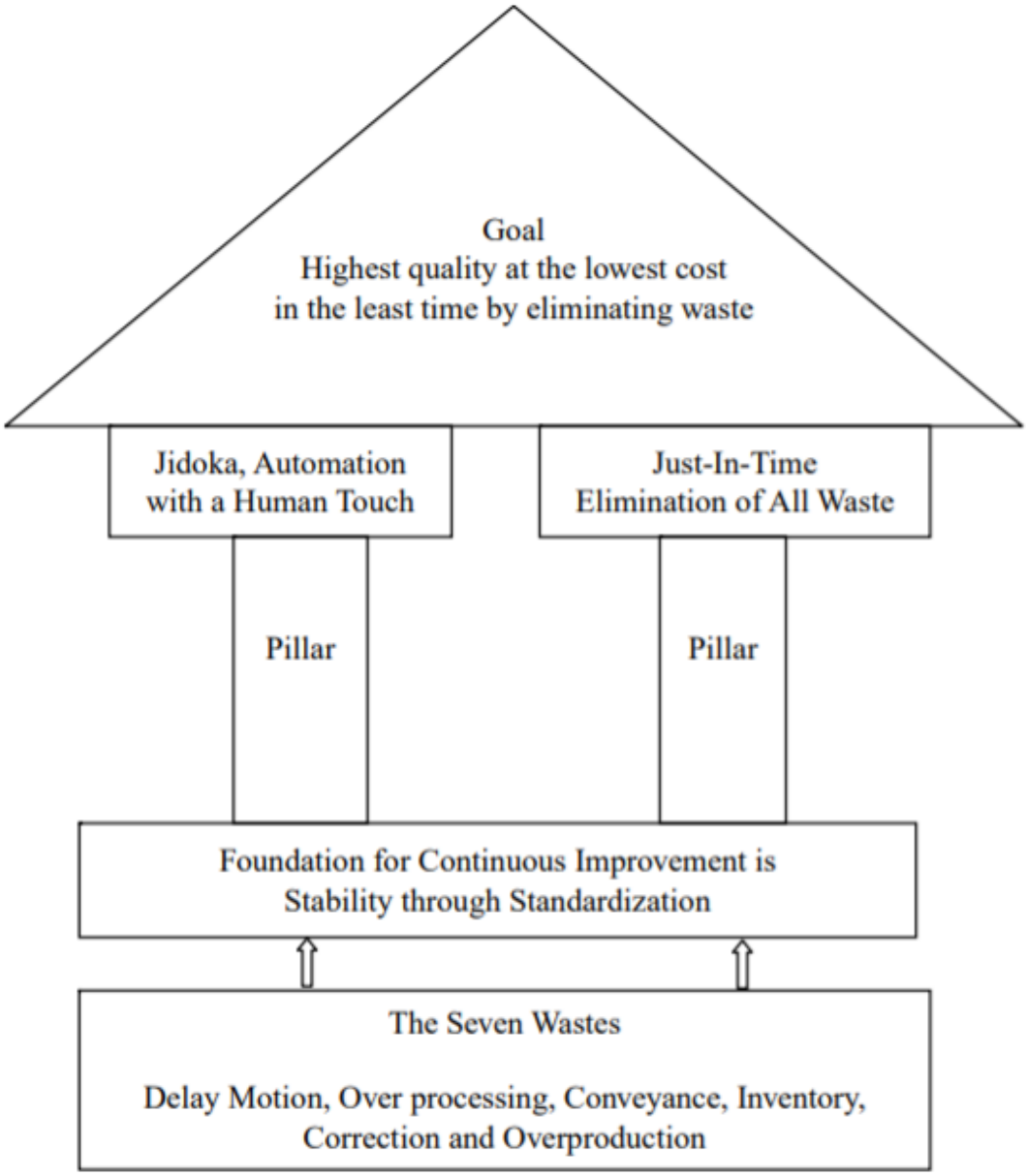
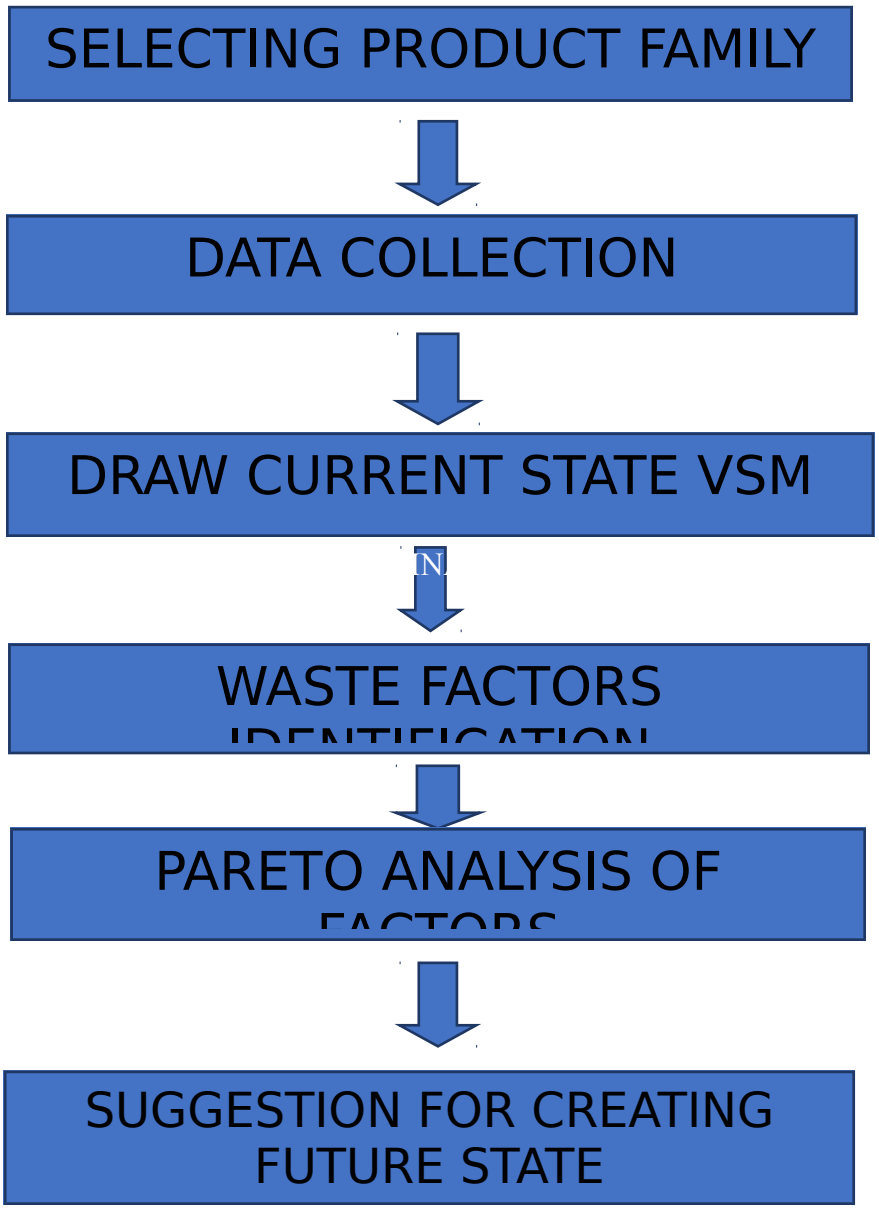


Figure 3.1 Basic lean concepts and method[8]

The above figure shows the basic lean concepts and method. The main aim of applying the lean manufacturing is to obtain the high quality of product at the least possible cost and also reduce the waste which are not adding any value to the product and obtain the customer satsifaction. The different waste is to reduced by using different lean tools like JIT (just in time), Kaizen, Kanban, and many more.

Figure 3.2Showing Methodology


SELECTING PRODUCT FAMILY
DATA COLLECTION
DRAW CURRENT STATE VSM
WASTE FACTORS
PARETO ANALYSIS OF
SUGGESTION FOR CREATING
FUTURE STATE

3.1.1. Selecting product family

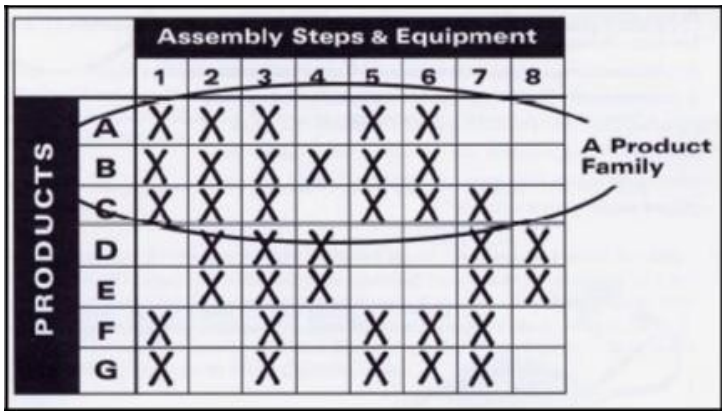


Figure 3. 2 A, B, C as product family

Product family are those which have almost similar sequence of process or value addition process. It is necessary to choose a product family as it will broadly cover the function of the organization and also try mitigate the factors causing waste with a holistic approach. The products which we choose have similar value adding process but varies only in one process. It is also shown by Rother and shook (1998) [18] that the VSM manager should not choose large number of product family which will become hectic for them to handle.

3.1.2. Data collection

We have two methods by which we can select our data one method is Qualitative and the second one is Quantitative method. The data present in the report is composed by follow the procedure of the product in the plant on the shop floor and also by talking to staff members and the case study.

3.1.3. Current state VSM

The current state VSM is defined the initial condition of the product and drawn in a paper with the all the procedure of the product and value addition processes of each the process i.e. cycle time, process time, changeover time etc. It can be virtually drawn in MS excel through the help of templates.

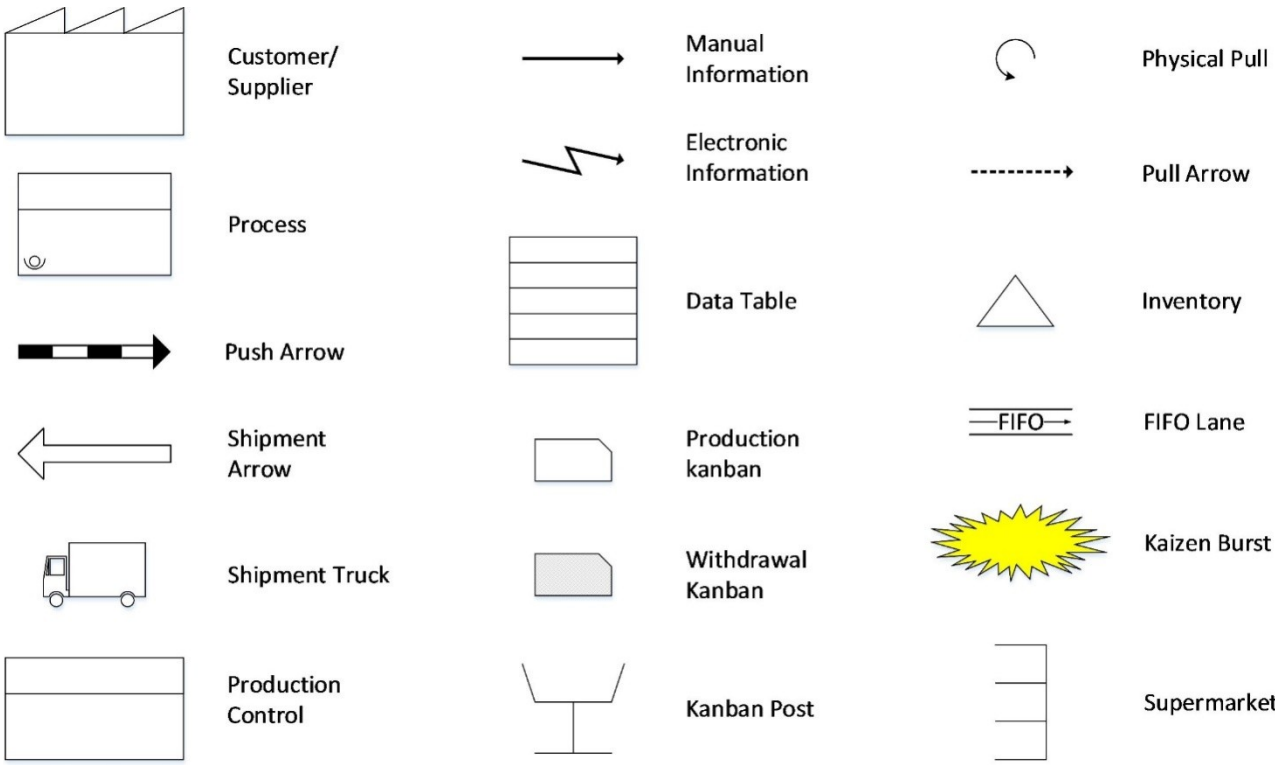


Figure 3.3 Icon used in VSM[3]

3.1.4. Waste factors identification

The waste Factors identification refers to the waste present in the procedure of product processing that can be in the form of waiting, overproduction, motion, inventory and others.which cab be reduce by value stream mapping. By analysis of cycle time changeover time and explanations the non-value adding process can be seen.

3.1.5. Pareto analysis of factors

The factors which are causing waste are detected and their frequency of defects are noted which further recognized in the form of Pareto chart through which we are able to analyze the 20 percent factors which are causing almost 80 percent of waste.

3.1.7. The suggestion for future state map

By drawing the current value stream mapping various waste factors can be identify and to remove these waste causing factors various lean tools can be implemented like supermarket Kanban (continuous improvement), Kaizen (customer pull), SMED etc. proposal is provide so that the current state map can be improved.

CHAPTER 4- IMPLEMENTATION

The Lean tool implementation is included in this chapter from the data gather by physical observation on the production floor and the past record from the industrial engineering and Bikanerwale planning department and also through some interview. To get the quick inference from the data , the collection of data can be tried to put in some visual forms . By using Microsoft excel and templates , the various execution and function can be done .

Steps involve in implementing a lean manufacturing

1. Waste identification in the system/organisation:

   According to this every organisation should know about their wastes hidden in the system.

2. Different types of waste can be present in the system:

   Organisation should know about their waste present in the system and also the remedies of the waste. It is the duty of the organisation to identify the waste and rectify them. Lean manufacturing helps in rectifying the problem permanently.Lean manufacturing uses different tools to reduce the waste from the organisation

3. To find out the main cause of the problem:

   Using lean tools it is easy to identify the main causes of the problem. Looking at the each process properly help to identify the waste.

4. Testing of the solution:

   After finding the solution then it can be implemented. Lean manufacturing gives advantage against those companies which are not using lean manufacturing system.

4.1. VALUE STREAM MAPPING

The discrete production line of rasgullas and kaju katli of the value stream mapping has been shown in this division. By physical observation and some question at the workplace ,the various data can be obtained through it .

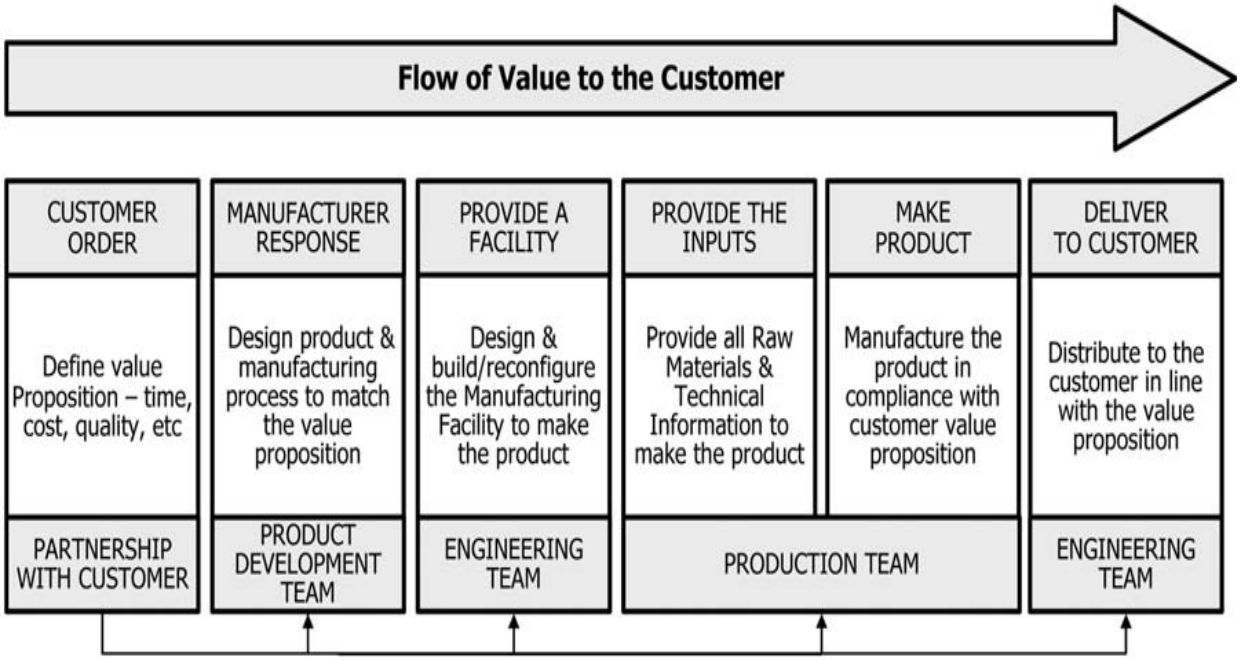


Figure 4.1. A simple value stream.[10]

4.1.1 VSM of Rasogolla

Activities	Making of balls	heating	Packaging
1	5	62	28
2	4	60	26
3	4	58	27
4	4	60	27
Average	4.25	60	27

Table 4. 1 Cycle Time Calculation for rasgullas

The different parameters requried to obtain the value stream mapping is gathered from the physical observtion. The requried parameter includes cycle time, process time and change over time.

The cycle time dedined as the ratio of process time to the number of product produce in that time

$$\text{Cycle time} = \frac{\text{Process time}}{\text{Product produce in that time}}$$

Table 4. 2 Process time and change over time for rasogolla

Activities	**Process time(minutes)**	**Change over time(minutes)**
Boiling	9	16
Paneer Filtering	8	7
Maida Mixing	6	11
Making of ball	10	11
Heatinf/frying	.98	16
Packaging	.516	16

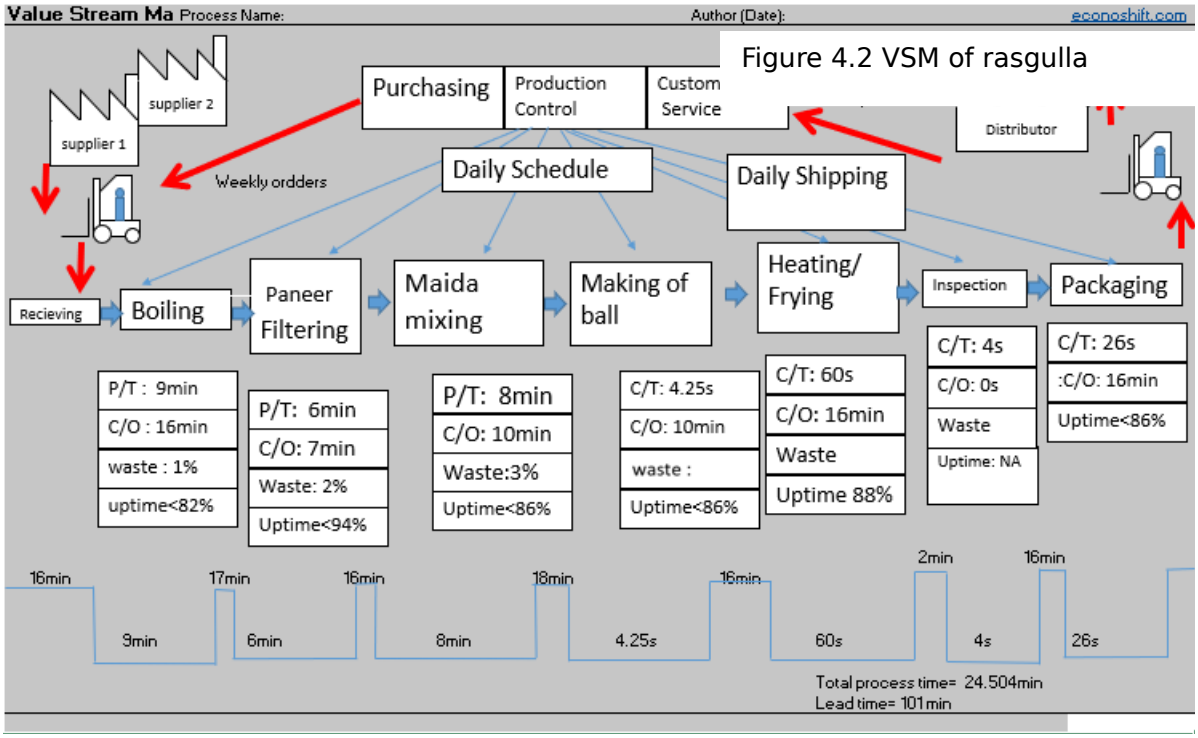


Figure 4.2 VSM of rasgulla

The current state value stream mapping of rasogollamaking in the shop floor is shown in the above figure 4.2 . The weekly demand of costumer for the making the rasogollaare 4300kg which is to be fulfilled by the plant . The working of rasogollamanufacturing is for 9hr in a day and to 6 days per week. The sugar and milk is mainly consisted by the supplies delivery. Due to the difference in process time of each the accumulation of large WIP take place , the manufacturing is done in batch

starting with 200 litres of milk various process on the raw material is performed . The completed products from the previous machine device held up before start of handling at the following stage however the machines were never kept sit still. In Shipping Area the prepared parts were then kept where they held up to be dispatched. The stream had a great extent push in nature. The full procedure is very much discrete manufacturing . From the batch is transported from one process through other the batch is transported due to which the large transportation of material internally has a lead increase .

It is very low for the cycle time of ball making and very high for the process time for mixing maida by which sometime machine is unable to utilize to the full capacity so it remain idle. The defect in making balls during the ball making is high the defect generally are development of crack on the surface low binding characteristics etc. The shipment of rasgulla can be done daily to the

distributor. By the usage of ERP system to join cross function team and Haldiram retailing center , the demand forecasting can be done conveniently .

It takes 101 minutes for the process lead time while it takes 24.504 min for the total value adding hence large amount of waiting is happening between the different processes. To understand the demand of the customer sometimes the manufacturing unit becomes unable and overproduction is leaded . The underutilizing is done by the machines . To match the customer demand without producing waste , it is necessary to use pull system.

4.1.2 TAKT time calculation for Rasgullas

The Takt time is defined as the ratio of total time availabe to the customer demand.

$$\text{Total time available} = \frac{\text{Taken time}}{\text{Customer demand}}$$

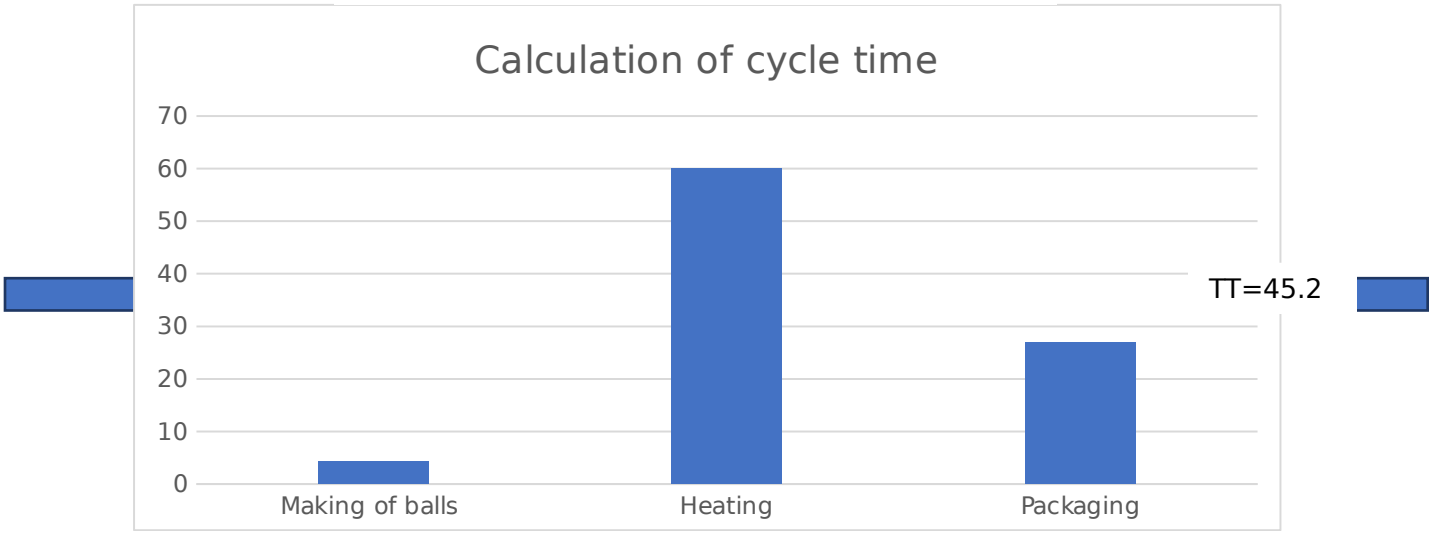
Total weekly time available = 6 × 9 × 3600s = 194400s

Weekly customer demand = 4300kg

By using the above data and the equation the takt calculated as

$$\text{Taken Time} = \frac{194400}{4300} = 45.209\text{s}$$

Figure 4.3 Calulation of cycle time



The figure is shown between the activity an the cycle time. So from the figure we can understood the heating of the rasogollatake more time than the takt time so to moderate the effect of this proper change in value stream map should be taken.

Pareto chart determines that in a system 20 percent of the factors cause 80 percent of waste which is based on the rule of 80-20 . This technique is tried to find out the dominating factor in the value stream mapping which are responsible for 80 percent of the factors.

Sr. No.	Name of the Activity	frequency	cumulative frequency	percentage
1	Making of ball	125	125	64.86%

2	Cutting and rolling	30	155	83.78%
3	packing	18	173	93.51%
4	inventory	12	185	100.00%

Table 4. 3 Frequency and Cumulative Frequency for plotting Pareto Chart

4.1.3 Pareto chart

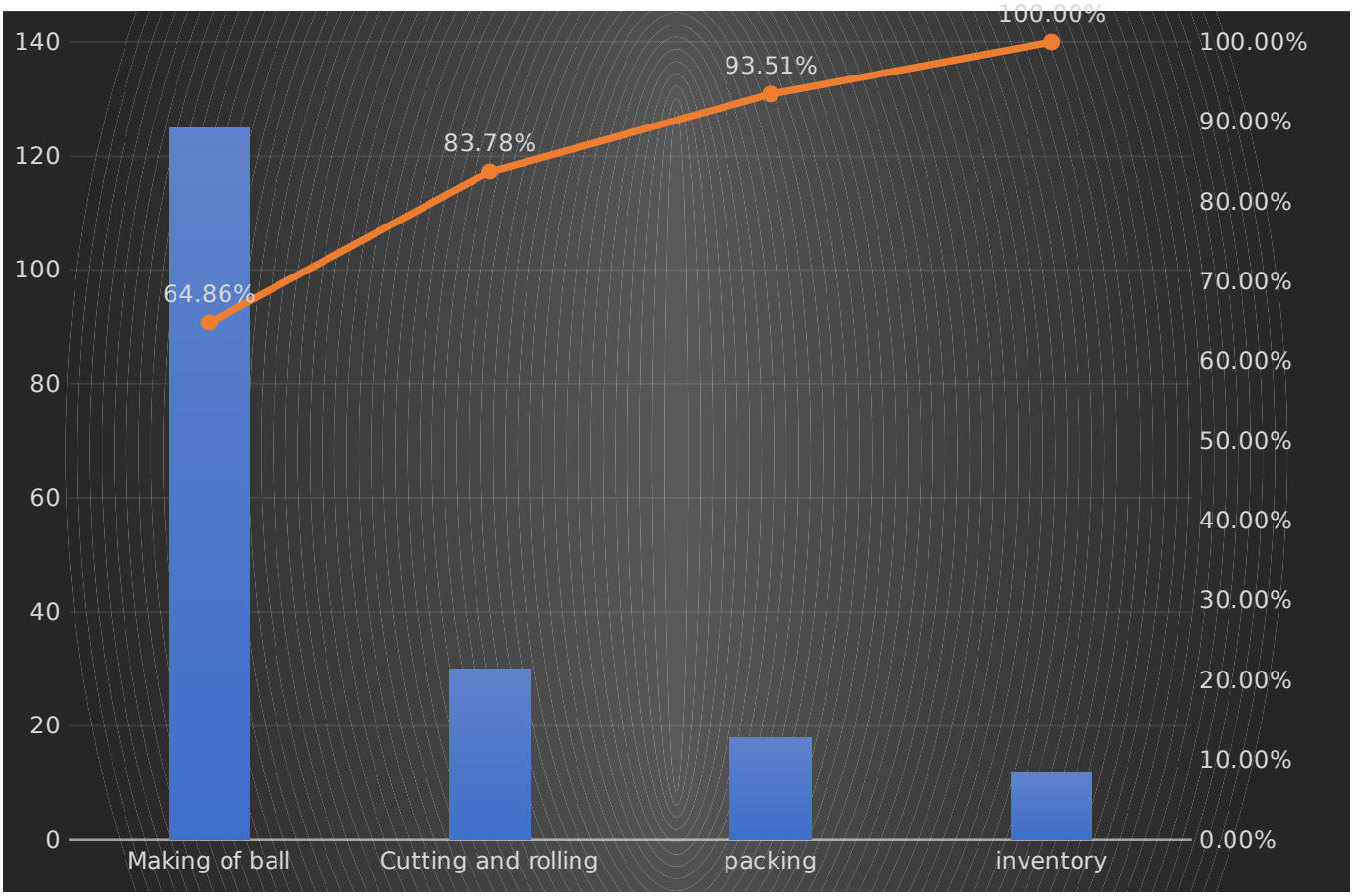


Figure 4. 4 Pareto Chart for rasogolla

Conclusion : The ball making , rolling and cutting together contributes the 84 percent of waste so to reduce those 80 percent of waste producing we must manipulate the waste production through these factors .

CHAPTER 5- THE FUTURE STATE OF VSM

To show the source of muda and to remove by implementation of a future state value stream which could came to reality within short duration is the main motive of VSM. To design a future state value stream map for the production of rasgullas in manufacturing plant of haldiram is the objective of this chapter. This is made possible by linking the value stream with customer either by continuous flow or pull so that each process in value stream come close as possible to produce under the desire of customer need.

5.1 GUIDELNES FOR FUTUTRE STATE

Four guidelines to follow while producing the future state of value stream map for optimizing manufacturing system (Rother and shook, 1998, 44-54) is illustrated by Rother and Shook .

1. Try to produce as much possible as near to the takt time
2. Possess continuous flow in the stream
3. Utilize supermarket to handle production where the application of continuous flow is not applicable
4. Schedule the production system on the basis of pacemaker process.

Through various lean tools like kaizen, Kanban, first in first out supermarket, employee empowerment etc , the above points can be implemented in the current VSM . It is necessary to find out the waste by analyzing the current stream map to be successful.

As we find out through the graph between cycle time and activity (fig.4.3) that the heating of rasgullas taking more time that the takt time so to match the pace of production . It is necessary to produce near the takt time otherwise it is very much possible that the customer demand cannot be met which will lead to good will losses. This follows the first guideline of Rother & Shook .

It is necessary to combine the heating process with some other process so as the production occur near to the takt time to mitigate and overcome the effect of this. There is very much chance to reduce the cycle time of process when we combine the two process.

It is necessary to have a continuous flow if the process takes more time than the takt time , if continuous flow is not applicable then supermarket flow is put between them which work on the concept of Kanban i.e. pull system. An basic apparatus to control material stream in a framework is called Kanban as said before. For the most part, two kanban cards are utilized viz. withdrawal kanban and generation kanban , the two kanban cards that are being utilised . At the point when a succeeding workstation specialist comes to pull back the items from going before workstation, the laborer needs to expel the generation kanban physically connected with the items and supplant it with the comparing withdrawal kanban. The creation kanban contains the subtle elements of the item to which it is connected are holded by the creation kanban an the points of interest of the items required are holded by withdrawl kanban . This causes the withdrawer to think about these subtle elements carefully are caused by this and hence it will diminish the likelihood of any mistake.

Although one-piece stream can not be connected , first-in-first-out or FIFO technique can be utilized as a substitute. In FIFO, on the main employment downstrem the dependability of the principal work upstream will be there which means the way occupations entered in a similar request they will exit . In FIFO , the measure of work permitted to line is restricted, in light of the fact the upstream procedures stop to enable the downstream accumulation to clear when the line is full. In this way, FIFO can be extremely viable in monitoring the stream of materials and keeping away from the unnecessary WIP between workstations. It likewise incredibly decreases the WIP stock and the lead time of the occupations, sometimes up to 80%. This strategy was utilized between recently framed cell (protracting and lapping) and quality investigation to smoothen the stream of items between the two phases.

5.2 FUTURE STATE VSM OF Rasogolla

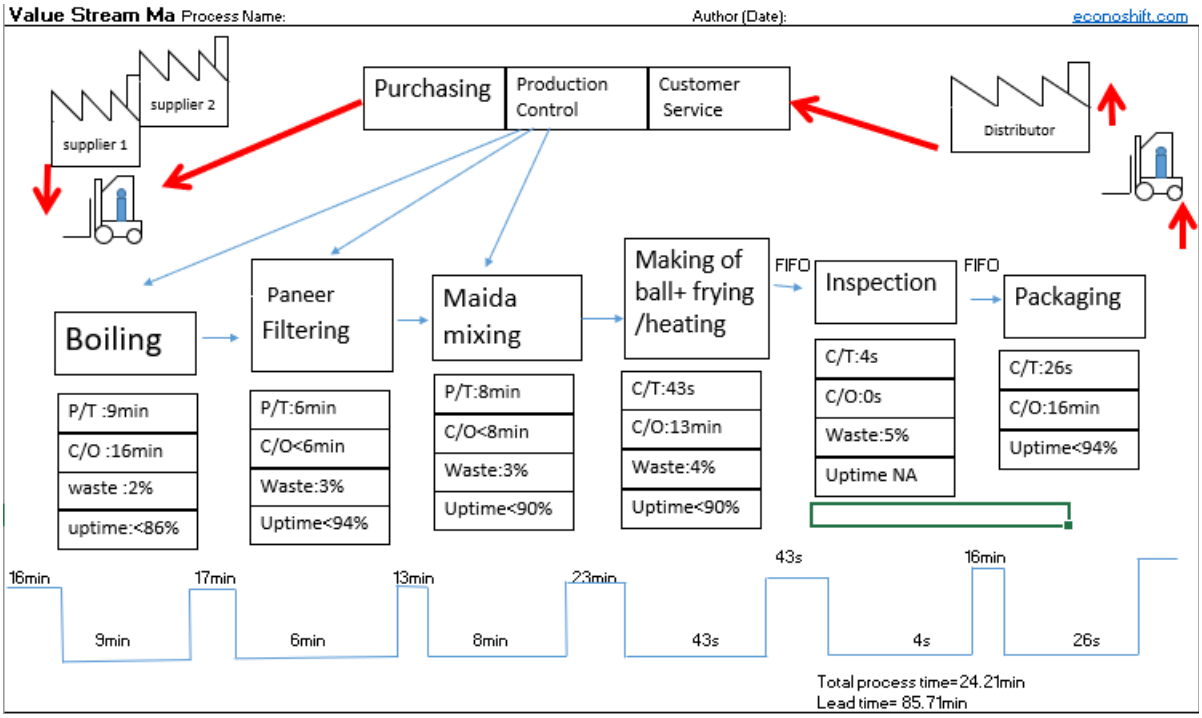


Figure 5. 1 Future State VSM ofrasogolla

The above figure showing the future state map of rasogolla making in this map various implementation of supermarket Kanban and FIFO is done so that continuous production between the different processes is possible and combining of two process is done by which there is high reduction in lead time occur also the system created a philosophy of customer pull system by using the supermarket concept. The Kanban cards are control by production control so that the customer demand is met by the manufacturing unit. It has also been observed that heating of sweet balls take more time then the takt time, by combining the two process ball making and heating a reduction in the cycle time of process occur also great reduction in changeover time happen which further reduces the lead time.

The supermarket pull system is deployed at the supplier side, shipping side and between ball making and mixing. The FIFO lane is employed between ball making, inspection and packaging. Through this the lead time of the value stream is obtain to be 85.71 minute and the value added time or process time is obtain to be 24.21 min hence there is a reduction of large amount of lead time in the process.

CHAPTER 6 CONCLUSION

FMCGs have a vast field of application of lean tools but it is great for the food industrial company for waste management in implementation in mass production. Pull based generation are being laid on the establishments of a lean creation framework to limit inventory conveying costs and lessen the general space prerequisite for setting up the plant. Under the observation , in the plant the discrete manufacturing function is done for the production of sweets which is challenging to bring lean study lean tools over them. In the organization , by using the current state map of value stream the VSMs application lead us to find factors causing waste. By the guidance of the Pareto chart , it guides us to the major factor for the production of defect in the organization . By utilizing the lean tools the future state map is drawn like supermarket Kanban pull system, FIFO lane for creating a customer pulls continuous production governed and at high capacity , utilizing the resource leading to zero overproduction. By using future state map and the involvement of employee for making the process less prone to defect using poka yoke and kaizen there is a possible reduction in lead time and cycle time. Although under the specific limitations , as a lean procedure ,VSM can be effectively used to recognize and turn away wastage in a production system.

FUTURE SCOPE AND LIMITATION

Mass production characteristics has been in the FMCG sector . With this feature , implementing the lean tools in the sector to reduce the perishability affect in the production of waste and by the costumer pull producing which is mainly governed is the most important thing . Speeding up of lean foundation and planning the procedures relying upon the cluster size and process duration (C/T) , the helping could be given by Computer based models. To validate the immediate relationship of utilizing VSM as an enabler in lean change, Cost-Benefit Analysis could likewise be performed to examine the direct fiscal advantages of VSM's application.

The limitation arises as It is only used for discrete manufacturing system so the limitation arises while it is preferred for mass producing continuous manufacturing system is preferred. The lean tools which applied to the study of this report are less than the actual number of lean tools due to their behavior in different manufacturing system lead to us to be selective in choosing the tools to implement.

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