Studies on the Establishment of Foundry Workshop in Kombolcha Textile Factory

Yichalewal Goshime

ABSTRACT - This research focused on the establishment of foundry workshop in Kombolcha Textile Share Company (KTSC). It has six broad chapters. The first section discussed about the existing problems of the factory related to productivity. Objectives were clearly stated, its scope was delimited and the expected outcome of the study was briefly highlighted. The second chapter elaborated about principal operations of textile industries, failures of textile machineries, causes of failures and their remedies. In the third section the basic foundry practices starting from design till inspection were explained together with foundry equipments and tools. Following this, the principal data which are crucial to analyze the problem (questionnaires, interviews, observation and secondary data), were collected, presented, analyzed, interpreted and their findings were summarized. In the fifth section, the basic equipments and tools of jobbing foundry were identified followed by layout design and cost estimation. Finally, outcomes of the study were concluded and possible measures were recommended by the researcher.

Index Terms – foundry, productivity, textile industry, machineries, operations, equipments;

1. INTRODUCTION

This chapter has discussed the basic rational behind the problem under study and its impact on the productivity of textile industries as a whole. The problems together with their objectives were clearly stated. Moreover, the methodology used to conduct this study was defined and the expected outcomes at the end of this research were predicted. Furthermore, the scope and limitation of the research were explained shortly. Industries whether they are large, medium or small scale, have great role for fast and sustainable development of a nation. For instance; they support the agricultural sectors: by purchasing their products as inputs for industrial process and by manufacturing and supplying agricultural machineries and equipments. Moreover, industries facilitate foreign exchange by exporting internationally accepted products and hence they contribute a lot for the Gross Domestic Product (GDP) of a country. In addition to this, they give job opportunity for citizens which have a great contribution for minimizing unemployment. Beginning with need assessments, till quality inspection of products, a number of professional activities have been done such as design, production planning, manufacturing, assembling, quality control and inspection, etc… Out of these, the main burdens of industrial activities are laid on the shoulders of manufacturing engineers. Most developed nations have gone far beyond agricultural activity and they have played a major role in political, social and economical issues of the world via industrial revolution.

- *Yichalewal Goshime is currently working as Deputy Scientific Director in Kombolcha Institute of Technology, Wollo University, Ethiopia.*
  PH: +251 912689098
  E-mail: yichmena@yahoo.com

The issue of industrialization is not only the issue of developed nations but also the issue of developing countries, like Ethiopia. [16] In Ethiopia, there are a number of private and government owned industries that have their own contribution for the country's Gross Domestic Product (GDP). Out of those, textile factories take large share of the market in foreign exchanges. Textile is one of the manufacturing industries that range from micro- to large-scale units. The term 'textile' is understood mainly in two ways. Firstly, it can refer only to the fibre-to-fabric segment, excluding clothing/apparel/garments. Secondly, it can also refer to the whole complex of textile including clothing/apparel/garments. The sector, apart from the provision of clothing and other textile products, has served the population by providing employment opportunities. The tremendous backward and forward linkages of the textile sector make it unique from other types of manufacturing.

Kombolcha Textile share Company /KTSC/ is a processing industry which uses: lint cotton, furnace oil, electric power, water steam, dye staff, chemicals and packing materials as inputs and 2 processes cotton in to different market yarn and fabrics as outputs. The factory lies on 449,331m2 land of which 80,751m2 is covered by construction and major of the rest is free space for expansion. The theoretical capacity of the company was 22,000,000m2 but the company do not achieve more than 56% due to inefficiency of old machines, lack of spare parts, lack of efficient foundry workshop which aggravates the shortage of raw materials for the production of spare parts, absence of scientific maintenance system, etc…On the other hand, scraps and chips of metals, which have thrown away: hold places, pollute the environment and give unattractive site for the plant.

2. PROBLEM STATEMENT

For the past twenty-four years (since 1986 GC), the company did not achieve its production and quality target for most of the product so far produced due to machineries failure which in turn because of lack of appropriate spare parts. That is, most of the manufacturers of the machineries have got liquidated so that there is no sufficient spare. Even though some spares are available from other suppliers, they are expensive and do not meet the original manufacturer' specifications and they have a negative impact on the performance of the machines. Generally, the problems of the factory are classified as follows:

- Lack of spare parts of textile machineries which have been existed due to shortage of foreign currency or high price and liquidation of spare parts suppliers which lead to increment of down time and reduction of productivity.

- Lack of sufficient raw materials, with the required quality and optimum price, and unwise utilization of resources i.e. scraps and chips of metals which can be used as an input for the production of ingots and caste products, have thrown away.

- Lack of foundry workshops and skilled man power.

3. OBJECTIVES OF THE STUDY

3.1 General Objectives:

- To conduct a study on the establishment of foundry workshop at Kombolcha textile mills.
- To analyze the impact of establishment of foundry workshop on the overall quality and productivity of the company.

3.2 Specific Objectives:

- To identify the root causes for the frequent breakage of textile machineries and lack of spares using previous documented data and interviews.
- To show the significance of establishment of foundry workshops, by comparing the existing system with the new.
- To utilize metal scraps and chips as an input for foundry work and enhance efficient resource utilization.
- To suggest appropriate foundry workshop together with its necessary equipments, tools and qualified personnel.
- To show economical benefits of the company from the foundry workshop establishment.
- To supply ingots and cast products to any external clients in general and to Kombolcha Textile Mills mechanical workshop in particular.
- To reduce down time through sustainable supply of spare parts, those enhance productivity.
- To convince the management of KSTC on the establishment of foundry workshop at Kombolcha textile factory.

4. RESEARCH METHODOLOGY

The methods of study that will be used throughout this thesis comprise:

- Literature survey: list of relevant materials on textile machineries and their failure, basics of foundry technology and relevant foundry practice for textile machines and the design practice of foundry workshop.
- Data collection: primary data (this includes industry survey, peer discussion, interviews and questionnaires), and Secondary data (information gathering and researches conducted on the productivity and quality of KTSC)
- Data analysis and synthesis: the collected data will be organized, analyzed and interpreted.
- Design of Foundry workshop: modelling and design of appropriate foundry workshop.
- Economical analysis
- Discussion, conclusion and recommendation

5. SCOPE OF THE STUDY

Even though lack of sustainable and defect-free supply of spare parts are critical problems of all manufacturing industries of Ethiopia , the scope of this study is delimited to Kombolcha factory because of the following reasons:

a. There are financial and time problems to assess all industrial sectors in general and textile factories of Ethiopia in particular.

b. Since Kombolcha is an industrial town, it is possible to get sufficient information for the study.

c. Currently, the management of Kombolcha textile factory are willing to assist researchers who are in a position to conduct research in their plant.

d. The outcome of the study will be beneficial for all other textile and any manufacturing industries of Ethiopia.

6. LIMITATION OF THE STUDY

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The limitation of the present study includes that about 35% of the factory spare parts made of steel are found to be difficult to be considered in jobbing foundries since they require a very high initial investment. Another limitation of the study is shortage of financial capacity which limits the researcher to observe only Kombolcha Textile Factory and Bahir Dar Textile Share Company. The other important point that has been considered as drawback of the research is that some respondents may not give realistic responses. To minimize the risk and assure the validity of the questions, an explanatory survey was conducted on almost all areas and the questionnaire had been revised several times before being administered. Absence of recent information and lack of organized data are also considered as a limitation of this study.

7. TEXTILE MANUFACTURING

Textile manufacturing is the process of converting textile raw materials in to use full products such as clothes. Clothes are made of cotton, wool, silk, etc... Cotton leads the first place in textile engineering. For the first time quality cotton fibre was founded in Egypt. Even though Egypt was the first country for producing quality cotton fibre, at that time the country was not well known in textile production. Instead, America and Europe lead the sector. Lately, the Far East Asian countries have taken the first rank in textile engineering by integrating their high number of population with their medium technology. In Ethiopia, there are fertile farming areas of cotton such as Humera, Asa'eta, Dubti, Awash valley, etc. Farmers and investors have cultivated cotton for country consumption as well as for export. Besides, there are textile industries in Ethiopia, such as Kombolcha Textile Factory that uses cotton fibre as inputs so as to produce textile products. Improving productivity through sustainable research works should be the corner stone for any textile industries. In any case, the consumption of cloth has been increasing with human civilization. In most textile industries, there are three main sections, i.e. spinning, weaving and wet processing. Again each section is divided into sub-sections.

7.1 Failure of Textile Machineries

Machines which are used to perform spinning, doubling or twisting and reeling or winding are blending feeder, auto mixer, six step cleaner, horizontal opener, case condenser, etc… These machines have critical spares such as spur gears, sprockets, pulleys, keys, shafts, pins, rack and pinion, drums, levers, beaters, etc…The main reason for their failures includes; wear and tear, lack of regular maintenance schedule, obsolescence of machineries and poor quality of spares. Some of common spares of spinning machineries and a ring spinning machine are illustrated in the following table and picture respectively. These spares are produced using metal casting, machining, and metal forming. Among the listed manufacturing process casting is more preferable from the perspectives of cost, time as well as labor.

Likewise, there are different weaving machineries (looms) which perform interlacing of warp and weft threads to form a fabric. Different models are manufactured by different suppliers; some of them are: UTAS, Versamat, etc… Among these models, the most widely used model in Ethiopian Textile Factories is Versamat model. Common spare parts which have been employed in these machineries are: keys, cups, washers, bearings, flanges, shafts, rotors, frames, pulleys, armatures, spacers, rings, spur gears, clutches, springs, discs, cams, shedding boxes, bevel gears, worm gears, worm shafts, sprockets, cranks, belts, etc.

The main reason for their failures includes; wear and tear, lack of regular maintenance schedule, obsolescence of machineries, deterioration of spares due to improper storage and poor quality of spares. Usually these spare parts are produced by metal casting, machining and metal forming. Among the listed manufacturing process casting is more preferable from the perspectives of cost, time as well as labor.

Finishing machineries for washing, cleaning, wringing, drying, ironing, pressing (including fusing presses), bleaching, dyeing, dressing, finishing, coating or impregnating textile yarns, fabrics or made up textile articles include sniggering and designing machines, dryer machines, dyeing machines, printing machines, calendaring machines, etc… Spares of finishing processes include: rollers, bevel gears, spur gears, worm gears, worm shafts, pulleys, etc.

The main reason for their failures includes; wear and tear, lack of regular maintenance schedule, obsolescence of machineries, deterioration of spares due to improper storage and poor quality of spares. Usually these spare parts are produced by metal casting, machining and metal forming. Among the listed manufacturing process casting is more preferable from the perspectives of cost, time as well as labor. All of the above textile machineries are very sensitive for minor faults and affect the productivity of the plant because of damage or breakage of spares.

As we know spare parts are parts identical to the parts of a machine which need replacement due to wear and tear, failure of the part, drop in the efficiency of the part, etc. during the operation life of the equipment. They may look small and appear cheaper than the machine or raw material, but they play a vital role in maintaining, ensuring and reinforcing the reliability of any equipment.

8. DATA COLLECTION

8.1 Primary Data Collection

The primary data include observation, questionnaires and interviews.

8.1.1 Observation

The researcher assessed and observed the existing situation of the plant for about twelve times from the perspectives of Manufacturing Engineering using the following check lists.

- General plant location
- Mechanical workshop location
- Professional, physical and systematic structure of mechanical workshop
- Existing conditions of textile machineries
- Frequency of spares breakage
- Spares' samples which have been manufactured in the workshop
- Current working status of mechanical workshop machines
- Chips, scrapes and discarded machine parts storage
- Raw materials and tools storage and
- Work habit of employees.

8.1.2 Questionnaires

The target populations for questionnaire were classified in to two categories as employees of the plant under study and external clients of the factory. From 2072 employees (both permanent, contract and temporary) those who are under department of engineering are directly responsible to respond the questionnaires. Again from employees of engineering department (444); about 42 249 are machinists (junior, senior), mechanics (junior and senior), maintenance workers,
electrical experts, production heads, team leaders, foreman, researchers, welders and section heads who are best fitted to give tangible feedback for the study. Regarding external clients of the factory; industries, garages, mechanical workshops and technical institutions which are located at Dessie (55) and Kombolcha (30) are considered as target populations. 30% of the total population was taken as sample size so as to increase the validity of the data.

8.1.3 Interviews

A semi-structured interview was conducted with the concerned officials of the factory, that is: about thirteen questions for General Manager of the plant, fourteen questions for Head of Budget and Cost Management and sixteen questions for Head of Engineering Department.

8.2 Secondary Data Collection

Secondary sources are previous related works (which were already done in the previous three chapters/ and past documents of the plant. Those documents include:

- Annual list of spare parts and accessories of textile machineries which can be manufactured in the mechanical workshop
- Monthly report of engineering support division
- List and status of mechanical workshop machines
- Recent prices of cast ingots per kg and
- Comparison table of labour cost against workshop spare parts production.

9. Data Interpretation and Findings

As we discussed in the former section, a total of seventy-nine (79) questions, which could be divided into questionnaires and interviews, were conducted. For ease of understanding the data were interpreted and summarized by grouping similar questions of different respondents in the following manner.

a. Strength and opportunity of the company,
b. Current status of the company,
c. Encountered problems, causes and possible solutions,
d. Demands for spares and ingots,
e. Existing condition of mechanical work shop,
f. Treatments of chips and scraps
g. Past experiences in foundry practices and
h. Establishment of foundry workshop.

9.1 Data Interpretation

9.1.1 Strength and opportunity of the company

Although Kombolcha Textile Factory has already identified that its productivity is declining, measures have been taken to scale-up its rate of production by implementing Quality Management System (QMS) and Business Processing Re-engineering (BPR). Besides, the opening of higher institution near the company has created favorable situations to extend performance of the plant.

9.1.2 Current status of the company

The current productivity and status of the company is inefficient due to lack of spares which increase down time. Actually there are some respondents (about 5.48% from the total population) who said that productivity of the company is good due to high demand of the product. However, high demand of company's products doesn't mean productivity is high. By the end of 2003 E.C, the company has planned to upgrade its productivity by increasing textile products from 13,000,000m2 to 25,000,000m2 (increment by 92.3%) and export fabrics from 3,000,000kg to 4,500,000kg (increment by 52%). Nevertheless, from the three consecutive year's data (1999-2001 E.C), it was clearly seen that the annual expense of the company is greater than its income, i.e. the

balance is negative (a reduction by 6.14% from the previous year). Unless problem of spares are avoided and down time of textile machineries are minimized it is difficult to improve productivity. The performance of textile machineries is usually low due to lack of sustainable and defect-free supply of spares and obsolescence of machineries. During site visit, the researcher has also observed that there are excess areas where successive breakdown of textile machineries have been occurred. Regarding customer satisfaction, the company had produced only 28.57% of textile products from the request of its customers which shows that customers are dissatisfied in quantity, delivery, cost and quality both at local and international level.

9.1.3 Encountered problems, causes and possible solutions

Low productivity, high down time and less customer satisfaction are bottle necks of the company which have been occurred due to lack of spares, lack of skilled labor, lack of quality awareness, obsolescence of textile machineries, lack of good management system and employees have not been motivated through incentives and rewards.

Solutions to minimize problems and upgrade productivity include: organizing the plant with QMS and BPR, manufacturing spares within the factory, upgrade the skill of employees via training, conducting regular maintenance program, replace old machines by new, organizing the mechanical workshop with well-equipped machineries and skilled labor, extending the scope of the market, privatize the company, and establishing research and development centre.

9.1.4 Demands for spares and ingots

The annual budget allotted for spares and ingots consumption of KTSC is about 7,000,000.00 (seven million) birr. The estimated total consumption of spares of the company which can be manufactured through casting is about 6970.15kg per year. From responses of questionnaire two, 25% the annual consumption of spares and ingots for external clients is about 134,482.75kg or 1,848,252.90 birr. Hence, there is high demand both in the company as well as from external clients.

The productivity of these companies is inefficient due to lengthy procurement system and high cost. Moreover, they are unable to manufacture spares within their workshop due to lack of financial capacity and skilled man power. They assured that if the mechanical workshop of Kombolcha Textile Factory produces spares they will be benefited.

9.1.5 Existing condition of mechanical work shop

The mechanical workshop of the factory was established with an aim of repairing and maintaining textile machineries, giving garage services and producing some spares. However, the workshop has not been working with its full capacity due to absence of design sections, lack of well equipped foundry workshop and obsolescence of machineries. Moreover, the spares that have been manufactured in the workshop do not satisfy the required mechanical property. Nevertheless, these can be solved by offering training for workers, recruiting better skilled professionals, repairing damaged machines, controlling raw materials quality and strengthening heat treatment process. All spares have not been produced within the workshop due to lack of foundry workshop as well as specific finishing and strengthening machines. During site visit the researcher has observed that the heat treatment furnace of the workshop has size limitation.

9.1.6 Treatments of chips and scraps

Chips and scraps have been avoided from the plant by selling with very low price. (From 0.30 to 1.35 Ethiopian birr) Moreover, only few scraps are used as raw materials for spares. From the site observation it has clearly seen that chips and scraps have been improperly stored and there is no wise resource utilization which has high contribution for environmental pollution.

9.1.7 Past experiences in foundry practices

There have been some preliminary foundry practices at KTSC which produce some ingots for the production of spares. Nevertheless, it was not satisfactory both in quantity as well quality. This can be improved by reorganizing the overall structure of mechanical workshop with appropriate equipment, human power and other physical facilities.

9.1.8 Establishment of foundry workshop

Establishing foundry workshop enables the mechanical section of the factory to produce spares and ingots with short time and affordable cost. Consequently; it saves labor, time and money; serves as income generating department for the company; minimizes problems of foreign currency; improves creativity of the worker; increases customer satisfaction; reduces manufacturing cost, increases productivity; enhances wise resource utilization and has great contribution on the prevention of environmental pollution. Casting of steel bars will not be done in the short term plan of the company as they need high investment capital, better skilled professionals and well equipped machineries, equipments and laboratories. However, the production of spares using steel can be improved and strengthened through proper heat treatment process and product inspection. Delivering spares and ingots to the workshop through casting process reduces the expenses of the factory from 25 to 50% (1,750,000.00 to 3,500,000.00 birr). Whether textile machineries are new or old the establishment of foundry workshop is a corner stone for the productivity of the company as the demand for spares is inevitable. The foundry workshop should be organized with

equipments such as spectrometers, surface grinders as well as material properties' testing instruments (hardness tester, tensile strength testing machine, etc...); skilled personnel such as foundry engineer, mould maker, pattern maker; skill-gap training centre; well-equipped heat treating sections; appropriate foundry materials such as sands, binders, additives, etc; and appropriate pattern making, mould making and pouring equipments. In addition to this, research works should be conducted to improve quality of spares and ingots on one hand and to minimize cost of the product on the other which increase customer satisfaction and assure the sustainability of the company.

9.2 Findings

The bottlenecks of Kombolcha Textile Factory are: low productivity and less customer satisfaction due to high down time of machineries which in turn due to lack of sustainable and defect-free supply of spares, low performance of textile and mechanical workshop machineries, poor working system and lake of skilled professionals. There is high demand for spares both within the factory and from external clients. However, the mechanical workshop of the factory couldn't produce spares which are durable, reliable, and affordable, and reached at the right time. Because it doesn't work with its full capacity and there are shortages of skilled labor and equipments. So, customers are dissatisfied in quality, quantity, delivery as well as cost. Chips and scraps are either improperly stored or sold at negligible price which shows unwise resource utilization and contribution for environmental pollution. The problems of the plant can be alleviated by: manufacturing spares within the factory, establishing good working system such as QMS and BPR, giving capacity building training for employees, organizing the mechanical workshop with well-equipped equipments, extending market capacity of the company, strengthening research and development centre and lastly but not least, establishing foundry workshop. The establishment of foundry workshop enhances the production of intricate and large sized spares at the right time and with affordable cost, there by:

- Saves labor and money,
- Generates income for the company,
- Solves the problems of foreign currency,
- Improves workers creativity,
- Increases customer satisfaction,
- Increases productivity,
- Enhances wise resources utilization and
- Prevents environmental pollution.

10. Foundry Workshop Equipment Selection & Layout Design

In this chapter, raw materials, equipments, tools and instruments which are used for establishing jobbing foundry workshop were selected and analyzed based on the annual production capacity of the workshop, demand of clients and existing condition of the factory under study. In addition to this, basic features of any plant layout in general and foundry layout in particular were briefly discussed. Next to this, layout analysis of the proposed foundry workshop was conducted by considering the fundamental elements of project layout. Spaces for aisles, buildings, equipments and future expansions were clearly identified and affinities of each pair of departments were also analyzed. Moreover, the bloke plan and populated/detailed layout of the proposed foundry workshop were designed and load comparison of the new with existing was analyzed. Lastly, expected total cost of the new workshop was done by analyzing material cost, labor cost and other expenses on one hand and the expected income on the other so that the cost benefit analysis was shown in figure.

10.1 Foundry equipment

Foundry equipment includes machineries (heavy, medium and light), hand tools, and measuring and testing instruments. They are used for making patterns, cores, core boxes and moulds; for melting and pouring metals; and for fettling, finishing, heat treating and inspecting castings. They are selected based on the type of foundries, i.e. captive and jobbing foundries. Their availability and technological competency affect the productivity of the company which in turn influences willingness of customers to purchase the product.

10.2 Furnace Selection

There are different furnaces which can be used for melting ferrous and non-ferrous alloys. The selection depends on the melting temperature of the metal, quantity of metal to be melted, fuel cost, cost of installation and daily operation, and control of composition of the alloy. Among the different casting furnaces, crucible furnaces are very convenient for jobbing foundries where the operation is intermittent and a variety of alloys are handled in small quantities. The metal to be melted is heated in a heated crucible which acts as a melting pot. The crucible is made of clay and graphite and by moulding these materials in to a standard shape. It is produced in size from number 1 to 400. The crucible number represents its approximate melting capacity in kilogram of copper. The capacity of the crucible for other metals may be determined by multiplying with the zero of densities. The fuel used for heating the metal may be coke, oil or gas. From different kinds of crucible furnaces, the one which is manufactured by Morganite Thermal Designs Limited was selected for this study. It is known as Morganite Crucible Furnace that uses gas and oil as a fuel. It is preferred than others because of the following reasons.

- There is no wastage of fuel,
- The output in a given time is greater due to higher efficiency,
- Better temperature control can be maintained,

- Less contamination of metal takes place,
- Saving in floor space is achieved,
- As stocking is required, labour cost is reduced.

10.3 Foundry layout design

10.3.1 Introduction

Plant layout is the most effective arrangement and coordination of the physical plant facilities to allow greatest efficiency in the combination of men, materials, and machines necessary for operation of any unit of a plant or business. It is a floor plan for determining and arranging the desired machinery and equipment of a plant, whether established or contemplated, in one best place, to permit the quickest flow of material at the lowest cost and with the least amount of handling in processing the product from the time of the receipt of raw materials to the shipment of finished products. Problems of layout develop when needed:

- To start a new product.
- To change the product design
- The market demand changes
- The plant , the product, the building become obsolete
- Accidents occur frequently.
- The working environment is poor.

The objectives of a good plant layout are to: ensure specific space utilization, minimize the cost of material handling, for see future development of the plant according to a rational master plan, improve workers convenience as well as safety and create job satisfaction, and avoid unnecessary capital investment.

Plant layout can be classified as:

- Flexible-flow layout: A layout that organizes resources (employees) and equipment by function rather than by service or product.
- Line-flow layout: A layout in which workstations or departments are arranged in a linear path.
- Hybrid layout: An arrangement in which some portions of the facility have a flexible flow and others have a line-flow layout.
- Fixed-position layout: An arrangement in which service or manufacturing site is fixed in place; employees along with their equipment, come to the site to do their work.

Among these the flexible-flow layout is more appropriate for this design because in jobbing foundries variety of works have been done which need flexibility. Moreover, this type of layout is often easier to design, and the accounting system does not penalize the high inventory required by functional layout.

10.3.2 Plant Design and Location

Plant design involves: acquisition of capital, Product design, Sales planning for requirement, determination of the production process, make or buy analysis, organizational development, diversification, building type selection, plant layout, plant location, product price range and plant size.

A systematic approach for plant location divides in to selection of general territory and selection of a specific community and site. Selection of general territory includes: cost of construction, market, wages and labor, raw material, transport and energy. Selection of the specific site includes: community attitude, transport, water, and communication, and wind direction, condition of the site, future development, and complementary plants.

10.3.3 Advantages of Good Foundry Layout

- Improvement in the manufacturing process which results from elimination or reduction of delays, smoother material flow in the process and improved control
- Improved quality control
- Minimum equipment
- Effective use of available area
- Improved utilization of labor
- Improved employee morale and
- Improved efficiency in plant services.

In captive foundries, the major factor is the location of the foundry in relation to machine shop and other units which would receive the castings in the main plant. In jobbing foundries, the layout should cater for the maximum number of castings of different sizes that are likely to be cast. The size and weight of large castings would determine the size of melting units, molding machines and crane facilities to be provided.

The layout should provide for separate bins and areas of storing different kinds of compositions so that mix-up does not occur. It is essential to keep separately different kinds of scraps which are to be re-melted. Even sand mixes of different compositions and properties should be segregated. In general jobbing foundries would require large floor space than captive foundries for same output or tonnage of metals due variations in size of castings they have to produce.

10.3.4 Layout design of the proposed Foundry Workshop

Foundry layout refers to location of various shops within the foundry. The layout should fulfill the following major requirements:

- It should be such that a minimum material handling is required to move the raw materials such as: foundry sands, metal scraps, moulds, etc…

- It should enable easy entry and exit of these materials.
- It should reduce the required movement of shop floor personnel
- It should cater for possible expansion of facilities, additional melting furnaces, molding machines, further mechanization and so on.
- It should enable installation of safety and fume/dust extraction equipment

- It shows cater for support facilities such as sand lab, metallurgy lab, air compressor room, additional generator sets, etc…

The main shops to be considered for the layout are: Pattern shop, Core shop, Melting shop, Molding shop, pouring bay, shake-out and fettling bay and Inspection bay. As previously explained, in order to achieve optimum layout which is applicable for low volume production and which needs the arrangement of similar equipments and similar machines together, the foundry workshop should be of a flexible-flow layout.

11. CONCLUSION

The present thesis work focuses on the study which was conducted with the aim of establishing a foundry workshop and analyzing its impact on the overall quality and productivity of the Kombolcha Textile Share Company (KTSC, by identifying the root causes for the frequent breakage of textile machineries. The research methodology followed in this thesis work includes: industry survey, peer discussion, interviews, questionnaires, information gathering and review of researches conducted on the productivity and quality of KTSC were used as the basic sources of information.

The author collected, analyzed, interpreted, and produced his findings that the urgent establishment of the foundry workshop is of paramount importance to increase the productivity of the company. In particular the current problems affecting the overall performance of the factory were classified as: lake of spare parts for the existing textile machineries, lack of sufficient raw materials, unwise utilization of resources, unavailability of the required machines to produce spares in the workshops, lack of skilled man power and other problems related with quality management and production planning and control.

The three sections of the KTSC i.e. spinning, weaving and finishing have different machineries which are manually operated, semi-automatic or automatic. These machines have critical spares such as spur gears, sprockets, pulleys, keys, shafts, pins, rack and pinion, drums, levers, beaters, cups, washers, bearings, flanges, rotors, frames, armatures, spacers, rings, clutches, discs, cams, shedding boxes, bevel gears, worm gears, worm shafts, cranks, belts, rollers, etc.

After a thorough analysis of the failure pattern of the existing spare parts and their impact on the performance of the company it was found that:

- Most of these spare are critical to failure and stoppage of machines,
- Difficulty to import some of the spares for the existing machineries due to
- unavailability of these spares in the market, and lack of foreign currency resulted to frequent breakage of machinery
- Use of locally manufactured spares with poor quality resulted frequent failure of machines,
- The improper storage of the spares resulted damage on the spares
- Lack of systematic and regular maintenance schedule, resulted to failure of and ultimate stoppage of the machines
- obsolescence of machineries and liquidation of the machines manufacturer aggravated the availability of the spares

Meanwhile, in addition the high demand for spares in the factory it was found that external clients located in and around Kombolcha town have also similar demand for quality raw materials to produce various spare parts. Nevertheless the inability of the mechanical workshop of the factory to meet this demand has resulted dissatisfied customers due to the product quality, quantity, delivery time and production cost of the KTSC's product. The experience from other developing nations indicate that even very old machines can be operated efficiently with a little decline in productivity if a sustainable and defect-free spare parts supply is organized.

Therefore, the establishment of foundry workshop enhances the production of intricate and large sized spares at the right time and with affordable cost, there by: Saving labor and money, generating income for the company, solving the problems of foreign currency, improving workers creativity, increasing customer satisfaction, increases productivity, enhances wise resources utilization and preventing environmental pollution. The questionnaires, the authors' observation and interviews conducted in and outside the company justified all agrees upon the establishment of the foundry workshop in KTSC.

Thus the following points were considered while designing the foundry workshop:

- The capacity of the foundry workshop was decided on the basis of the existing demand for raw materials by the company and by considering the external clients need
- All the necessary and important equipment to establish the foundry workshop were selected
- Selection of furnaces were conducted by considering, the melting temperature of the metal, quantity of metal to be melted, fuel cost,

cost of installation and daily operation, and control of composition of the alloy

- After selecting the required equipment machinery and the next issue which this thesis had focused is at the design of the layout of the foundry workshop by considering
- The business plan/sales information of the company, the selected equipment list, and equipment information were considered while calculating space requirement

- Using weighted factor analysis and proximity factors a flexible workshop layout capable of merging with the existing facilities of the company was designed
- Space planning identifiers /SPIs/ , affinities, and space constraints were taken into account to design a layout with minimum material handling requirement
- The issue of safety and fume/dust extraction equipment was also considered while designing the layout.
- Support facilities such as sand lab, metallurgy lab, air compressor room, additional generator sets, etc
- Likewise the following constraints were considered while designing the foundry workshop; the distance to the mechanical workshop, financial shortcomings, shape of the existing building and awareness of top management

In addition to being fully merging with the existing mechanical workshop the designed foundry workshop alleviates the acute shortage of spare parts and reduces the cost of purchasing spares by about 67% i.e., about 4,690,000.00 birr can be saved. Moreover the designed layout saves 54% of the existing material handling cost. Additionally the company may get additional revenue amounting 1,848,252.90 birr from external clients. Besides the scraps, chips and damaged machine parts which are usually pollute the environment until they are sold to external clients at a very low price can be sources revenue to the company. Thereby improving the overall productivity of the company and meeting the customers demand with regard to quality, quantity, delivery as well as cost.

12. RECOMMENDATION

The layout of foundry workshop has been designed for jobbing foundry. So, interested researchers are expected to design layout for captive foundries. Textile industries are corner bridges to transfer from agricultural to industrial era. If researchers focus their attention on alleviation of problems related to textile production, there will be radical developmental change on the GDP of Ethiopia. The finding of this research has great impact on the productivity of KTSC. Therefore, the factory should have to set a strategy for its implementation by:

- Establishing good working system such as QMS and BPR
- Offering training for employees
- Organizing the mechanical workshop with well-equipped equipments
- Extending market capacity of the company and
- Strengthening research and development centre and lastly but not least, establishing foundry workshop

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REFERENCES

[1] Adithan M and Pabla B. S, (2004), Production Engineering Estimating and Costing, First Edition, Shiba Offset Printing Press, Konark Publishers, New Delhi

[2] Beeley Peter, (2001), Foundry Technology, Second Edition, University of Leeds, London.

[3] Choudary R.B and Tagore G.R.N, (March, 2001), Plant lay out a Material Handling, second Edition, Khanna Publishers, New Delhi.

[4] Daniel Kitaw (Dott-ing), Industrial Management & Engineering Economy, AAU Press, September 1994

IJSER

[5] Engineering department of Kombolcha Textile Share Company, (2007) Technological Gap Analysis Preliminary Study of KTSC machineries, Kombolcha, Ethiopia.

[6] Gebresenbet Tafesse (PHD), (2008), Automation, Compiled Lecture Notes, Addis Ababa University, Addis Ababa, Ethiopia.

[7] Gopalakrishnan p and Banerji A. k, (October, 2006), Maintenance and Spare parts Management, Prentice-Hall, India

[8] Humar B, (2002), Manufacturing Process and Technology, Fourth Edition, Kahanna Publisher, New Delhi, India.

[9] International finance Corporation, (April 30, 2004), Environmental, health and Safety Guide Lines on Foundries.

[10] Jain P. L, (2006), Principle of Foundry Technology, Fourth Edition, Tata Mc Graw-Hill, New Delhi.

[11] Jain R.K, (2008), Production Technology (A Text Book of Engineering Students), 16th edition, Khanna Publishers, New Delhi

[12] James A.Rehg & Henry W.Kraebber, (2001), Computer Integrated Manufacturing, Second Edition, Prentice Hall Press.

[13] James B. Dilworth, (1991), Production and Operations Management, McGraw-Hill Companies

[14] Kjell B, (2004), Industrial Engineering Hand book, Fifth Edition. McGraw-Hill

[15] Marczyk G, Dematteo D and Festinger D, Essentials of Research Design and Methodology (2005), John Willey and Sons, Canada.

[16] Martin-Vega Louis A, (2004), Industrial Engineering: Past, Present and Future, Natural Science Foundation, Mc Graw –Hill Companies, Arlington, Virginia.

[17] Millennium Celebration Bulletin Committee, (2007), 25th Silver and Millennium Celebration Bulletin of KTSC, Kombolcha, Ethiopia Srinivasan N. K, (2000), Foundry Engineering, Third Edition, Khanna Publishers, New Delhi.

[18] Morganite Thermal Designs Limited, (2006), Operational Manual of Central Axis Tilting Cruciple Furnace, Worcestershire, England.

[19] Novortis Foundation for Sustainable Development, Hand Book of Project Management, (2005), Switzerland.

[20] Phillip and Ostward F, (1997), Manufacturing Process and System, University of Colorado, USA.

[21] Potter John R, (17 September 1975), A Model for Foundry Molding Equipment Selection in Developing Countries, Master thesis of Mechanical engineering, Massachusetts Institute of Technology. 94

[22] Saarelainen S., Piha O. Makkonnen P. and Orks J , (2008), Casting Users' Perspectives on Foundries as Suppliers, World academy of science, Engineering and Technology.

[23] Srinivasan N. K, (2000), Foundry Engineering, Third Edition, Khanna Publishers, New Delhi.

[24] Textile Machinery Corporation Ltd, (2008), Textile Machinery spare parts Catalogue, Hong Kong, China.

[25] Versamat Textile Machineries Suppliers, (1988), Manual for Versamat Weaving Machineries, France Companies, Belgium.

[26] Wynne A, (1997), Textiles, First Edition, Masmillan Education Ltd, Hong Kong.

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