ISLAMIC UNIVERSITY OF TECHNOLOGY

ORGANIZATION OF ISLAMIC CO-OPERATION

A Case Study:
Implementation of Lean Tools to Reduce Lead Time in a Cable Manufacturing Company in Bangladesh

BSc Engineering (Mechanical) Thesis

Authored by

Raihan Mahmud
Student ID: 151402

Supervised by

PROF. DR. SHAMSUDDIN AHMED

Professor
Department of Mechanical and Production Engineering
Islamic University of Technology (IUT)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

NOVEMBER 2019

CERTIFICATE OF RESEARCH

This thesis titled **"A CASE STUDY: IMPLEMENTATION OF LEAN TOOLS TO REDUCE LEAD TIME IN A CABLE MANUFACTURING COMPANY IN BANGLADESH"** submitted by **RAIHAN MAHMUD** (Student ID: 151402), has been accepted as satisfactory in partial fulfillment of the requirement for the Degree of Bachelor of Science in Mechanical Engineering on November 2019.

Supervisor

PROF. DR. SHAMSUDDIN AHMED

Professor
Department of Mechanical and Production Engineering
Islamic University of Technology (IUT)

Head of the Department

Prof. Dr. Md. Zahid Hossain

Department of Mechanical and Production Engineering (MPE)

DECLARATION

It is hereby declared that, their thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

Signature of the Candidate

RAIHAN MAHMUD
Student ID: 151402

Department of Mechanical and Production Engineering (MPE)
Islamic University of Technology (IUT)
Board Bazar, Gazipur, Dhaka, Bangladesh

Signature of the Supervisor

PROF. DR. SHAMSUDDIN AHMED

Professor
Department of Mechanical and Production Engineering
Islamic University of Technology (IUT)

ACKNOWLEDGEMENTS

Firstly, I would like to thank Almighty Allah for giving me opportunity, determination and strength to complete my research within time. Then, I would like to express my sincere gratitude to my thesis supervisor Prof. Dr. Shamsuddin Ahmed, Professor, Department of Mechanical and Production Engineering, Islamic University of Technology (IUT) for his enormous, support, guidance and inspiration in every single step towards the completion of the thesis. The door to his office was always open whenever I ran into a trouble spot or had a question about my research or writing. He consistently motivated me and steered me in the right direction whenever he thought I needed it.

I would also like to thank the management and workers of the factory where the study was conducted. Without their passionate participation and input, the operation could not have been successfully conducted.

Finally, I must express very profound gratitude to my parents for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

ABSTRACT

Every small scale company has an effect on the industrial economy of a country and the world if broadly speaking. Globalization, updating technology, and higher competition have a big impact on small scale companies. These companies need to update their production management methods to reach economic, social and environmental development without making extensive changes. Most small scale companies are even unaware of lean manufacturing tools that exist today.

The target of this study is the implementation of 'Lean tools' in a small scale company to increase productivity through effective workplace management.

The purpose of this study is to understand the effect of lean manufacturing tools like SMED, 5s in plant management, material movement in a cable manufacturing company to understand how productivity and efficiency is changing.

The methodologies used in the study are SMED in wire-drawing RBD machine, 5s in workplace rearrangement, plant layout for reducing lead time.

The study reveals that lean tools are vital for this cable company. After implementing SMED in wire-drawing RBD machines and optimizing the layout, lead time was reduced by 26% hence profit margin will grow.

This literature adds value to the research of lean tools by giving an insight into the implementation of lean tools in cable companies.

The tools are implemented only for a static working condition without taking any unforeseen causes into account for delay.

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 1

INTRODUCTION & BACKGROUND INFORMATION

1.1 Introduction

Industrialization is the key to the economical development of the country. The cable manufacturing industry is a vital export base for Bangladesh and it has major impact on country's economy, as well as on society, because of large number of worker involvement. To meet the ever increasing demand of the mass population and the international demand of the textile products, the emerging and important sector of national economy, the cable manufacturing sector has the great chance and opportunity to improve the productivity. Because of being technologically labour dependent it has a large number of worker involvement and most of them are female worker so it helps in socio ñ economical development of the poor fraction of population of the country. So the females are playing an important role in the largest foreign exchange earning sector of our country and they are becoming conscious about women rights by their economic independency. The cable industries in Bangladesh do have the organizational structure but do not have the proper job description of the employees so the problem arises from the mid level management. Description of rules and responsibilities along with power and authority is essential for smooth production running of any organization. In today's competitive world the manufacturers need to be conscious about time, cost, quality and delivery. To be the champion in business these four components should be given most priority along with good management skill and innovative technological aspects of modern development. The present situation of the cable manufacturing sector is not in a satisfying one and in the last year there was a massive worker agitation because of salary structure, working environment, compliance issues and other human rights. The local cable manufacturers are facing fierce competition in Quota and GSP free market as per WTO agreement and they are well behind from the competing countries like India, Sri Lanka, China, Indonesia and Vietnam etc. In order to face the challenges Bangladeshi manufacturers have to apply new methods, tools and techniques in different area of production and operation management and in other business areas.

After the World War II Japanese manufacturers, particularly in the automotive industry, were faced with the dilemma of shortages of material, financial and human resources. Eiji Toyoda and Taiichi Ohno at the Toyota Motor Company in Japan pioneered the concept of the Toyota Production System (TPS), or what is known today as Lean Manufacturing. Lean manufacturing is a new term defined by Womack and Jones that helps the manufacturer to produce quality product with less material, greater efficiency, shorter lead time, and in timely manner. Lean has many tools for better manufacturability and it needs proper guideline, management involvement, appropriate knowledge and overall factory transformation to the system.

The thesis addresses the application of lean manufacturing concepts to the production sector of cable manufacturing with a focus on the process of wire-drawing including cutting, wire-drawing, finishing. The objective of the study is to investigate the present status of the industry, scope of the improvement and the benefit gain by the implementation of new tools of lean manufacturing.

1.1.1 Rationale of the Study

Many manufacturers are now critically evaluating their processes to determine their effectiveness in bringing maximum value to customers. Factory management techniques of yesterday are being replaced by more efficient methods that greatly minimize delays, reduce costs, and improve quality. Lean manufacturing is a whole systems approach being used in enterprises from Europe to the USA and from Brazil to India that creates a culture in which everyone in the organization continuously improves processes and production. It is a system focused on and driven by customers, both internal and external.

Local manufacturers need to become aware of the benefits the Lean Management Approach can bring to their operations. Informal research has revealed that there is a lack of awareness amongst the local manufacturing community of Lean Thinking and an urgent need to address this deficiency. In order for cable manufacturers to meet the challenges of competition in an expanded market place, they need to be equipped with the tools to make their operations more efficient. There is no cookbook for manufacturing to follow rigidly. Each firm has its own unique set of products, processes, people, and history. While certain principles may be immutable, their application is not. Manufacturing Strategy will always be a difficult, uncertain, and individual process. Strategy is still, largely, an art. But, that should not prevent us from bringing the available science to bear on the problem. Converting to a lean production system is a process that requires every level of an organization to develop a complete understanding to the basic tents of the concept and its execution. Companies that have fully implemented lean systems are rare, but the list of manufacturers trying to become lean is growing fast.

1.1.2 Background of the thesis

The application of lean manufacturing concept in cable manufacturing sector is totally new in Bangladesh. So there is a great necessity to study the scope of implementation and the areas of improvement and the step by step methodology to do it in a positive and learned thinking. The industry with quality product, higher efficiency, lower cost and trained manpower is ahead in the competition. So the productivity, efficiency and effectiveness are increasingly becoming the burning issue in today's economy. To survive in the hard contest economy the industry should develop itself with

systematic identification and elimination of waste, productivity improvement, cost reduction, employee benefit incentives and social welfare activities. So the necessity arises to study the scope of implementation of lean tools in different unit of cable production sector with thorough analysis and research. Now a days the buyers are searching market for lower price and they are getting new exporter on their hand with their requirement. So the profit margin is narrowing and the competition is expanding as a result the production process and new technology is the only way to cope up the crisis. The project work tries to find out the common phenomenon to implement lean tools and the barriers to overcome.

1.2 Research Problem Statement

In this study, the identified problems are,

- The production rate of RBD machine is being hampered because of high changeover time and excessive idle time of the machine.
- Workstation and inventory layout is causing time waste between tasks.
- Due to improper arrangement of machineries and infrastructure, men and materials have to travel more distance to reach from one point to next point. It is as much high as 460 ft. for (Cu) 1.2 mm per cycle. It is concluded that the copper material is the main element in both raw and product material. The study was done on copper material only.

1.3 Goals and Objectives of the study

Goal:

- To reduce overall lead time from 2 hour 30 minutes to 1 hour 50 minutes, a 26.66% reduction.

Objectives:

- To reduce lead time in RBD machine from 1 hour 47 minutes to 56 minutes, a 46% reduction.
- To rearrange the workstation layout to reduce 30% of material (copper) movement.

1.4 Scope and limitation of the study

The scopes of the study,

- Identifying the idle period of man and machine
- Reducing cycle time of each process
- Applying Lean tools in each step of the process
- Reduction of Material Movement

Limitations of the study,

- The principles are implemented only for a static working condition, i.e., continuous productivity throughout the day without considering any unforeseen causes for delay

1.5 Methodology of the study:

For this study, SMED and 5S are chosen because it can reduce changeover time ultimately it will reduce lead time and improve productivity. The literature reveal that implementation of lean tools are very much important in small scale industries and the most popular implementation is 5S then kaizen then VSM, SMED, OEE etc. to improve productivity and for lead time reduction.

Methods that has been used was,

- SMED in wire drawing machine/rod breakdown machine
- 5s in whole plant and workplace rearrangement with plant layout optimization in plant

1.6 Contribution of the study

The main contribution of this study is the implementation of lean tools for the first time in this company. It improved the production efficiency by reducing lead time significantly. The use of SMED lean manufacturing tool seemed to be of benefit and it cut the RBD wire drawing machine lead time by a lot. Insufficient workers and wrong machine placement were the cause for unncecessary time lag along with scattered inventory. In this regard, 5S tool were effective to reduce the waste in movement.

1.7 Arrangement/organization of the thesis

First it introduces the study in chapter 1. In chapter 2, the literature study is presented. Then research design in chapter 4. Then the report is finished with data in chapter 4 and conclusion in chapter 5.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

In today's world every manufacturing sector is looking for a growth in their discipline, without increasing their capital venture. They only want to improve productivity and profitability and quality. Implementation of lean tools are more beneficial in terms of financial and productivity. Lean tools focusses-reduction in wastes. Literatures on different lean tools were covered before the study. Some are SMED, 5S, JIT etc.

The literatures relevent to this study are summerized below,

2.2 Prem S. Kukrejaet el

5S

5s stands for-

- Set in order (organize remaining items)
- Shine (clean and inspect work area)
- Sort (eliminate that which is not needed)
- Standardize (write standards for above)
- Sustain (regularly apply the standards)

That is it eliminates waste that results from a poorly organized work area. (E.g. wasting time looking for a tool. [2]

2.3 McIntosh, Liker et el

SMED (Single Minute Exchange of Dies) Approach:
SMED was proposed as a workshop improvement tool focusing on low cost proposals with a kaizen improvement basis, involving shop floor teams [3]. Later on, the evolution of Toyota Production System contributed to the spreading of the methodology around the world [4].

Shingo claimed that SMED is "a scientific approach to set-up time reduction that can be applied in any factory to any machine With regards this statement, many studies are focusing in its applicability to other types of factories and machines. [5]

2.4 Shingo

Shingo [6] bases his method on categorizing all setup activities into internal and external ones. With internal activities being the ones that can be performed only when the machine is shut down, and external being those that can be conducted during the normal operation of machine, when it is still running. These internal and external set-up activities involve different operations: Such as preparation, after-process adjustment, checking of materials, mounting

and removing tools, settings and calibrations, measurements, trial runs, adjustments, etc. SMED methodology is formed by four single stages[6]; a preliminary stage where the internal and external set-up conditions are not distinguished; the first stage were separating internal and external set-up takes place; the second stage where internal activities are converted to external ones; and finally the third stage focusing on streamlining all aspects of the set-up operation. Results into two main benefits: increasing manufacturing capacity and improving the equipment flexibility [7]. That allows working with smaller batch sizes, creating a flow of materials by eliminating waiting.

2.5 Selection of tools

The project debates the implementation of lean tools such as SMED(Single minutes exchange of dies), 5S,Industrial engineer tools like time study , workplace rearrangement etc.thistools areverymuchhelpfulinreducing wastesandreducinglead time which will ultimately helpful for the company.

First of all by using SMED tools for reducing changeover time that will ultimately reduce lead time and also using workplace rearrangement by plant layout optimization. The Company offers a comprehensive range of Submersible Winding Wire, Super Enamelled Copper/ Aluminium Winding Wire, Fiber Glass Cable, Lead Wire, DMD Cable, Paper Covered Copper/ Aluminium Single and Multi-strand wire, Paper Covered Copper/ Aluminium Single/Bunch Strip, Copper and Aluminium Bare Wire/Strip.

2.6 Lean Manufacturing

Lean manufacturing is a whole-systems approach that creates a culture in which everyone in the organization continuously improves processes and production. It is a system focused on and driven by customers, both internal and external. Lean manufacturing isn't just the latest industry buzzword or quick-fix alternative. Increasing competition demands a continuous focus on minimal costs, maximum options, fast delivery, and high-quality products and services. Today's manufacturers must be innovative while focusing on waste reduction, improved leadtime, maximized flexibility, and upgraded quality. Lean manufacturing concepts are proven strategies to help manufacturers obtain these attributes.

National Institute of Standards and Technology Manufacturing Extension Partnership (NIST-MEP) Lean Network defined Lean Manufacturing [12] as:

"A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection." It is also known as continuous flow, or synchronous flow manufacturing, one pieceor piece part flow manufacturing, just-in-time manufacturing, demand flow technology, world class manufacturing, or Toyota Production System [13]. systematic method to continually improve the manufacturing operation at little expense by involving all employees

in solving problems, eliminating wasteful costs, reducing lead times, and improving quality [9].

It is the systematic elimination of waste from all aspects of an organization's operations, including customer relations, product design, production management, services, and supplier networks where waste is viewed as any use or loss of resources that does not lead directly to the product or service a customer wants when want it.

In the volume, Lean Thinking [7], James P. Womack and Daniel T. Jones distilled these lean principles to five:

- Specify the value desired by the customer.
- Identify the value stream for each product providing that value and challenge all of the wasted steps currently necessary to provide it.
- Make the product flow continuously through the remaining, value-added steps.
- Introduce pull between all steps where continuous flow is possible.
- Manage toward perfection so that the number of steps and the amount of time and information needed to serve the customer continually falls.

2.6.1 Lean Thinking

Eliminating Waste with the Goal of Creating Value

- Customer-focused: Customer needs and expectations pull enterprise activities.
- Knowledge-driven: Draws upon knowledge and innovation from everyone - workers, suppliers.
- Eliminating waste: Stresses elimination, not just reduction, of all types of waste.
- Creating value: Puts premium on ìgrowing the pieî, not just reducing costs, to benefit all stakeholders.
- Dynamic and continuous: Pursues on-going systemic as well as incremental improvement - both innovation and continual improvement.

In their recent article for the Harvard Business Review on Lean Consumption, Womack and Jones have set out six additional principles of what they call lean consumption that correspond closely with those of lean production.

1. Solve the customer's problem completely by ensuring that all the goods and services work, and work together
2. Don't waste the customer's time
3. Provide exactly what the customer wants
4. Provide what's wanted exactly where it's wanted
5. Provide what's wanted where it's wanted exactly when it's wanted
6. Continually aggregate solutions to reduce the customer's time and hassle.

2.6.2 Insights of Lean

Lean provides positively-reinforcing concepts, practices and tools delivering just-intime: pull based production

- Striving for perfect quality: Completely defect-free parts must flow to each subsequent process; quality designed-in, not based on inspection, mistake proofing
- Flexibility and responsiveness: Small processing sizes and quick set-up times; ability to respond to shifts in demand
- Trust-based relationships: Mutual commitments and obligations, internally and externally with suppliers
- Continuous improvement Kaizen: Continuous improvement through work standardization, productive maintenance, root cause analysis, and worker training and empowerment [14].

Objective of the Lean manufacturing

- Primary focus is the elimination of waste
- The goal is to build the highest quality product at the most competitive cost in the shortest possible time
- The philosophy is that quality should be ensured in the production process itself so that defects are not passed on or overlooked
- The approach is to create simple rules that make it very easy for people on the shop floor to follow
- One plan for improvement
- Top management involvement

2.6.3 Lean Manufacturing Characteristics

Customer, simplicity, visibility, regularity, synchronization, prevention, improvement, partnership, variation, participation, made to order, single piece production, just in time supplies, pull scheduling, short cycle times, highly flexible equipment, highly flexible and responsive processes, quick changeovers, continuous flow (work balancing, cells), high first-pass yields, significantly less waste and defects, collocated equipment, tools, people, compressed space, multi-skilled employees [15].

2.6.4 5S

Based on Japanese words that begin with ëS', the 5 S Philosophy focuses on effective work place organization and standardized work procedures. 5 S simplifies work environment, reduces waste and non ñ value activity while improving quality efficiency and safety.

5S is a powerful method to create stability and repeatability (often called ìindustrial housekeeping).

1) Seiri - put things in order / remove what is not needed and keep what is needed (Sort out).
2) Seiton - proper arrangement/ place things in such a way that they can be easily reached whenever they are needed (Set in order/ Systematize).
3) Seiso - clean / keep things clean and polished; no trash or dirt in the workplace (Sweep, scrub, shine).
4) Seiketsu - purity / maintain cleanliness after cleaning ñ perpetual cleaning (Standardize).
5) Shitsuke - commitment/ actually it is not a part of ë4S', but a typical teaching and attitude towards any undertaking to inspire pride and adherence to standards established for the four components (Sustain).

2.6.5 1st S, Sort Out

Remove all items from the workplace that are not needed for current production or tasks. An effective visual method to identify these unneeded items is called red tagging.

It looks for:
Broken or deteriorated items, dusty items, items with no clear location, items loose in drawers, outdated signs and notices, unused management boards, outdated posters and slogans, returned goods, scrap, over-runs, jobs that have been sitting for a long time, Items that are rarely used. Items with a quantity on hand much larger than will soon are used.

Figure 1: Sorting the necessary items

2.6.6 2nd S, Set In Order

It focuses on efficient and effective storage methods. Ensures what is needed for a job is in place and easy to find, use, and put back, and find ways to prevent the need for future cleaning.

How can equipment and materials be rearranged for:
Less walking, less crowding, less bending, climbing, stretching, reaching, less searching, less obstacles to flow

2.6.7 3rd S, Shine, Scrub, Sweep, Straighten, Safety

Cleanliness: get the areas looking clean and new.

3rd S Mess

- Clutter spreads like the flu! From one cluttered area an epidemic soon results.
- Maintaining the standard is for everybody, everyday.
- Set locations make clutter and foreign material clear at a glance.

3rd S, Straighten for Setup

- Clean and ordered tool crib eliminates frustration or searching for tools 3rd S for Setup
- Preparing for set-up can take extra time if tools are not easily located.
- Sometimes it's faster to get (or make) a new tool.
- Customer doesn't want to pay for this waste.

2.6.8 4th S, Standardize

Creating a consistent way of implementing the tasks performed daily, including Sort, Set in order, and Shine.

2.6.9 5th S, Sustain

This takes discipline on everyone's part. Sustain, make it a habit to follow the procedures. The goal of this tool is stability and repeatability

2.6.10 The necessity of 5S

5s is the prime urgency to implement lean for the following reasons,

- To eliminate the need to work around, walk around and trip over obstacles that aren't needed in our jobs.
- To shorten steps and reaching.
- To eliminate bending or stretching
- To create a safer work environment.
- To reduce errors caused by excess tools and material.
- To eliminate searching for tools and jigs
- To organize all needed items for ìstress-lessî use.
- To reduce ìcrowding.î
- To enable better organization of the items we do need to do our jobs
- To reduce the total number things we need to keep track of.

2.6.11 Focus on Waste

Waste is anything other than the minimum amount of equipment, materials, parts, space, and worker's time which are absolutely essential to add value to the product. - Shoichiro Toyoda, President, Toyota

Need to include: Energy Waste, Resource Waste, Process Waste and Solid Waste.

2.6.12 Main types of waste

The main wastes are - Overproduction, Waiting, Inventory or Work in Process (WIP), Processing waste, Transportation, Motion, Making defective products, Underutilizing people, Lack of system discipline, and Limited IT resources. Nearly every waste in the production process can fit into at least one of these categories. Lean manufacturing is an approach that eliminates waste by reducing

Figure 2: Different Wastes in Manufacturing

costs in the overall production process, in operations within that process, and in the utilization of production labor. The focus is on making the entire process flow, not the improvement of one or more individual operations.

2.6.13 Quick Changeover

Tool changeover is the time between the last good part from one series and the first good part of the next series. Quick changeover means the reduced time to get the new quality product after changing the setup as early as possible. It has two points to be noted- the internal operations (operations that can only be performed with the machine at a standstill) and external operations (operations that can only be performed with the machine running)

2.6.14 Advantage of set-up reduction

Reduction of change-over costs, production of smaller lot sizes combined with an increased number of change over, Trial-runs are minimized, urgent orders can be quickly produced, improved productivity (increased efficiency, less waste, less machine defects), set-up becomes easy, reduction of intermediate inventory, improved flexibility, reduced work in progress.

2.7 Lean Manufacturing Benefits

Organized and ëvisual' workplace, Lower space/facility requirements, Improved use of floor space, Allows more strategic management focus, Improved knowledge retention, New employees fit in more quickly with less training, Cross-trained employees, Flexible work cells with flexible people, Small batch operations more cost effective, Productivity / Capacity increase, Inventory reduction, Cost reduction, Improved efficiency, Improved communication, Improved profit margins, Improved customer relations, Quality improvement, Improved vendor support and quality, Higher labor efficiency and quality, Reduced scrap and waste, Reduced cycle time, Reduced obsolescence, High quality and reliability, Lower overall costs, Selfdirected work teams, Lead time reduction, Fast market response, Longer machine life, Improved flexibility in reacting to changes, Increased shipping and billing frequencies [21]

Chapter 3

RESEARCH/EXPERIMENTAL DESIGN

3.1 Introduction

This chapter will illustrate the research procedure which was followed to conduct the study. This will include process flow-chart, Data collection procedure and other related materials.

3.2 Research Design

The research was divided into data collection, inspection of different processes in the production line and implementing the lean tools. The diagrams and flow-charts used in the study is presented below.

3.2.1 Wire-drawing flow diagram

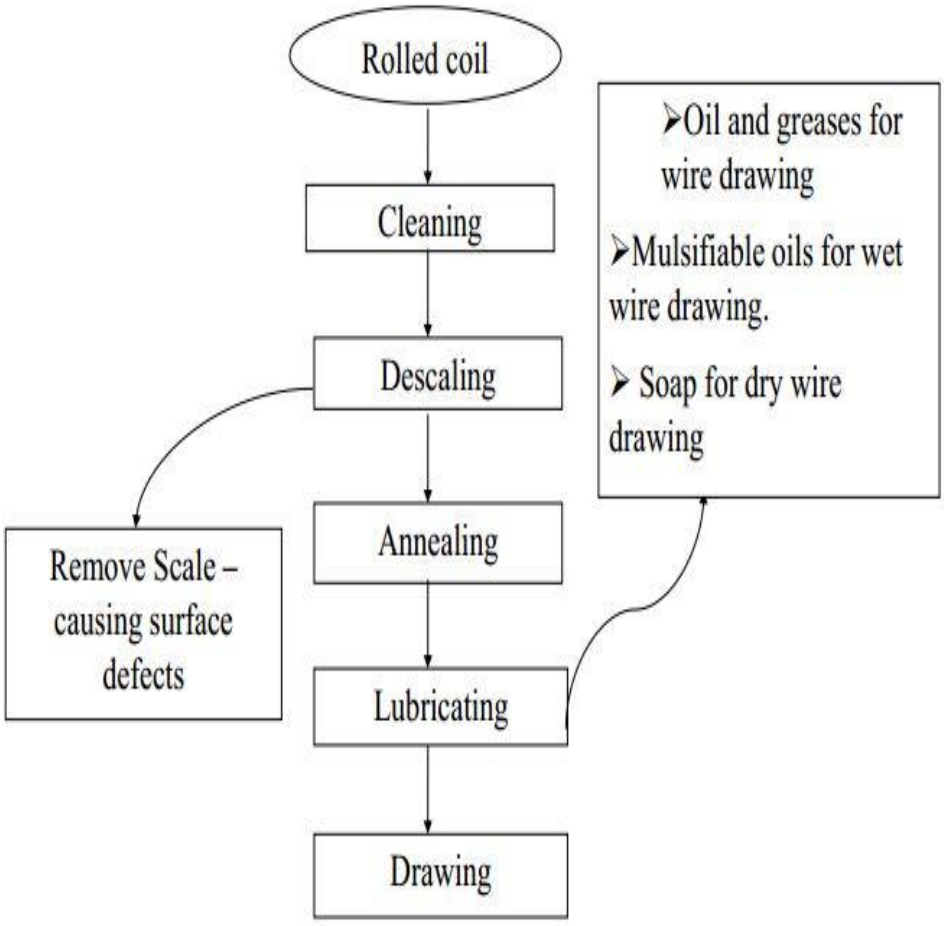

Figure 3: Wire-drawing process block diagram

3.2.2 Fish-bone diagram for unnecessary material movement

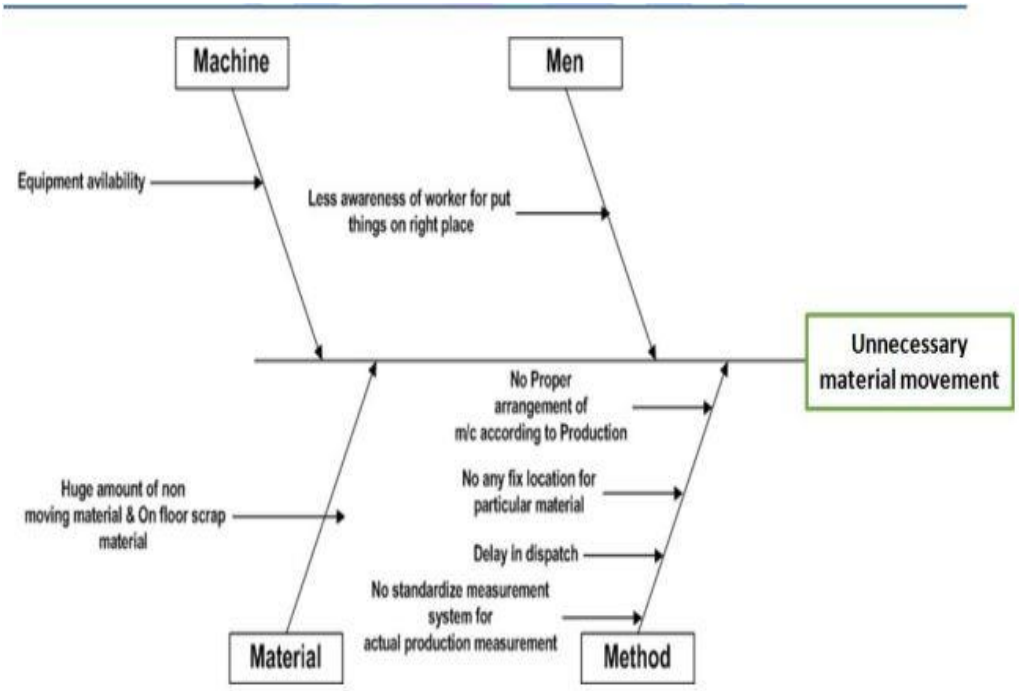

Figure 4: Cause-effect Fish-bone diagram

3.2.3 Copper material movement diagram

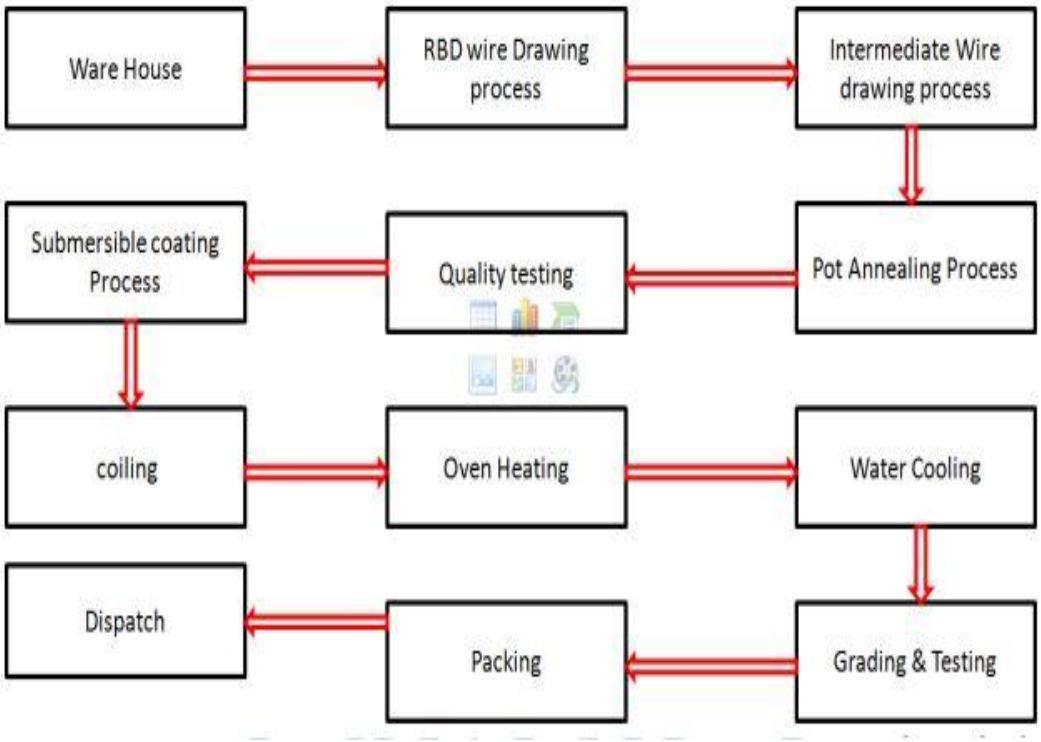

Figure 5: Cu material movement diagram

3.3 Process flow chart

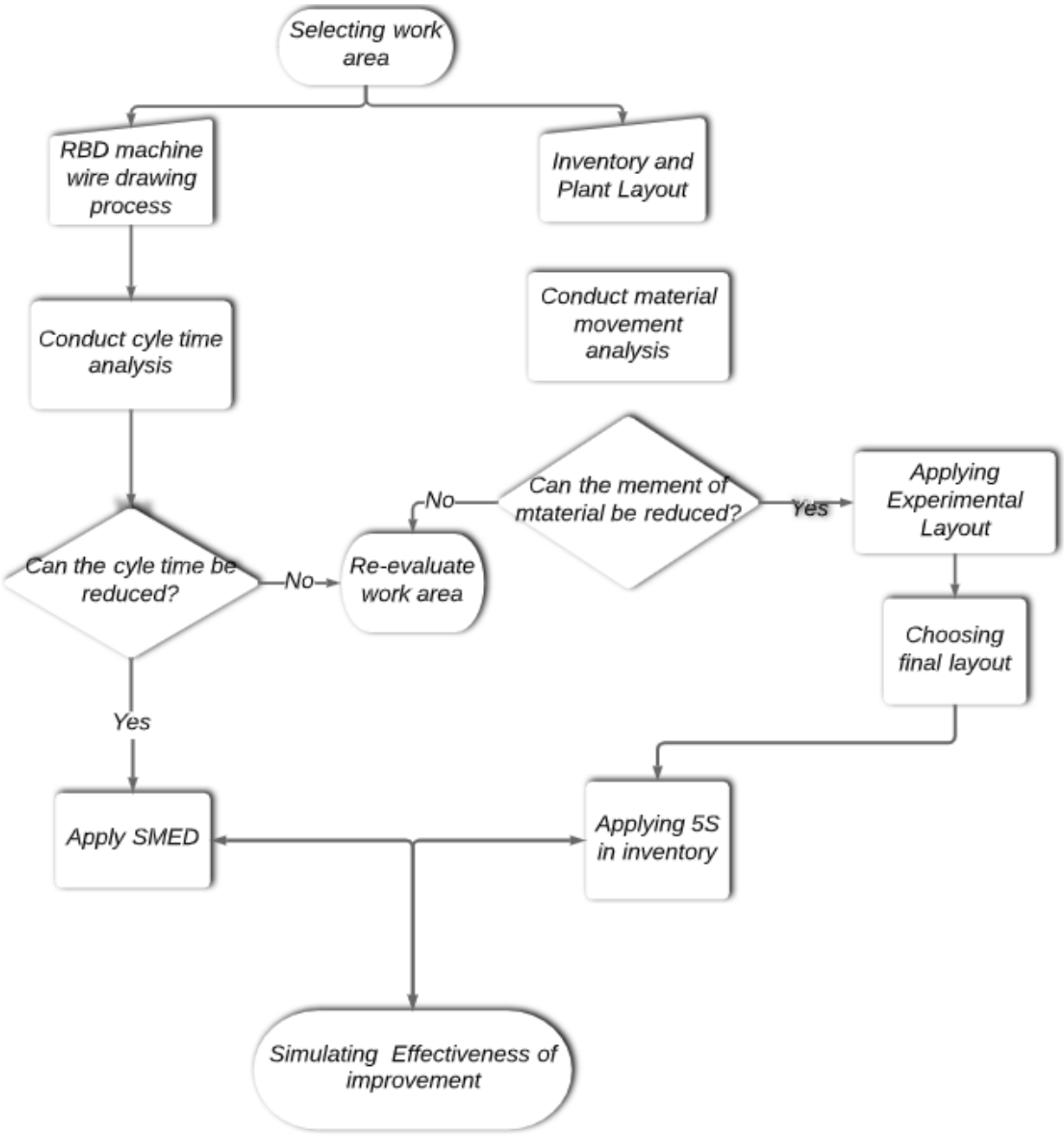

Figure 6: Process flow chart

Chapter 4

DATA GENERATION/COLLECTION, ANALYSIS AND DISCUSSION

4.1 Introduction

This chapter will illustrate the collected data and the implications of it.

4.2 Company Profile

The selected cable manufacturing industry is the Evana Cables Industries Ltd. The company started its business in the year 1999. It is located at Nawabpur, Dhaka, Bangladesh.

Product Range:

- Copper Bare Wire and Strip
- Paper covered copper single and Bunch Strip
- Paper covered Aluminum single and Bunch Strip
- Paper Covered Copper single and Multi-Strand Wire

Manpower of Evana Cable Ltd:

Merchandising dept : 5

Wire-Drawing dept : 25

Sampling dept : 10

Wire Cutting dept : 20

Quality dept : 20

Finishing dept : 5

Commercial dept : 5

Administration dept : 10

Social compliance dept : 3

Accounts dept : 4

Floor Space : 10,000 Sq Ft

4.3 Data Collection

The data for the study was collected from the audit of the company. The production manager and procurement executive were the source. The data after implimenting the tools was also collected by the production manager and was delivered to me.

4.3.1 Cycle Time, Payoff & Take up side

Operations(Payoff Side)	Time
Loading on the stand	4 min 5 sec
Strip Cutting	3 min 40 sec
Welding Process	5 min 30 sec
Switch on Machine	3 min 44 sec

Figure 6: Cycle time of Payoff side

Operations(Take Up Side)	Time
Unmounting of the Coiler	4 min 5 sec
Moving the Trolley	40 sec
Mounting on the Trolley	30 sec
Moving the Coiler to Take up side	1 min
Welding	1 min 2 sec

Figure 8: Cycle time of Take up side

4.3.2 Segregation of external and internal activities

SL No	Operations	Internal	External
1	Transportation of Stand to m/c Crane area		
2	Unloading of Coil on Stand		
3	Transportation of Stand from Cranes to m/c area		
4	Strip Cutting		
5	Welding		
6	To Collect Dies by Worker		
7	Die Setting		
8	Unmounting of Coiler		
9	Moving the Trolley		
10	Mounting on Trolley		
11	Moving the Coiler to Take up side		
12	Welding		
13	Finish/Setting up the coil		

Figure 9: Segregation of activities

SL No	Operations	Internal to External	Time
1	Transportation of Stand to m/c Crane area		1 min 40 sec
2	Unloading of Coil on Stand		58 sec
3	Transportation of Stand from Cranes to m/c area		1 min 55 sec
4	Strip Cutting		3 min 15 sec
5	Welding	Reduce to 2 min 20 sec	5 min 40 sec
6	To Collect Dies by Worker		15 min 45 sec
7	Die Setting	Reduce to 50 min	1 hour 12 min
8	Unmounting of Coiler	Reduce to 1 min 30 sec	4 min 5 sec
9	Moving the Trolley		1 min
10	Mounting on Trolley	15 sec	55 sec
11	Moving the Coiler to Take up side		1 min 10 sec

Figure 10: Reduction of cycle times

4.3.3 Comparison between cycle times

SL No	Description	Before	After	Improvement
1	Total Time Taken	1 hour 40 minutes	54 minutes	45%
2	No of Operator	1	2	--------
3	Internal Activities	7	2	Internal Activity reduced by 5
4	External Activities	0	5	External Activity increased by 5

Figure 11: Change in Payoff side operation

SL No	Description	Before	After	Improvement
1	Total Time Taken	7 minutes 5 seconds	1 minute 15 seconds	82%
2	No of Operator	1	2	---------
3	Internal Activities	4	2	Internal Activity reduced by 2
4	External Activities	0	2	External Activity increased by 2

Figure 11: Change in Take up side operation

4.3.4 Comparison between idle & working time (before-after)

Man Vs Machine	Man/Machine	Working TIme
Total	Man	2 hour 16 minute
Utility	Machine	56 minute

Figure 13: Man-machine working time

- Overal Utility time:

2 hr 16 min + 56 min = 3 hr 12 min

- % idle time for,

Worker= 56 min / 3 hr 12 min= 30%

Machine= 2 hr 16 min/ 3 hr 12 min= 70%

4.3.5 Wire Drawing Man-Machine Chart

Idle

Active

SL No	Time	Operation	Operator	Machine
1	1 min 40 sec	Transportation of Stand to m/c Crane area	■	
2	58 sec	Unloading of Coil on Stand	■	
3	1 min 55 sec	Transportation of Stand from Cranes to m/c area	■	
4	3 min 15 sec	Strip Cutting	■	
5	10 min 40 sec	Welding	■	
6	56 min	Process Continues		■
7	2 hour 4 min	Die Setting	■	
8	2 hour 5 min	Maintainance	■	
9	2 hour 55 min	Unmounting of Coiler	■	
10	2 hour 56 min	Moving the Trolley	■	
11	2 hour 56 min	Mounting on Trolley	■	
12	2 hour 58 min	Moving the Coiler to Take up side	■	
13	2 hour 59 min	Welding	■	
14	3 hour 12 min	Finish/Setting up the coil	■	

Figure 14: Man-machine chart

4.3.6 Before-After comparison of Material movement distance

Operation	Distance Before	Distance After
Transfer bobbin production in area to intermediate m/c	90 ft	30 ft
Transfer product to annealing area plant	300 ft	250 ft
Material Loading in annealing pot	20+115 ft	20 ft
Coated material transfer	70 ft	10 ft
Total Distance	460 ft	310 ft
Reduction	150 ft	

Figure 15: Change in specific distance of material movement

Before Current Layout	After Current Layout	Benefit
460 ft	310 ft	32% reduction

Figure 16: Change in total distance of material movement

4.4 In graphs

4.4.1 Before-After Comparison(Payoff Side)

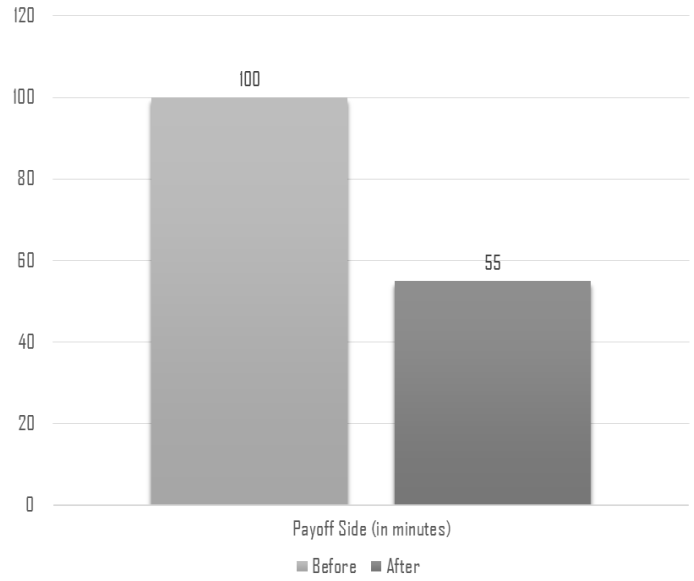

Figure 17: Change in cycle time of Payoff side (graph)

4.4.2 Before-After Comparison(Take Up Side)

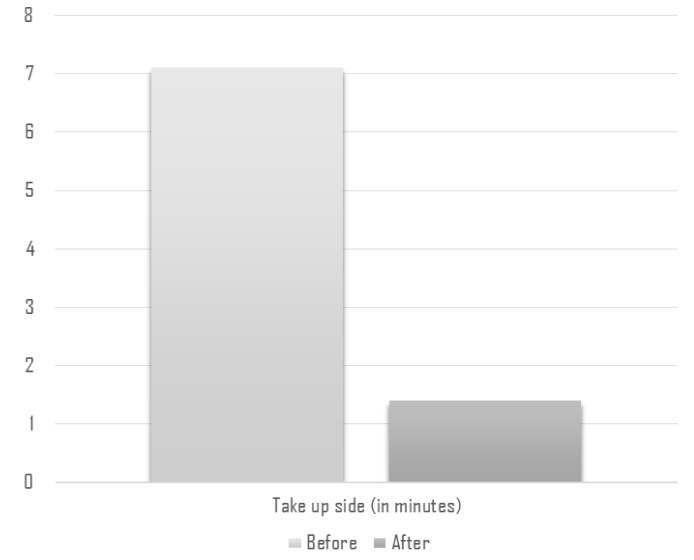

Figure 18: Change in cycle time of Take up side (graph)

4.4.3 Comparison of idle time (Before & After)

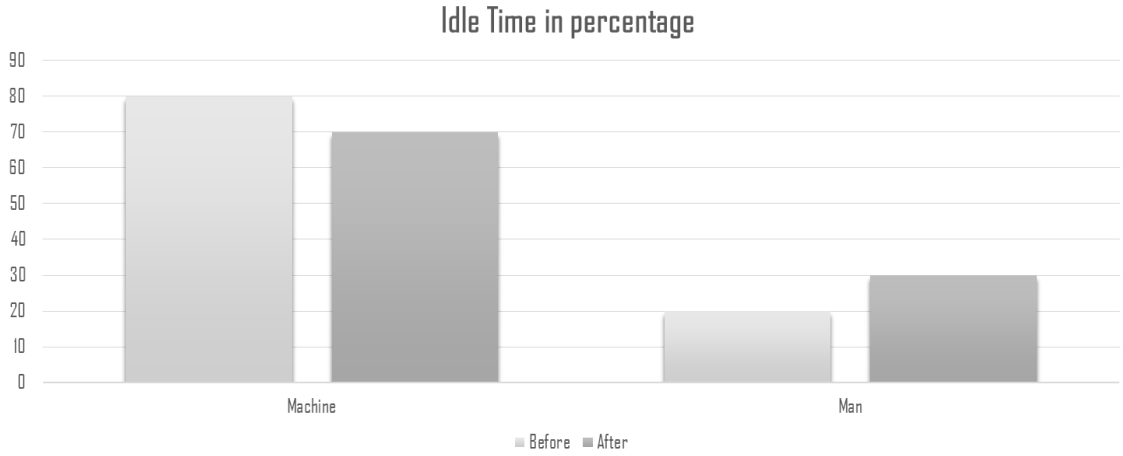

Figure 19: Change of Idle time (graph)

4.5 Discussion

It was found that the implimentation of lean tools had a major impact on the production process of the factory. The cycle times were reduced, material movement were optimized resulting to a reduction in overall lead time. The condition can be further improved in time.

Chapter 5

CONCLUSION AND RECOMMENDATION

5.1 Summary

In the study, the production line of the company was assesed to define the problems. Then data was collected to verify those problems and solutions were researched and found. The solutions were applied carefully and then data was taken again to determine the change in data. The change in data was noted and various tables and graphs were made to show how the changes has taken place.

After completing project successfully and taking care of all the objective it can be concluded that by usage of SMED, 5S ,

- The changeover time has been reduced from 1 hour. 40 minutes to 54 minutes, benefit is of 46 minutes reduction in input side of wire drawing machine, a (46%) reduction. In output side of wire drawing machine change over time reduces from 7 minutes to 1 minutes 15 seconds.

After rearrangement of the layout,

- The Copper material movement was reduced 32% of the previous distance.

5.2 Conclusion

The production rate of the company was being held behind by high idle time and excessive material movement. The use of SMED lean manufacturing tool seemed to be of benefit and it cut the RBD wire drawing machine lead time by a lot.

For the second and third objective, insufficient worker and wrong machine placement were the cause for unncecessary time lag along with scattered inventory. In this regard, 5S tool were effective to reduce the waste in movement.

The goal and objectives of this study were justified by the gained outputs from SMED and 5S and rearranged layout of the plant.

5.3 Recommendation

For further improvement, the company can implement lean tools such as JIT, ATO, MTO etc to reduce cost and inventory. Furthermore, the lead time of the production line can be reduced more if the applied lean tools are applied more stringently.

References

[1] G.Muthukumaran, V.S.K.Venkatachalapathy, K.Pajaniradja, "Impact on integration of Lean Manufacturing and Six Sigma in various applications - a review," *IOSR Journal of Mechanical and Civil Engineering,* vol. 6, no. 1, pp. 98-101, Mar. - Apr. 2013.
[2] Prem S. Kukreja, Dr. A. G. Matani, Dr. S.K. Doifode "Analysis of Production Processes in a Small ScaleFoundry Industry" International Conference On Emanations in Modern Technology and Engineering (ICEMTE-2017) ISSN: 2321-8169 Volume: 5 Issue: 3
[3] McIntosh, R.I., Culley, S.J., Mileham, A.R., Owen, G.W., 2001.Changeover improvement: A maintenance perspective. International Journal of Production Economics 73, pp. 153-163.
[4] Liker, Jeffrey L., 2006. The Toyota Way: 14 Management principles from the World's Greatest Manufacturer. Free Press division from Simon & Schuster, Inc., New York.
[5] McIntosh, R.I., Culley, S.J., Mileham, A.R., Owen, G.W., 2000. A critical evaluation of shingo's SMED) methodology. International Journal of Production Research 38, pp. 2377-2395.
[6] Coimbra, E. A., 2009. Total Flow Management: Achieving Excellence with Kaizen and Lean Supply Chains. Kaizen Institute.
[7] Shingo, S., 1985. A revolution in manufacturing: The SMED system. Productivity Press, Stanford, CT.
[8] Womack J. P, Daniel T. Jones, and Daniel Roos, The Machine that Changed the World, HarperCollins, 1990.
[9] Shingo Shigeo, NY- 1989. A Study of The Toyota Production System, Productivity Press, pp. 41 -57
[10] Schonberger R. J., World Class Manufacturing The lessons of simplicity applied, 2008, pp. 1- 6, 17-30
[11] NIST-MEP , 2000. Lean, Lean Certificate Series, NIST Manufacturing Extension Partnership, Gaithersburg, MD, NIST.
[12] Creehan K. D., and Taylor R E, summer 2003. Lean Manufacturing and Six-Sigma Integration, Flexible Automation and Lean Manufacturing, Center for High Performance Manufacturing, Center-Designated Project,.
[13] Womack J. P. and Jim, Getting Started on the Lean Journey
[14] Taninecz George., 2005, Lean Beyond Production, LEI, Brookline, pp.
[15] Rother M., and Shook J., 2003.Learning to See Value Stream Mapping to Create Value and Eliminate Muda, The Lean Enterprise Institute,