KAUNAS UNIVERSITY OF TECHNOLOGY
FACULTY OF MECHANICAL ENGINEERING AND DESIGN

Selvakumar Palaraman

“APPLICATION OF LEAN CONCEPT TO ACHIEVE PRODUCTIVITY IMPROVEMENT IN LAXMI SANKAR SPINTEX COMPANY”

Master’s Degree Final Project

Supervisor
Assoc. prof. Antanas Čiuplys

KAUNAS, 2016

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Industrial Engineering and Management (621H77003)

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(Title of study programme, code)

" **Application of lean concept to achieve productivity improvement in Laxmi Sankar Spintex company**

DECLARATION OF ACADEMIC INTEGRITY

20 May 20 16

Kaunas

I confirm that the final project of mine, **Selvakumar Palaraman**, on the subject "**Application of lean concept to achieve productivity improvement in Laxmi Sankar Spintex Company**", is written completely by myself; all the provided data and research results are correct and have been obtained honestly. None of the parts of this thesis have been plagiarized from any printed, Internet-based or otherwise recorded sources; all direct and indirect quotations from external resources are indicated in the list of references. No monetary funds (unless required by law) have been paid to anyone for any contribution to this thesis.

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Approved:

Head of

Production engineering Department

(Signature, date)

Kazimieras Juzėnas

(Name, Surname)

MASTER STUDIES FINAL PROJECT TASK ASSIGNMENT
Study programme INDUSTRIAL ENGINEERING AND MANAGEMENT

The final project of Master studies to gain the master qualification degree, is research or applied type project, for completion and defence of which 30 credits are assigned. The final project of the student must demonstrate the deepened and enlarged knowledge acquired in the main studies, also gained skills to formulate and solve an actual problem having limited and (or) contradictory information, independently conduct scientific or applied analysis and properly interpret data. By completing and defending the final project Master studies student must demonstrate the creativity, ability to apply fundamental knowledge, understanding of social and commercial environment, Legal Acts and financial possibilities, show the information search skills, ability to carry out the qualified analysis, use numerical methods, applied software, common information technologies and correct language, ability to formulate proper conclusions.

1. Title of the Project

Application of Lean Concept to Achieve Productivity Improvement in Laxmi Sankar Spintex Company

Approved by the Dean Order No.V25-11-7, 3 May 2016

2. Aim of the project

To improve the productivity with minimum investment and production cost

3. Structure of the project

- To establish the importance of productivity improvement
- To learn how manipulate the production process
- To analysis and make selection of suitable source of energy for power consumption by machine system

4. Requirements and conditions

- Productivity analysis should be done for labor hour and power consumption
- Suitable lean concept has to be selected

5. This task assignment is an integral part of the final project

6. Project submission deadline: 2016 May 20th.

Given to the student Selvakumar Palaraman

Task Assignment received ______________________________ _______________________

(*Name, Surname of the Student* (*Signature, date*)

Supervisor ______________________________ _______________________

(*Position, Name, Surname*) (*Signature, date*)

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Study field and area: Production and Manufacturing Engineering, Technological Sciences.

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SUMMARY

This thesis is about application of Lean concept over Laxmi Sankar Spintex to achieve the productivity improvement in all the best possible ways.

For the past few years Lean concept topic has become considered as one of the best management technique to achieve the improvement not only in the case of productivity but also in the cost investment and quality of the product. It is widely acknowledged by many of the textile industries all over the world to maneuver the lean techniques to annex well-healed advantage in terms of Cost, Quality and Productivity.

Laxmi Sankar Spintex is one of the Medium scale Industry located in a small village Chatrappati in the state of Tamil Nadu, India. This enterprise is manufacturing cotton yarn which is used as the base product for many knitted and woven fabrics. It also manufactures cotton medical disposable gauze from the base product yarn they are producing. Due to labor crisis and various changes in the norms and conditions, electricity tariffs in TamilNadu the management is struggling to meet their demand of the product in the market by its productivity with the conventional machineries.

The Application of suitable Lean technique over this firm would help to improve its productivity with less cost of production to economically leverage its ability to meet the market demand of the product.

Selvakumar, Palaraman. Lean kocepcijos taikymas siekiant padidinti gamybos našumą "Laxmi Sankar Spintex" įmonėje. *Magistro* baigiamasis projektas / vadovas doc. dr. Antanas Čiuplys; Mechanikos inžinerijos ir dizaino fakultetas, Kauno technologijos universitetas.

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Raktiniai žodžiai: *produktyvumas, Lean koncepcija, kainų mažinimas, vidutinio dydžio pramonė.*

Kaunas, 2016. 58 p.

SANTRAUKA

Šis baigiamasis darbas yra apie taupios gamybos (angl. Lean manufacturing) principo pritaikymą vietoj „Laxmi Sankar Spintex" įmonėje naudojamų metodų, norint padidinti gamybos našumą geriausiais būdais.

Pastaraisiais metais „Lean" koncepcija buvo laikoma viena iš geriausių valdymo metodų siekiant ne tik produktyvumo, bet taip pat ir investicinių sąnaudų bei produkto kokybės pagerėjimo. Šis būdas plačiai pripažįstamas tekstilės pramonėje visame pasaulyje. Naudojant „Lean" metodus pasireiškia pranašumai kalbant apie kainą, kokybę ir produktyvumą.

„Laxmi Sankar Spintex" yra viena iš vidutinio dydžio įmonių, esanti nedideliame Chatrappati miestelyje, Tamilnado valstijoje, Indijoje. Ši įmonė gamina medvilnės verpalus, kurie yra naudojami kaip daugelio megztų ir austų medžiagų pagrindas. Taip pat iš pagrindinių produktų – verpalų, yra gaminamos ir medvilninės vienkartinės medicininės marlės. Dėl darbo krizės bei įvairių normų ir sąlygų pokyčių, taip pat ir elektros tarifų Tamilnado valstijoje, valdyba stengiasi patenkinti produkto paklausą rinkoje.

„Lean" metodų pritaikymas šioje įmonėje padėtų pagerinti produktyvumą su mažesnėmis gamybos sąnaudomis ir ekonomiškai išnaudotų šių metodų galimybes, patenkintų produkto rinkos paklausą.

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INTRODUCTION

Lean Manufacturing

Lean manufacturing is an enterprise or an organizational structure and cluster of strategic methods which emphasize the elimination of non-value added activities to deliver good quality products to the user on time at minimal cost with maximual performance. In simple statement, it means producing with no 'waste', or with no 'organisational slack' [1].

Lean philosophy has become prevailing in the manufacturing industry during recent period of time. However, even today numrous manufacturers are struggling to deal with Lean principles [2].

Productivity

Productivity**,** is the proportion between the output product manufactured or created from a process or system of single or multiple input. Productivity is neither efficiency nor effectiveness, it is how effectively the work has done to achieve the efficiency.

$$\text{Productivity, P} = \frac{output}{Input}$$

Spinning Industry

Spinning industry is a unit of textile industry, more over it is the base of the textile industry especially to Yarn (cotton, jute fiber, etc.,) manufacturing process. The textile industry was found when the human civilization initiates its development. In the beginning stage, textile industry comprised of only weaving process, but at present it diverged into various fields such as ginning, reeling, spinning, processing, sizing, printing and garment manufacturing.

Laxmi Sankar Spintex

Laxmi Sankar Spintex, is one of the Medium scale Industry located in a small village **Chatrappati** in the state of **Tamil Nadu, INDIA**. The industry is manufacturing cotton yarn which is used as the base product for many knitted and woven fabrics. It also manufactures cotton medical disposable gauze from the base product yarn they are producing. The production capacity of this spinning mill is 2000 kgs of cotton yarn per day by using its conventional machineries. It employs a total of 98 employees per day.

AIM

Aim of this thesis is to achieve productivity improvement in Laxmi Sankar Spintex company by the application of Lean Concept

OBJECTIVE

The main objective of this research project is to improve the productivity of Laxmi Sankar Spintex simultaneously optimizing the time consumption as well as cost investment incurred to the industry with the application of Lean concept.

1. LITERATURE REVIEW

1.1 Lean Concept

The concept of manufacturing a product in a “Lean“ manner was first point out by John krafick in his article, “Triumph of the Lean production system“, after learning the Japanese way of manufacturing, mainly Toyota Production Systems (TPS in the 1980s) for his master‘s thesis at MIT Sloan School of Management [3].

After World War II, Japanese manufacturers were faced the massive shortage of the base product or raw materials, economy and man power. They face the issues that is entirely differ from the western counterparts. Such criterias leads to the formation for the foundation of Lean Manufacturing concept. In mid 40‘s of 19th century, American Industries were outperforming the Japenese counterparts, inorder to move forward in this competition of manufacturing Japenese early leaders like shiegeo and Taichi Ohno in the manufacturing field equiped a new system called “Toyota Production System“ (TPS) which in terms now a days called as “Lean Manufacturing“ [4].

Lean practices of Japan initially adopted from American entrepreneur‘s Henry Ford‘s production concept which includes the following:

1) Waste Elimination
2) Standardized Work Practices
3) Just-In-Time System
4) Doing it Right at the first time (Quality Control)

TPS employs continuous improvement process to focus on the elimination of some unnecessary non value added steps in manufactring the product. Few more steps were also added by the Japanese which are as follows [5],

1.Integrated Supply Chain (from JIT)
2.Enhanced Customer Value (from Quality Control)
3.Value Creating Organisation

4.Committed Management

5.Winning Employee Commitment/Empowering Employees

6.Optimized Equipment Reliability

7.Measurement (Lean Performance) System

8.Plan-Wide Lines of Communication

9.Making and Sustaining Cultural Change

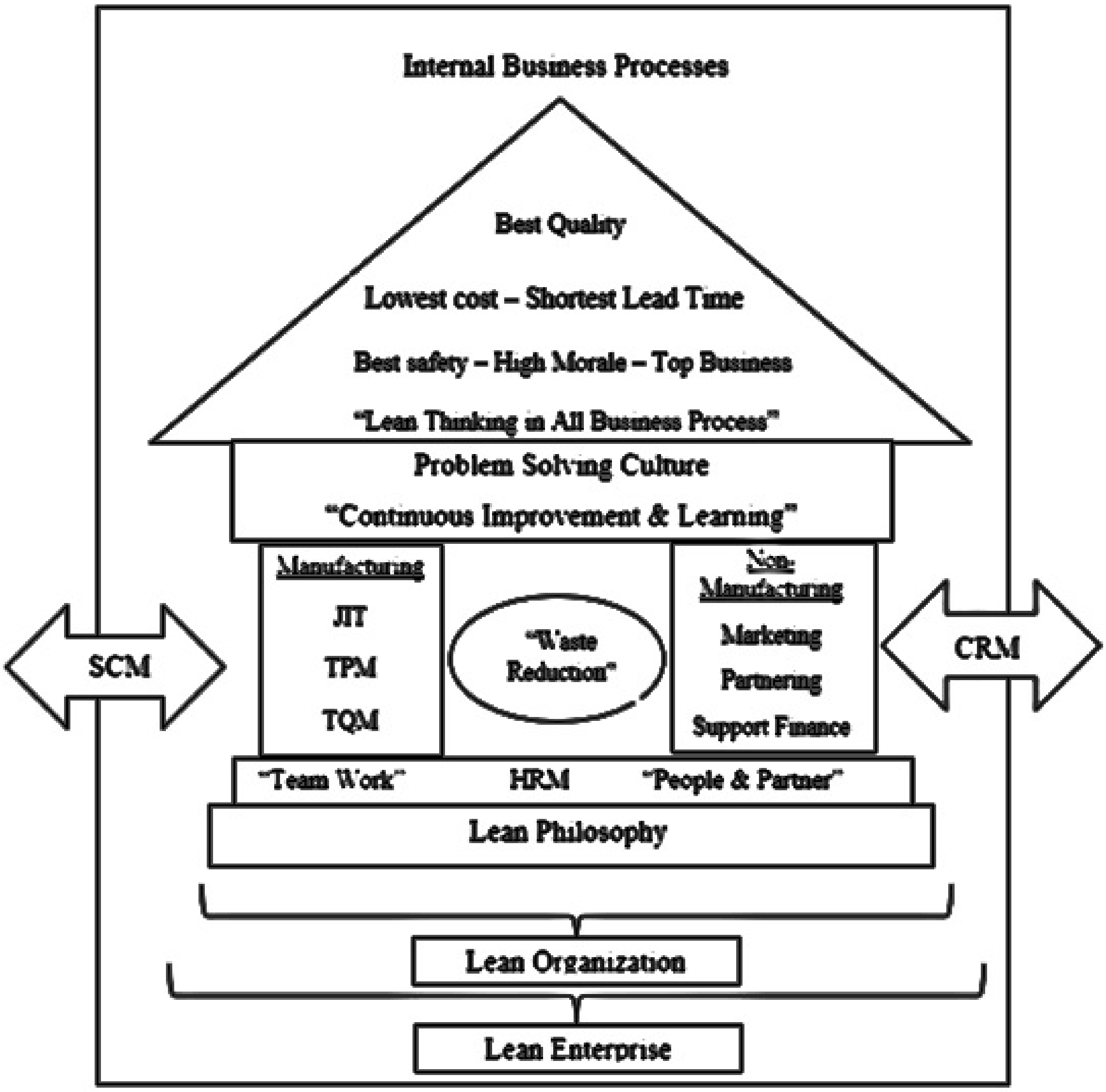


Fig 1.1 Lean Conceptual Structure

1.1.1 Wastes According to Lean Concept

The following are the seven types of wastes according to lean concept.

1. Overproduction
2. Defects
3. Inventory
4. Waiting
5. Transportation
6. Motion
7. Over-processing

i. Overproduction

Production of product which exceeds the market demand or customer demand, Early production product before getting the order is known as Overproduction. Overproduction leads to the obsolence of the product and increases the chances of producing wrong product. It leads to excessive storage and lead time in the factory. It also leads to the excess work-in-process stocks which heads to physical dislocation of with lack of communication [6].

ii. Defects

Apart from physical defects which is directly added to the cost of goods sold (COGS), Production with wrong or approximate specifications, excessive raw material usage or generating lot of scraps are also comes under the title of defects. Generating defective product not only leads to material wastage but also generates idle time in the subsequent workstations and then lead time [7].

iii. Inventory

Stocking excessive raw material, work-in-process and finished product are all comes under inventory wastes. Excess inventory heads to loss in inventory investment cost and increases the defect rates by the usage of older raw materials. It heads to increased lead time, dodges the rapid identification of issues and occupies more storage space. Inorder to conduct effective and efficient procurement, it is necessary to stack of inventory.

iv. Waiting

Waiting is indirectly defined as the idle time for workers and machineries used in the process of production particular product. It leads to the inefficient usage of the production flow in the workfloor. It also includes little bit delays between the processing units. The waste of waiting occurs when the time is being used inefficiently and ineffectively. This opens up when the product is not done on time and or being inprocess. This kind of waste indirectly affects the investment cost and directly affects the work time of labor and machine[6]. To overcome this waiting time wastage, this period of time can be used for training and shift changing for workers and maintanance incase of machineries.

v. Transportation

According to the Lean wastage, transportation is defined as the movement of goods or materials that does not add any kind of value to the product (ex: movement of material between the workstations without any reason). Transportation takes place between different process results in prolongation of production cycle time, inefficient manpower and shop floor usage. Multihandling and excessive movements can cause defects and damages as well as deterioration with the process.

vi. Motion

Motion define unwanted and unnecessary movements physically by the labors which deviate them from the work. This might include walking around the working area or shopfloor to look for an equipment or tool, poorly designed ergonomics which leads to the lack in work time by the motions bending,stretching and picking up of equipment or tools.

vii. Over processing

Over processing is simply defined as unwanted and unnecessary non value added works that is performed on the product apart from the customer specification such as polishing and excess coating over the product. It occurs when an exagerrate solutions are exercised for a simple procedures.

The over-complexity of the ownership and encourages employees to outcome the recovery of huge investment in the complexive new technologies [8].

1.1.2 Value Creation

Value creation is a criteria that solely depends on the requirements of the customer willing to pay for.Value creating activity are of three types and as follows,

Value-added activity is the activity that sculpt the materials into the precise and exact product as customer desired.

Non value-added activities are comes with product in the form accessories that customer want to but does not provide any value to the customer. These activities are sometimes considered as a waste that is added to the product.

Necessary non value-added activities are the activities that does not provide any value for the customer but it is necessary for the production unless the present supply or manufaction process is changed from the basic. This type of waste can be eliminated only in a chronic manner but is unlikely to be eliminated in short-term. For example, high level of inventory may require a buffer stock although this could be consistently reduced by stable production [9].

1.2 Importance of Productivity

Productivity is highly prominent factor a manufacturing industry to meet its demand in a significant way to ensue its reputation in the market with the customers. Industry with the higher productivity value has faster growth in the race against the competitors.

Below the average level or rate of growth of productivity will head to the Bankruptcy", said by John Kendrick, 1993. In general, at present productivity and quality have become a global concern.

Productivity Vs Production

Production is defined as the process of generating or manufacturing a product or services. Whereas, Productivity is how efficiently as well as effectively the service or product is provided or generated. The improvement in production does not have any of its reflection over improvement in productivity.

Productivity Improvement

Productivity Improvement the is output of operating and interceding in transfiguration or an work process. Productivity will occur if the following condition happens,

1. Increase in output with less involement of input
2. Stable input resulting in Increase in output
3. Increase in output with increase in input
4. Stable output generation even with decrease in Input
5. Decreased output in accordance with decreased input

Productivity Measurement

Producitivity can be measure by means of two types as follows,

- Single factor productivity
- All factor productivity

In single factor productivity, the input factor can be in both physical and finicial form. Whereas in all factor productivity, the input factor is the sum of all the form (ex: power, time, machine, labor) and the output factor is as same as the single factor productivity.

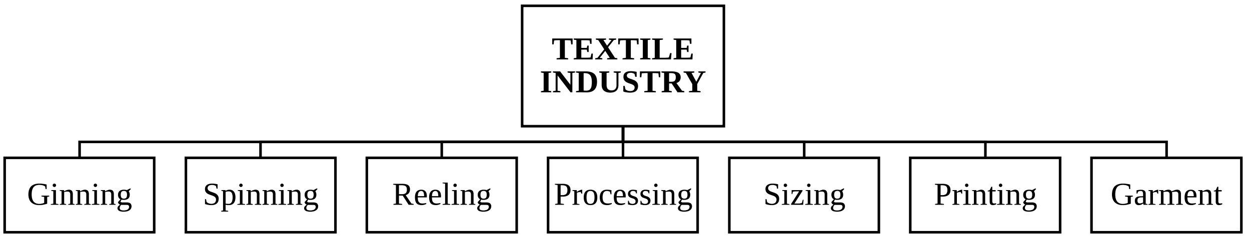
1.3 Textile Industry in Indian Economy

Textile industry is one of old and enduring industries in India, has robust presence in the economy of the nation. Textile industry holds a vital role in the countries economic development. Next to the agriculture field, it brings up the raise in the Gross Domestic Product (GDP) value of the country. It‘s contribution is comes up around 4% of country‘s GDP, 14% in the case of Industrial production, 18% of employment creation, 9% of excise collection and 16% in country‘s export. Textile industry provides 35 million people employment in India [10].

What is spinning of yarn?

The term ‘Spinning‘ simply defined as the twisting of specific or customer desired required number fibers together to form a single lenghty yarn. In other words, the process of converting natural or man made fibre into rope kind of material or filament is known as spinning [11].

The end product of spinning process is the fine continuous lengthy yarn which has the properties of making woven and knitted fabrics.



Flowchart 1.1 Textile units

1.3.1 History of spinning industry

The first ever textile machinery used in the human history was the spinning wheel. It was first developed in the India during Hindus valley civilization around 2303 B.C afterwards in 14th century it was adopted by Europeans. Since the dawn of civilization, clothing was one of the man's primary needs. This led to the spinning of fiber into yarn and the cloth weaving which finally resulted in innovation of new technologies for textile industries [12].

From its initial beginnings as a hand craft, to the mechanization of the process during the Industrial Revolution, and through into the twentieth century when a wide range of different spinning techniques was developed.

During the 1970’s, there appeared to be a heap of spinning systems, such as twist less spinning, self-twist spinning, fasciated yarns, composite yarns, wrap-spun yarns, pot spinning, continuously felted yarns; and the many possible variants in open-end spinning such as rotor, electrostatic, friction spinning, and vortex spinning (the original “Polish” system). At the same time, there were continued developments in ring spinning, with ventures into rotating ring and traveler systems, individual spindle drives, high draft systems, modified travelers, double roving spinning, and hybrid systems [13].

Timeline of Development in Spinning Industry

- 1733 Flying shuttle was invented by John kay, which improves the performance of the weaving machine in terms of speed
- 1742 First cotton mill was inaugurated in England
- 1764 Richard Arkwright invented the Water frame which was the first electrically powered textile machine
- 1770 Hargreaves pattented the spinning jenny
- 1779 Spinning mule was invented by crompton which has greater dominance over the weaving process
- 1828 Ring Spinning machine earlier called as Dansforth throstle was first invented in United states of America
- 1828/9 In the dawn of 1929 Ring frame was invented in Rhode island by John throp
- 1885 Ring frame was developed on the basis of its performance by Jencks of Pawtucket of Rhode island
- 1937 Berthelson first gave shape to the perfect open end spinning machine [14]
- 1963 Airjet spinning machine was unearthed by Du Pont de Numeros & Co [15].

1.3.2 Raw material

Ginned cotton is mainly used as the raw material in most of the spinning mill in India due to its high quality. It results in high rate of productivity. Ginning is the process of removing cotton from seed s by means machineries. Unlike hand plugged cotton ginned cotton are more clean and contain less foreign particles.

Market for Raw material

It is around thirty to thirtyone million hectare and twenty million tons of cotton are cultivated globally. United states of America, Eastern Europe, China, Sudan, India, Pakistan and Egypt are the biggest cultivators of cotton in the world.

India has the third position in cotton cultivation due to its geographical location in exact equator and soil fertility that suits for cultivation of cotton. USA and China holds the top two places in the market. Though Indian and China are in top three position in the market, they are also in the top position on importing the cotton due to the short of their domestic requirements.

Andhra Pradesh one of the four southindian state is the top cultivators of cotton in Insia. When it comes to users of the cotton as a raw material, china heads the race followed by India, Pakistan, USA and Turkey based on the usage of cotton as industrial base product.

1.3.3 Types of spinning system

The different types of spinning system generally employed from the begining stage are as follows,

1. Hand spinning
2. Mule spinning
3. Ring spinning
4. Open End (OE) spinning
    a. OE Rotor spinning
    b. OE Friction spinning
5. Air-jet spinning

1) Hand spinning system

Hand spinnind system is the mother of all spinning spinning system. It is the manual spinning method, which was used at the birth stage of spinning field. It is considered as an art of twisting twisting filaments of fiber or the process of roving wool, angora (hair of a breed of rabbit called angora), alpaca (a domestic american breed camelid), etc.,

The initial techniques were handled without any equipment or tool, instead a thin cluster of fiber are streched by one hand and twisted with two fingers in the other hand. For having more twist, the yarn would be fastened to a rod shaped stone called whorl, which was twisted by hand and let to drop vertically to generate twisting torque.

2) Mule spinning

Mule spinning is amechanical spinning manchine which is used to produce extremely thin yarn by drawing and twisting yarn, then winding the resultant yarn in spindle or bobbin.

3) Ring spinning

Ring spinning is a process in which yarn is twisted by revolving the traveler. This technology remains unchanged for a long period of time. But some significant replacements were made over the machine incase of material used in fabrication of machine to improve its performance. To reduce the cost of doffing longer frame were introducted. To improve enhancement in adoption automation a combination of spinning frame and link winders are integrated with the machinery.

4) Open end spinning

Open-end (OE) spinning system which is also called as breaker spinning system in which the raw material (input material) is highly drafted to the individual fibre state. The output fibre is subsequently collected onto the tail end of the root yarn that is rotated to twist the filament into yarn structure to form new lenghty yarn. Since the input yarn is continuously fed into the machine, the spinning has also become continuous to collect the open end of previous yarn.

a) OE Rotor spinning

OE Rotor spinning is a type of OE spinning system which uses a rotor to collect the individual filament into yarn. The filament enters into the spontaneously spinning rotor and are served around its circumference then thereby centrifugally held by a bobbin. The yarn is cut down from the wall of the rotor and because of its rotation the twist is generated.

This system is also called ring spinning system was found out a long before when the rotor spinning system was introduced into commercial market in 1967. In this system, the twist insertion rate is depending on the rotational speed of the packing system. It is due to the rapid fiber flow during spinning. Countless number of attempts have been made since before the dusk of the 19th century, for the debut of a break into the flow of fiber in which the end of yarn needs to be rotated to insert a twist. An absolute high twisting speed can thus be achieved.

b) OE Friction spinning

This is the another type of OE spinning system in which an external surface of two rotating rollers are used to collect and twist the filament into yarn. Here at least one of the roller is perforated to avoid the formation of heat between the rollers which is produced by the friction. In here the twisting is appeared at the nip of the rollers end because of comparatively high difference between the yarn and diameter of the roller. High velocity of rotation is achieved by the friction which created between the rollers surface and the yarn.

5) Air-jet spinning

It is very similar to the OE spinning, instead of ring and rollers here in this system a stream high speed air produced by an air compressor is used to collect and twist the filament into yarn and this system is known for its name Air-jet spinning system.In this system the produced air is blown through the tiny arrangements of holes which are tangential to the surface of the yarn, which made the yarn to rotate over the bobbin or spindle. In present days, majority of the spinning mill uses this system to produce fascinated yarns. To produce yarns with more controlled characteristics but with complex structure two opposing twist of air jet can be used in operation.

1.3.4 Process involved in General spinning system

In general, spinning system followed by majority of the spinnig mill in India are as follows.

1. Blow room
2. Carding
3. Combing
4. Drawing
5. Ring Frame
6. Cone winding
7. Packing

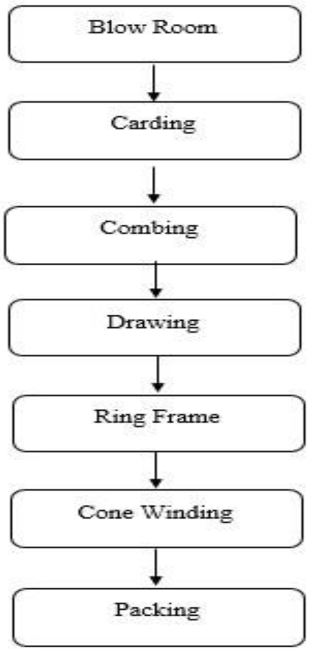


Fig.2.2 General Spinning System

a. Blow Room

Blow room is the begining stage of the spinning process. Here in the blow room the bale of cotton get seperated and mixed with all other cotton and fed into the machine. Inside the blow room machine a stream of high velocity air is generated from the two stage or single stage air compressor (depends upon the specification) to clean the cotton from the dirt and remove away the foreign particle like stone dead insects, cotton seeds, etc.,. The name blow room is given because of its way of working

Operations in the Blow room

The list of operation involved inside the blow room are given below,

1. Opening
2. Cleaning
3. Dust removal
4. Blending
5. Even feed of material to the card

b. Carding

Carding is mechanism which untangle, swab and mixes the fibres to create a continuous lengthy web or sliver which will be suitable for subsequent process. It can be achieved by feeding the yarn inbetween differentially moving surface covered with cloths. It splits up the locks anddisordered cluster of fibre then aligns each and every single fibre parallel with each other.

Carding process

The blended and opened fibre the undergoes carding process. The following are the functions of carding process,

- Seperation of fiber clumps into Single yarn
- Mixing of fibres to get mean variation in thhe characteristics of fibre
- Forming similar web of uniform weight per unit area

c. Combing process

This process is carried out on the fibre to make it very fin, smooth, strong and more uniform.Combing process is usually braces to high grade, lengthy natural fibre. Now-a-days, this process is used to enhance the quality of the yarn, in addition to that combed cotton needs lesser twist than carded cotton yarn.

Operations of combing process

1. Eliminating exactly pre-determined amount of small fibres
2. Eliminating impurities
3. Removing excess neps in the yarn
4. Providing maximum possible evenness
5. Generating lengthy and parallel fibres

d. Drawing

It is operation done on the sliver to blend, double and level it. In this process slivers are extended or stretched while passing through the group of roller pairs. Each of the roller pair are rolling fater than the previous one. This alllows combing, drwing stretching of several slivers to make them robust and uniform. In sophisticated drawing sets there are three passages of pin drafting and roving process.

Objective of drawing

1. The main aim of this process is to,
2. Straighten the crimped, hooked and curled yarn or fibre clusters
3. Paralleling the fibre
4. Optimizing fibre by drafting and doubling
5. Decreasing the weight per length unit of sliver
6. Extracts impurities from sliver
7. Mix raw material of same coil precisely

e. Ring spinning frame

It is a process that twists and drafts the yarn when the yarn is passing through a small metal device travelling spontaneously around a ring in the operation of winding the yarn over the spindle or bobbin

This technology is conventional and very simple. The productivity and demand in present days creates a lot of pressure to optimize the process and machine parameters by technologists.

f. Cone Winding

Cone winding is the final stage of the spinning process. In present scinario , good winding is the reflection of the manufacturer in the market. It is necessary for all the personnels in the handling department to clearly understand the importance of this process. Yarn winding thus can be viewed simply as a packaging process which forms a link between begining to the end process by means quality.

g. Packing

It is the End process of the spinning mill in which the finished product in the cone is packed in whole amount as desired by the customer with specified packing material.

2. SHOP FLOOR

2.1 Layour of Ground Floor

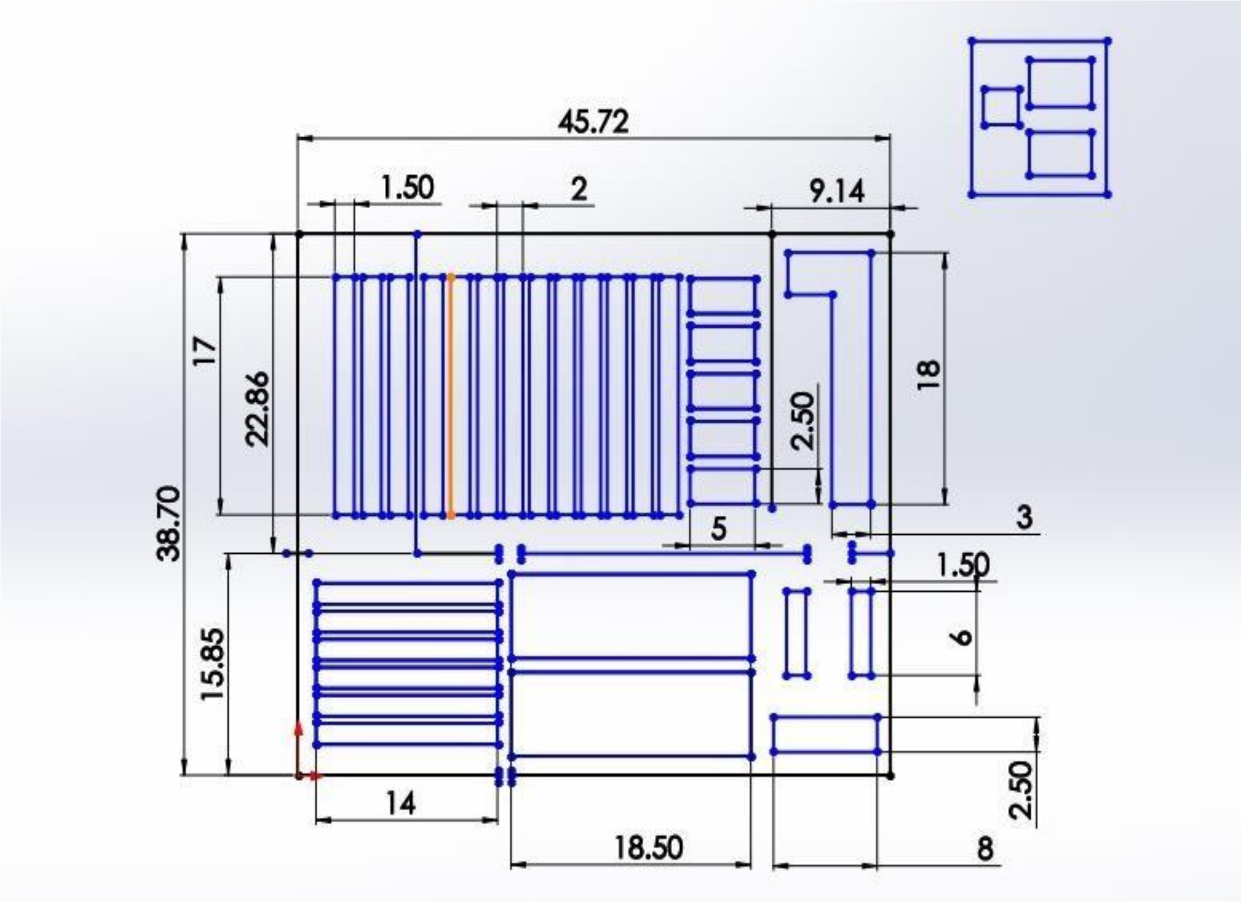


Fig 2.1 Ground Floor (All Dimensions are in meter)

In Laxmi Sankar Spintex, the production unit is located in the ground floor (first floor). It consist of one blow room machine, which is located in the top right corner of Figure 2.1. Below the blow room, Drawing machine (Breaker- 2 Nos. and Finsher- 1 No.) is located in the production line. Besides that drawing machine two simplex machines are setup in the line according to the system. In the left end of the production unit twenty number of ring spinning machine are planted, then to the left side blow room five number of carding machines are placed which are facing parallel to each other in lengthwise and are perpendicular spinning machine in breadth wise.

2.2 Layout of Top floor

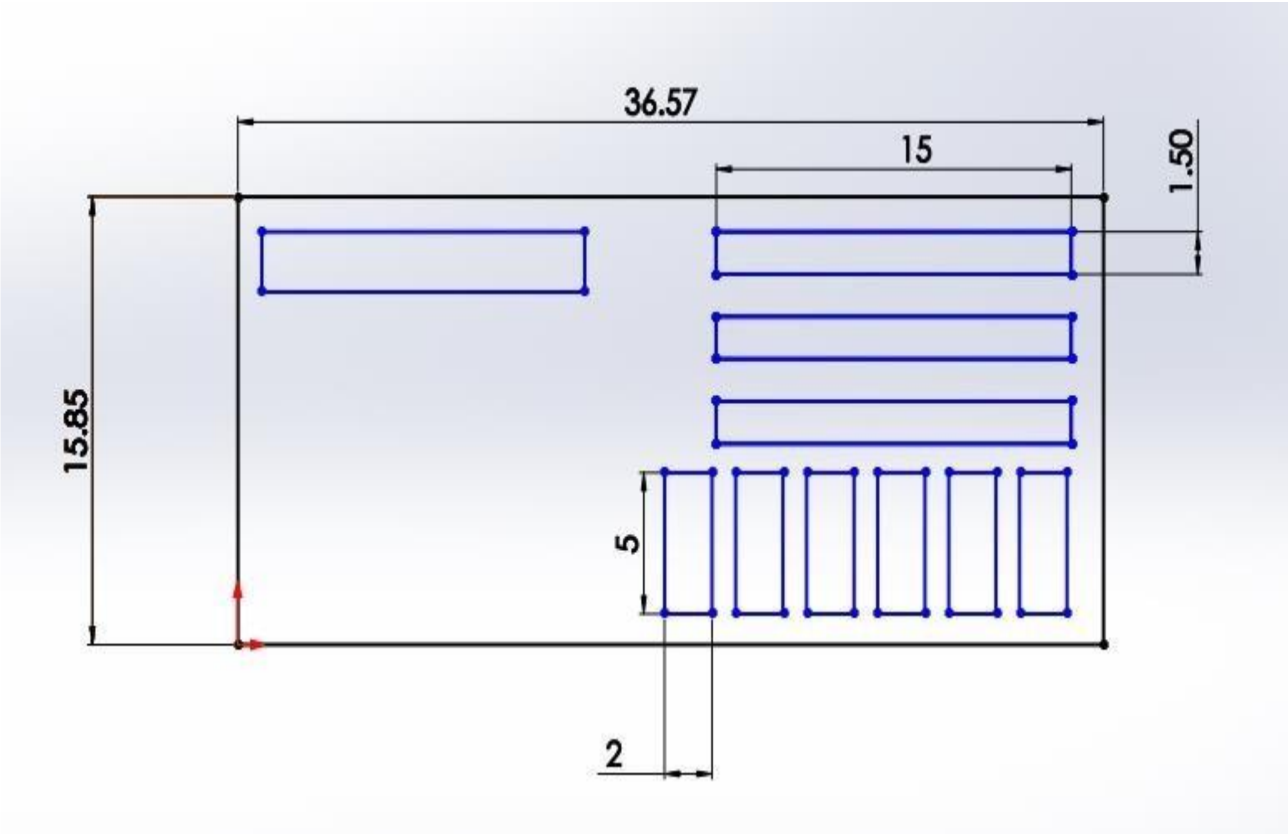


Fig. 2.2 Top floor (All Dimensions are in meter)

The top floor (Second floor) acts as the packing unit of Laxmi Sankar Spintex. Here the spunned cotton fibre are carried out by the elevator and fed into the cone winding machine. After yarns were wounded over the bobbin or spindle, it is then get into the packing machine for further packing process.

In the Figure 2.2, the space allocation of machineries are clearly represented. Four number of winding machines are located in the top of the layout and six packing machines are in the bottom.

The area of the top floor is comparatively smaller than the area of the first floor, since only few number of machines are placed in this floor

3. COST ESTIMATION ANALYSIS

3.1 Conventional Machine System

Cost estimation of Conventional Machineries in Laxmi Sankar Spintex is provided in the following table

Table 3.1 Cost estimation for Machineries

Machine		Motor Specification (HP)	Cost (RS)	Number	Total Cost (RS)
Blow room		45	1700000	1	1700000
Carding		10	600000	5	3000000
Drawing	Breaker	10	100000	2	200000
	Finisher	10	1500000	1	1500000
Simplex		15	2000000	2	4000000
Spinning		20.5	72000	20	1440000
Cone winding		10	670000	3	2010000
Air compressor		7.5	96000	2	192000
				Overall Cost	**14,042,000 (€187,226.67)**

The Conventional machine system used in Laxmi sankar spintex are refurbished, which can produce 2000 kg of carded yarn per day. The Overall cost of the conventional production line is Rs. 14, 042,000 which values approximately € 187,226 (At an exchange rate of € 1 = Rs 75). These conventional machines are less efficient and consumes comparatively more energy to produce 2000 kg of yarn per day. It also occupies more working space which affects the work ergonomics of the labour and requires more number of labor

List of employee details in both production and Non-production line of Laxmi sankar spintex are provided in the following tables,

Table3.2 Employee Details in production line

Production Line		**No. of Hours/Shift**	**No. of Shift/Day**	**No. of Employee/ Shift**	**No of Employee Per Day**
Mixing		8	3	1	3
Blow room		12	3	2	4
Carding		8	3	1	3
Drawing	Breaker	8	3	1	3
	Finisher				
Simplex		8	3	2	6
Spinning		8	3	13	39
Cone winding		8	3	18	24
Packing		8	1	2	2
			Total Employee		**84**

These machine systems in the conventional production line requires comparatively more number of workers due to more number of machines. Especially the Spinning machine system is occupying almost around 50% of employee, which values 39 in number in the production line and also most of the work space in the shop floor, because of high in number. The total working employee in the production line is 84 in number. Total number of employee in a process is calculated the product of number of shift per day and number of employee per shift. Since, there is a rise in labor crisis in the surroundings of Laxmi Sankar Spintex, getting such a number of employees become an issue for management to engage the industry with production in all the working days.

Details of employee in non-production line are provided in the following table

Table 3.3 Employee Details in Non-production line

Non Production line	**No. of hours/ shift**	**No. of shifts/ Day**	**No. of. Employee/ Shift**	**No. of Employee/ day**
Supervisor	8	3	1	3
Quality control	12	2	1	2
Fitter	12	2	1	2
Electrician	12	2	1	2
Cashier	8	1	1	1
Spinning Master	8	1	1	1
Security	8	3	1	3
		Total Employee		**14**

Non-production line employees are mostly skilled employee like spinning master, whom acts as the head of all the employee in both production and non-production line. Followed by spinning master, Supervisor is the highest possession in the management hierarchy.

In this hierarchy of non-production line employees, securities are non-skilled employees of all the employees. The total number of employee in the non-production line are 14 in number per day.

Wage Estimation of Conventional production line employee are listed in the following table

Table 3.4 Wage Estimation of employee- Production line

Production line		**No. of employee per day**	**Salary per employee/ day (Rs)**	**Salary per employee/ Month (Rs)**	**Salary per month of all employee (Rs)**
Mixing		3	250	6,250	18,750
Blow room		4	250	6,250	25,000
Carding		3	250	6,250	18,750
Drawing	Breaker	3	250	6,250	18,750
	Finisher				
Simplex		6	250	6,250	37,500
Spinning		39	250	6,250	243,750
Cone winding		24	250	6,250	150,000
Packing		2	250	6,250	12,500
			Total labour wages		**525,000** **(€ 7,000)**

The wage provided to the employees working in the production line is Rs 250/ day, which is approximately € 3/day (at an exchange rate of €1= Rs 75). The monthly salary of an employee is Rs 6,250 (€ 83/ month). The total labor cost in production line incurred to the industry is Rs 525,000 (€ 7000).

Wage estimation of Non-production line employee are as follows

Table 3.5 Wage Estimation of Non Production line

Non Production line	No. of Employee/ day	Salary per employee/ day (Rs)	Salary per employee/ Month (Rs)	Salary per month of all employee (Rs)
Supervisor	3	250	6,250	18,750
Quality control	2	250	6,250	12,500
Fitter	2	250	6,250	18,750
Electrician	2	250	6,250	18,750
Cashier	1	300	7,500	7,500
Spinning Master	1	1,000	25,000	25,000
Security	3	250	6,250	18,750
		Total wages of all Employee		**107,500 (€ 1,433)**

In the Non-production line, the highly paid employee is the spinning master with Rs. 1000 per day, which is Rs. 25,000/ month (€ 333/ month). Followed by spinning master cashier is paid with Rs. 300/day (€ 4/day) and per month is Rs. 7500 (€ 100/ month). Apart from these two employee, remaining employees are paid with Rs. 250/ day (€ 3.33/day)

The total employee wages per month incurred by the non-production employee to the management is Rs. 107,500/month (€ 1433/month)

Estimation of Energy Consumption for Conventional Machineries are provided in the following table

Table 3.6 Cost Estimation of Energy Consumption

Machine		**Power consumption Per kg Production (kwh)**
Blow room		0.12
Carding		0.20
Drawing	Breaker	0.02
	Finisher	0.04
Simplex		0.12
Spinning		3.05
Cone winding		0.18
Compressor		0.07
Automatic plant humidifier		0.80
Lighting and miscellaneous		0.12
	Total Power consumption/kg (kwh)	**4.72**

The total power consumed in the production line of the industry is 4.72 kwh/kg of production of yarn. In that consumption, spinning machine consumes more power when compared to other machines, since these machine are high in number in the production line.

3.2 Modern Machine System

Cost of Modern Machine system is listed in the are given below table

Table 3.7 Details of Machine system

Machine		Motor specification (HP)	Cost (RS)	Number	Total cost (RS)
Blow room		50	2500000	1	2500000
Carding		15	2500000	3	7500000
Drawing	Breaker	15	100000	1	100000
	Finisher	5.5	2500000	1	2500000
Simplex		17.5	2700000	2	5400000
Spinning		80	4200000	6	25200000
Cone winding		50	10000000	1	10000000
Air compressor		50	96000	2	192000
				Overall Cost (RS)	**53,392,000 (€711,893.33)**

The cost of the modern machine system is costly when compared to conventional machine system. From the investment data, it is clearly showed that the total cost of Rs 53,392,000 (€ 711,893.33) is incurred to the company. But, it saves a lot of working space, time and labor in the production line to the company. The specification of individual machines in this system is also quite high when compared to the conventional machine system.

Labor calculation details of Modern Machineries are provided as follows,

Table 3.8 Labour Estimation (Production line)

<table>
<tr><th colspan="2">Production Line</th><th>No. of Hours/Shift</th><th>No. of Shift/Day</th><th>No. of Employee/ Shift</th><th>No of Employee Per Day</th></tr>
<tr><td colspan="2">Mixing</td><td>7</td><td>3</td><td>1</td><td>3</td></tr>
<tr><td colspan="2">Blow room</td><td>11</td><td>2</td><td>1</td><td>2</td></tr>
<tr><td colspan="2">Carding</td><td rowspan="3">7</td><td rowspan="3">3</td><td rowspan="3">1</td><td rowspan="3">3</td></tr>
<tr><td rowspan="2">Drawing</td><td>Breaker</td></tr>
<tr><td>Finisher</td></tr>
<tr><td colspan="2">Simplex</td><td>7</td><td>3</td><td>1</td><td>3</td></tr>
<tr><td colspan="2">Spinning</td><td>7</td><td>3</td><td>6</td><td>18</td></tr>
<tr><td colspan="2">Cone winding</td><td>7</td><td>3</td><td>2</td><td>6</td></tr>
<tr><td colspan="2">Packing</td><td>7</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td colspan="3"></td><td colspan="2">Total Employee</td><td>37</td></tr>
</table>

The total number employee required to operate the machine system is 37 in number, which is nearly 50% less when compared to conventional machine system. This saves a descent amount of labor cost required to the company. Here, the shift time for the labor is also reduced by 1 hour per each shift which can be used as shift changing time for the employee. In the conventional machine system, there is no shift changing time since the shift time was 8 hours/shift and three shifts per day.

Analysis of labor estimation details of Non-production employee are provided in the below table

Table 3.9 Labour Estimation (Non- Production line)

Non Production line	No. of hours/ shift	No. of shifts/ Day	No. of. Employee/ Shift	No. of Employee/ day
Supervisor	8	3	1	3
Quality control	12	2	1	2
Fitter	12	2	1	2
Electrician	12	2	1	2
Cashier	8	1	1	1
Spinning Master	8	1	1	1
Security	8	3	1	3
		Total Employee		**14**

The total number of employees in the non-production line is as same as the conventional machine system, since the machines in the production only is changed in the company.

Wage Estimation details of production line employee are listed in the table given below,

Table 3.10 Salary estimation of Production line employee

Production line		**No. of employee per day**	**Salary per employee/ day (Rs)**	**Salary per employee/ Month (Rs)**	**Salary per month of all employee (Rs)**
Mixing		3	250	6,250	1,8750
Blow room		2	250	6,250	12,500
Carding		3	250	6,250	1,8750
Drawing	Breaker				
	Finisher				
Simplex		3	250	6,250	1,8750
Spinning		18	250	6,250	112,500
Cone winding		6	250	6,250	37,500
Packing		2	250	6,250	12,500
			Total labour wages per month		**231,250 (€ 3,083)**

Since the number employee in the production line is reduced by around 50%,the salary cost incurred to the company is also reduced by around 50% to the company, which is Rs, 231,250 per month (€ 3,083).

Analysis of cost estimation details of Non-production employee are provided in the below table,

Table 3.11 Salary estimation of Non-production line employee

Non Production line	**No. of Employee/ day**	**Salary per employee/ day (Rs)**	**Salary per employee/ Month (Rs)**	**Salary per month of all employee (Rs)**
Supervisor	3	250	6,250	18,750
Quality control	2	250	6,250	12,500
Fitter	2	250	6,250	12,500
Electrician	2	250	6,250	12,500
Cashier	1	300	7,500	7,500
Spinning Master	1	1000	25,000	25,000
Security	3	250	6,250	18,750
		Total Employee wages per month		**107,500 (€ 1433.33)**

Since there is no change made in the non-production line, the number of employee is also as same as the conventional machine system, there is no change in the salary cost incurred to the company, which is Rs. 107,500 (€ 1433.33)

Energy Consumption Estimation for Modern Machine are given in the table below,

Table 3.12 Energy Consumption Estimation for Modern Machines

Machine		Power consumption per kg Production (kwh)
Blow room		0.10
Carding		0.27
Drawing	Breaker	0.20
	Finisher	0.03
Simplex		0.12
Spinning		2.60
Cone winding		0.33
Compressor		0.36
Automatic plant humidifier		0.80
Lighting and miscellaneous		0.09
	Total Power consumption/kg (kwh)	**4.72**

The total energy consumption of set of modern machine system is as same as the conventional machine system, which does not make any improvement in the single factor (energy) productivity

3.3 Combinational Set of Conventional and Modern Machine System

Cost of combination of Conventional and Modern Machineries are listed in the following table. In this combinational set of Machine system, the machineries are selected by the management on the basis of return value of the conventional machine system with some percentage of depreciation cost in the market, working condition of the machine, labor required for operation, capacity of the motor, workspace occupancies and some criteria which are confidential with the management

Table 3.13 Cost Estimation for combinational set of Machineries

Machine		Motor specification (HP)	Cost (RS)	Number	Total cost (RS)
Blow room		50	2500000	1	2500000
Carding		10	600000	5	3000000
Drawing	Breaker	10	100000	2	200000
	Finisher	10	1500000	1	1500000
Simplex		17.5	2700000	2	5400000
Spinning		80	4200000	6	25200000
Cone winding		50	10000000	1	10000000
Air compressor		7.5	96000	2	192000
				Overall Cost (RS)	**47,992,000 (€ 639,893.33)**

In the combinational set of machine system, except carding and drawing machine all other machines are belongs to modern machine system. By selecting this set of machine system the company can save up to Rs. 5,000,000 which is around € 75,000.

Table.3.14 Labour Estimation for combinational set (Production line)

Production Line		No. of Hours/Shift	No. of Shift/Day	No. of Employee/ Shift	No of Employee Per Day
Mixing		7	3	1	3
Blow room		11	2	1	2
Carding		8	3	1	3
Drawing	Breaker	8	3	1	3
	Finisher				
Simplex		7	3	1	3
Spinning		7	3	6	18
Cone winding		7	3	2	6
Packing		7	1	2	2
			Total Employee		**40**

The total number of labor required for the combinational set of production line machine system is 40, which is almost 50% less when compared to conventional system and increased by 3 when compared to modern machine system.

Table 3.15 Labour Estimation for combinational set (Non-Production line)

Non Production line	**No. of hours/ shift**	**No. of shifts/ Day**	**No. of. Employee/ Shift**	**No. of Employee/ day**
Supervisor	8	3	1	3
Quality control	12	2	1	2
Fitter	12	2	1	2
Electrician	12	2	1	2
Cashier	8	1	1	1
Spinning Master	8	1	1	1
Security	8	3	1	3
		Total Employee		**14**

The total number of labor in the non-production line in the combinational set is also as same as the other two machine system, since there is no changes are done in the non-production line.

Table 3.16 Total labour wages (Production line)

Production line		No. of employee per day	Salary per employee/ day (Rs)	Salary per employee/ Month (Rs)	Salary per month of all employee (Rs)
Mixing		3	250	6,250	18,750
Blow room		2	250	6,250	12,500
Carding		3	250	6,250	18,750
Drawing	Breaker	3	250	6,250	18,750
	Finisher				
Simplex		3	250	6,250	18,750
Spinning		18	250	6,250	112,500
Cone winding		6	250	6,250	37,500
Packing		2	250	6,250	12,500
			Total labour wages		**250,000 (€ 3333.33)**

The labor salary per month in the non-production line is quite high when compared to modern machine system's production line and very low when compared with conventional system

Table 3.17 Total labour wages (Non-Production line)

Non Production line	**No. of Employee/ day**	**Salary per employee/ day (Rs)**	**Salary per employee/ Month (Rs)**	**Salary per month of all employee (Rs)**
Supervisor	3	250	6,250	18,750
Quality control	2	250	6,250	12,500
Fitter	2	250	6,250	12,500
Electrician	2	250	6,250	12,500
Cashier	1	300	7,500	7,500
Spinning Master	1	1,000	25,000	25,000
Security	3	250	6,250	18,750
		Total Employee wages per month		**107,500 (€ 1,433.33)**

The total labor cost of non-production line is as same as the other machine system, since there is no change made in the non-production line

Energy Consumption estimation for combination of Modern and Conventional Machineries

Table 3.18 Energy Consumption Estimation

Machine		Power consumption per kg Production (kwh)
Blow room		0.10
Carding		0.20
Drawing	Breaker	0.02
	Finisher	0.04
Simplex		0.12
Spinning		2.60
Cone winding		0.33
Compressor		0.07
Automatic plant humidifier		0.80
Lighting and miscellaneous		0.12
Total Power consumption/kg (kwh)		**4.4**

The power consumption is comparatively low with conventional and modern machine system. Since both modern and conventional system requires 4.72 kwh per kg of production and it is 0.32 kwh higher than the combinational set. When the analysis is made for 200kg of production, it is 640 units per day of production. Financially it is a big saving for the company to select this set of machine system for production line. It also increases the all factor productivity and energy productivity.

3.4 Power consumption Cost

As per the tariff revision of Tamilnadu Generation and Distribution Corporation Limited (TANGEDCO) is Rs. 6.35/ kwh [16]

Auro Mira Energy Company Ltd., is nearby located private power generation unit which offers power supply services produced by three different forms of renewable energy source and its power tariff details are as follows [17],

- Biomass energy Rs. 6.6/ kwh
- Windmill energy Rs. 3.75/ kwh
- Solar energy Rs. 3.5/ kwh

Cost estimation of power consumption (Single factor Productivity Input factors)

Table 3.19 Power Consumption charges per kg of production

Type of Production System	**Consumption of electricity per kg of production (kwh)**	**Cost of Electricity consumption by different sector and source of energy (Rs/kwh)**			
		TANGEDCO	**AURO MIRA Energy Co.**		
			Biomass	**Windmill**	**Solar**
Conventional	4.72	29.97	31.15	17.7	16.52
Modern	4.72	29.97	31.15	17.7	16.52
Combination	4.4	27.94	31.15	16.5	15.4

The above mentioned table 3.19 clearly shows that the cost incurred for production of 1 kg of cotton yarn by implementing different source of energy. Of them all, Combinational machine system with solar energy incurs less cost for production

Table 3.20 Power consumption charges for 2000 kg pf production

Type of Production System	Electricity consumption per day of production (2000 kg) in kwh	Cost of Electricity consumption by different sector and source of energy (Rs/kwh)			
		TANGEDCO	AURO MIRA Energy Co		
			Biomass	Windmill	Solar
Conventional	9440	59,944	62,304	35,400	33,040
Modern	9440	59,944	62,304	35,400	33,040
Combination	8800	55,889	58,080	33,000	30,800

3.5 Raw material costs

Government fixed Minimum support price (MSP) for purchasing cotton from farmer is 3800 to 4200 Rs/quintal in India [18]. Average cost is taken as Rs. 4000/quintal (€53/quintal). One kilogram of cotton is Rs.40 (€0.53/kg)

Where, 1 quintal= 100 Kg

Raw material (2400 kg of cotton/day) Cost for production of 2000 kg of yarn per day is Rs. 96,000/day (1,280 €/day), where € 1 is taken as Rs. 75 as an average exchange rate.

3.6 Production cost

Estimation for 2000 kg of yarn by Different type of Machine Set (All factor productivity Input factors)

Table 3.21 Production cost estimation

Power Source	**TANGEDCO**		**AURO-MIRA Energy Co.**					
			Biomass		**Wind mill**		**Solar**	
Type of Machine System	**RS**	**EUR**	**RS**	**EUR**	**RS**	**EUR**	**RS**	**EUR**
Conventional	180,244	2,403.25	182,604	2,434.72	155,700	2,076	153,340	2044.53
Modern	168,144	2,241.92	170,504	2,273.38	143,600	1914.67	141,240	1883.2
Combinational Set	166,189	2,215.85	168,380	2,245.07	143,300	1,910.67	141,100	1881.33

4. PRODUCTIVITY ANALYSIS

4.1 All factor Productivity

All factor productivity is the ratio between the quantity or value of the output factor to the sum of all the input factor (in this case production cost is taken as input factor)

Table 4.1 All Factor productivity

Type of Machine System	**Power Source**			
	TANGEDCO.	AURO MIRA ENERGY Co.		
		Bio mass	Wind mill	Solar
Conventional	1.936	1.911	2.241	2.280
Modern	2.075	2.046	2.430	2.470
Combinational set	2.100	2.073	2.435	2.475

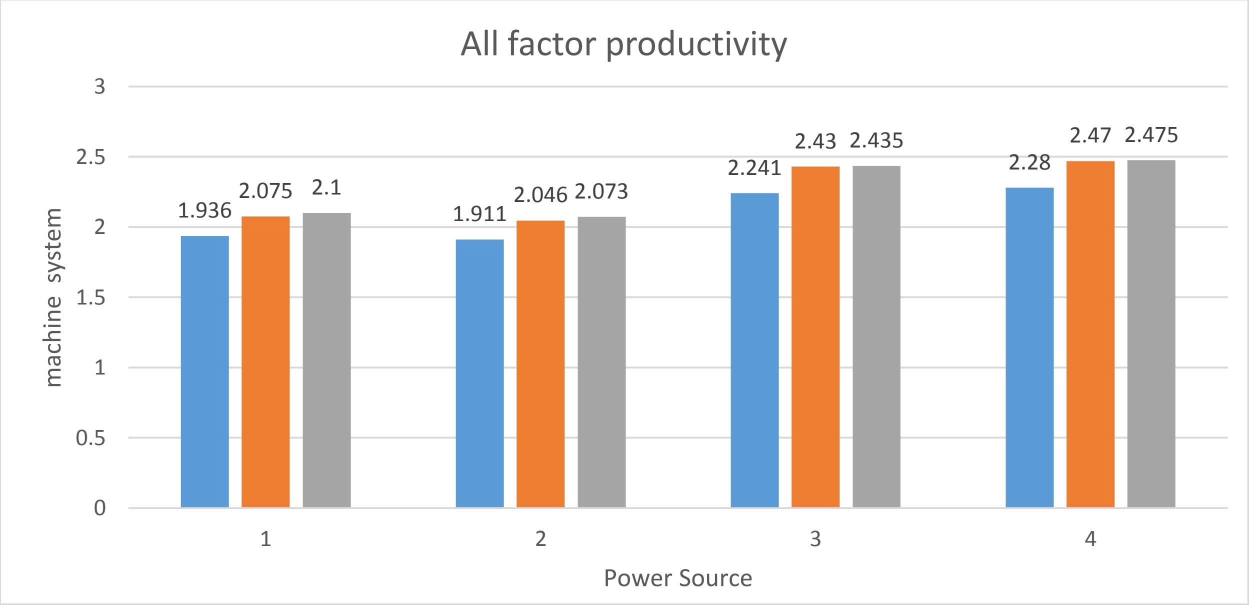


Fig 4.1 Comparison of All factor productivity

4.2 Single factor Productivity

Single factor productivity is based on the individual input factors like labor, machine, energy and time. Single factor productivity can be calculated by means of two factors, which are financial form and physical form.

Labor productivity

Labor productivity can be calculated by means of both labor charges and labor time. Labor charges comes under the concept of single factor productivity in financial form, whereas labor time productivity comes under the concept of physical form of single factor productivity, since it deals with number of working employee.

The following table is based on the physical form, which is analyzed on basis of labor hours requires for the production of yarn.

Table 4.2 Labour productivity

Type of Machine system	Number of labor hours	Labor productivity (kg/ labor hour)
Conventional	960	2.08
Modern	267	7.49
Combinational set	294	6.8

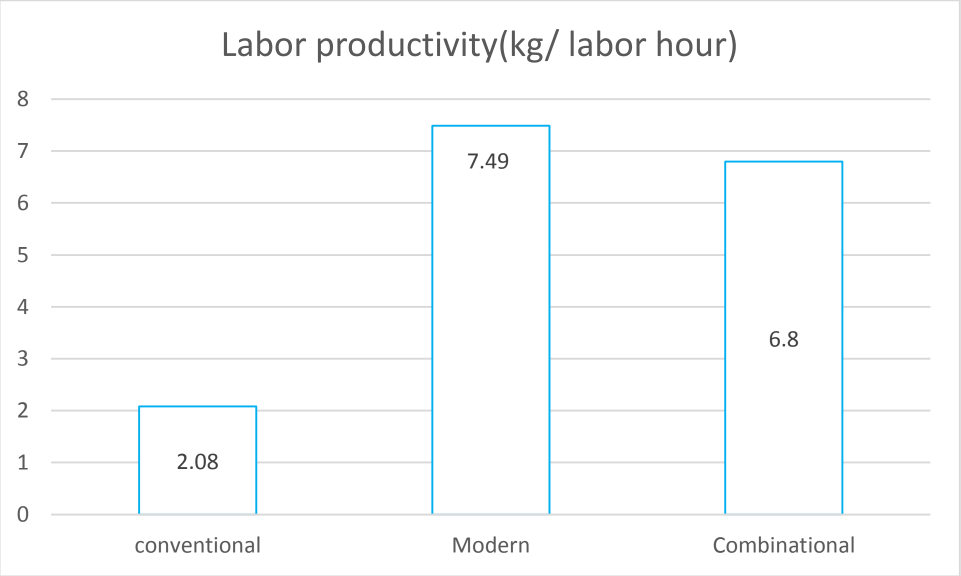


Fig 4.2 Comparison of labor productivity

Energy Productivity

In energy productivity, the output factor is same as all other productivity measurement, which can be either quantity or value of the output and the input factor should be either value or energy consumption per quantity. In this case energy productivity is analyzed by means of physical quantity of output.

Table 4.3 Energy Productivity

Type of Machine System	Energy consumption (kwh)	Energy Productivity (kg/kwh)
Conventional	4.72	0.212
Modern	4.72	0.212
Combinational Set	4.4	0.227

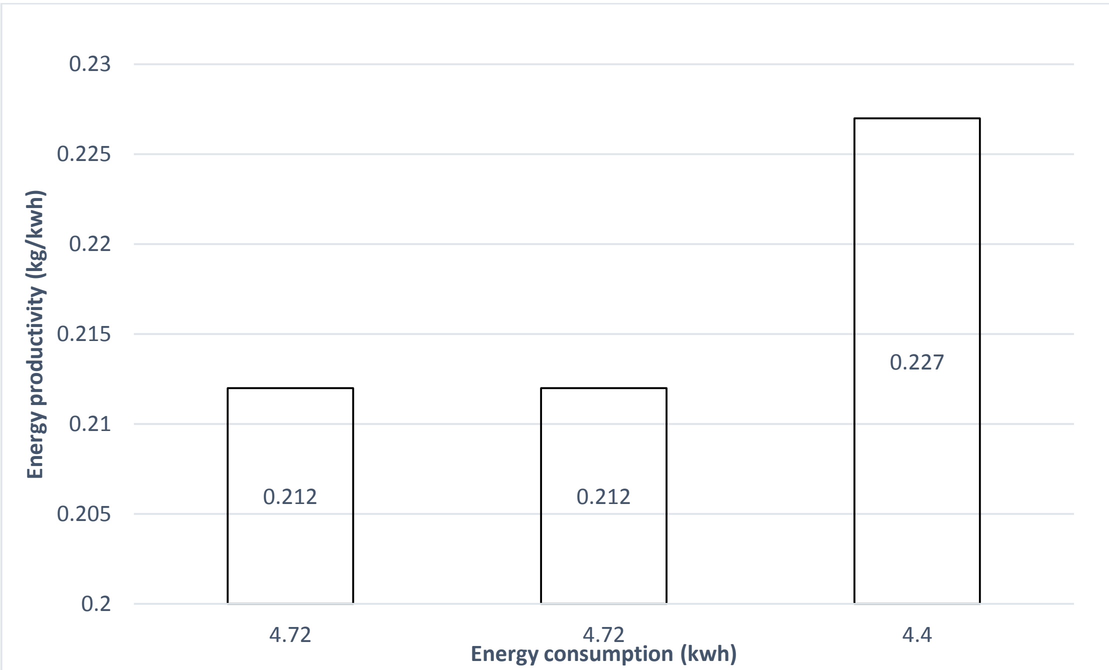


Fig 4.3 Comparison of Energy productivity

5. MODEL CALCULATION

The following modal calculation is for 2000 kg of yarn production per day by conventional machines system. The modern machineries and combinational set calculation are also similar to the conventional machine system calculation. [19]

1) Raw material cost

Raw material cost for manufacturing 2000 kg of yarn per day is the product of cost of raw material and the quantity of raw material used for the production.

Raw material cost = 40*2400 (Rs/kg *kg/day) [since 2400 kg of cotton is consumed for 2000 kg of yarn]

= Rs. 96,000/day (€1,280/day) [Where, € 1 = Rs. 75]

2) Power consumption cost

Power consumption cost is the product of power consumed by the machineries for the quantity of yarn manufactured and the cost per unit (kwh) of electricity.

Power consumption cost = 9440*6.35 (kwh/day * Rs/kwh)

[Data are taken from conventional set with TANGEDCO]

= Rs. 59,944/day (Euro 799.25/day)

3) Labor calculation

a. Labor working in a process is calculated by the product of number of labors per shift and total number of shift per day. Data is taken from Conventional Blow room process.

{Number of Labours working on a process per day} = {Number of shifts per day} * {Number of labours per shift}

= 2*2

Number of labors working in process/day = 4 labors/day

b. Total number of employees working in the industry per is calculated by the summation of all the employees in both production and Non- production line. Data are taken from Conventional process.

$$\text{Total employee in Industry} = \sum \left[\text{Employees in production and Non-production line} \right]$$

= (3+4+3+3+6+39+24+2+3+2+2+2+2+1+1+3)

Total employee in Industry = 98 employees/day

c. Labor salary per day is fixed by the Management of Laxmi Sankar Spintex as per the demand or availability of the man power in the surroundings of the Industry. In general, at present the management pays Rs. 250/day (€ 3.33/day) for Skilled and semi-skilled labor, Rs. 300/day (€ 4/day) for cashier and Rs. 1000/day (€ 13.33/day) for spinning master. The total salary paid by the management to its employee is Rs. 24,300/day (€ 324/day).

4) Production cost

Production cost is the Sum of labor cost, raw material cost and power consumption cost. Example is given for TANGEDCO power cost

Production cost = 24,300+59,944+96,000

= Rs. 180,244/day (€ 2403.25/day)

5) Productivity

a. All factor productivity is the ratio between the quantity or value of the output factor to the sum of all the input factor (in this case production cost is taken as input factor)

Value of output product is the market value of the yarn manufactured, which is Rs. 99/kg to Rs. 250/kg. For analysis, average value of Rs. 174.5/kg [20] is considered and for input factor, production cost is taken for calculation.

All factor productivity = (2000*174.5) / 180,244

= 1.94

b. Single factor labor productivity is the ratio between the quantity of output per day to the labor hours per day

Single hour labor productivity = [2000 (kg/day)] / [960 (labor hour/day)]

= 2.08 kg/ labor hour.

c. Single factor energy productivity is the ratio between the quantity of output produced per day to the energy consumed per day

Single factor Energy = [2000 (kg/day) / (2000*4.72) (kg/day * kwh/kg)]

= 0.21 kg/kwh

CONCLUSION AND RECOMMENDATION

1) All factor productivity is improved by 6.69% in terms of Modern Machine system and combinational system‘s productivity is by 7.8% over Conventional machine system.
2) Labor productivity (based on labour hour per day) is improved by 72.23% for Modern system and for Combinational System, it is improved by 69.41% when compared to Conventional Machine system.
3) Energy productivity (in terms of physical value) is improved by 7.1% in Combinational set of Machine system over Conventioal System, when it comes to Modern machine system the power productivity remains same, since same amount of energy is consumed to produce 2000 kg of yarn per day. Application of financial value in the productivity analysis may bring a descent improvement in the energy productivity.
4) Implementation of new machine system reduced the production time by one hour between each shift of production in all the process in production line which reflects the improvement in the labor productivity. It also brings up a change in shopfloor ergonomics by providing some free space in it.
5) By selecting suitable source of energy supply which inccur less cost per kilowatt of energy consumption for the production line may bring some changes in the cost incurred to production line at the rate of a descent amount and also improves the energy productivity in terms of financial form.

REFERENCE

[1] MICHEL LESEURE, "*Key Concepts in Operation Management*", Sage publications, Published year: 2010

[2] HASSAN HOSSEINI-NASAB, MOHAMMAD DEHGHANI, and AMIN HOSSEINI-NASAB, *"Analysis of Technology Effectiveness of Lean Manufacturing Using System Dynamics".* June 2013.

[3] KRAFCIK, JOHN F. "*Triumph of the Lean Production System*". Sloan Management Review 30, 1988

[4] MOHAMMED SUFIAN ABUSHAABAN *"Waste Elimination as the First Step for Lean Manufacturing"*, April, 2012

[5] RICKY SMITH, BRUCE HAWKINS*," Lean Maintenance – Reduce costs, Improve Quality and Increase Market Share*", Published year: 2004

[6] PETER HINES NICK RICH, "*The seven value stream mapping tools*", International Journal of Operations & Production Management, Vol. 17, 1997

[7] RAWABDEH, I.A. "*A model for the assessment of waste in job shop environments*" on International Journal of Operations and production Management, 2005

[8] KHALIL A. EL-NAMROUTY, MOHAMMED S. ABUSHAABAN International Journal of Economics, Finance and Management Science, "*Seven Wastes elimination targeted by lean manufacturing case study "Gaza strip manufacturing firms*", 2013

[9] JERRY KILPATRICK, "*Lean principles",* Published by Manufacturing Enterprise Partnership, 2003

[10] PAUL SCHREYER, "*Measuring Productivity- Measurement of Aggregate and Industry level productivity growth (OECD Manual)",* OECD publications 2001.

[11] International Journal of Economics, Finance and Management Science, 2013

[12] CARL A. LAWRENCE, "*Fundamentals of Spun Yarn Technology*", CRC Publications, 2003.

[13] PERRY WALTON, The Story of Textiles, "*A bird's eye view of the history of the beginning and the growth of the industry*", Published by Forgotten Books 2013

[14] WILLIAM OXENHAM, Ph.D., *"Developments in Spinning*", Journal of apparel and textile management, 2001

[15] C.A. LAWERENCE, **"***Advances in yarn spinning technology ",* Woodhead publishing, 2010.

[16] http://www.tangedco.gov.in/linkpdf/Approvedtariffrates(12.12.2014).pdf

[17] http://www.auromiraenergy.in/index.php

[18] http://farmer.gov.in/mspstatements.html

[19] DAWN CAMUS, "*The ONS productivity Handbook",* Publisher: Paulgrave Macmillan, 2007

[20] http://cottonvyapar.com/

APPENDIX-A

LAXMI SANKAR SPINTEX
328 / 4, Nathampatti Road, Ayyanapuram.
CHATRAPATTI - 626 102.
(Via) Rajapalayam - Tamilnadu. INDIA.

Date : 2nd Aug 2015

TO WHOM SO EVER IT MAY CONCERN

It is to certify that Mr.Selva kumar Palaraman underwent a work practice in our mill for a period of 27 days from "1-July-2015to31-July 2015".

He got his training as a Project Engineer During this period, all his work was based on Productivity calculation for further improvement of the functioning of the mill.

During this period of time, his moral and behavior was found to be excellent.

With regards

For LAXMI SANKAR SPINTEX

PARTNER

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