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SCHOOL OF GRADUATE STUDIES

ADDIS ABABA INSTITUTE OF TECHNOLOGY

MECHANICAL ENGINEERING DEPARTMENT

DESIGN OF PRODUCTIVITY IMPROVEMENT METHOD FOR ETHIOPIAN GARMENT INDUSTRIES

(With Special Reference to Novastar Garment PLC)

By

Azemeraw Tadesse

A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Mechanical Engineering (Industrial Engineering Stream)

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Co-Advisor

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November, 2011

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitled "**Design of Productivity Improvement Method for Ethiopian Garment Industries: With Special Reference to Novastar Garment PLC**" is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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Abstract

Productivity is one of the major determinants that enable manufacturing organizations to compete in the global market. A nation's efforts to improve productivity must first begin with basic economic units namely, manufacturing and service organizations. The gains in productivity are one of the major weapons to achieve cost and quality advantages for competition.

EGIs are not competitive in the global market. One of the main reasons is low productivity. The main objective of the study is to develop a method that supports productivity improvement of EGIs. To achieve this objective, a literature survey has been conducted to get empirical knowledge. The existing productivity measurement and improvement practices, and productivity factors[1] of EGIs have been assessed using questionnaire and secondary data. In order to make the study practical and realistic, a case study has been conducted on Novastar Garment PLC. The result shows that the productivity of EGIs and the case company is low when it compared with the best practice. The partial and total productivity indicators of the case company show under target performance. Most of surrogate productivity and process indicators of the company show poor status. There are multidimensional productivity factors related to human, capital, material, method, control, process and product. To solve the problems associated with these productivity factors, sustainable and organized productivity improvement program is required.

To improve the productivity, a method called PIM has been developed considering the existing situation of EGIs and the case company. The important characteristics which make the PIM preferable are compatibility with knowledge and skill of the user (i.e. easy to use); compatibility with existing tools and techniques; addressing the possible productivity factors; being continuous improvement tool based on Deming cycle (i.e. plan-do-check-act); having clearly defined productivity targets setting, measurement and analysis framework; and flexibility to apply from operation to firm level. The PIM has clearly defined user manual which makes it organized and sustainable productivity improvement program.

For academicians and researchers, the PIM can be used as a guideline how to develop a method that supports productivity improvement of manufacturing firm.

[1] Both internal (firm level) and external (national level) productivity factors are discussed in the literature review. But only internal factors are considered to develop the PIM since they are under the control of the firm and potential for productivity improvement.

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List of Acronyms

AGOA	African Growth Opportunity Act
ANSI	American National Standard Institute
APC	American Productivity Center
BLS	Bureau of Labor Statistics
CMT	Cut, Make, Trim
CSA	Central Statistics Agency
EPA	European Productivity Agency
EGIs	Ethiopian Garment Industries
ETGMA	Ethiopian Textile and Garment Manufacturers Association
EU	European Union
FDI	Foreign Direct Investment
FOB	Free on Board
GDP	Gross Domestic Product
GNP	Gross National Product
IET	Industrial Engineering Terminology
MOI	Ministry of Industry
NPBS	National Productivity Board of Singapore
NBER	National Bureau of Economic Research
OPT	Office of Productivity and Technology
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PIM	Productivity Improvement Method
PLC	Private Limited Company
SDPR	Sustainable Development and Poverty Reduction
SSA	Sub-Sahara Africa
UNIDO	United Nations Industrial Development Organization
US	United States
USD	United States Dollar
TGIDI	Textile and Garment Industry Development Institute

Chapter One

1-Introduction

1.1-Background of the Study

The rapid pace of globalization and the forces driving it have created new market conditions. The structure of international and domestic markets has changed. In the globalized economy competitiveness means an ability to take the most advantageous position in a constantly changing market environment. The major determinants of the ability to sell products and services in highly competitive markets are no longer the relative cost advantages. More and more, competitiveness is based on quality, speed, technical superiority, and service and product differentiation. In the ultimate analysis though, one of the major determinants of competitiveness, whether at national, industrial or firm level, is raising total productivity [34].

Global competitiveness has forced businesses to examine their operation for the purpose of making process improvements. These improvements generally involve better utilization of resources and higher level of quality. Essentially the focus is on enhancing productivity to meet or beat the competition on relevant cost, quality, time and flexibility issues. Productivity improvements require designing and successful implementing of sound programs [8].

At today's competitive market place, there is a need for organizations to ensure continual improvement. Garment industries experience growing pressure to improve quality, increase productivity, and reduce cost with limited resources. Fashion industry need to reduce response time, eliminate errors and improve customer satisfaction [10].

Garment is one of the three basic needs of mankind. Hence, textile and garment have retained an important place in human life starting from historical era to today’s modern world. Textile and garment industry in today’s contemporary market place is a truly global industry. It is a well documented fact that the textile and apparel industries have been the driving force for all developing countries. Today, such countries have targeted the garment industry as means to provide jobs, raise their standard of living and create economic wealth. There are two primary reasons that the garment industry continues to be the industry that is used to lead developing countries to the promise of a better tomorrow. The reasons are the industry continues to be labor intensive, and the barriers to entry are relatively low [19].

The development of textile sector is closely linked with industrial revolution in England and US in seventh and eighth century respectively. Garment industry took one more century to develop after the growth of textile industry [19]. The modern garments industry started with the establishment of Addis Garment Factory by three Italians in 1965. In 1992, Ethiopia's largest garment factory, Nazareth garment, became operational [9]. Currently, there are 397 small size, 7 medium and 32 large garment industries in Ethiopia. These small, medium and large size industries employ 1,961, 343 and 7,442 employees respectively. Totally, the sector creates a job opportunity for 9,756 employees [29].

The government of Ethiopia has a planned projection of getting 1 billion USD from the export of garment and textile related products in the next 5 years which is 40 times as much as it actually earned during the 2009/10 (i.e. 25 million USD form garment export) [42]. However, EGIs are not competitive in the global market mainly due to low productivity.

The general objective of the study is to develop a method that supports productivity improvement of the EGIs by identifying the possible productivity factors and selecting the intervention areas.

1.2-Statement of the Problem

Garment is one of the basic needs of mankind. Today, garment industries make a significant contribution to many national economies especially in the developing world. Many countries are exploiting this industry for reasons of economic growth. The high amount of labor involved in garment production has caused garment industries to seek locations with lower wage employees for reduced production costs. Garment industries in developing countries have low cost labor advantage compared to developed countries. In this regard Ethiopia has a comparative advantage in producing garment.

Though EGIs have market opportunity, low cost labor comparative advantage and incentives by government, they are not yet competitive in the global market. One of the main reasons is low productivity. For instance the human productivity achieved by EGIs is 10 t-shirts/worker/day and 30 trousers/worker/day whereas the best practices[2] are 50 t-shirts/worker/day and 80 trousers/worker/day [30]. The productivity factors of EGIs are multidimensional related to human, capital, material, method, control, process and product that require organized and sustainable productivity improvement program.

[2] Best practice is taken from garment industries of two countries, namely Turkey and Romania. The benchmark is done by Romanian experts in cooperation with MOI and UNIDO, Ethiopia.

Low skilled employees, shortage of adequate training, low employees satisfaction level, absenteeism, capacity underutilization, work in process, high rework and scrap rate, low product quality, low volumes of production, long lead time, waiting time, downtime, setup time and poor inventory management system are some of the specific problems of EGIs.

Currently EGIs and the case company use disorganized and reactive problem solving approach which is not effective for productivity improvement. The main reasons for not using organized and sustainable productivity improvement program are lack of understanding where to start productivity improvement, lack of identifying critical success factors, lack of addressing the possible productivity factors, lack of defining, measuring and analyzing productivity indicators (except human productivity), and lack of identifying the intervention areas for productivity improvement.

It is believed within this study that productivity improvement is an essential criterion for the competitiveness and success of a manufacturing company. Without productivity a company will not be able to compete and will therefore not survive in a long-term perspective.

Therefore, in this study by considering the existing situation of EGIs and the case company, a method that supports productivity improvement of EGIs has been developed.

1.3-Objective of the Study

The general objective of the study is to develop a method that supports productivity improvement of EGIs. In order to achieve this general objective the specific objectives are:

- ☞ To assess existing productivity measurement improvement practices of EGIs
- ☞ To identify critical success factors and productivity indicators
- ☞ To identify productivity factors and define their status
- ☞ To measure and analyze productivity
- ☞ To identify intervention areas for productivity improvement
- ☞ To propose a solution by developing the PIM

1.4-Significance of the Study

Organizations need to know how to manage their productivity effectively. The study gives a guideline how a method that supports productivity improvement of manufacturing firm is initiated and implemented. The study can give empirical knowledge about concepts of productivity, productivity factors, and various tools and techniques of productivity

measurement, analysis and improvement. In general the case company, EGIs, researchers and academicians are the beneficiary of the study.

1.5-Scope of the Study

The study has been done for EGIs with special reference to Nova Star Garment PLC. The study is dedicated to development of PIM at firm level. The study mainly uses data collected from various literatures, organizations like CSA, MOI, UNIDO, TGIDI, ETGMA, 15 EGIs using survey questionnaire and the case company. The study is limited to internal (firm level) productivity factors develop the PIM.

1.5-Research Methodology

In order to conduct the study, various literatures are surveyed from various sources like books, journals and thesis; both primary and secondary are collected from different sources; then the collected data are organized, analyzed and presented by using different software and tools.

1.5.1-Literature Survey

A survey has been conducted on the existing literatures to get empirical knowledge about concepts of productivity, productivity factors, productivity measurement, productivity analysis, productivity planning and productivity improvement.

1.5.2-Data Collection

The data have been collected using primary and secondary data sources.

The primary data sources are questionnaire, physical observation, interview, formats and consultation. Survey questionnaire has been prepared and distributed to 30 garment industries in order to assess the existing productivity measurement and improvement practices, and productivity factors. The existing layout, internal transport, transfer time and process flow sequence are collected using physical observation of the case company. Interview is conducted to know how productivity is understood by managers, experts, checkers, supporting staffs and operators of the company. Formats are prepared to collect data for measuring and analyzing productivity. Valuable and timely feedbacks and directions are found from consultation by the advisor.

The secondary data sources are books, journals, thesis, statistical information and organization documents. Books, journals and thesis are referred to construct the study. Six years (i.e. from 2003/4 to 2008/9 G.C.) statistical data has been taken from CSA to assess productivity of EGIs. The study also uses documents prepared by MOI, UNIDO, TGIDI, ETGMA and the case company.

1.5.3-Data Analysis and Presentation

Microsoft Office Excel and Microsoft Office Visio have been used to analyze and present the data. Cause and effect diagram, pie chart, bar graph, line graph, flow process chart, process mapping, formats and templates are the tools used to analyze and present the data.

After analyzing the data, problems have been identified and intervention areas have been selected using four fields. Then a solution has been proposed by developing a PIM for the problems.

Finally, conclusion has been drawn; and important recommendation for current and future EGIs regarding productivity improvement has been forwarded.

1.6-Organization of the Study

The study has been organized into six chapters. The first chapter introduces the background, statement of the problem, objectives, scope and problem statement the study. The second chapter is the literature review that states the study matter. Chapter three presents the overview and assessment of EGIs. The case study has been presented in chapter four. Chapter five contains the PIM developed for the solution. The final chapter consists of the conclusion and recommendation of the study.

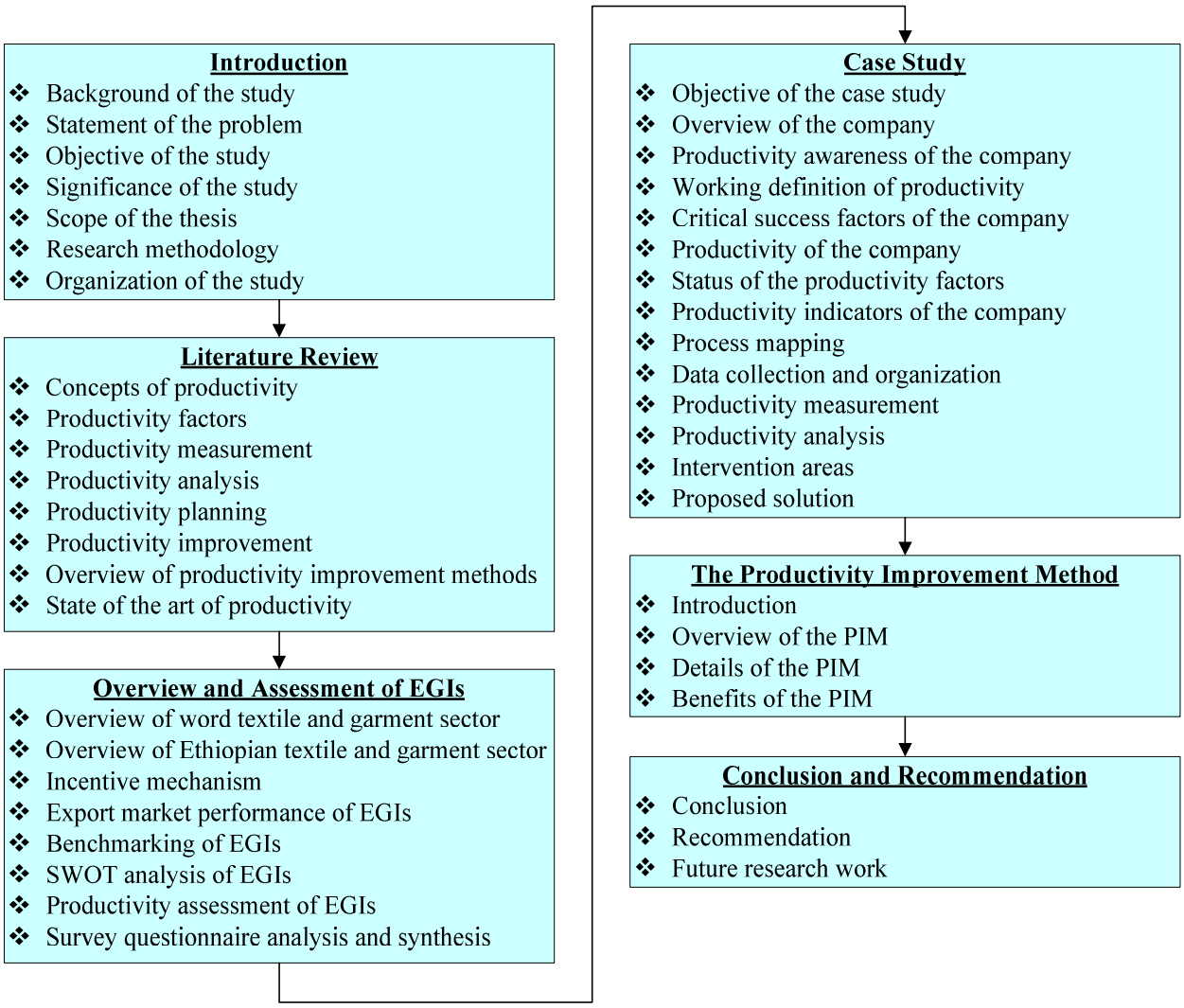

Figure 1.1: Organization of the study

Chapter Two

2-Literature Review

The literature review of the study has been organized into eight main parts, namely concepts of productivity, productivity factors, productivity measurement, productivity analysis, productivity planning, productivity improvement, overview of productivity improvement methods and state of the art of productivity.

2.1-Concepts of Productivity

In a formal sense, the first time the word productivity was mentioned in an article by Quesnay in the year 1766. In 1883, Littre defined productivity as faculty to produce. In 1950, OEEC give a formal definition to productivity as quotient obtained by dividing output by one of the factors of production. In 1955, Davis defined productivity change in product obtained for the resource expended. In 1962, Fabricant defined productivity as always a ratio of output to input. In 1965, Kendrick and Creamer defined productivity as functional definitions for partial, total factor and total productivity. In 1976, Siegel defined productivity as a family of ratios of output to input. In 1979, Sumanth defined total productivity as ratio of tangible output to tangible input [11].

EPA defined productivity as it is an attitude of mind. It is the mentality of progress, of the constant improvements of that which exists. It is the certainty of being able to do better today than yesterday and continuously. It is the constant adaptation of economic and social life to changing conditions. It is the continual effort to apply new techniques and methods. It is the faith in progress [1]. Productivity is a state of mind that strives for and achieves the habit for improvements (NPBS).

Productivity refers to the efficiency of the production system. It is the concept that guides the management of production system. It is an indicator to how well the factors of production like land, capital, labor and energy are utilized [1]. Productivity is a measure of system performance, system efficiency, resource utilization, and the relationship between real output and inputs [3]. According to the book, IET (ANSI, 1983), productivity is the quantitative and qualitative results of the inputs of all resources [4]. Productivity is defined as the ratio of output (goods and services) to input (men, materials and money). It is the most reliable index of how effectively an enterprise's resources are being utilized [5]. Productivity is a very

important measure in manufacturing operations, besides turnover and profit, because it provides insight into the efficiency and effectiveness of the operations. Productivity is concerned with the efficient utilization of resources (inputs) in producing goods and/or services (output) [3].

In general, input and output are the two pillars that define productivity. A simple firm model that relates inputs, constraints, outputs and productivity indicators is shown in figure 2.1.

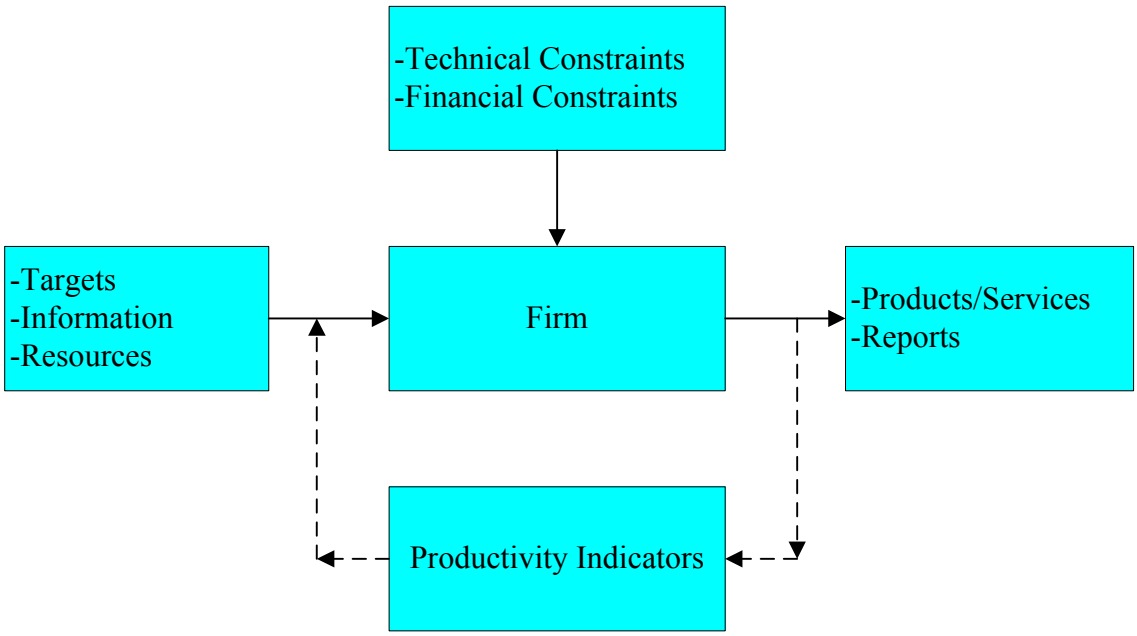

Figure 2.1: Simple firm model

To define and measure productivity, defining of the inputs and outputs is very crucial and mandatory. Inputs and outputs are presented in different approach by different authors.

Yilmaz et al (2009) presents inputs as material, labor, capital, equipment, energy and data; and outputs as completed product, information (report, plan) and data which can develop process [27]. Attia et al. (2006) present the inputs of a manufacturing company as materials, machines, manpower, method, technology, land, building, money, market, management tools and information [3]. Nakajima (1959) presents production, quality, cost, delivery, safety, hygiene, environment and morale as outputs [2]. The official United States Department of Commerce (1954) define national product as it is the market value of the output of (final) goods and services produced by the nation's economy. Kuznets (1941) define national product in terms of goods and services needed to satisfy the needs of ultimate consumers, both present and future. Kendrick (1992) prefers to emphasize that the national product is basically a net concept, the value of production minus the value of purchased intermediate products consumed in the production. Fabricant (1940) define output and input as follows:

gross output is equal to aggregate value of goods produced, excluding capital gains, and net output is equal to gross output minus value of all commodities and services purchased from other business organizations and consumed in the production. Kendrick and Creamer (1965) define net output is equal to output minus intermediate goods and services; and total factor input is equal to man-hour input of the measured period weighted by base-period average hourly earnings, preferably including fringe benefits plus total capital of the measured period expressed in base-period prices and weighted by the base-period rate of return, with depreciation treated as intermediate service. Craig and Harris (1972, 1973) define labor input as summation of man-hours worked in each classification multiplied by base year wage rate and/or salary scale for that job classification); raw materials and purchased materials input as summation of purchased units adjusted for inventory changes multiplied by base-year material prices; capital input as it is the sum of the annuity values calculated for each asset on the basis of its base-year cost, productive life, and the firm's cost of capital; and miscellaneous other inputs as any resources except labor, capital, raw materials/purchased parts. According APC, capital input is given by total depreciation plus profit relative to the total assets (i.e., fixed assets plus working capital) employed. Thus, the capital input for any particular period is equal to depreciation for that period plus the product of return on assets in base period and current assets employed. Sumanth (1979) define total tangible inputs as value of (human plus material plus capital) plus energy plus other expense inputs used; and total tangible output as summation of value of finished units produced, value of partial units produced, dividends from securities, interest from bonds and other income [1]. The total tangible inputs are human, capital, material, energy and other expense; and the total outputs are finished units for sale and internal use, partial units produced for sale and internal use, dividends from securities, interest from bonds and other income.

Human inputs can be coordinators which involve managers and professionals and producers include bureaucrats and workers. Capital inputs categorized into fixed and working capital; fixed capital involves land, buildings and structures, machinery, tools and equipments, and amortized research and development costs; working capital includes inventory, cash, accounts receivable and notes receivable. Material inputs are raw materials and purchased parts. Energy inputs consider oil, gas, coal, water, electricity, etc. Other expenses are travel, taxes, professional fees, marketing, information processing, offices supplies, research and development, general administration expenses, etc [11].

For this thesis productivity is defined as is effective and efficient utilization of resources used to produce products/services that meet customer requirements continuously by applying

appropriate methods and by controlling the parameters. To justify this definition, productivity is represented by the following conceptual model[3].

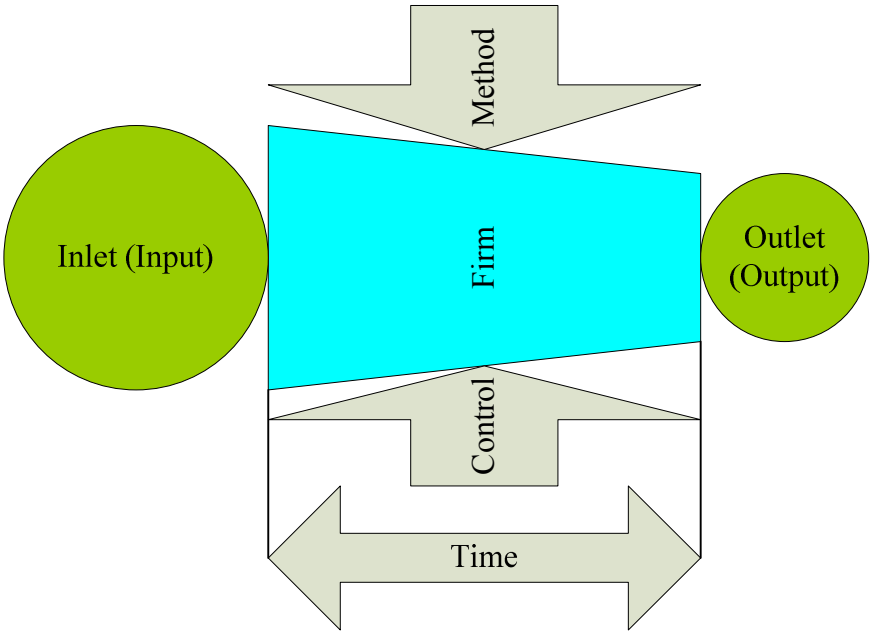

Figure 2.2: Conceptual model of productivity

In the above conceptual model, input is represented by inlet of the frustum; firm represented by volume of the frustum; method and control are represented by volume of the cylindrical arrow; output is represented by outlet of a frustum; and time is represented by the length of frustum. The frustum is hollow to represent flow of materials.

The conceptual model is represented as a frustum to show all the input can not be converted to output and there is waste. Waste increases along the length of the frustum. The basic thing while thinking productivity improvement is minimizing the waste. Waste is represented by the difference of volume of the cylinder and frustum. Theoretical (zero waste) conceptual productivity model is can be represented by cylinder.

In this thesis the inputs of the firm considered are human, capital, material, energy and miscellaneous inputs. The outputs considered are finished and partial products for sale and internal use. Method is a means applied to do activities in a better way. Control deals with regulating activities and parameters to be within acceptable limit. All operation and non-operation time are considered. Waste is the part of the resources that has no purpose or value to the firm and customers.

[3] The conceptual model is developed after analyzing several concepts of productivity from the literature survey.

2.2-Productivity Factors

Identifying the possible productivity factors is one the basic element for productivity improvement. Productivity factors can either boost or hinder productivity. The productivity factors surveyed from different literatures are presented as follows.

ETGMA (2010) identify the following constraints of Ethiopian garment sectors: access to inputs at competitive price, access to market, low margin operation, high transport cost, high transaction cost, bureaucratic hurdles, undercapitalization, and threat of foreclosure from the banks [28].

Kumar et al. (2008) presents controllable (internal) factors and uncontrollable (external) factors that influence productivity. Product factors, plant and equipment, technology, material and energy, human factors, work methods, and management style are controllable factors. Structural adjustment, natural resources, government, and infrastructure are uncontrollable factors [11].

Belgin (2008) classify productivity factors in to internal and external factors and presents by the following diagram. The internal factors categorized into materialistic and non-materialistic. Materialistic internal factor involves product, plant and equipment, technology, and material and energy; and non-materialistic internal factor includes human, organization, work methods and management. The external factors categorized into structure, natural resources and governmental issues. Structure external factor involves ergonomics and social situation; natural resources external factor includes land, energy and raw material; and governmental issues external factor involves corporate mechanisms and politics [27].

Grunberg (2007) after analyzing several literatures, he classifies factors influencing performance of operations into four namely process, control, product and resource. Factors related to process are lead-times, bottlenecks, material flow, volumes, development, inventory, integration, losses layout, measurement, cycle-times and transport; factors related to control are purchasing, ABC analysis, overproduction, total quality, location, financing, administration, subcontracting, routines, suppliers, customer, outsourcing, planning, cost and articles; factors related to resource are organization, efficiency, measurement, work methods, capacity, communication, motivation, satisfaction, accidents, resetting, utilization, maintenance, scheduling, absenteeism, ergonomics, new technology, competence, losses and downtimes; and factors related to products are development, design for assembly, product variants, standardization and modularization [20].

Tangen (2004) shows that productivity is influenced both directly and indirectly. The direct influence factors are number of products produced as well as resources consumed. The indirect influence factors involve flow principle and layout, flexibility requirements, automation, capacity, resetting, maintenance, quality management, production planning and control, materials supply, customer/supplier relations, information handling, product complexity, product variety, standardization of parts, competence, work environment, and work organization [37].

Bheda (2003) by collecting data from small, medium and large garment industry groups and performing analysis of variance and correlation analysis, he presents the following as factors associated with garment industry productivity: age of the factory, lead time, work-in-process level, repair as final inspection, rejection level, number of sewing machine installed, sewing technology index, production location, organization type, major export destination, major product category, education level operators, production systems, payment systems, presence of industrial engineering cell, rewarding creative suggestions, training to supervisors/managers, operators, induction training and production standards [19].

Yamfwa (2001) presents internal factors and external influences that affect the performance of the firm. Condition of production process, labor, management, firm level investment, marketing, organizational structure, firm intellectual property, and firm level technological capability and effort are typical internal factors. National infrastructure, trade policies, good governance, political stability, demand and inflation, national investment, national systems of innovation, and competition and intellectual property are external influences affecting firm's performance [14].

Rantanen (1997) classifies productivity improvement factors in to three categories: internal, external and general obstacles. The internal obstacles are factors that inside the firm and it is possible to eliminate or weaken them by actions performed inside the firm. Lack of knowledge and poor production methods are typical internal obstacles. The external obstacles are factors that are outside the firm. The firm can not affect these factors directly. Legislation and action of trade unions are typical external obstacles on productivity improvement. General obstacles are factors that are not so easy to categorize clearly to either internal or external obstacles. Theoretical problems, measurement problems and lack of public information can be general obstacles [13].

Sumanth (1979) presents the factors that affect the productivity of United States of America (USA) are investment, capital/labor ratio, research and development, capital utilization,

government regulations, age of plant and equipment, energy costs, workforce mix, work ethics, workers' fear about loss of jobs, unions' influence and management [11].

2.3-Productivity Measurement

In order to analyze and improve productivity first it should be measured. By itself, a productivity measure has no meaning. It only gains meaning when compared to productivity measurements for prior periods or to measurements from comparable facilities producing similar outputs. Productivity measures attempt to highlight improvements in the physical use of resources, that is, to motivate and evaluate attempts to produce more outputs with fewer inputs while maintaining quality. Productivity measurement systems analyze performance based on actual outputs and inputs in different time periods. The productivity measurement system can be viewed as a variance analysis of the actual costs incurred in successive periods [6].

Productivity can be measured as the ratio of output to input; the ratio between the amount produced and the amount of any resources used in the production; and output per unit of input [1]. Productivity broadly classify into total productivity and partial productivity. Total productivity is the ratio of total output to the sum of all inputs. Partial productivity is the ratio of output to one class of input [3]. There are many different productivity measures. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Total productivity, partial productivity, multifactor productivity and total factor productivity indexes are used to measure productivity. Multifactor productivity is ratio of output to a bundle of inputs [7]. Total factor productivity is the ratio of net output to the sum of associated labor and capital inputs [3].

Productivity can be measured at international, national, industrial and company level. It can be measured for short run, medium run and long run. It is also measured at operational level, tactical level and strategic level.

2.3.1-Productivity Measurement at International Level

2.3.1.1-Benefit of Productivity Measurement International Level

Productivity comparisons based on some systematic approaches at the international level are valuable tools for understanding and evaluating the impact of productivity on domestic and international markets of competing countries.

2.3.1.2-Productivity Measurement Approach at International Level

This measurement usually made by economists. Rostas (1955) proposes four measures for international comparison of productivity:

1. Comparison of the value of the gross output per unit of labor
2. Comparison of the value of the net output per unit of labor
3. Comparison of the physical output (gross as well as net) per unit of labor
4. Comparison of the physical input of materials

Shelton and Chandler (1963) provide the following measures most commonly used to compare the productivities of countries:

1. Hourly labor cost = E/L
2. Output per man-hour = Q/L
3. Unit labor cost = (E/L)/(Q/L) = E/Q

Where: E = aggregate labor cost (or expenditure), L = man-hours of labor and Q = quantity of output

The OEEC used two measures for productivity comparison: GNP per capita and GNP per person employed.

The United States BLS, OPT, used the following for productivity comparisons: GDP per capita and GDP per employed civilian.

2.3.1.3-Limitation of Productivity Measurement International Level

- ☞ While using the exchange rates, comparisons often do not consider the prices of similar goods and services in all countries for a given year.
- ☞ The available few industrial level comparisons are limited in the number of industries or countries covered.
- ☞ Several factors, including social, cultural, political, and economic conditions have not been studied sufficiently. For this reason, the explanation of international productivity differences is less than adequate [11].

2.3.2-Productivity Measurement at National Level

2.3.2.1-Benefit of Productivity Measurement National Level

Much attention has been given to the measurement of productivity at the national level, primarily by the economists. Rostas (1955) outlines some of the benefits of measuring productivity for the national economy as follows:

- Productivity estimates can be used in forecasting national income and output at some future date, the probable size of the workforce, occupational shifts, labor requirements, etc.
- Being an element in labor costs, productivity can be used to compare the competitive power of various industries in different national economies.
- Being a factor in the distribution of the product of industry, productivity is relevant to collective bargaining.

The 15th edition of Encyclopedia Britannica (1974) mentions three additional uses of productivity at the national level:

- Productivity is an index of growth because a nation advances by using less to make more. Labor productivity is an especially sensitive indicator of this growth.
- An overall rise in a nation's labor productivity implies a large quantity of goods and services per worker than before, and hence a potential for higher real income per worker. Countries with high real wages usually tend to have high labor productivity.
- Productivity is also used to measure efficiency. It is also a means to assess the uses to which resources are being applied, because the extent to which resources flow to various uses depends, in large measure, on their productivity in each of these uses.
- Productivity is an important factor affecting prices and wages. Although economists are far from a complete knowledge of the interaction of variables, there seems to be agreement on some fundamental points: Increases in real wages in many countries are closely related to large increases in labor productivity in these countries; and an increase in labor or other partial productivities usually brings with it a reduction in costs, and hence prices and wage increases, or both.

2.3.2.2-Productivity Measurement Approach at National Level

At the national level, productivity measurement efforts have been primarily from the economists' point of view. Index approach is used to measure productivity at national level.

Mark (1971) divides the various productivity measures at national level into three, namely: labor productivity indexes, capital productivity indexes, and labor and capital productivity indexes. Among these indexes, labor productivity appears to be the most commonly used.

The three types of labor productivity indexes commonly employed are BLS indexes, NBER indexes and Brookings institute indexes.

According to BLS indexes: Labor productivity = [constant dollar value of goods and services provided/man-hours of employed persons] = [real GNP originating in the private economy or the/individual sectors man-hours of all persons employed (including proprietors and unpaid family workers)] = [purchase of goods and services by consumers, gross private domestic investment (including the change in business investors), net foreign investment, and government all deflated separately for price changes/human-hours of all persons employed (including proprietors and unpaid family workers)]

In BLS indexes, the human hour can be paid human hour or actual human hour.

According to NBER indexes defined by Kendrick (1961): Labor productivity = [output/weighted human hour]

In NBER indexes, the weighting is done by using average earnings.

According to Brooking Institute indexes published by Denison (1962): The procedure to accomplish this is different from Kendrick's, however, since the adjustment is based on sex, age, education, and since other changes in the labor force are applied to basic employment and man-hour measures.

Capital productivity indexes at national level defined by:
Capital productivity = [output/capital input]
Total labor and capital productivity indexes at national level defined by two measure, namely NBER measures by Kendrick and Denison's measures.

According to NBER measures by Kendrick: Total labor and capital productivity = [output/(labor + capital)]

Where: Labor input = man-hours, adjusted for quality change in labor, capital input = net stock of structure + plant equipment + inventories + working capital + land

Here the inputs are added together with factor prices as weights.

According to Denison's measures: Total labor and capital productivity = [net domestic product (excluding depreciation)/weighted sum of capital and labor]

Here, the weights are the base-period share of the dollar output of each of the inputs, labor and capital.

2.3.2.3-Limitation of Productivity Measurement National Level

- Due to the nature of output to input direct quantity measures of output and input are difficult to obtain. Therefore, in many cases some kinds of approximations or substitutions are employed.
- For the sake of productivity measurement most data are not collected and compiled. Therefore, some modifications are made to suit the data to such concepts of productivity measurement as perceived by the researcher [11].

2.3.3-Productivity Measurement at Industry Level

2.3.3.1-Benefit of Productivity Measurement Industry Level

- Productivity measures at the industrial level can be helpful economic indicators in tracing the economic performance of a country. Since productivity measures identify the leading and lagging industries, potential problem areas can be marked, and then examined in detail.
- Changes in manpower utilization, future manpower projections, trends in labor costs, effects of technological advancement on industry employment and unemployment can be analyzed by the industry productivity measures. Productivity progress for particular industries in different countries can also be compared.
- Comparison of performance of individual companies can be done using the industry productivity measures.
- The industry productivity measures can assist the firms and trade associations to forecast industry growth patterns, future conditions, etc.

2.3.3.2-Productivity Measurement Approach at Industry Level

According to economists there are three basic approaches in measuring the productivity of industry in general namely, index approach, production function approach and Input-output approach.

***Index Approach*:** Several researchers and organizations have attempted to develop index-based measures for the industry in general. And some of the index approaches are:

***Mills's Indexes*:** Mills (1932) was perhaps the first to present productivity indexes for industries. According to his definition:
Mills productivity index = [output/number of wage earners]

***Magdoff's Indexes*:** Magdoff (I939) defines the following two measures for the industry:

Unit labor requirements index = [relatives of total man-hours/production index]
Productivity index = [1/unit labor requirements index] = [production index/relatives of total man-hours]

The total man-hours is taken as the measure of labor time, assuming that the labor is homogeneous and that its unit of measure is an hour of undifferentiated labor; the qualitative differences in skills, occupations, and the efficiency of the individual employees are ignored.

***BLS Indexes*:** BLS uses two indexes to derive productivity measures for industry: unit man-hour index and deflated value index. The unit man-hours index is the ratio for two periods of the total hours expended in the production of a mix of products. The deflated-value index is identical to the physical output index that makes use of substitute unit value weights. It is derived from value of production data that relate to total value of products produced by the industry alone.

***Production Function Approach*:** Solow (1957) developed aggregate production functions, while Lave (1966), Salter (1966), and Aigner and Chu (1968) dealt with the measurement of technological change by making use of the production functions.

***Input-Output Approach*:** Most of the efforts using input-output analysis are at the national and industrial levels. Elliott-Jones (1971) applied input-output analysis to determine the total output and input in industries. He used the input-output tables to consider inter industry flows. Blackett (1971) illustrated the application of input-output analysis to determine the input requirements of industries.

Index approach and production function approach is done by different researchers to measure manufacturing industries productivity. Siegel (1940) defined unit labor cost index as follow:

Index of unit labor cost = [index of wages/index of production] = [(index of man-hours x index of average hourly earnings)/index of production] = [index of average hourly earnings/index of productivity]

Griliches (1968) reported a production function approach in measuring the output of the manufacturing industry. Also, David (1966) proposed an index for measuring the real net output, having assumed a production function of the form $Q = F(L_i, K_i, M_i)$, where Q = industry physical output, L_i = labor inputs, K_i = capital inputs and M_i = purchased raw materials. Nadiri (1970) presents an excellent survey on total factor productivity measurement and production functions.

2.3.3.3-Limitation of Productivity Measurement Industry Level

Mark (1971) mentions three major problems in measuring output at the industrial level:

1. Lack of relevant detailed product data for many industries.
2. Quality changes that result from the development of new products, and changing the specifications of existing ones.
3. Usually nonexistence appropriate weights [11].

2.3.4-Productivity Measurement at Company Level

2.3.4.1-Benefit of Productivity Measurement Company Level

Researches related to company level and operational unit level productivity measurement is still in the developmental stages, although interest among academics and practitioners has been increasing in the last few years.

Sumanth (1981) mentions the following benefits of productivity measurement at company level.

- The organization can evaluate the efficiency of conversion of its resources so that more goods or services are produced for a given amount of expended resources.
- Resource planning can be done through productivity measurement, both on short and long term basis.
- Through productivity measurement effort, the economic and noneconomic objectives of the organization can be reorganized by priority.
- Based on the measured productivity levels now, planned productivity level targets for the future can be modified realistically.
- Strategies for improving productivity can be formulated based on the extent of the gap between the planned level and the measured level of productivity.
- Productivity measurement can be used for comparing the productivity levels between organizations within a particular category, either at the industry or at the national level.

- ❖ Productivity values generated as a result of a measurement may be useful in planning the profit levels in an organization.
- ❖ The productivity measurement can create competitive action.
- ❖ Once productivity estimates have been done, collective bargaining can be accomplished more rationally.

2.3.4.2-Productivity Measurement Approach at Company Level:

For measuring productivity at company level, there are different approaches taken by economists, engineers, managers, and accountants. Some of them are index approach, production function approach, input-output approach, utility approach, servo-system approach, array approach, financial ratios approach, capital budgeting approach and unit cost approach.

***Index Approach*:** It is used by economists and engineers to measure productivity at company level. The following index approaches are used to measure productivity at company level.

***Kendrick-Creamer Model*:** Kendrick and Creamer (1965) introduced productivity three indexes at the company level, namely total productivity, total factor productivity, and partial productivity.

Total productivity index for a given period = [measured period output in base period prices/measured period inputs in base period prices]

Where: the sum of inputs in base period prices = output in base period prices in the base period; and the difference between the sum of inputs in base period prices and the output in base period prices is the productivity gain (or loss) in the measured period.

Total factor productivity index = [net output/total factor input]

Partial productivity of labor = [output (gross or net) in base period price/labor input in base period price]

Partial productivity of capital = [output (gross or net) in base period price/capital input in base period price]

Partial productivity of material = [output (gross) in base period price/purchased intermediate products in base period price]

***Craig-Harris Model*:** Craig and Harris (1972, 1973) define a total productivity measure at company level using the following expression.

$P_t = [Q_t/(L+C+R+Q)]$

Where: P_t = total productivity, Q_t = total output, L = labor input factor, R = raw material and purchased parts input factor and Q = other miscellaneous goods and services input factor

***Hines's Model*:** Hines (1976) defines total productivity the same as Craig-Harris model but he expresses the Craig-Harris model in a more symbolic form. He does not, however, show the application of his definitions to any numerical example.

***APC Model*:** The APC has been advocating a productivity measure that relates profitability with productivity and price recovery factor. The way this measure is derived is:

Profitability = [sales/costs] = [output quantities * prices/input quantities * unit costs] = [output quantities/input quantities] * [prices/unit costs] = [productivity * price recovery factor]

Price recovery factor is a factor which captures the effect of inflation.

***Mundel's Model*:** Mundel (1976) presents two alternative forms of productivity indices as follows.

PI = [(OMP/IMP)/(OBP/IBP)] x 100 = [current performance index/base performance index] * 100

PI = [(OMP/OBP)/(IMP/IBP)] x 100 = [outputs index/inputs index] * 100

Where: PI = productivity index, OMP = aggregated outputs, measured period, OBP = aggregated outputs, base period, IMP = inputs, measured period and IBP = inputs, base period

***Taylor-Davis Model*:** Taylor and Davis (1977) forward the following total factor productivity measure for a firm:

$TFP = [((S + C + MP) – E)/((W + B) + (K_W + K_f) * F_b * d_f)]$ =[total value added output/total input (labor and capital)]

Where: S = net adjusted sales = net sales billed, deflated to base-year dollars using an internal company price index = [sales dollars for the period/(price deflator / 100)], C = inventory change = sum of inventory changes for raw materials, finished goods, 1/2 work in

process (raw material), and 1/2 work in process (finished goods), MP = manufacturing plant = items that could be purchased from outside sources but are produced internally; for example, internal maintenance and repair, internally produced machinery and equipment, and research and development, E = exclusions = [materials and services purchased from outside the firm + depreciation on buildings, machinery, and equipment + rentals], W = wages and salaries, B = all benefits, such as overtime, vacation, sickness, insurance, profit sharing, social security tax, retirement, bonus, K_w = working capital = [cash + notes and accounts receivable + inventories + prepaid expenses], K_f = fixed capital = [land + buildings + machinery and equipment + deferred charges], F_b = investor contribution, expressed as a percentage and d_f = price deflator

***Total Productivity Model (TPM)*:** Recently, Sumanth (1979) developed a productivity measurement model that considers the impact of all input factors on the output in a tangible sense. The model is applicable not only as an aggregate tool at the firm level, but it can also be used at an operational unit level. TPM is a basic model from which several versions are derived. It is based on total productivity measure and a set of five partial productivity measures. The model can be applied in any manufacturing company or any service organization. The TPM is defined as:

Total productivity = [total tangible output/total tangible input]

According to this model, total productivity is at product and firm level. Total productivity of a product can be found using two approaches namely, as ratio of total outputs to total inputs and as weighted value of one of its partial inputs. Three approaches are used to measure total productivity of a firm namely, as ratio of total output to total inputs, as weighted sum of total productivity of product and as a weighted value of one of its partial inputs.

Total productivity model, which is one of the most important components of total productivity management philosophy, has been applied in different organizations including manufacturing, construction, insurance, banking, healthcare, utilities, education, financial services, engineering consulting, process industries, transportation, mining, fast food business printing business, computers, heavy equipment, stock brokerage, retail, tourism, government, defense industry, and many more others [41].

***Production Function Approach*:** It is usually used by economists to formulate some general mathematical expression for output as a function of input factors.

There are three distinct areas of research in developing this approach appear in the literature: pure theory of production functions, econometric theory of production functions, and applied econometric theory of production functions.

***Pure Theory of Production Functions*:** There are three kinds of pure theory of production functions: the Cobb-Douglas function (CEF), the constant elasticity of substitution (CES) function, and the variable elasticity of substitution (VES) function.

***The Cobb-Douglas Function*:** The Cobb-Douglas function is given by:

$Q = aL^{d}K^{f}e^{u}$

Where: Q = output, L = labor input, K = capital input and u = random measurement error component, and a, d, and f are constants to be estimated

***The Constant Elasticity of Substitution (CEF) Function*:** The CES function was first proposed by Arrow et al. (1961). It is given by:

$Q = a[bL^{-r} + (1-b)K^{-r}]^{-v/r}e^{u}$

Where: Q = value-added output, L = labor input = total man-hours, K = gross book value of capital adjusted by capacity utilization coefficient, a = arbitrary constant of proportionality, b = distribution parameter, r = substitution parameter, v = degree of returns to scale, e = base of the natural logarithm and u = random measurement error with mean zero and variance

***The Variable Elasticity of Substitution (VEF) Function*:** The VES function is a generalized form of the CES function and is given by:

$Q = [cK^{-r} + dK^{-mr}L^{-r(1-m)}]^{-1/r}$

***Econometric Theory of Production Function*:** The econometric theory of production function involves the use of statistical concepts to study the effect of the random measurement error.

***Applied Econometrics Theory of Production Functions*:** Applied econometrics theory of production functions deal with the actual fitting of some functions to sample data from economics, industries, and firms. Klotz (1970) concentrates his efforts in this area.

***Input-Output Approach*:** Economists used this approach and it is originally applied to study the flows in national economy. Although much work has been reported using the input-output

approach at the national and industrial levels of productivity measurement, very little has been done on applying this technique at the firm level.

***Utility Approach*:** Engineers used this approach. Stewart's (I978a, 1978b) used this approach for measuring manufacturing productivity by defining productivity "as the ratio of performance toward organizational objectives to the totality of input parameters". The essence of his approach is to combine various "surrogate measures" to produce a single number. He defines a surrogate measure as "one which is used in place of another and is often used when the desired measure is unobtainable".

***Servo-System Approach*:** Engineers used this approach. Hershauer and Ruch (1978) provide a servo-system model of worker productivity by defining productivity "as it relates input to output through a conversion process". The servo-system model does not used to measure a company's productivity in terms of numbers. However, recognition of the complex nature of factors affecting the productivity of one input, the worker, is valuable in forming a partial basis for future development of productivity models.

***Array Approach*:** Managers used this approach. De Witt (1970, 1976) forwards a quantitative technique for measuring the productivity of management. The method uses arrays (numbers of mathematical elements arranged in rows and columns) as an evaluation tool. The method requires the management be evaluated on the basis the performance of the managed firm, the relationship of enterprise performance to the resources that have been used to achieve this performance, and the position of the firm in its competitive environment.

***Financial Ratios Approach*:** Managers used this approach to measure of productivity of the company. [current assets/current liabilities] and rate of return are some of the measures listed and discussed by Tucker (1961). In recent years, it has been suggested that some productivity measures reflect the financial health of an organization. And two of such measures are proposed by Gold (1976) and Aggarwal (1979).

***Gold's Model*:** Gold (1976) focuses on the rate of return on investment. He combines product prices, unit costs, utilization of facilities, productivity of facilities and allocation of capital resources between fixed and working capital by the following expression:

Profit/total investment = [(product revenue/output) – (total costs/output)] * [output/capacity] * [capacity/fixed investment] x [fixed investment/total investment]

***Aggarwal's Model*:** Aggarwal (1979) proposed a composite productivity index based on four financial ratios:

Composite productivity index = [a(net profit/total investment) + b(value added/number of weighted man-hours) + c(total sales revenue/number of customers) + d(total dollar purchases/number of suppliers)]

The coefficients a, b, c, and d can be determined only when the company has past data on eight variables of the equation for five or more periods so that a linear regression can be run. The idea is to use the composite productivity index to compare the relative performance of a company from period to period.

***Capital Budgeting Approach*:** Accountants used this approach. Mao (1965) demonstrated the use of the capital budgeting technique in measuring the "productivity" of public investment. According Mao, the productivity of a project is the savings, both tangible and intangible, that accrue to it. His approach is to compute a rate of return for each of the projects and then rank the projects according to their rates of return, and to determine the cost of social capital and use it as the cutoff rate for the projects.

***Unit Cost Approach*:** It is one of the indirect ways of measuring productivity used by accountants. Adam et al. (1981), advocate a method called quality productivity ratio (QPR) which considers unit costs of processing and rework separately, to account for the quality changes in an organization [11].

QPR_1 = [number of items not rejected/((total number of items * processing cost per item) + number of error items x reject processing cost per item))]

QPR_2 = [number of items not rejected/(total number of items * processing cost per item)]

QPR_3 = [number of items not rejected/(number of error items * reject processing cost per item)]

In addition to the above production measurement approaches, many researches have been done on productivity measurement. For instance the following ways of productivity measurement are forwarded by different authors.

Shabrawy et al. (2006) present productivity index as function of effectiveness divided by function of efficiency. Effectiveness is related to performance, is the degree of accomplishment of objectives and how well a set of results is accomplished. Efficiency is

related to resource utilization, is the degree of resource utilization and how well the resources are utilized to achieve the results [3].

Bheda (2003) proposed a productivity measurement system for apparel industry and it have the following elements: work for all tasks, productivity reports for internal and external bench marking, review performance and plan improvement, communicate performance, generation of productivity reports, garment analysis sheets and worker allocation, practice of hourly productivity data collection, and communication of time standards to workforce. He presents three types of three types of productivity measurement methods, namely: physical productivity measurement method, value productivity measurement method and value-added productivity measurement method. Productivity measurement method uses the quantity of output and input as a data for calculating productivity. Value productivity measurement method uses the monetary value of output and input as a data to for calculating productivity. Value-added productivity measurement method uses value-added expressed in momentary units as a data for calculation [19].

Wilson (1993) prescribed a new approach, oriented towards the goals of management, in measuring productivity at the National Standard Company. It was characterized as a weighted multi-factor productivity model, where the total productivity for a given firm is a function of various partial productivity. Each partial productivity possesses a distinct magnitude of influence on the overall productivity measure (i.e. a weighted influence) [22].

Pradip et al. (1992) provided the details of the sensitivity analysis of the factors considered in the Ray-Sahu model of productivity measurement for multi-product manufacturing firms. And the information obtained through sensitivity analysis determines the possible combinations of production factors with which management would be able to increase the total productivity of each of the products [18].

Sink (1985a) developed the multi-factor productivity measurement model (MFPMM) by modifying the total factor model developed for by the American original work by Davis (1958) [23].

2.4-Productivity Analysis

Productivity analysis is a powerful systematic methodology to measure system performance, system efficiency, system effectiveness, resource utilization and profitability. Productivity

analysis helps decision makers to identify the driving factors of productivity, adopt the appropriate action and monitor its consequences [3].

Sumanth (1979) developed methodologies to analysis total productivity for any given product between two periods two successive periods and within a given period. To analyze total productivity, the tasks undertaken are:

- ☞ Develop an expression for the change in total productivity between two successive time periods, and then derive the possible ways that this change could occur
- ☞ Develop two methods for obtaining budgeted values of total productivity, and compare them with corresponding actual values
- ☞ Establish a step-by-step procedure for analyzing total productivity between any two successive time periods and within a given time period
- ☞ Illustrate the methodology with a numerical example [11].

2.5-Productivity Planning

Scott (1965) define planning as it is an analytical process which encompasses an assessment of the future, the determination of desired objectives in the context of that future, the development of alternative courses of action to achieve such objectives and the selection of a course or courses of action from among these alternatives.

Cotton (1976) recognizes the importance of productivity planning and suggests a three-step procedure:

1. Develop an effective planning process and structure in the organization
2. Prepare productivity goals and permeate the planning process with specific objectives based on these goals
3. Establish productivity surveillance, assistance, and coordination in a manner tailored to the organization's needs

Sumanth (1979) identifies two types of formal productivity planning, namely: short-term productivity planning and long-term productivity planning. According to him, the responsibility for short-term productivity planning should be at plant or division level and the responsibility for long-term productivity planning should be at corporate level. He indicates five forecasting methods to prepare short-term productivity planning; the methods are weighted partial productivity model, productivity evaluation tree (PET) model, linear trend

model, comparative productivity evaluation model and seasonal variation model. Also he presents two models for long-term productivity planning namely, total productivity maximization model and total productivity profit model [11].

2.6-Productivity Improvement

Improving productivity have a positive impact on the direct costs of the products, as the same output is produced with less input or as the same inputs are producing more output. This can create new opportunities and improve the competitiveness of the manufacturing operations. Low productivity indicates that an enterprise is wasting its resources, and this means that it will eventually lose its international competitiveness and thereby reduce the scale of its business activities. Low productivity decreases the growth of a nation's industries and economy as a whole. Improving productivity is especially important for export oriented industries since it is the only viable option for competing in the long term [5].

Patra et al. (2009) present the following ten commandments to improve productivity: leadership commitment, manage change, organize and plan, people are the assets, organize training, process is the backbone, metrics based approach, assess and evaluate, improved communication, and focus on benefits [26].

Belgin (2008) stated five ways of increasing productivity: more output and less input, more output and same input, much more output and more input, same output and less input, and less output and much less input [27].

Roman (2008) examines how changes made to an existing team based incentive plan affects labor productivity, product quality, and worker absenteeism using data from three production units of a large manufacturing plant that employs production teams in its assembly operations [18].

Grunberg (2008) develop and evaluate a performance improvement method which has seven steps. Step 1-planning, step 2-pre-study, step 3-process mapping, step 4-process measurement, step 5-analysis, step 6-implementation and step 7-evaluation [20].

Attia et al. (2006) presents a four phase productivity improvement cycle. Phase I-measurement, phase II-evaluation, phase III-planning and implementation, and phase IV-control and updating. Once the productivity level of an organization is measured in the current time period (for example, the current month, quarter, or year), it must be compared with the target level set up in the preceding period. Based on this evaluation, a new

productivity level must then be planned for the next coming period. Finally, depending on the nature and level of the planned target of productivity, improvement must take place in the next period. To determine if the planned level has in fact been achieved, productivity must be measured again in the next period. The entire cyclic process repeats for as long as an organization formally manages its productivity level and growth rate.

Herron et al. (2006) describe a model which has been developed to direct and generate productivity improvement in a group of manufacturing companies. The methodology developed has three clearly defined steps, the first step is a productivity needs analysis (PNA), which gives an overview of the current manufacturing condition of the company, identifies the key productivity measures for the plant and forms the basis for a detailed study of production efficiency. The second step is a manufacturing needs analysis (MNA) in which the plant processes and problems are defined and associated with the appropriate tools and metrics, and generates an initial 1-year improvement plan for a particular manufacturing unit. The third step is a training need analysis used to ensure that the tools which are found to be efficacious are fully embedded within the company by combining PNA and MNA [17].

Huang et al. (2003) develop a systematic methodology for productivity measurement and analysis at the factory level. Metrics of overall equipment effectiveness (OEE) and overall throughput effectiveness (OTE) are introduced and developed to improve manufacturing productivity then validate the methodology with simulation [12].

Bheda (2003) presents the following strategies for productivity improvement in apparel manufacturing industry: initiate supervisor and manager training, strengthen work measurement and methods improvement, setup operator selection and training procedures, introduce productivity measurement system, strengthen quality system, improve worker involvement and working conditions, strategic technology up gradation, strengthen production planning and scheduling, introduce incentive scheme, and introduce information system for productivity improvement [19].

Sumanth (1998) develop a ten step total productivity management methodology. Step 1-customer satisfaction survey, Step 2-mission statement development, step 3-total productivity analysis, step 4-management goals development, step 5-fishbone analysis and action plan development, step 6-productivity and quality training, step 7-implementation of action plans, step 8-assessment of management goals, step 9-total productivity gain sharing analysis and step 10-new goals development [39].

Daniels (1997) productivity improvement does not rely for its success on the application of specific productivity techniques. It depends much more on the commitment and creativity of all members of the organization. He presents value analysis, Pareto analysis, cause and effect diagram, method study, cost-benefit analysis and work measurement as productivity improvement techniques [15].

Sumanth et al (1983) proposed a six step procedure for improving the total productivity of an organization: step 1-data collection, step 2-computation of productivity changes and data file compilation, step 3-determination of productivity improvement coefficients, step 4-evaluation of the productivity improvement coefficients and technique usage, step 5-final selection of the productivity improvement techniques and step 6-implementation of the selected techniques [21].

Ramadan proposes a mathematical framework that addresses an improvement planning program for the organization level. A proposed model based on the concept of total productivity is presented to determine the best programs among those productivities' improvement programs. The proposed framework eliminates the lack of the current known model, analytical productivity improvement model (APIM) [24].

Sumanth cataloged more than fifty different techniques of productivity improvement in a comprehensive survey of the literature. These techniques classified into seven basic groups: 1-Technology based techniques includes computer applications, computer graphics (Auto-Cad), computer aided design (CAD), computer aided process planning (CAPP), computer aided manufacturing (CAM), group technology, new production lines / machines, rebuilding old machines, maintenance planning & control and layout; 2-Material based techniques includes inventory control, material requirements planning (MRP), quality control, material handling improvement, material reuse / recycling and new materials; 3-Product based techniques includes research & development (R&D), product design, product standardization, product reliability improvement and value engineering; 4-Employee based techniques includes individual financial incentives, group financial incentives, training & education, quality circles, brain storming, working conditions improvement, communication improvement and job rotation; 5-Task based techniques includes work study, job evaluation, job safety, human factors engineering (ergonomics), computer aided data processing and scheduling; 6-Management based techniques includes marketing management, production management, quality management, cost management, maintenance management, material management and resource management; and 7-Investment based techniques includes

reducing the administration cost, increasing value added, increasing contribution and increasing profit [3].

2.7-Overview of Productivity Improvement Methods

There are several productivity improvement methods developed so far. Sumanth categorized the methods into seven basic categories namely, employee based, material based, task based, management based, technology based, product based and investment based. And any other techniques can be grouped in any of these categories [3]. Kanthi and Samuel (2006) summarized manufacturing system productivity improvement methods into operation research based, system analysis based, continuous improvement based and performance metrics based. Grunberg (2007) represented the productivity improvement methods into the following categories: logistics, quality, production engineering and others [20].

2.7.1-Total Quality Management

Total quality management focuses on control of business processes and customer satisfaction. Activities such as improvement, statistical control, supply control and quality engineering are ingredients of total quality management [20].

2.7.2-Six Sigma

Six sigma is a concept to decrease variation in manufacturing processes using statistical tools [20]. It is a disciplined methodology for process improvement that deploys a wide set of tools based on rigorous data analysis to identify sources of variation in performance and ways of reducing them [35].

2.7.3-Total Productive Maintenance

Total productive maintenance is a waste reducing approach to stabilize the utilization of equipment. It focuses on improving machine availability and includes monitoring of machine equipment called overall equipment efficiency to visualize losses of utilization [20].

2.7.4-Just In Time

Just in time is a logistic approach to reduce waste and throughput-time for an ideal stockless production with planned elimination of waste [20].

2.7.5-Lean Manufacturing

The ultimate goal of lean manufacturing to reduce lead time that is to length to be acceptable to customers [20].

2.7.6-Business Process Reengineering

Business process reengineering concentrates on radical change to improve operations. The radical change allows new revolutionary ideas to evolve which can help to improve operations [20]. It is an approach to review and redesign organizational processes in order to achieve improved performance in terms of cost, quality of service and timeliness [35].

2.7.7-Balanced Scorecard

Balanced scorecard is a multi-dimensional framework for managing strategy by linking objectives, initiatives, targets and performance measures across key corporate perspectives [35].

2.7.8-Work Study

Work study is a generic term for method study and work measurement which are used in the examination of human work in all its contexts. And which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement [1].

2.7.9-Supply Chain Management

Supply chain management aims to create efficient resource flows from the source to the end customer [20].

2.7.10-Theory of Constraints

Theory of constraints pays attention on bottlenecks. It is important to increase throughput to the maximum in production bottlenecks [20].

2.7.11-Five S

Five S have five steps which contain workable aspects to improve efficiency. The steps are sort (arranging), set in order (neatness), shine (cleanup), standardize (discipline) and sustain (ongoing improvements) [20].

2.7.12-Kaizen

Kaizen is the Japanese word for continuous improvement. It originates from a Japanese work method, which uses a continuous work method, which in turn was adopted from Deming and Juran [20]. It is short term and intensive performance improvement approach to improving business processes [35].

2.7.13-Total Productivity Management

Total productivity management as it is generally known, provides a system for coordinating all the various improvement activities occurring in a company so that they contribute to goals for the entire company [36]. Starting with a corporate vision and broad goals, these activities are developed into supporting objectives, or targets, throughout the organization. Total Productivity Management is a proactive, pragmatic, innovative and unique concept, management philosophy, and systematic process, based on the industrial engineering and behavioral sciences. The concept of total productivity management is generic; therefore, it is easily adapted to any type of organization or enterprise, as has been demonstrated during the last 10 years in many countries around the world [41].

The following criterion have been used to evaluate the above productivity improvement methods: compatible knowledge and skill (i.e. easy to use) (1), compatible with existing tools and techniques (2), addressing the possible productivity factors (3), being continuous improvement tool (4), having clearly defined productivity targets setting, measurement and analysis framework (5), and having flexibility to apply from operation to firm level (6).

Table 2.1: Evaluation of the productivity improvement methods

S.No.	Method	Criteria					
		1	2	3	4	5	6
1	Total Quality Management	No	Yes	Yes	Yes	No	No
2	Six Sigma	No	Yes	No	Yes	No	No
3	Total Productive Maintenance	No	Yes	No	Yes	No	No
4	Just In Time	No	Yes	No	Yes	No	No
5	Lean Manufacturing	No	Yes	No	Yes	No	No
6	Business Process Reengineering	No	Yes	Yes	Yes	No	No
7	Balanced Score Card	No	Yes	Yes	Yes	No	No
8	Work Study	No	Yes	No	No	No	Yes
9	Supply Chain Management	No	Yes	No	No	No	No

10	Theory of Constraints	No	Yes	No	No	No	No
11	Five S	No	Yes	No	No	No	No
12	Kaizen	No	Yes	Yes	Yes	No	No
13	Total Productivity Management	Yes	Yes	Yes	Yes	Yes	Yes

As shown in table 2.1, only total productivity management fulfills the important criterion of productivity improvement. In state of the art of productivity, a method developed based on total productivity management philosophy is demanded.

2.8-State of the Art of Productivity

The term productivity is not new over two centuries. Traditionally, productivity is viewed mainly as efficiency concept. Today, productivity has four dimension namely, time, quantity, quality and cost. Time and quantity are a measure of effectiveness, and quality and cost are a measure of efficiency. Hence productivity is a combination of effectiveness and efficiency [3].

The most commonly used productivity indicators are partial productivity, total factor productivity, multifactor productivity and total productivity but these are direct measurements based on tangible outputs and inputs. Today productivity ranges from direct measurements to indirect measurements that are not based on tangible outputs and inputs like rates of turnover, absenteeism, customer satisfaction, disruption in work flow, morale, loyalty and job satisfaction [25].

Productivity can be measured at international, national, industrial, company and operational unit level. Productivity measurement at company and operational unit level is at developmental stage Sumanth (1979) i.e. there are no enough researches done on productivity measurement at company and operational unit level [11]. The productivity measurement model developed by Sumanth (1979) is applied for both company and operational unit. This model is used to measure total productivity and partial productivity but neglects surrogate productivity and process indicators measurement. On the other hand, Grunberg (2007) define the importance of measuring surrogate productivity and process indicators for performance improvement of operations but gives less emphasis on measuring and analyzing partial and total productivity indicators for improvement [20].

According Tangen (2004) productivity is directly and indirectly influenced [37]. Therefore measuring, analyzing and improving both productivity influencing factors is very important.

The directly productivity influence factors are measured by partial and total productivity indicators. Whereas the indirectly productivity factors are measured by surrogate productivity and process indicators.

In Addis Ababa University, many studies related to productivity has been done at Master level under Industrial Engineering Stream. But the studies do not consider both the directly and indirectly measured productivity indicators. In addition, the studies do not have clearly defined framework for target setting, measuring and analyzing productivity. For instance, Nigus (2006) developed a model for productivity improvement of EGIs using work study approaches but the model does not have clearly defined framework for target setting, measuring and analyzing productivity. In addition, work study does not address the possible productivity factors [38]. Miskir (2004) conducted a study to improve the productivity of Ethiopian leather industries through efficient maintenance management. But maintenance is one factor of productivity from several productivity factors. In addition, the study does not have clearly defined framework for target setting, measuring and analyzing of productivity [39].

This study gives emphasis on productivity improvement of EGIs by considering both directly measured productivity indicators (i.e. partial and total productivity) and indirectly measured productivity indicators (i.e. surrogate productivity and process indicators) and by formulating clearly defined framework for target setting, measuring and analyzing productivity.

Chapter Three

3-Overview and Assessment of Ethiopian Garment Industries

3.1-Overview of World Textile and Garment Sector

The garment industries in developed countries are now always on a lookout for cheap source of garment production. The days are gone when garment industry was concentrated in the consumption hubs of US, EU and other developed countries of the world. The garment wholesale supply is increasing worldwide in all the sectors of the industry, whether it is men's clothing, women's clothing, kids wear or infant wear. The elimination of global export quotas has led to a shift towards low cost countries having strong and established garment industry especially the Asian countries [40].

3.1.1-Major Trends in World Textile and Garment Sector

- Global garment exports are valued at more than 310 billion USD a year, of which the world's top 15 garment exporters account for more than 80%.
- China continues to develop its textile and garment exports despite the re-imposition of quotas by the US, EU and some other developing countries till December 2008 as a temporary safeguard measure on exports from China. The gain is due to the strategy of China to divert its garment wholesale destinations from US and EU to other Asian countries.
- Developing countries in Asia continue expanding their textile and garment sector due to their very low cost production. Apart from China, the true gainers of the post quota period are India, Bangladesh, Cambodia and Vietnam.
- India is the second most preferred country after China for textile and garment sourcing. Its garment industry is likely to achieve an export target of 25 billion USD by 2010/11. The rise of exports in India is due to several factors like vast sources of raw materials, low labor costs, entrepreneurship and design skills of Indian traders, changes in the policies to open up Indian economy to the outside world etc.
- Bangladesh has emerged as a key player in RMG sector (Ready Made Garment Industry). 76% of its total textile and clothing export earnings comes from the garment industry. The chief factor behind this is abundant and cheap labor force available here.
- Turkey and Brazil are the emerging markets for investment by garment manufacturers and traders.

- In the first quarter of 2008, sales of Vietnamese garment in the US market were grown by over 30%.
- Cambodia's garment industry is continuing to attract new investors and increase its garment exports. This is due to EU and US restraints on China and also because of its positive 'sweat-shop free' reputation on labor standards. It is the ninth largest supplier to the American market. Its garments exports to the EU are also rising [40].

3.1.2-Future Strategy for World Textile and Garment Sector

Textile and garment sector has been under the hands of large retail firms who look for few vendors with bulk orders and thus select for vertically integrated companies. Hence, there is a need for integrating the operations from spinning to garment making in order to gain advantage from the changed scenario. Trade skills, design capabilities, textile technology, management and negotiating skills will also be significant determinants.

To conclude, it can be said that in future, the factors that will affect the rise or fall of the clothing industry of sourcing countries include labor standards, tariff preferences, access to materials and supplies, political and economic stability among others. With the increase in demand for performance apparel, the sectors like industrial clothing and sportswear will experience growth and due to the increased fashion consciousness globally, fashion clothing will also see an upward trend [40].

3.2-Overview of Ethiopian Textile and Garment Sector

Textiles and garment sector has been one of the leading branches of manufacturing industry in terms of its contribution to output, employment and trade. The sector’s collective output was 95 million USD in 2009/10 and it employed over 20,000 people directly in 2007/8 (CSA, 2009). The sector generated 21.8 million USD in terms of foreign exchange in 2009/10. The level of output, employment and foreign exchange earned from the sector is by far small compared to the opportunities and the potentials available in the country. This improving competitiveness in this labor intensive sector has become one of the critical issues for export led growth and poverty reduction efforts.

Many countries in South East Asia with much lower comparable resource with that of Ethiopia has made the textile and garment industries an engine of growth for their economy. In 2007, textile and garment constituted around 80% of the total exports of Bangladesh providing direct employment to 3 million people; 45% of the total exports of Sir Lanka

employing 1.8 million people; 55% of the total exports of Pakistan employing 15 million people; and around 12% of the total exports of India employing 1.8 million people. This was achieved through the joint effort of the government and the private sector.

The Ethiopian textile and garment industry not only as earner of foreign currency but also play a significant role in saving foreign exchange. At present, Ethiopia imports large volume of textile and garment products annually. According to the data obtained from Ethiopian Revenue and Custom Authority the country imported textile and garment products that worth birr 3 billion in 2009. This accounts 4% of the total import. Substantial amount enters through illegal trade. Several studies made by researchers indicate that the demand for textile and garment increases by 40% as a result of population growth and by 60% as a result of income growth. The per capita consumption of textile and garment in 2008 in developing countries was 9.2 kg. This was estimated to grow by 2.3 per annum as result of population and income growth [28].

According to the benchmarking study of the Ethiopian textile industry made by the Ministry of Trade and Industry, local textile mills has installed with a capacity of 377 million square meters woven fabrics and 16,134 tons of knitted fabrics. The actual capacity attained is 192 million square meters of woven fabrics and 8,103 thousand tons of knitted fabrics. This is about 50% capacity utilization for woven fabrics and 50% for knitted fabrics.

The current supply from 16 local textile mills does not match the requirements of the garment industries and does not meet more than 27% of the country's demand for the product. The balance 73% is imported in the form of fabrics readymade garments costing the country's huge foreign exchange and loss of revenue due to large volume of illegal trade.

In addition to inadequacy of supply of fabrics from local textile in relation to the demand underutilization of installed capacity, there is huge mismatch between the supply of fabrics and the type demanded by garment industries for domestic and export market. Garment industries can manage to source only small quantity of fabrics from local textile mills as a result they depend on imported fabrics or CMT[4] production.

Absence of backward integration of the garment industries to textile mills to the ginneries to cotton farms has resulted in lower value addition in the value chain with lower overall contribution to the national economy.

[4] In CMT production system, the customers give the required fabrics and accessories for their order, the task of garment industries are to give cut, make and trim service.

Garment industries were encouraged and promoted during SDPR and PASDEP in anticipation of upstream development in the textile mills and cotton farms but contrary to the expectation not much exchange has been observed since then through the operation of market forces. This calls for government interventions to correct market failures.

Table 3.1: Capacity utilization in Ethiopian textile and garment sector (Source: Benchmarking of the Ethiopian textile industry)

Description	Available Capacity	Actual Capacity	Utilization (%)
Land Suitable for Cotton Cultivation	2.6 million hectares	85,000 hectares	3%
Ginneries	200,000 tons	<100,000tons	<50%
Spinning	37,625 tons	25,858 tons	69%
Weaving (Woven Fabrics)	377 million m^2	192 million m^2	50%
Weaving (Knitted Fabrics)	16,134 tons	8,103 tons	50%
Knitting	15,959 tons	7,610 tons	40%
Garment	-	-	<40%

As shown in table 3.1, the ginneries and textile mills operate at the capacity of 50-70% where as the cotton farms and garment industries are operating at 3% and 40% capacity respectively. Capacity utilization rates are compared to with potential or installed capacity and not with market demand. When compared with the level of demand the coverage is much lower than that of installed capacity utilization as the larger proportion of demand is covered by imports. This unsatisfactory state affairs in the whole value chain to be investigated in detail to lead to clear policy decision in order to improve performance and benefit from this branch of industry.

Until local textile mills are modernized and begin to produce fabrics of quality and variety for global market, the garment industries have no choice but to depend on imported inputs to supply the domestic and export market.

Ethiopian garment industries producing for export are operating under duty free import of raw materials. However they are not competitive enough in the global market due to high shipping, inland transport and handling costs of suppliers. Moreover their capacity is very small compared to large orders of big customers. In some cases, garment export from Ethiopia has to be shipped to South East Asia for consolidation and bound to United States market which makes buying from Ethiopia more expensive [28].

3.3-Incentive Mechanism to Promote Ethiopian Textile and Garment Sector

The government of Ethiopia has granted a range of incentives to promote the textile and garment sector. The following are among the incentives.

- ***Long term financing at concessional rate of interest***: The Development Bank of Ethiopia provides long term funds to the sector at an interest rate of 7.5% per annum. The loan is payable over a period of 5-15 years which includes a moratorium period of up to 3 years. The bank covers 70% of the total investment and 30% from the owners.
- ***Duty free import of machinery and spare parts****:* This incentive is provided for all sectors of the economy and the textile and garment sector is also beneficial from this package. This incentive lowers the investment requirements of projects and encourages further investment. It also facilitates operation by lowering the cost and to ensure the availability of spare parts. For those exporting the finished products duty free import of raw materials under different schemes such as duty drawback scheme, voucher scheme and bonded warehouse scheme were granted.
- ***Tax holiday for a period of 2-7 years depending on location:*** This incentive is motivational for industries that are making profit. Garment industries as a whole are loss making and are not benefiting from the tax holidays.
- ***Cheap land lease:*** This is motivational when industries are operating and make profit because it lowers investment cost of the business. At present the garment industries as a going concern do not see much benefit as they are not making any money from the business.
- ***Capacity building support by way of meeting the cost of hiring expatriate and towards cost of training (local and oversea):*** Not all garment industries are beneficial from this package. Even if the benefit is less as it does not translate to the efficiency of industries since they are not fully operational.
- There are other incentives that can be negotiated on the merit of the case. In light of the above incentives there is a need to look into other forms of arrangement that can make this branch of industry fully operational and benefit all stake holders i.e. banks, government, entrepreneur and the country at large [28].

3.4-Export Market Performance of Ethiopian Garment Industries

In 2009, the global garment industry grew by 2.1% year-on-year, to reach a value of 1,078 billion USD; by 2014, the global garment industry is forecast to have a value of 1.2 trillion

USD. The largest segment of the global garment industry is women's wear, accounting for over half (51.3%) of the industry's total value, followed by men's wear, women's underwear, and children's wear. The largest market is the Americas which accounts for over a third of the global apparel retail industry value (35.7%). The largest exporter of garment in general and clothing in particular is China: by 2009, one-third of world's garment exports came from China compared to less than 10% twenty years earlier. Other major exporters of clothing are the EU countries (30% of world exports in 2009), followed by Turkey, India, Bangladesh and Vietnam, each country accounting for roughly 3 percent share of the world garment exports. Sub-Saharan Africa (SSA) in general and Ethiopia in particular plays a limited role in the international market for clothes and other apparel. In 2009, all SSA countries exported roughly 2 billion USD worth of garment, which constitutes little less than 1 percent of the global exports of garment [29].

Table 3.2: World, Africa and SSA countries garment export market performance (Source: Global Development Solutions LLC)

Exporters	Garment Export Values ('000 US Dollars)				% of World	% of SSA
	2006	2007	2008	2009		
World	340,626,012	383,678,608	408,126,132	359,532,180	100	-
Africa	8,959,393	10,325,969	11,525,187	10,267,308	2.9	-
SSA	2,539,483	2,970,069	3,022,420	2,014,444	0.6	-
Mauritius	771,922	884,065	843,054	552,645	-	27.9
Madagascar	347,450	502,897	888,173	461,626	-	23.3
Lesotho	418,649	413,895	370,149	303,433	-	15.3
Kenya	279,255	286,231	288,419	215,847	-	10.9
South Africa	171,282	157,512	168,305	159,969	-	8.1
Swaziland	150,204	48,059	133,546	99,888	-	5.0
Tanzania	29,181	69,128	76,678	70,205	-	3.5
Malawi	43,047	34,919	27,637	31,489	-	1.6
Zimbabwe	61,394	79,677	49,328	25,326	-	1.3
Botswana	148,941	347,636	30,835	21,976	-	1.1
Cote D'Ivoire	17,352	15,623	20,116	16,823	-	0.8
Senegal	5,891	6,255	7,657	12,840	-	0.6
Ethiopia	8,196	10,927	10,753	7,904	-	0.4

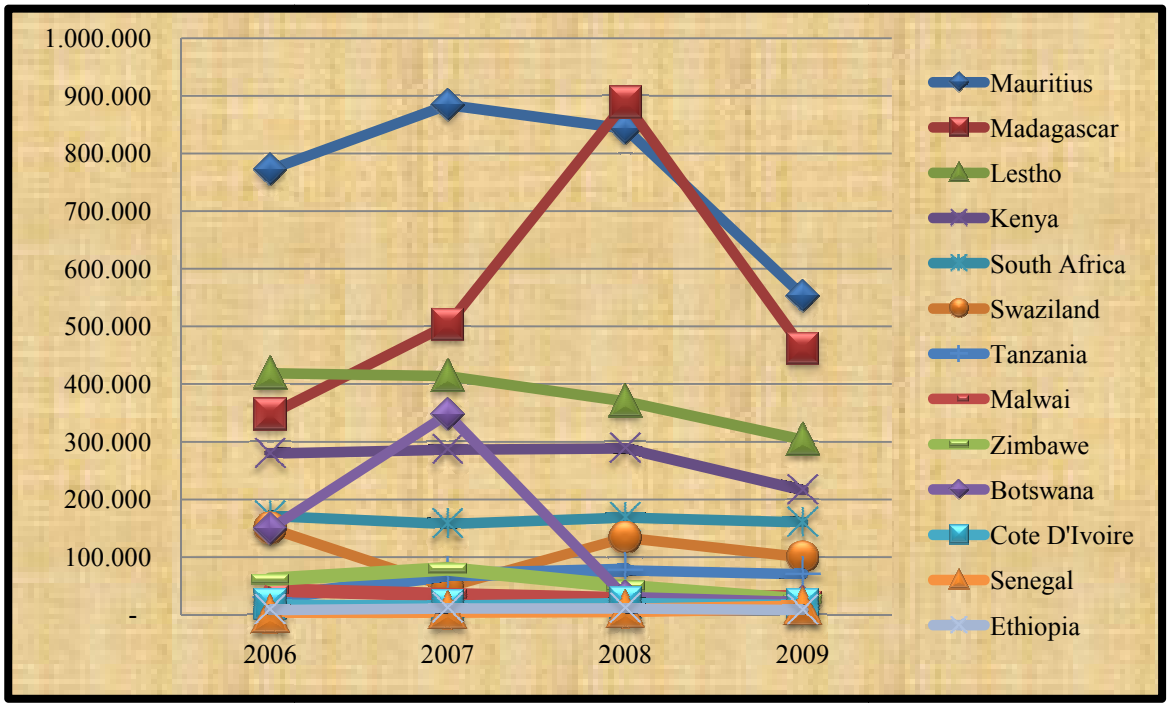

Figure 3.1: Garment export market performance of World, Africa and SSA courtiers

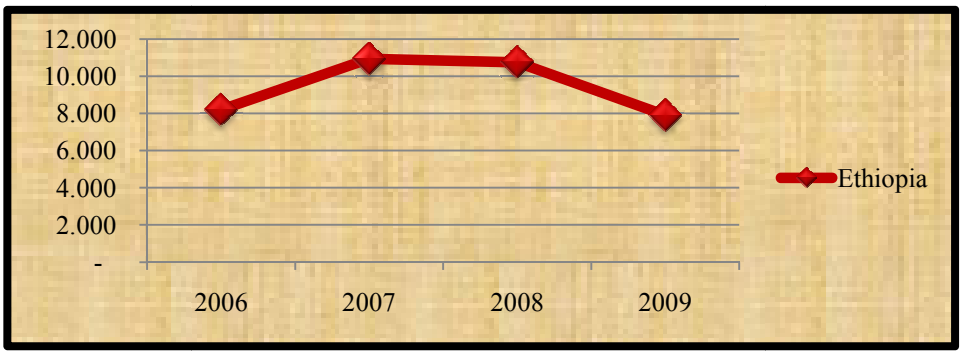

Figure 3.2: Garment export market performance trend of Ethiopia

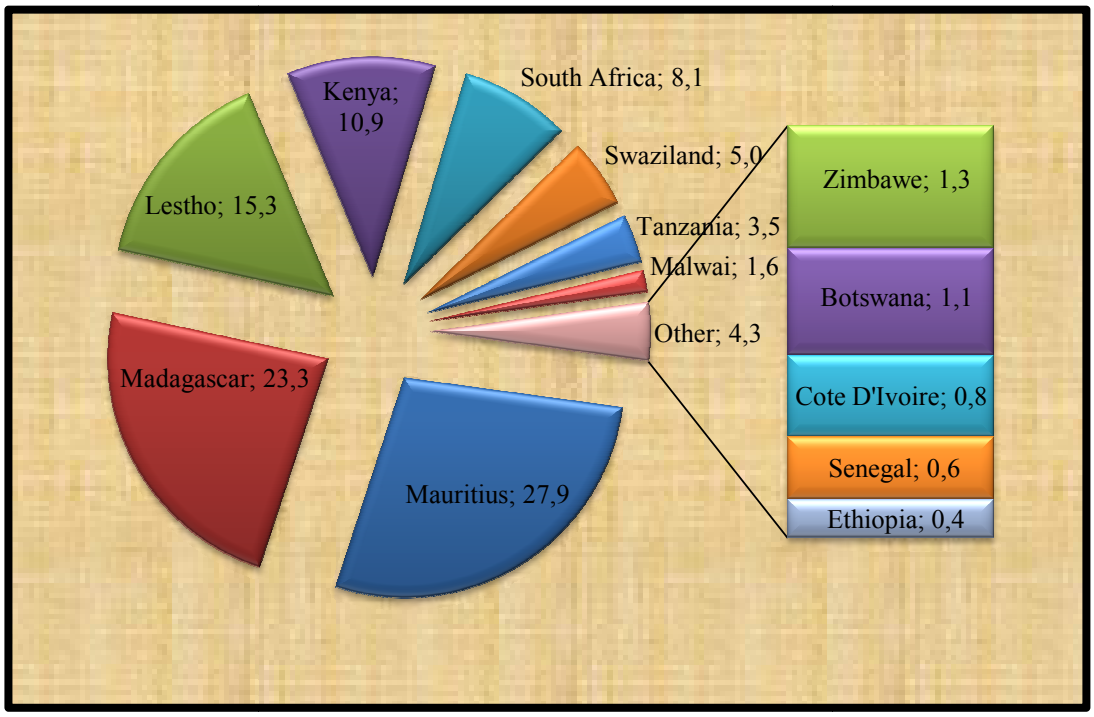

Figure 3.3: Garment export market performance of SSA countries by percentage in 2009

Ethiopia exports roughly 7 to 10 million USD worth of garment each year. Although exports have increased significantly from earlier periods (4 million USD in 2002), the country remains an insignificant player in the global and regional garment trade. From the SSA countries Mauritius has the largest percentage of garment export value (27.9%) and Ethiopia is has the least percentage value (0.4%). Even at these comparatively low export volumes, however, the Ethiopian textile and garment sector is a major contributor to the country's industrial production: for the year ending in June 2010, the sector accounted for 7% of the country's industrial production.

3.5-Benchmarking of Ethiopian Garment Industries

The benchmark was performed at the request of MOI and sponsored by UNIDO Ethiopia. Scope of this study is to benchmark Ethiopian garment industry with other 4 countries and to assess the major factors of the industry. Target of this study is to create an understanding of the Ethiopian status in 2008 and create foundation for a further preparation of a master plan on the garment industry.

Four countries are selected for benchmarking by considering two factors. The first is by choosing reference countries: countries with best practices to which Ethiopia need to compare and target on long term. And the second is by choosing competitor countries: competitor countries of Ethiopia are taken for a better understanding of the market conditions.

Reference countries are Romania (an important EU supplier of high quality garments mainly on CMT basis with imported fabrics) and Turkey (second major supplier of garments in EU after China, Turkey is well known for their technical capabilities to deliver FOB[5] garments with fabrics produced within the country). Competitor countries are Bangladesh (an important garment supplier for EU and US, which almost 75% from the exports is textile and garment and hence Bangladesh is a competitor of Ethiopia which face the same characteristics within the industry); and Egypt (an African country which have a policy to attract textile & garmenting companies from Turkey and EU, definitely being competitor of Ethiopia) [31].

The bench mark analysis using different parameters like countries general profile, general export market performance, textile and garment export market performance, factors scoring and others are shown below.

Table 3.3: Benchmarked countries general profile comparison (Source: [30])

Parameter	Ethiopia	Egypt	Turkey	Romania	Bangladesh
Country Area (Km^2)	1,127,127	980,869	783,562	238,391	144,000
Population (million)	81.5	81.7	71.8	22.2	153.5
Labor Force in 2007 (million)	45.3	22.1	24.7	9.3	69.4
GDP (USD/person)	700	5,244	9,600	11,100	1,400
GDP Growth in 2007 (%)	11.1	7.1	7	6	6.3
Inflation in 2007 (%)	17.2	9.5	8.7	4.8	9.1
FDI in 2006 (billion USD)	0.37	10.4	20.2	11.2	0.63

From table 3.3, Ethiopia has large land area and the smallest one is Bangladesh. The highest populated country is Bangladesh and the lowest is Romania. Labor force is highest in Bangladesh and lowest in Romania. Romania GDP is highest and the lowest GDP is recorded by Ethiopia. GDP growth is highest in Ethiopia and lowest in Romania. Ethiopia faces highest inflation and inflation is lowest in Romania. The highest FDI is for turkey and the lowest is for Ethiopia.

Ethiopia has the second largest labor force, but Ethiopian economy is the lowest as value GDP. Agricultural extensive is the specificity of Ethiopian economy.

The comparison of growth of the GDP and FDI as visible there are huge difference between Romania/Turkey on one side and Ethiopia/Bangladesh on the other side, regarding the

[5] In FOB production system, the customers give order only, the garment industries produce based on the order. It is a full package production system.

capacity to attract Foreign Direct Investment, which bring the financial and "know-how" power for that country out of which GDP would benefit.

Romania and Turkey are considered medium industrialized countries with a strong growth of the economy in the past 5 years. The industry is oriented to machines and equipment production, and generally to technologies, and gives importance to value added products like automotives, electronics and heavy industry. Good infrastructure especially in Turkey; and both countries have massively invested in education at all levels, which create a future base for the growth of the industry [31].

Table 3.4: General export market performance comparison (Source: [30])

Country	General Export Market Performance (Billion USD)			
	2004	2005	2006	2007
Ethiopia	0.59	0.8	1	1.2
Egypt	12.3	16	19	24.4
Turkey	63.1	73.3	85.1	107.2
Romania	23.5	27.7	28.4	29.3
Bangladesh	-	8.4	10.3	12.5

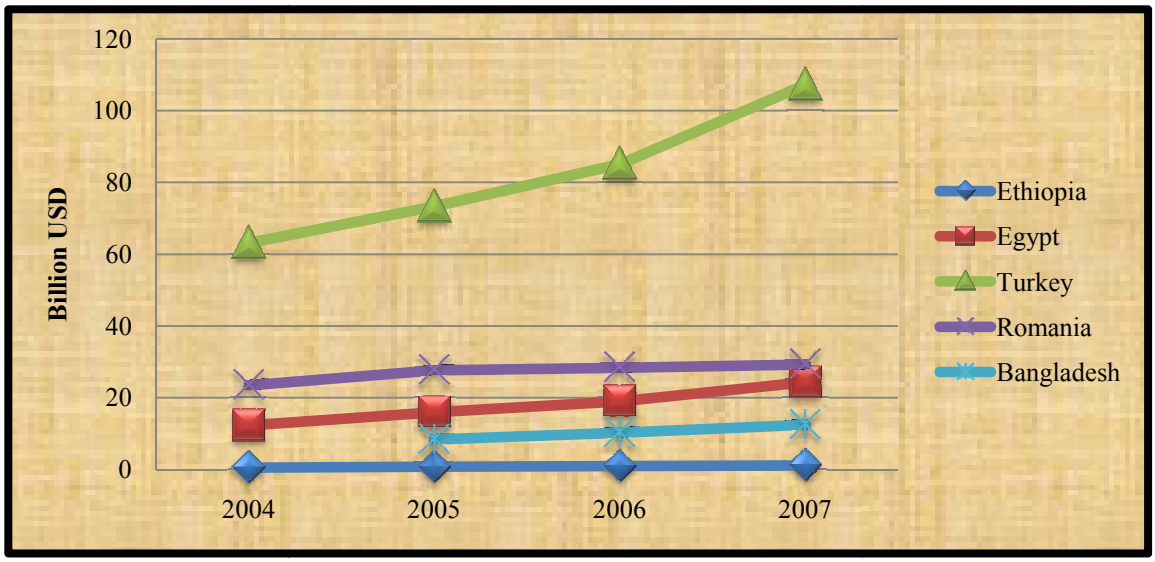

Figure 3.4: General export market performance trend

From table 3.4 and figure 3.4, all countries show increasing general export market performance except Romania. The highest export market performance is achieved by turkey and the lowest is by Ethiopia. In 2007, the difference between Turkey and Ethiopia general export market performance is 106 billion USD.

Table 3.5: Textile and garment export market performance comparison (Source: [30])

Country	Textile and Garment Export Market Performance (Billion USD)			
	2000	2005	2006	2007
Ethiopia	0.002	0.007	0.011	0.14
Egypt	1.1	1.1	1.3	1.8
Turkey	10.2	18.8	19.5	22.6
Romania	2.56	5.3	5.26	3.9
Bangladesh	4.3	6.6	8	9.12

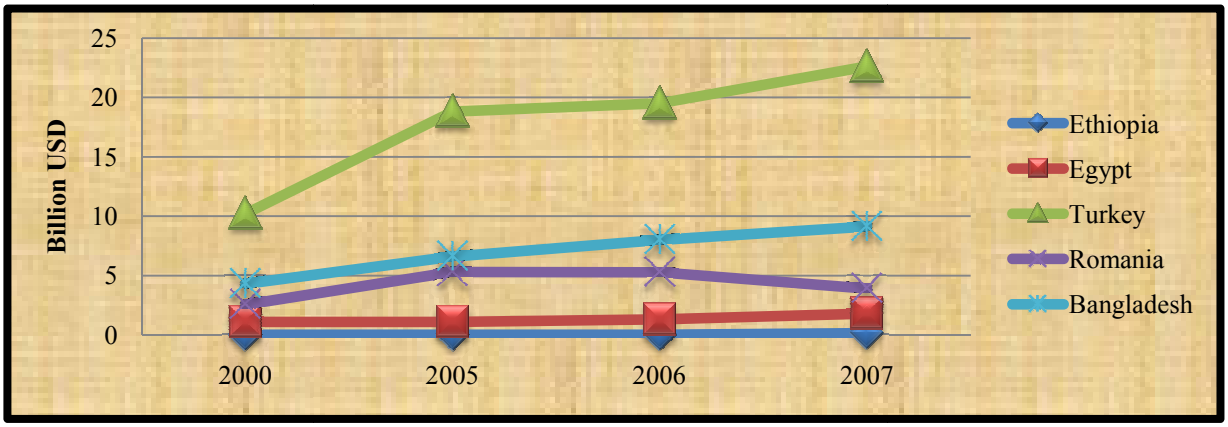

Figure 3.5: Textile and garment export market performance trend

From table 3.5 and figure 3.5, from Ethiopia, Turkey, Romania and Bangladesh show textile and garment export performance growth by 71.4%, 45.7%, 51.7% and 34.8% respectively. All countries show increasing textile and garment export market performance except Romania. The highest export market performance is achieved by turkey and the lowest is by Ethiopia. In 2007, the difference between Turkey and Ethiopia textile and garment export market performance is 22.46 billion USD.

Table 3.6: Scored values of key factors for each benchmarked countries (Source: [30])

Key Factors	Scoring				
	Ethiopia	Egypt	Turkey	Romania	Bangladesh
Price Competitiveness	5	5	1	2	5
Social Compliances	2	2	5	3	2
Availability of Raw Materials	2	4	5	3	4
Value Added	1	3	5	4	3
Management Abilities	2	2	5	5	2
Technology	3	3	5	5	3

Quality Control	2	3	5	5	3
Productivity	1	2	4	5	3
Technical Flexibility	3	4	5	5	3
Infrastructure	1	4	5	4	2
Certifications and Testing Labs	1	2	5	4	4
Machine Suppliers and Services	1	3	5	5	4
Fairs and Trade Shows	1	3	5	5	3
Business Environment	1	3	5	5	4
Lead Times	1	2	5	4	3
Product Development	1	2	5	4	3
Marketing Abilities	1	3	5	4	3
Average Employees Skill	2	3	5	5	3
Availability of Technology	1	3	5	5	3
Transportation	1	3	5	4	2
Industrial Parks	3	5	5	5	4
Banking	1	4	4	5	2

The methodology of comparison, contain evaluation of key points among apparel industry which are graded based on a scoring from 1 to 5 (poor to excellent). And the evaluation of the key points creates an overview of the capabilities of that country and finally ranks the competitiveness of the country.

Turkey apparel production is high value added products where the preproduction stage is very well developed as well as the skills of the people in performing FOB using Turkish fabrics and raw material availability at high quality standards (integrated textile industry from cotton to finished goods; Turkey is the 6th major producer of cotton in the world). There are massive investments in technology and Product development which sustain the competitiveness of Turkey for a long time ahead despite the fact that it is one of the most expensive countries within the major supplier countries. Turkey score 5, the highest.

Romania produced one of the finest apparel productions in the world in a CMT bases since Romania textile infrastructure does not exist and Romanian producers did not develop their capabilities of purchasing. Productivity is the highest within the benchmarks countries, but because of the CMT structure of the export and increasing costs after joining EU in January 2007, Romania is losing its competitiveness year by year, its export fails down and apparel industry is shrinking at the moment with a rate of 15-20% per year. Romania score 4.

Egypt has been trying to absorb FDI because of the relocation of factories from EU and Turkey. The industry is mostly based on food, cotton and textiles. Infrastructure is medium but sea port access makes an advantage for Egypt to exchange goods with all EU countries. Apparel productivity is low, the skill does not exist, and Egypt is in process of upgrading the Industry. Egypt score 3.

Bangladesh is the largest country for population among the selected benchmark countries, having a poor level of FDI comparing with population size. The infrastructure is poor and creates problems to the industry; the textile export represents 73% from the total exports in FOB system, Bangladesh is using her ability to grow cotton and silk as well benefit from the proximity of India and Pakistan where can source fabrics mainly denim and knits from cotton. Productivity is medium, the technology used is also medium but because country is very competitive price wise (very low salaries). Bangladesh score 3.

Ethiopia is the least developed country among the benchmarked ones; the level of industrial development is low, with low level of FDI. Textile is only 1% from the export, poorly developed; the level of skills is low, depending on poor infrastructure. However, because Ethiopia is a cotton producer, in the long term, this could be an advantage to develop a strong apparel industry. Ethiopia score 2, the least.

Table 3.7: Benchmarked countries garment comparison (Source: [30])

Parameter	Ethiopia	Egypt	Turkey	Romania	Bangladesh
Average Sewing Rework Rate (%)	5-10	30	5	5	10
Average Second Quality Fallout Rate (%)	2	10	4	3	7
Average Overall Efficiency (%)	30	40	75	80	50
Productivity-Trouser (pcs/worker/day)	10	15	40-50	50	30
Productivity-T-shirt (pcs/worker/day)	30	40	70	80	50
Average FOB Selling Price-Trouser (USD/pcs)	0.85-CMT	7.5-10	20	25	-
Average FOB Selling Price-T-shirt (USD/pcs)	0.45-CMT	2.5	10	10-12	-
Average SAM-Trouser (min/pcs)	20-30	15-20	15-30	25-35	15-25

Turkey and Romania are from far expensive countries which compensate their labor cost with high productivity and value added products. Bangladesh and Ethiopia have the lowest level of minute cost which makes them extremely interesting. Bangladesh and Egypt have strong advantage over Ethiopia due to the abilities of producing FOB [31].

3.6-SWOT Analysis of Ethiopian Garment Industries

3.6.1-Strength

- Political and social stability
- Involvement of key funding organizations: UNIDO, GTZ, Italian Cooperation
- Labor availability
- Population which is open to learning and develop
- Good climatic conditions
- Government is active in promoting development of the industry
- Low cost labor and other operational costs country

3.6.2-Weakness

- European Union buyers do not know Ethiopian opportunities
- No preproduction abilities like merchandising, planning, purchasing and sampling
- Social complains are poor
- Low level of investment in the factories
- Low level of automation and workstation engineering which result a low productivity level
- Managerial procedures and systems are not implemented
- Poor managerial skills at the line supervisors and managers level
- Poor target attitude oriented, there is no industrial experience available in Ethiopia
- Lack of experience in international market
- Difficult to access sea ports, transportation costs are high
- Poor infrastructure especially roads and railways
- Poor facilities for training
- Working in CMT bases is not bringing profit and opportunities on the long perspective
- Communication through emails and phones are not reliable yet
- Missing industrial mentality of workforce and management

3.6.3-Opportunity

- Duty free and quota free US market access through AGOA
- Approaching EU market
- Attracting FDI especially from EU countries (Germany, Italy, Romania) and Turkey, companies ones investing in Ethiopia bring know-how and competitiveness

- ☞ Preparing and develop a curricula for training centre and university as a base for a professional training for a future skilled workforce
- ☞ Possible production relocation of factories from East EU (Romania and Bulgaria), Turkey, China
- ☞ Internal market consumption and proximity African markets of neighboring countries

3.6.4-Threat

- ☞ Increasing costs of oil and food will create social movements which could affect the industry competitiveness
- ☞ Difficult sea port access can create risks in the future especially if social problems occur with the neighbors
- ☞ Undeveloped infrastructure will reduce drastically the development of the industry. Infrastructure develop too slow comparing with needs of Industry
- ☞ Time frame of actual agreements with US and EU could be cancelled at certain time
- ☞ Global market competition, Ethiopia is not prepared for it at this moment
- ☞ Bureaucracy
- ☞ Electric power availability in case of quick development of the industry.
- ☞ Capability of local managers to efficiently implement programs and systems

3.7-Productivity Assessment of Ethiopian Garment Industries

The productivity assessment of EGIs is done by using the following six years (i.e. from 2003/4 to 2008/9 G.C.) data from CSA of Ethiopia [32], [33].

Let the following items are represented for technical purpose in the following table.

Table 3.8: Representation of items

S.No.	Description of Item	Unit	Representation
1	Volume of Production	pieces	VOP
2	Value of Production	birr	VAP
3	Number of Employee	number	NE
4	Value of Human Input	birr	VAH
5	Value of Material Input	"	VAM
6	Value of Energy Input	"	VAE
7	Human Productivity by Volume	pcs/emp	HPVo
8	Human Productivity by Value	birr/birr	HPVa
9	Material Productivity by Value	"	MPVa

10	Energy Productivity by Value	"	EPVa
11	Multifactor Productivity by Value	"	MFPVa

Then the data is summarized as follows.

Table 3.9: Source data for productivity assessment (Source: [32], [33])

Item	Fiscal Year					
	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9
VOP	3,283,704	1,681,164	2,482,644	3,327,060	7,032,900	13,315,644
VAP	86,511,000	62,612,000	80,516,000	273,249,000	388,351,000	409,329,000
NE	3,806	2,606	4,099	7,604	7,613	7,793
VAH	20,914,000	12,984,000	25,458,000	61,335,000	73,045,000	61,324,000
VAM	37,061,000	-	-	-	-	176,611,000
VAE	737,000	-	-	-	-	44,198,000

The productivity assessment of EGIs focuses on partial and multifactor productivity measurement and analysis.

3.7.1-Human Productivity

The human productivity for a period of one year is given as follows:

HPVo = volume of output/volume of human input

HPVa = value of output/value of human input

HPVo for fiscal year 2003/4:

HPVo = 3,283,704/3,806 = 863 pcs/emp

HPVa for fiscal year 2003/4:

HPVa = 86,511,000/20,914,000 = 4.1 birr of output/birr of human input

Analogously, HPVo and HPVa for other fiscal years are done and summarized in the following table.

Table 3.10: Human productivity of Ethiopian garment industries

Item	Fiscal Year					
	2003/4	2004/5	2005/6	2006/7	2007/8	2008/9
VOP	3,283,704	1,681,164	2,482,644	3,327,060	7,032,900	13,315,644
VAP	86,511,000	62,612,000	80,516,000	273,249,000	388,351,000	409,329,000

NE	3,806	2,606	4,099	7,604	7,613	7,793
VAH	20,914,000	12,984,000	25,458,000	61,335,000	73,045,000	61,324,000
HPVo	863	646	606	438	924	1,709
HPVa	4.1	4.8	3.2	4.5	5.3	6.7

Figure 3.6: Human productivity trend of Ethiopian garment industries by volume

From the above line graph, HPVo shows a decreasing trend from fiscal year 2003/4 to 2006/7 then after shows an increasing trend. The minimum HPVo is obtained in 2006/7; and the maximum is achieved in 2008/9.

The maximum human productivity (HPVo) is 1,709 pcs/emp/year. By considering one fiscal year has 300 days and 60% of the total employees are direct workers, the direct worker based human productivity by volume (HPVo) becomes 10 pcs/worker/day which is lower than the best practices (i.e. 50 t-shirts/worker/day and 80 trousers/worker/day).

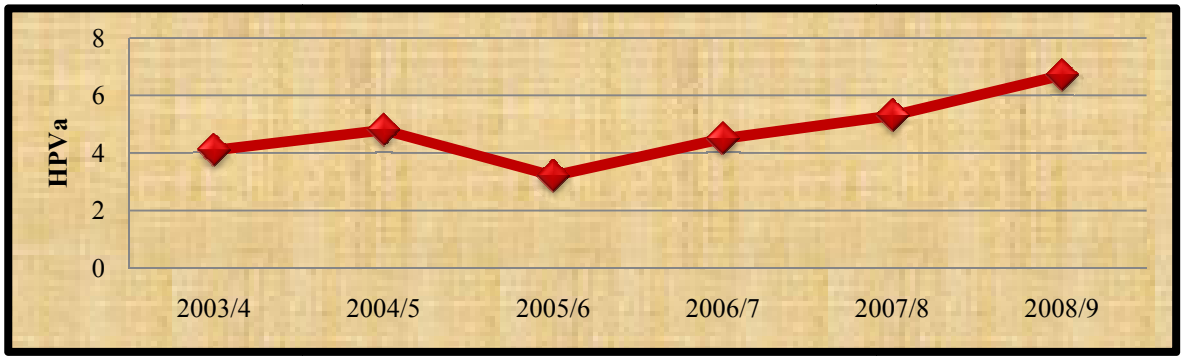

Figure 3.7: Human productivity trend of Ethiopian garment industries by value

From the above line graph, HPVa shows an increasing trend from 2003/04 to 2004/05; shows a decreasing trend from 2004/5 to 2005/6 then after shows an increasing trend. The minimum HPVa is achieved in 2005/6; and the maximum is obtained in 2008/9.

3.7.2-Material Productivity

The material productivity for a period of one year is given as follows:

MPVa for fiscal year 2003/4:

MPVa = value of output/value of material input

MPVa = 86,511,000/37,061,000 = 2.33 birr of output/birr of material input.

Analogously, MPVa for fiscal year 2008/9 is 2.32 birr of output/birr of material input.

From the above analysis, MPVa for fiscal year 2003/4 is slightly greater than MPVa for fiscal year 2008/9. This indicates material productivity is not improved.

3.7.3-Energy Productivity

The energy productivity for a period of one year is given as follows:

EPVa for fiscal year 2003/4:

EPVa = value of output/value of energy input

EPVa = 86,511,000/737,000 = 117.38 birr of output/birr of energy inputs

Analogously, EPVa for fiscal year 2008/9 is 9.26 birr of output/birr of energy input.

From the above analysis, EPVa for fiscal year 2003/4 is greater than EPVa for fiscal year 2008/9. This indicates energy productivity is not improved.

3.7.4-Multifactor Productivity

The multifactor productivity for a period of one year is given as follows:

MFPVa for fiscal year 2003/04:

MFPVa = value of total output/value of (human + material + energy) inputs

MFPVa = 86,511,000/(20,914,000 + 37,061,000 + 737,000) = 1.47 birr of total output/birr of bundle of inputs.

Analogously, MFPVa for fiscal year 2008/9 is 1.45 birr of total output/birr of bundle of inputs.

From the above analysis, MFPVa for fiscal year 2003/4 is greater than MFPVa for fiscal year 2008/9. This indicates total productivity is not improved.

The productivity evaluation of the Ethiopian garment industries using CSA data is done by calculating change in productivity between 2003/4 and 2008/9 fiscal years; and summarized as follows.

Table 3.11: Productivity analysis of Ethiopian garment industries

Item	Productivity in 2003/4	Productivity in 2008/9	Change (%)	Status
HPVo	863	1,709	49.5	Growth
HPVa	4.1	6.7	38.8	Growth
MPVa	2.33	2.32	-0.4	Decline
EPVa	117.38	9.26	-1,167.6	Decline
MFPVa	1.47	1.43	-2.8	Decline

From table 3.11, except human productivity which shows productivity growth, the other productivity measures show productivity decline. HPVo and HPVa increased by 49.5% and 38.8% respectively. MPVa, EPVa and MFPVa declined by 0.4%, 1,167.6% and 2.8% respectively.

3.8-Survey Questionnaire Analysis and Synthesis

In order to assess existing productivity measurement and improvement practices of Ethiopian garment industries, and their productivity factors, the survey questionnaire is prepared and distributed to 30 garment industries physically and through internet (one questionnaire to one company). Only 15 industries (50%) are responded to the questionnaire (refer annex 3).

The survey questionnaire has four major parts. The first part is about respondent information which involves position, qualification and work experience in the current company. The second part focuses on company information such as company name, year of establishment, market segment, number of total employees, average working days per year, average working days per month, average working days per week, number of working shifts per day and number of working hours per shift. The third and the fourth part focus on assessment of existing productivity measurement and improvement practices, and productivity factors of EGIs respectively. The analysis is done for each part of the survey questionnaire as follows.

Note that some results of the survey questionnaire (especially on the existing productivity management practices) in annex 2 contradict with information gained from literature survey, secondary data and the case study. In this case, the results are justified why they contradicts. In general, the main reasons for contradictions are due to lack of understanding of

productivity in the current perspective; and some of the respondents fill the questionnaire carelessly.

3.8.1-Respondent Information

The positions of the respondents are general manager, production and technique manager, marketing manager, production head, planning and controlling head, training head, designer, and information technology expert. The qualifications of the respondent are B.Sc. in textile engineering, B.Sc. in industrial engineering, B.Sc. in information technology, diploma in textile technology, and diploma in mechanical engineering. The respondents work experience in the company is below one year, between one and five years, and above five years. The respondent information is summarized as shown below.

Table 3.12: Position of the respondents by number and percentage (Source: Survey questionnaire)

S.No.	Positions	Number	Share (%)
1	General Manager	1	7.7
2	Production and Technique Manager	4	30.8
3	Marketing Manager	1	7.7
4	Production Head	3	23.1
5	Planning and Controlling Head	1	7.7
6	Training Head	1	7.7
7	Designer	1	7.7
8	Information Technology Expert	1	7.7
Total		**13**	**100**

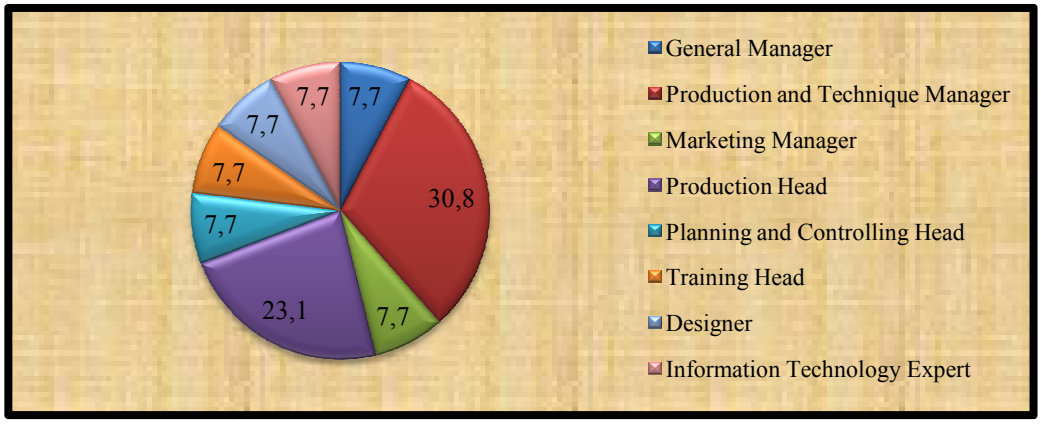

Figure 3.8: Percentage share of the respondents position (Source: Survey questionnaire)

From table 3.12 and figure 3.8, most of the respondents are production and technique department managers.

Table 3.13: Qualification of the respondents by number and percentage (Source: Survey questionnaire)

S.No.	Qualifications	Number	Share (%)
1	B.Sc. in Textile Engineering	6	54.5
2	B.Sc. in Industrial Engineering	1	9.1
3	B.Sc. in Information Technology	1	9.1
4	Diploma in Textile Technology	2	18.2
5	Diploma in Mechanical Engineering	1	9.1
Total		**11**	**100**

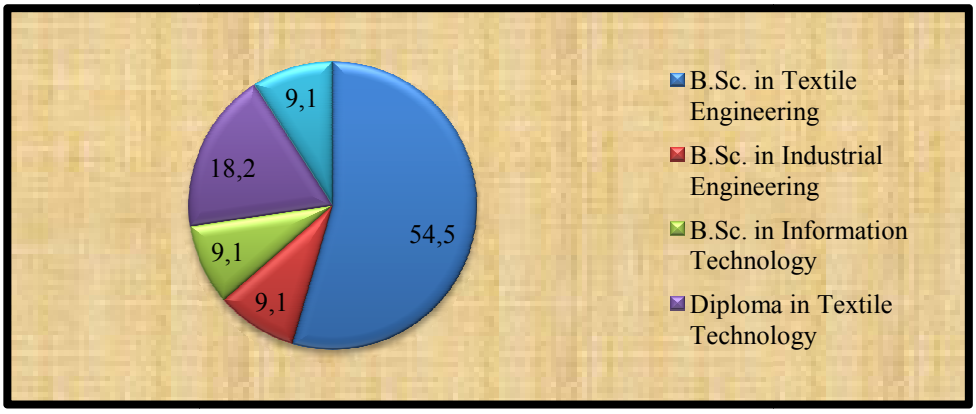

Figure 3.9: Percentage share of the respondents qualification (Source: Survey questionnaire)

From table 3.13 and figure 3.9, most of the respondents have bachelor degree. And most of them are textile engineers.

Table 3.14: Work experience of the respondents by number and percentage (Source: Survey questionnaire)

S.No.	Work Experience	Number	Share (%)
1	Below one year	6	46.2
2	Between one and five years	4	30.8
3	Above five years	3	23.1
Total		**13**	**100**

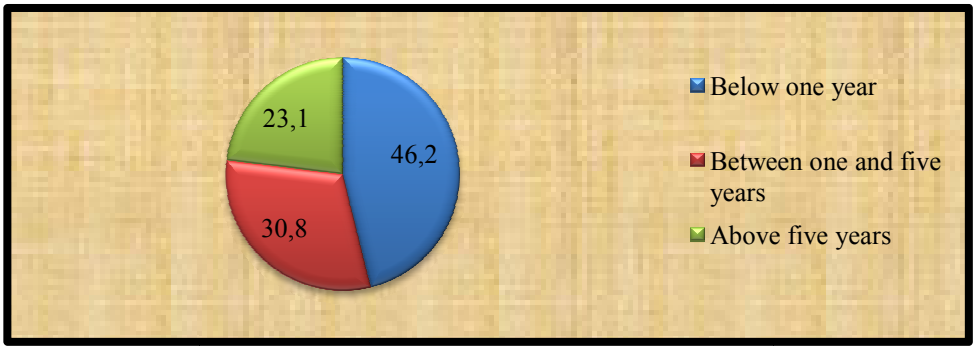

Figure 3.10: Percentage share of the respondents work experience (Source: Survey questionnaire)

From table 3.14 and figure 3.10, most of the respondents have work experience below one year in the current company.

3.8.2-Company Information

From the survey questionnaire (refer annex 2), about 58.3% of the garment industries are established before 2000; and the rest 41.7% are established after 2000. 26.7% of the garment industries produce for local market, 20% for export market, and 53.3% for both local and export market. On average a single garment industry created a job opportunity of 188 permanent and 35 temporary employees. The average working days per year, per month and per week are 295, 26 and 5.5 respectively. The garment industries work for one shift; and on average there are 7.5 working hours per shift. The percentage share of market segment of the garment industries are shown below using pie chart.

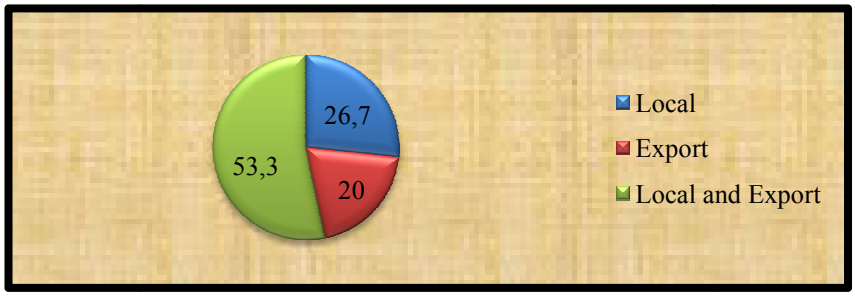

Figure 3.11: Percentage share of market segment (Source: Survey questionnaire)

From figure 3.11, it is shown that most of the garment industries produce for both local and export market.

3.8.3-Existing Productivity Measurement and Improvement Practices of EGIs

From annex 2 it is seen that, 80% and above of the garment industries respond that they have clear vision, goals and targets for their productivity; and identify problems of their productivity improvement. These are done only for human productivity but not consider other productivity indicators.

As shown on the survey questionnaire, the response of 80% and above of the garment industries indicates that top managers, middle managers, lower managers and experts of have awareness and basic understanding of productivity. But the scope of awareness and understanding is limited to human productivity.

Form the results of the survey questionnaire it is seen that, the working definitions of productivity applied by 80% and above of the garment industries is the ratio of volume of outputs to man-hour of labor inputs. In other words the only working definition of

productivity practically applied by the garment industries is as the ratio of volume of output to volume of human inputs (i.e. pieces/employee/shift)

The results gained the questionnaire shows that 80% and above of the garment industries measure human productivity, machine productivity, material productivity, skill level and absenteeism. But practically, material productivity is not measured.

To rate the productivity of the workforces, total point and percentage share of each workforces are calculated by giving 3 for high, 2 for medium and 1 for low.

Table 3.15: Total point and percentage share of workforces productivity level (Source: Survey questionnaire)

S.No.	Workforces	High	Medium	Low	Total Point	Share (%)
1	Top Managers	9	4	1	36	15.8
2	Middle Managers	7	7	0	35	15.4
3	Lower Managers	7	5	2	33	14.5
4	Experts	9	4	1	36	15.8
5	Checkers	7	6	1	34	14.9
6	Supporting Staffs	2	5	7	23	10.1
7	Operators	6	5	3	31	13.6
Total		**47**	**36**	**15**	**228**	**100**

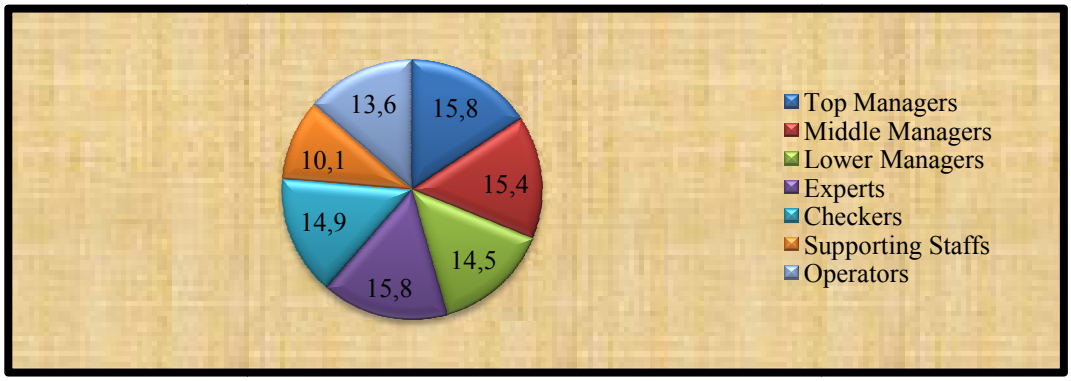

Figure 3.12: Percentage share of workforces productivity level (Source: Survey questionnaire)

From table 3.15 and figure 3.12, top managers and experts have the highest total point and percentage share whereas supporting staffs has the least total point and percentage share. This indicates that top managers and experts productivity is rated as the highest and supporting staffs productivity as the least.

From the results of the survey questionnaire, computer applications, new production lines/machines, rebuilding old machines, layout improvement, inventory control, marketing management, production management, quality management, cost management, resource

management, increasing value addition and increasing profit are applied by 80% and above of the garment industries.

But the above productivity improvement techniques are not well organized for continuous improvement. The garment industries do not have well established system to support effective and efficient implementation of the techniques.

3.8.4-Productivity Factors of EGIs

The impact level of the processes on productivity is given as follows by using total point and percentage share. The total point and percentage share of each process are shown below.

Table 3.16: Total point and percentage share of impact of processes on productivity (Source: Survey questionnaire)

S.No.	Processes	1	2	3	Total Point	Share (%)
1	Production	1	2	11	38	20.9
2	Sales and Marketing	3	5	6	31	17.0
3	Procurement and Property Administration	3	7	4	29	15.9
4	Human Resource Development and Property Administration	3	5	6	31	17.0
5	Finance and Accounting	2	11	1	27	14.8
6	Research and Development	3	10	1	26	14.3
Total		**15**	**40**	**29**	**182**	**100**

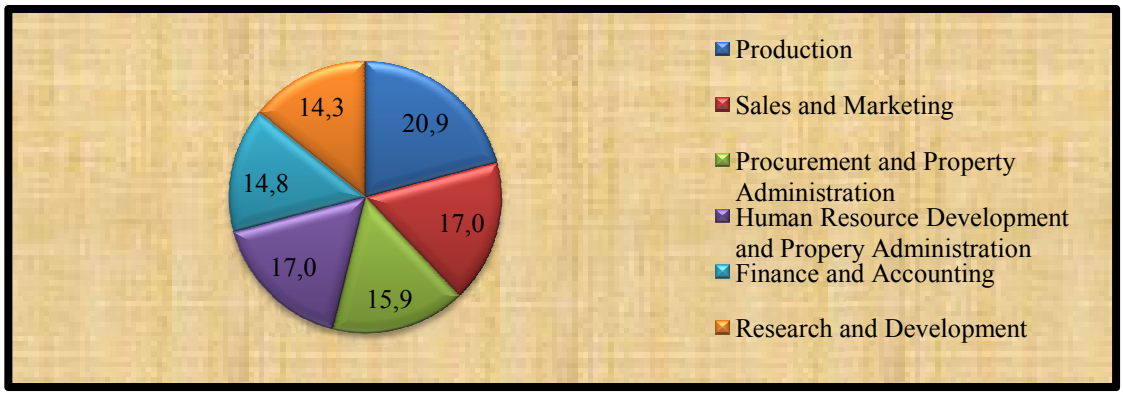

Figure 3.13: Percentage share of impact of processes on productivity (Source: Survey questionnaire)

From table 3.16 and figure 3.13, production process has the highest total point and percentage share whereas research and development process has the least total point and percentage share. This shows that production process has the highest impact, and research and development process has the least impact on the productivity of the garment industries.

The impact level of the input factors on productivity is given as follows by using total point and percentage share. The total point and percentage share of each partial input are shown below.

Table 3.17: Total point and percentage share of impact of partial inputs on productivity (Source: Survey questionnaire)

S.No.	Input Factors	1	2	3	Total Point	Share (%)
1	Human Inputs	2	1	11	37	23.4
2	Capital Inputs	2	7	5	31	19.6
3	Material Inputs	2	3	9	32	20.3
4	Energy Inputs	2	7	5	31	19.6
5	Miscellaneous Inputs	3	9	2	27	17.1
Total		**11**	**27**	**32**	**158**	**100**

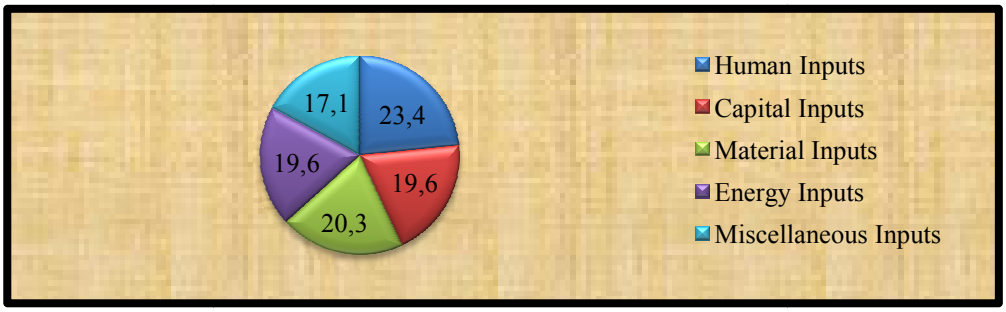

Figure 3.14: Percentage share of impact of partial inputs on productivity (Source: Survey questionnaire)

From table 3.17 and figure 3.14, human inputs have the highest total point and percentage share whereas miscellaneous inputs have the least total point and percentage share. This indicates that human inputs have the highest impact and miscellaneous inputs have the least impact on the productivity of the garment industries.

The impact level of the productivity is given as follows by using total point and percentage share. The total point and percentage share of each factor are shown below.

Table 3.18: Total point and percentage share of impact of productivity factors (Source: Survey questionnaire)

S.No.	Productivity Factors	1	2	3	Total Point	Share (%)
1	Knowledge and Skill	3	3	8	33	2.62
2	Motivation and Morale	1	4	9	36	2.86
3	Employee Satisfaction	1	5	8	35	2.78
4	Attitude and Culture	2	6	6	32	2.54
5	Life Standard	0	9	5	33	2.62
6	Absenteeism	2	4	8	34	2.70
7	Turnover	4	5	5	29	2.30

8	Human Capability	2	5	7	33	2.62
9	Technical Capability	2	3	9	35	2.78
10	Technological Capability	1	4	9	36	2.86
11	Process Capability	1	4	9	36	2.86
12	Maintenance	1	4	9	36	2.86
13	Depreciation	1	8	5	32	2.54
14	Speed Loss	2	5	7	33	2.62
15	Rejection	2	6	6	32	2.54
16	Rework	1	7	6	33	2.62
17	Scrap	4	7	3	27	2.14
18	Shortage	3	4	7	32	2.54
19	Rules and Regulations	1	5	8	35	2.78
20	Procedures	1	8	5	32	2.54
21	Work Instructions	1	4	9	36	2.86
22	Working Formats and Templates	2	7	5	31	2.46
23	Incentive Schemes	2	2	10	36	2.86
24	Ergonomics	1	3	10	37	2.94
25	Work Study	2	3	9	35	2.78
26	Other Productivity Improvement Techniques	2	7	5	31	2.46
27	Quality Control	2	5	7	31	2.46
28	Inventory Control	2	5	7	31	2.46
29	Production Control	2	3	9	35	2.78
30	Process Control	2	2	10	36	2.86
31	Environment Control	2	7	5	31	2.46
32	Standard Time	1	3	10	37	2.94
33	Lead Time	1	5	7	32	2.54
34	Waiting Time	0	8	5	31	2.46
35	Transfer Time	0	8	5	31	2.46
36	Downtime	0	3	10	36	2.86
37	Setup Time	0	9	4	30	2.38
38	Internal Transport	1	9	3	28	2.22
	Total	**58**	**199**	**269**	**1,259**	**100**

As shown in table 3.18, there is no significant difference among the total point and percentage share of the productivity factors. And hence this shows that all factors are important for productivity improvement of the garment industries.

Chapter Four

4-Case Study

4.1-Objective of the Case Study

The main objective of undertaking the case study is to make the study practical and realistic. Novastar Garment PLC has been taken for the case study.

4.2-Overview of the Company

4.2.1-Background of the Company

In 2003 a family of overseas business professionals eagerly embarked on the establishment of a new garment factory in their native country Ethiopian. Recent governmental efforts to improve Ethiopia's economy coupled with business incentives provided under AGOA[6] were key factors in the realization of the company. The building was completed in 2005.

The company founders received their business education and technical training in the United States of America. Collectively they hold over thirty years of experience in the Western market. They have combined their extensive overseas business training and knowledge of Ethiopian language, dialects and culture to establish a solid and innovative infrastructure. The merger of Western and African business culture contributes to high quality yet lower cost manufacturing attractive to overseas wholesalers.

4.2.2-Location of the Company

The factory and head office of Novastar Garment PLC is located in Gelan, Oromiya Zone, near to Atlas Resort on Debreziet road. The company has also branch office in United States of America.

[6] AGOA has already started giving a positive boost to the growth of garment industry in SSA. It offers beneficiary SSA duty free and quota free US market access for essentially garment products.

4.2.3-Vision, Vision and Values of the Company

4.2.3.1-Vision

To win the respect and love of our clients and work force alike, recognized as a manufacturer of high quality clothing, and become the manufacturer of choice as a leading garment factory in the sub-Saharan region.

5.2.3.2-Mission

To make each client the focal point of our operation by ensuring delivery of high quality merchandise with a very competitive price consistently on a timely basis delivery. To be considered as a major contributor in the effort to grow the Ethiopian textile industry and better life of the workers.

4.2.3.3-Values

Team work, initiative, focus in a diverse work environment where ethical treatment and equal opportunity are the foundation of the core value of the company. Fairness and trust in a familial setting is fostered and protected.

4.2.4-Machinery and Equipment of the Company

To keep abreast with the latest in fashion world, the company possesses a well equipped production, backed by hi-tech machines and latest technology. It has a retinue of modern machinery. It consists of high performance multiple needle machines, tufting machines and CAD systems.

Alongside, it is also equipped with capacious warehouses that facilitate storage of voluminous stock to meet all kinds of demand eventualities.

The latest machinery and well trained manpower ensure that the company's customers get true value for their needs.

4.2.5-Products of the Company

The company produces garments both for the local and export markets. The range of products produced by the company can be classified into the following: tops, t-shirts, polo shirts, shirts, bottoms, pants and uniforms.

Tops, t-shirts, polo shirts, shirts, bottoms and pants have three main categories, namely plain, screen printed and industrial embroidery. Uniforms are produced for different target markets, namely export market, corporate bodies, tourists and local market.

The export production volume of the company in 2008/9, 2009/10 and 2010/11 are 514,784, 607,206 and 577,527 pieces respectively.

Figure 4.1: Some of the products of the company

4.2.6-Quality Control of the Company

Being a quality driven company, the company laid emphasis on the quality of the products. There is quality control division even though it is not well organized in terms of staff, equipment and laboratory. The quality inspection begins from the receiving of raw materials. Once cleared, the raw materials are adopted for production.

All the company products are subject to in-house inspection. The products matching the quality criteria in a given stage of development pass to the succeeding stage.

4.2.7-Human Resource of the Company

Currently the company has on average 492 employees. Most of the employees are young. Most of the employees are direct workers which directly participate in the production of products. The current organizational structure of the company is shown in annex 4.

4.3-Productivity Awareness of the Company

Top managers, middle managers, lower managers and experts of the company have awareness and basic understanding of human productivity whereas checkers, supporting

staffs and operators of the company do not have awareness and basic understanding of human productivity. Total productivity and most of surrogate productivity are not understood by the company.

4.4-Working Definition of Productivity in the Company

In the company, productivity is defined as the ratio of volume of output to volume of human inputs (i.e. pieces/employee/shift).

4.5-Critical Success Factors of the Company

The critical success factors of the company are productivity, quality, efficiency, customer satisfaction, sales volume, market share and profit.

4.6-Productivity Factors of the Company

The productivity factors of the company are resource factors, method factors, control factors, process factors and product factors. The resource factors classified into three categories, namely factors related to human, factors related to machine, factors related to material.

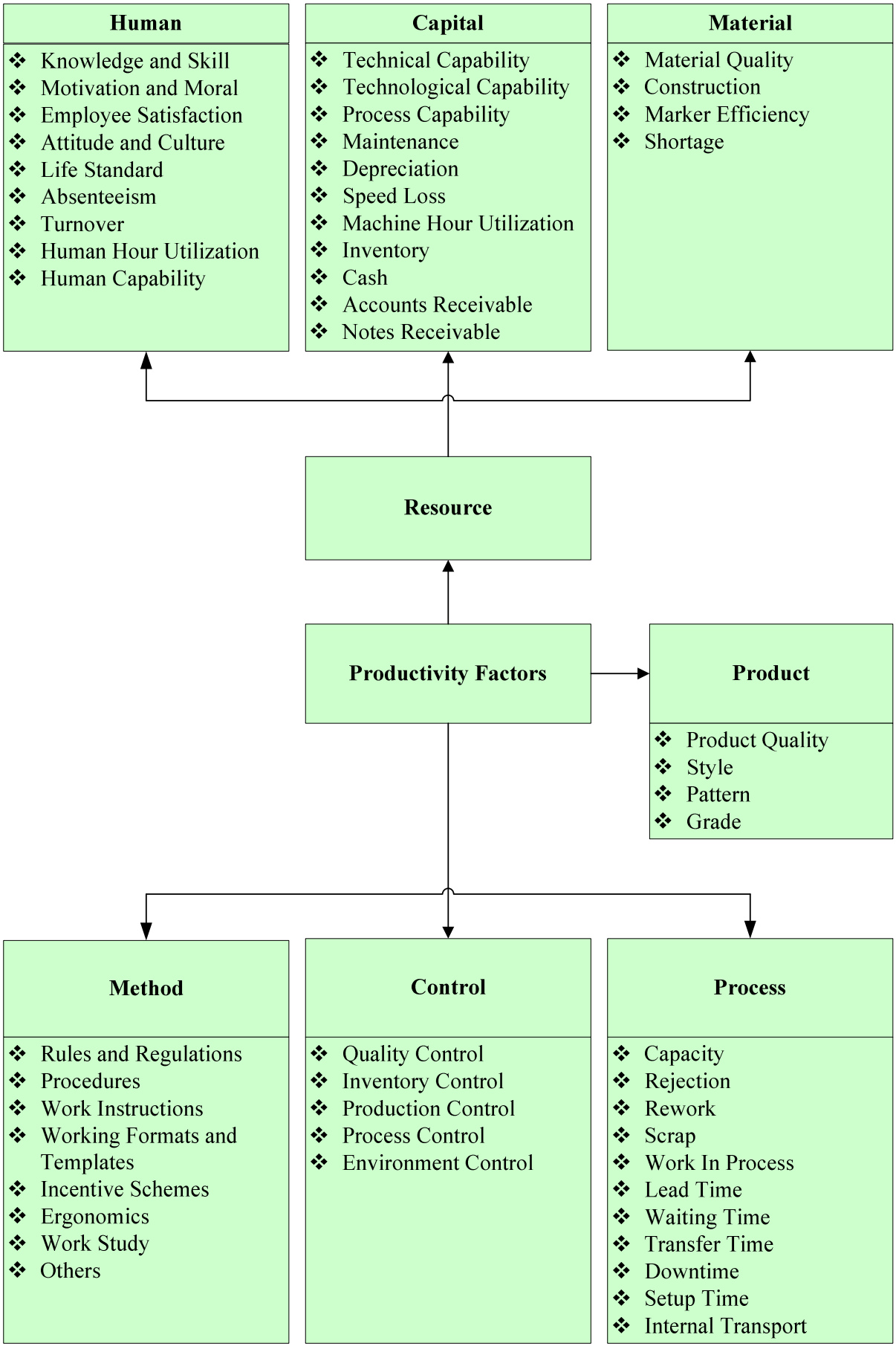

Figure 4.2: Productivity factors of the company

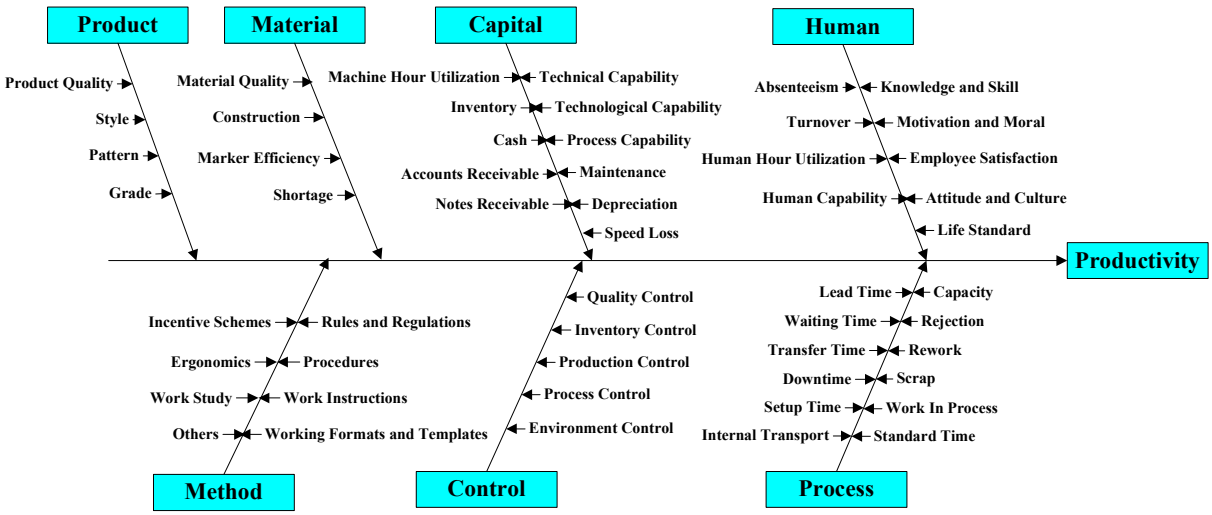

Figure 4.3: Productivity factors of the company using cause and effect diagram

The explanations and measurements of each productivity factors are summarized as shown below.

Table 4.1: Explanations and measurements of productivity factors of the company

S.No.	Factors	Explanation	Measurement
1	**Human Factors**		
1.1	Knowledge and Skill	Describes how well an employee is able to perform a job.	# Skilled employees
1.2	Motivation and Moral	Are the employees motivated to do their job to meet demands?	# Motivated employees
1.3	Employee Satisfaction	Are the employees satisfied with their work?	# Satisfied employees
1.4	Attitude and Culture	Commitment, team work, obeying company rules and regulations, and being cooperative for change.	# Committed employees
1.5	Life Standard	Living standard of the employees with respect to human needs.	# Employees who secure their basic needs
1.6	Absenteeism	Employees' non attendance time without pre-known reasons.	Hour
1.7	Turnover	Number of employees terminating to work for the company.	# Turnover
1.8	Human Hour Utilization	The ratio of utilized human hour to total human hour for specific period of time.	% Utilized human hour
1.9	Human Capability	Describes how well an employee is fit to perform a job.	# Fit employees
2	**Capital Factors**		
2.1	Technical Capability	Describes how well a machine is technically fit to perform a job.	# Technically fit machines
2.2	Technological Capability	Describes how well a machine is technologically fit to perform a job.	# Technologically fit machines

2.3	Process Capability	Describes how well a machine is technologically fit to perform a job.	Process capability index
2.4	Maintenance	Keeping machines at good operating condition.	Overall equipment efficiency
2.5	Depreciation	Decline in value of fixed assets especially due to wear and tear.	Birr
2.6	Speed Loss	Describes the reduction of production rate of machine.	Change in production rate
2.7	Machine Hour Utilization	The ratio of utilized machine hour to total machine hour for specific period of time.	% Utilized machine hour
2.8	Inventory	Describes the materials in stock	Square meters, pieces or birr
2.9	Cash	Money in the form of coin or note.	Birr
2.10	Accounts Receivable	Money collected from customers who bought products.	Birr
2.11	Notes Receivable	Money collected from creditors who borrowed money.	Birr
3	**Material Factors**		
3.1	Material Quality	Describes the amount of materials pass without rejection.	Amount of materials pass without rejection
3.2	Construction	Describes fabric variants by construction type and shading.	#Fabric by construction type, #fabric by shading
3.3	Marker Efficiency	The ratio of area of pattern in the marker plan to total area of the marker plan	% Area of pattern in the marker plan
3.4	Shortage	Materials unavailable within the required time.	Amount of materials unavailable within the required time.
4	**Method Factors**		
4.1	Rules and Regulations	Governing laws of the company.	# Effectively applied rules and regulations
4.2	Procedures	Describe the sequence of activities how a job is performed.	# Effectively applied procedures
4.3	Work Instructions	Describe the guidelines how a job is to be performed.	# Effectively applied work instructions
4.4	Work Formats and Templates	Documents developed to record data and information.	# Effectively applied formats and templates
4.5	Incentive Schemes	Incentive systems to encourage employees.	# Employees satisfied by the incentive schemes
4.6	Ergonomics	Relationship between employees and their working environment.	# Bad operations
4.7	Work Study	Enhancing productivity by eliminating waste and unnecessary operations.	# Time, distance
5	**Control Factors**		
5.1	Quality Control	Measuring and comparing the quality of products; and taking corrective action.	Quality specification
5.2	Inventory Control	Controlling the level of inventory by determining how much to order and when to order.	Economic order quantity, maximum and minimum inventory level, reorder point
5.3	Production Control	Controlling the production to go as per the required volume, quality and time.	Production efficiency
5.4	Process Control	Controlling the process to produce within the desired control limits.	Statistical process control

5.5	Environment Control	Assessing and controlling factors that affect environment.	# Environmental unfriendly operations
6	**Process Factors**		
6.1	Capacity	Describes ability to produce.	Pieces
6.2	Rejection	Products rejected due to not meeting the specifications.	Square meters or pieces
6.3	Rework	Products reworked due to not meeting the specifications.	Pieces
6.4	Scrap	Describes fabric rags in cutting and sewing operations.	Square meters
6.5	Work In Process	Partially produced products available within the production line.	Pieces
6.6	Standard Time	Standard allowed minutes required to accomplish a job.	Minutes
6.7	Lead Time	The time passed between ordering and receiving outputs.	Minutes
6.8	Waiting Time	Time elapsed due to waiting for inputs.	Minutes
6.9	Transfer Time	Time elapsed due to flow materials from raw materials store to finished products store.	Minutes
6.10	Downtime	Off operation time of the machines.	Minutes
6.11	Setup Time	Time elapsed for preparation to start operation.	Minutes
6.12	Internal Transport	Distance travelled due to flow materials from raw materials store to finished products store.	Meters
7	**Product Factors**		
7.1	Product Quality	Describes the amount of products pass without rework.	Amount of products pass without rework
7.2	Style	Describes the number and complexity of product style produced.	# Product styles
7.3	Patten	Describes the number of patterns per product style.	# Patterns per style
7.4	Grade	Describes range of sizes of product style.	# Grades per style

4.7-Status of Productivity Factors

The status of productivity factors of the company is defined by using colors namely, green-if there are no problems associated with the factor, red-if there are problems associated with the factor and gray-if the factor is not applicable. The data collection approaches for defining the status of productivity factors are interviewing sewing line-I 75 employees, considering sewing line-I 50 machines, comparing the company performance with the target and international benchmarking values (refer annex 5), the existing and improved layout of the company (refer annex 6 and 7), and discussion with accountants, supervisors, heads and managers. The status of each productivity factors and the associated comments is given as follows.

Table 4.2: Status productivity factors of the company

S.No.	Factors	Status	Comments
1	**Human Factors**		
1.1	Knowledge and Skill		From sewing line-I 75 employees, only 40% have high skill for the job. The main reasons for this are low education level and lack of adequate training.
1.2	Motivation and Morale		From sewing line-I 75 employees only 26.7% are motivated. The main reasons for this are unattractive salary, employee benefit and incentive schemes, and poor leadership in good working environment.
1.3	Employee Satisfaction		From sewing line-I 75 employees, only 8% are satisfied. The main reasons for problem are unattractive salary, employee benefit, and incentive schemes and poor leadership in creating good working environment.
1.4	Attitude and Culture		From sewing line-I 75 employees, only 8% have good industrial culture. The reasons for the problem are resistance for change, lack of accepting new work method, lack of commitment and being not punctual.
1.5	Life Standard		Only 8% of sewing line-I 75 employees secure their basic needs (i.e. food, cloth and shelter). The main reason for this is low salary scale and incentive.
1.6	Absenteeism		The average absenteeism rate is 1.5%. The international benchmarking value and the average target value is less than 1%.
1.7	Turnover		The average turnover rate is 4.9%. The international benchmarking value and the average target value are 10% and 3% respectively. The average turnover rate is less than the average target value.
1.8	Human Hour Utilization		The human hour utilization for the year 2010/11 is 90.8%. The rest 9.2% has been elapsed due to

			absenteeism and other types of leave.
1.9	Human Capability		Only 73.3% of sewing line-I 75 employees are capable to do the job.
2	**Capital Factors**		
2.1	Technical Capability		The company installed new established machines that are not working for long period of time; and they are fabricated by genuine material with sufficient spare parts.
2.2	Technological Capability		The company installed newly established machines.
2.3	Process Capability		The production process has been producing within the specification limit.
2.4	Maintenance		There is no maintenance plan and hence no planned maintenance. There is corrective maintenance. The maintenance is not well organized even to perform corrective maintenance in terms of workshop, equipment, and maintenance crews. There is no workshop.
2.5	Depreciation		The fixed asset of the company has been declined from time to time. For example, the depreciation cost of company in the year 2009/10 is 755,380 birr.
2.6	Speed Loss		The machines are capable to run at their maximum speed.
2.7	Machine Hour Utilization		Considering sewing line-I 50 machines, the machine hour utilization is 97.2%. The rest 2.8% is elapsed due to downtime.
2.8	Inventory		The company does not set the minimum and maximum inventory level. There is no economic order quantity and reorder point.
2.9	Cash		The company does not face cash constraint.
2.10	Accounts Receivable		Yearly on average, the company can collect accounts about 75% of its expectation. According to finance and accounting division, the company should collect 90% and above.

2.11	Notes Receivable		Currently there are no notes to be collected.
3	**Material Factors**		
3.1	Material Quality		The material quality rate is greater than 99%. The average target value is greater than 98%.
3.2	Construction		The company uses well constructed woven and knitted fabrics. The fabrics are in the form of plain or strip shading. The shading is uniform.
3.3	Marker Efficiency		The average marker efficiency for knit products is 83.8%. The international benchmarking value and the average target value is 90%.
3.4	Shortage		The company faces less than 1% of material shortage. According to the company, value is considered as small amount when compared to the large quantity of material consumed. For example in the year 2010/11 the company consumed about 743,711 m^2 fabrics.
4	**Method Factors**		
4.1	Rules and Regulations		Most of the rules and regulations of the company like timetable, leave, employee benefit and administrative measures are clearly known by most of employees.
4.2	Procedures		Most of the procedures of the company are not clearly applied by most of employees.
4.3	Work Instructions		Except verbal communication, there are no written work instructions especially for shop floor employees. The employees do not have written job description.
4.4	Working Formats and Templates		The working formats and templates of the company are used for reporting. There are no enough working formats and templates that define how to apply a certain activity.
4.5	Incentive Schemes		From sewing line-I 75 employees, only 46.7% are satisfied by the incentive scheme. Currently the company applied both individual and group

			financial incentive scheme.
4.6	Ergonomics		The company only provides clinical, cafeteria, transportation, shower and toilet. The employees do not have locker. The workstations on production area are not ergonomically designed.
4.7	Work Study		Except time study other techniques of work study are not implemented.
5	**Control Factors**		
5.1	Quality Control		The company quality control division is not well organized in terms staff, equipment and laboratory. There is no laboratory. Statistical quality control is not applied. The quality control is reactive and is not process based.
5.2	Inventory Control		Except periodic items inventory counting, the company does not apply inventory management system. The company only uses bin card system to control inventory.
5.3	Production Control		Though there is production planning and control section, it is not organized. Daily, weekly, monthly and yearly production planning is not done and hence it is difficult to control production.
5.4	Process Control		For instance, statistical process control techniques are not applied.
5.5	Environment Control		The company does not have environmental management program. There is only inclinator to burn dry waste.
6	**Process Factors**		
6.1	Capacity		The company uses about 47.8% of the attainable capacity. The capacity is underutilized mainly due lack of scheduling, low skill employees, low motivation to work, absenteeism and other types of leave, downtime, waiting time, transfer time and setup time.
6.2	Rejection		The average rejection rate of knit products is 0.08%. The international benchmarking value and

			the average target value 2% and 0% respectively.
6.3	Rework		The average rework rate of knit products is 11.2%. The international benchmarking value and the average target value is 2%.
6.4	Scrap		The average scrap rate for knit products is 16.2%. The international benchmarking value and the average target value is 10%.
6.5	Work In Process		For example, the monthly work in process for the BP3 within the production line is 19,244 pcs. But according to the target, the monthly work in process expected to be 1,653 pcs.
6.6	Standard Time		The average standard time required to produce one piece of knit t-shirt is 12.3 mins. The international benchmarking value and the average target value is 5 mins.
6.7	Lead Time		The average marketing lead time is 7 weeks. The international benchmarking value and the average target value is 5 weeks.
6.8	Waiting Time		From sewing line-I 75 employees hour, 1.8% is elapsed due to waiting.
6.9	Transfer Time		Due to layout problem there is extra transfer time (about 2 mins/trip).
6.10	Downtime		From sewing line-I 50 machines hour, 2.8% is elapsed due to downtime.
6.11	Setup Time		From sewing line-I 75 employees hour, 3.5% is elapsed due to setup.
6.12	Internal Transport		Due to layout problem there is extra distance travelled (about 50 mts/trip).
7	**Products Factors**		
7.1	Product Quality		The average knit products quality rate is 88.8%. The international benchmarking value and the average target value is 98%.
7.2	Style		The product styles produced in the company are not complicated. This makes patter making, sample

			making, marker making, cutting and sewing easy.
7.3	Pattern		The number of patterns per style of product are not that much large. This makes patter making, sample making, marker making, cutting and sewing easy.
7.4	Grade		The company has clearly defined grades for its products based on USA anthropometric data.

4.8-Productivity Indicators of the Company

The company has partial, total and surrogate productivity indicators. The indicators can be identified at firm, process, sub-process or operation level.

4.8.1-Partial and Total Productivity Indicators

Partial productivity indicators of the company are the measure of its input factors. The company has five input factors namely, human, capital, material, energy and miscellaneous inputs.

Human inputs involves involve operators, supporting staffs, checkers, experts and managers. Supporting staffs involve co-operators, material handlers, clerks, maintenance crews and the like. Capital inputs involve fixed capital and working capital. Fixed capital involves land, buildings, machines, tools, equipment, amortized costs and the like. And working capital involves inventory, cash, accounts receivable, note receivable and the like. Material inputs involve raw materials (fabrics) and purchased parts (accessories). Purchased parts (accessories) involve threads, buttons, elastics, zippers, labels, tags, packing materials and the like. Energy inputs involve electricity, water, fuel and the like. Miscellaneous inputs involve travel, tax, marketing, product development, office supplies, information, consultants, general administration and the like.

Therefore the partial productivity indicators of the company are human, capital, material, energy and miscellaneous inputs productivity.

Total productivity indicator is one of the productivity indicators of the company to be measured as function of total outputs to total inputs and as a function of partial productivity indicators.

4.8.3-Surrogate Productivity Indicators

Surrogate productivity indicators of the company are the measure of surrogate factors. Like partial and total productivity indicators, surrogate productivity indicators are not directly measures as ratio of output to input.

The surrogate productivity indicators identified are employee satisfaction rate, motivation rate, skill level rate, absenteeism rate, turnover rate, human hour utilization, speed loss rate, machine hour utilization, material quality, marker efficiency and product quality rate.

The productivity indicators of production process are presented below.

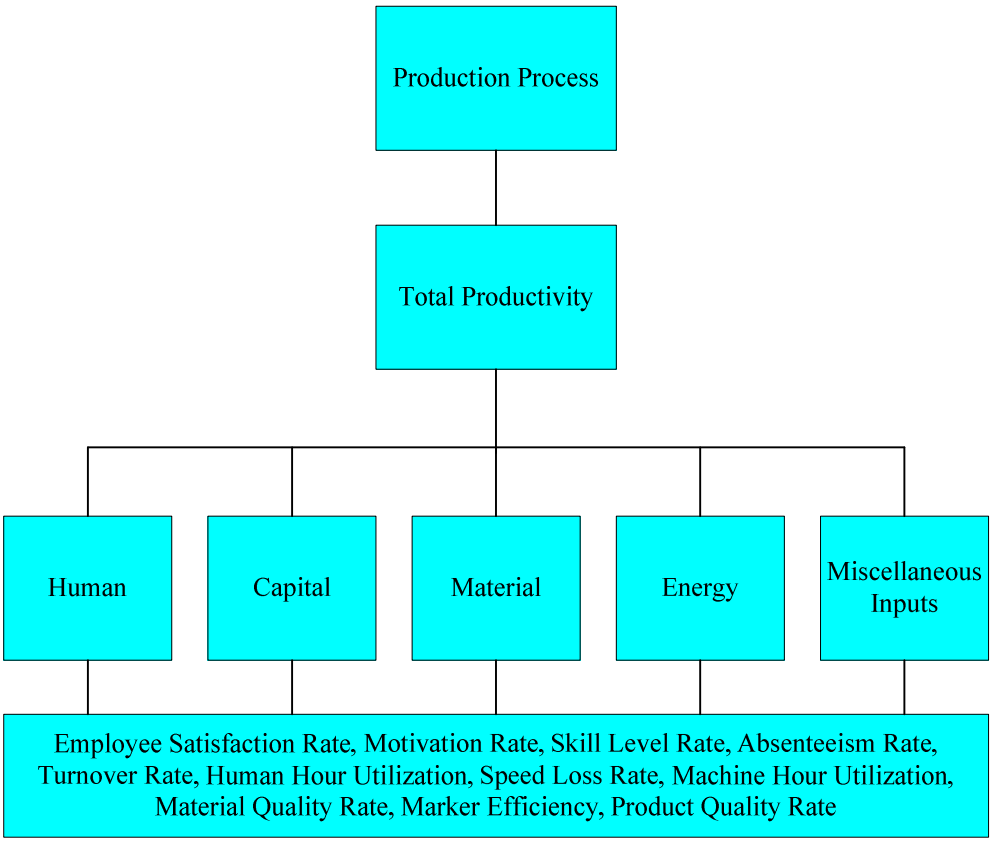

Figure 4.4: Productivity indicators of production process

4.9-Process Mapping

Process mapping can be done for processes, sub-processes or operations. The process map of production process of the company is given below.

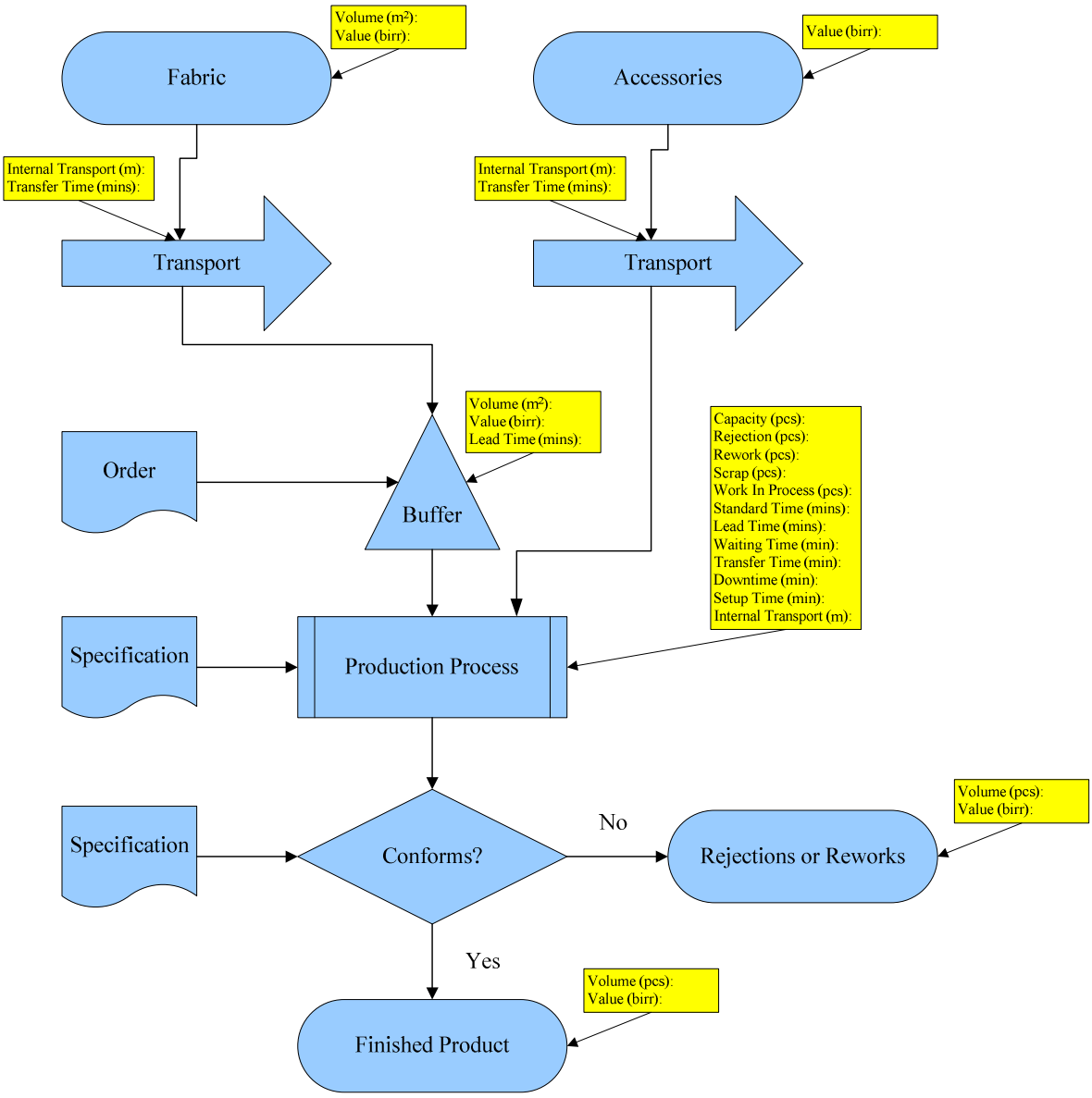

Figure 4.5: Process map of production process

As shown in the process map, production process has inputs, process factors and outputs. The inputs of production process are fabrics, accessories, human, capital, energy and miscellaneous inputs; and outputs are finished products, semi-finished products, rejections, reworks and scraps. For the detail, the production process is represented by the flow process chart as shown below.

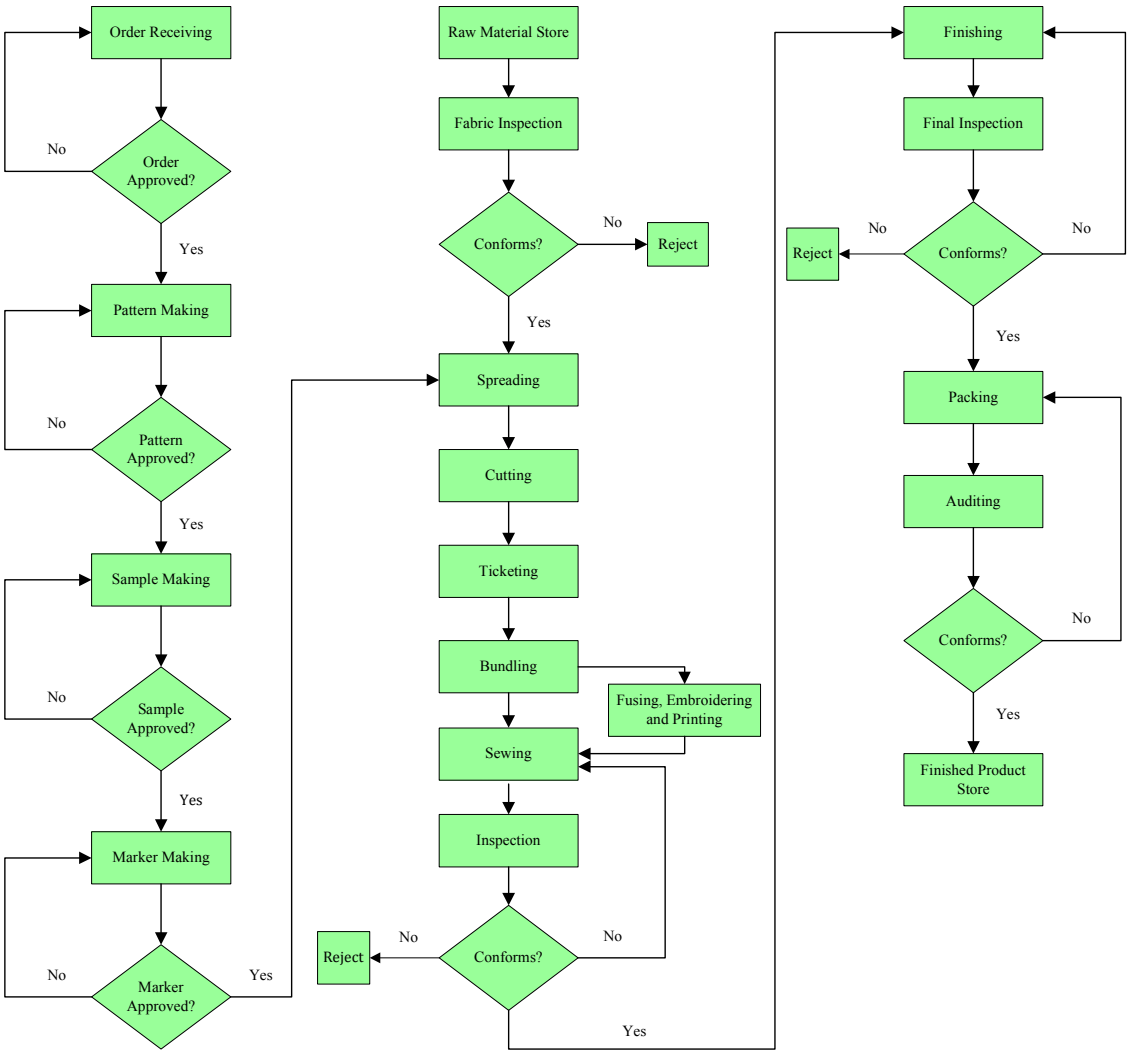

Figure 4.6: Flow process chart of production process

Order Receiving: Getting specification from customers about style, quantity, quality, delivery date and the like.

Order Approving: Accepting the order.

Pattern Making: Changing body measurements in to a paper pattern in such a way it shall fit the 3D shape of a human body in its final assembly. In the company pattern is made both manually or using CAD software.

Pattern Approving: Accepting the pattern.

Sample Making: Preparing the representative new product before going to mass production.

Sample Approving: Accepting the sample.

Marker Making: Preparing the most efficient layout of pattern pieces for a specified style, fabric and distribution of sizes. In the company marker is made using CAD software.

Marker Approving: Accepting the marker.

Fabric Inspection: Examine the fabric whether it fulfill the quality specification or not.

Spreading: Placing the number of plies of fabric that the production planning process has dictated, to the length of the marker plan, in the colours required, and correctly aligned as to length and width without tension.

Cutting: Separating fabric parts as replicas of the pattern pieces in the marker plan.

Ticketing: Giving a unique number to each cut parts of fabric so that the cut pieces of different sizes and colors do not get mixed.

Bundling: Fastened together the same size and color cut parts of fabric for the purpose of better handling and work in process controlling in the line.

Fusing: Bonding the interlining to the outer fabric by means of thermoplastic resin.

Embroidering: Decorating fabric with design stitches in strands of threads using a needle. Embroidery may also incorporate other material such as metals, pearls, beads, quilts, and sequins.

Printing: Stamping with different pattern and color.

Sewing: Assembling cut parts of fabric with accessories to produce garment products.

Inspection: Examine each sewn product whether it fulfill the quality specification or not.

Finishing: Ironing, tagging and folding the ready sewn, trimmed and quality checked products from the sewing lines.

Final Inspection: Examine each finished product whether it fulfill the quality specification or not.

Packing: Poly-packing the finished products dozen wise, color wise, size ratio wise; bundling and packing in the cartoon so that ready to ship or dispatch.

Auditing: Assessing whether the finished products are packed correctly or not.

The inputs and outputs of each of the above sub-process and operation are given as follows.

Table 4.3: Inputs and outputs of each sub-process and operation of production process

S.No.	Inputs	Sub-Process and Operation	Outputs
1	Customer Specification, Human, Energy and Miscellaneous Inputs	Order Receiving	Order Receipt
2	Order Receipt, Human, Energy and Miscellaneous Inputs	Order Approving	Approved Order, Rework or Rejection
3	Approved Order, Human, Capital, Energy and Miscellaneous Inputs	Pattern Making	Pattern
4	Pattern, Human, Energy and Miscellaneous Inputs	Pattern Approving	Approved Pattern, Rework or Rejection
5	Approved Pattern, Human, Capital, Material, Energy and Miscellaneous Inputs	Sample Making	Sample
6	Sample, Human, Energy and Miscellaneous	Sample Approving	Approved Sample, Rework or Rejection
7	Approved Sample, Human, Capital, Energy and Miscellaneous Inputs	Marker Making	Marker
8	Marker, Human, Energy and Miscellaneous Inputs	Marker Approving	Approved Marker, Rework or Rejection
9	Fabric, Human, Capital, Energy and Miscellaneous Inputs	Fabric Inspection	Inspected Fabric, Rejection
10	Approved Marker, Inspected Fabric, Human, Capital, Energy and Miscellaneous Inputs	Spreading	Spread Fabric
11	Spread Fabric, Human, Capital, Energy and Miscellaneous Inputs	Cutting	Cut Parts, Scrap, Rework
12	Cut Parts, Human, Capital, Energy and Miscellaneous Inputs	Ticketing	Ticketed Parts
13	Ticketed Parts, Human, Capital, Energy and Miscellaneous Inputs	Bundling	Bundled Parts
14	Bundled Parts, Human, Capital, Energy and Miscellaneous Inputs	Fusing	Fused Parts, Rejection or Rework

15	Bundled Parts, Human, Capital, Energy and Miscellaneous Inputs	Embroidering	Embroidered Parts, Rejection or Rework
16	Bundled Parts, Human, Capital, Energy and Miscellaneous Inputs	Printing	Printed Parts, Rejection or Rework
17	Bundled Parts, Fused Parts, Embroidered Parts, Printed Parts, Human, Capital, Energy and Miscellaneous Inputs	Sewing	Sewn Products, Scraps, Rejection or Rework
18	Sewn Products, Human, Capital, Energy and Miscellaneous Inputs	Inspection	Inspected Products, Rejection or Rework
19	Inspected Products, Human, Capital, Energy and Miscellaneous Inputs	Finishing	Finished Products, Rejection or Rework
20	Finished Products, Human, Capital, Energy and Miscellaneous Inputs	Final Inspection	Inspected Products, Rejection or Rework
21	Inspected Products, Human, Capital, Energy and Miscellaneous Inputs	Packing	Packed Products
22	Packed Products, Human, Capital, Energy and Miscellaneous Inputs	Auditing	Audited Products, Rework

As shown in table 4.3, each sub-processes and operations have their own input and output.

4.10-Data Collection and Organization

For measuring partial and total productivity, a three year (i.e. 2008/9 to 2010/11) data has been collected. And for measuring surrogate productivity and process indicators daily (i.e. 31/08/11) and monthly (16/05/11 to 24/05/11) BP3 have been taken. The product BP3 has been selected because it is frequently ordered and produced in large quantity. BP3 is a knit trouser produced in three colors, namely white, grey and black.

Table 4.4: Data for measuring partial and total productivity (Source: Finance and accounting division and commercial division of the company)

S.No	Parameters	Year		
		2008/9	2009/10	2010/11
1	Value of Human Inputs	458,522	276,487	309,665
2	Capital Inputs	2,476,722	2,763,108	3,094,681
3	Value of Material Inputs	14,732,876	17,377,949	19,283,309

4	Value of Energy Inputs	32,609	37,446	41,940
5	Value of Miscellaneous Inputs	4,292,384	3,515,216	3,937,042
6	Value of Total Outputs (birr)	22,139,750	29,004,137	29,508,701
7	Value of Total Inputs (birr)	21,993,113	23,970,206	26,666,637

Table 4.5: Data for measuring surrogate productivity (Source: Human resources development division and production division of the company)

S.No.	Item	Value	Remark
1	Total Number of Employees in Sewing line 1 (#)	75	Daily BP3 production
2	Satisfied Employees in Sewing Line 1	6	"
3	Motivated Employees in Sewing Line 1	20	"
4	Skilled Employees in Sewing Line 1	30	"
5	Absenteeism (hrs)	16,875	For the year 2010/11
6	Turnover (#)	25	"
7	Total Number of Employees	492	"
8	Utilized Human Hour (hr)	1,026,769	"
9	Total Human Hour (hrs)	1,130,616	"
10	Utilized Machine Hour in Sewing Line 1(hr)	372	Daily BP3 production
11	Total Machine Hour in Sewing Line 1 (hrs)	383	"
12	Total Fabrics Pass without Rejection (m^2)	70,255	Monthly BP3 production
13	Total Inspected Fabrics (m^2)	70,255	"
14	Total Products Pass without Rework (pcs)	40,059	"

Table 4.6: Data for measuring process indicators (Source: production division of the company)

S.No.	Item	Value	Remark
1	Attained Capacity (pcs)	35,858	Monthly BP3 production
2	Attainable Capacity (BP3)	75,000	Per month for BP3
3	Total Rejects (pcs)	0	Monthly BP3 production
4	Total Reworks (pcs)	3,858	"
5	Total Inspected Products (pcs)	43,917	"
6	Total scraps (m^2)	9,836	"
7	Total Consumed Fabric (m^2)	70,255	"
8	Production Line Input (pcs)	55,102	"
9	WIP within Production Line (pcs)	19,244	"
10	Standard Time for BP3 (mins/pcs)	25.5	Across the production line
11	Lead Time for BP3 (mins/pcs)	20.4	"
11	Total Human Hour in Sewing Line-I (hrs)	575	Daily BP3 production
13	Waiting Time in Sewing Line-I (mins)	626	"
14	Transfer Time (mins/trip)	5.04	"

15	Downtime (mins)	645	"
16	Setup Time (mins)	1,195	"
17	Internal Transport (m/trip)	126	"

4.11-Productivity Measurement

4.11.1-Partial Productivity Measurement

Human Productivity (HP_t) = Value of Total Outputs/Value of Human Inputs

HP_t = 22,139,750/458,522 = 48.3 for the year 2008/9. Analogously, the human productivity for the year 2009/10 and 2010/11 are 104.9 and 95.3 respectively.

Capital Productivity (CP_t) = Value of Total Outputs/Value of Capital Inputs

CP_t = 22,139,750/2,476,722 = 8.9 for the year 2008/9. Analogously, the capital productivity for the year 2009/10 and 2010/11 are 10.5 and 9.5 respectively.

Material Productivity (MP_t) = Value of Total Outputs/Value of Material Inputs

MP_t = 22,139,750/14,732,876 = 1.5 for the year 2008/9. Analogously, the material productivity for the year 2009/10 and 2010/11 are 1.7 and 1.5 respectively.

Energy Productivity (EP_t) = Value of Total Outputs/Value of Energy Inputs

EP_t = 22,139,750/32,609 = 678.9 for the year 2008/9. Analogously, the energy productivity for the year 2009/10 and 2010/11 are 774.6 and 703.6 respectively.

Miscellaneous Inputs Productivity (XP_t) = Value of Total Outputs/Value of Miscellaneous Inputs

XP_t = 22,139,750/4,292,384 = 5.2 for the year 2008/9. Analogously, the miscellaneous inputs productivity for the year 2009/10 and 2010/11 are 8.3 and 7.5 respectively.

4.11.2-Total Productivity Measurement

In this case, total productivity of the company at firm level has been found by two approaches: as function of total outputs and total inputs and as a function of partial productivity.

As a function of total outputs to total inputs

Total Productivity (TPF_t) = Value of Total Outputs/Value of Total Inputs

TPF_t = 22,139,750/21,993,113 = 1.01 for the year 2008/9. Analogously, the total productivity for the year 2009/10 and 2010/11 are 1.21 and 1.11 respectively.

As a function of partial productivity

Total Productivity of Firm (TPF_t) = Weight of Input j * Partial Productivity of Input j

$$TPF_t = W_j PP_{jt}$$

W_j = Partial Inputs j for the Firm/Total Inputs

$W_j = I_{jt}/IT_t$

Weight of Human Inputs (W_H) = Value of Human Inputs/Value of Total Inputs

W_H = 458,522/21,993,113 = 0.021 for the year 2008/9. Analogously, weight of human inputs for the year 2009/10 and 2010/11 are 0.012 and 0.012 respectively.

Weight of Capital Inputs (W_C) = Value of Capital Inputs/Value of Total Inputs

W_C = 2,476,722/21,993,113 = 0.113 for the year 2008/9. Analogously, weight of capital inputs for the year 2009/10 and 2010/11 are 0.115 and 0.116 respectively.

Weight of Material Inputs (W_M) = Value of Material Inputs/Value of Total Inputs

W_M = 14,732,876/21,993,113 = 0.670 for the year 2008/9. Analogously, weight of material inputs for the year 2009/10 and 2010/11 are 0.725 and 0.723 respectively.

Weight of Energy Inputs (W_E) = Value of Energy Inputs/Value of Total Inputs

W_E = 32,609/21,993,113 = 0.0015 for the year 2008/9. Analogously, weight of energy inputs for the year 2009/10 and 2010/11 are 0.0016 and 0.0016 respectively.

Weight of Miscellaneous Inputs (W_X) = Value of Miscellaneous Inputs/Value of Total Inputs

W_X = 4,292,384/21,993,113 = 0.195 for the year 2008/9. Analogously, weight of miscellaneous inputs for the year 2009/10 and 2010/11 are 0.147 and 0.148 respectively.

$TPF_t = W_H*HP_t = W_C*CP_t = W_M*MP_t = W_E*EP_t = W_X*XP_t$

TPF_t = 0.021*48.3 = 0.113*8.9 = 0.670*1.5 = 0.0015*678.9 = 0.195*5.2 = 1.01 for the year 2008/9. Analogously, the total productivity for the year 2009/10 and 2010/11 are 1.21 and 1.11 respectively.

From the result of the partial and total productivity measurement, year 2009/10 has greater value than the year 2008/9 and 2010/11. And hence 2009/10 can be taken as a base period.

4.11.3-Surrogate Productivity Measurement

The surrogate productivity measurement values are summarized as shown below.

Table 4.7: Surrogate productivity measurement value

S.No.	Indicators	Value
1	Employee Satisfaction Rate (%)	8
2	Motivation Rate (%)	26.7
3	High Skill Rate (%)	40
4	Absenteeism Rate (%)	1.5
5	Turnover Rate (%)	5.1
6	Human Hour Utilization (%)	90.8
7	Machine Hour Utilization (%)	97.2
8	Material Quality Rate (%)	100
9	Marker Efficiency (%)	86
10	Product Quality Rate (%)	91.2

4.11.4-Process Indicator Measurement

Process indicators are the measure of process factors. The process indicators measurement values are summarized as shown below.

Table 4.8: Process indicators measurement value

S.No.	Indicators	Value
1	Capacity Utilization (%)	47.8
2	Rejection Rate (%)	0
3	Rework Rate (%)	8.8
4	Scrap Rate (%)	14
5	Work In Process Rate (%)	34.9
6	Standard Time (min)	25.5
7	Lead Time (min)	20.4
8	Waiting Time Rate (%)	1.8
9	Transfer Time Rate (%)	7.7

10	Downtime Rate (%)	2.8
11	Setup Time Rate (%)	3.5
12	Internal Transport (m)	882

4.12-Productivity Analysis

4.12.1-Partial and Total Productivity Analysis

Partial and total productivity analysis has been done by comparing the current partial and total productivity with the target.

The partial and total productivity target for the year 2010/11 has been found using exponential smoothing forecasting technique.

$P'_{t+1} = \alpha P_t + (1-\alpha)P'_t$

$\alpha = [2/(m+1)]$

Where: P'_{t+1} is the forecasted value of productivity for next period; P_t is actual current period productivity; P'_t is the current period forecasted value of productivity; α is smoothing constant lies between 0 and 1; and m is number of periods.

In this case m = 2 since two periods moving average is taken, hence $\alpha = [2/(2+1)] = 0.67$

The human productivity target for the year 2010/11 = 0.67*95.3 + 0.33*100.1 = 95.6 Analogously, the capital productivity, material productivity, energy productivity, miscellaneous inputs productivity and total productivity targets for the year 2010/11 are 10.2, 1.6, 758.8, 7.7 and 1.18 respectively.

Table 4.9: Productivity analysis against target

S.No.	Indicators	Target (2010/11)	Actual (2010/11)	Deviation (%)	Status
1	Human Productivity	95.6	95.3	-0.3	Under Target
2	Capital Productivity	10.2	9.3	-9.7	Under Target
3	Material Productivity	1.6	1.5	-6.7	Under Target
4	Energy Productivity	758.8	703.6	-7.8	Under Target
5	Miscellaneous Inputs Productivity	7.7	7.5	-2.7	Under Target
6	Total Productivity	1.18	1.11	-6.3	Under Target

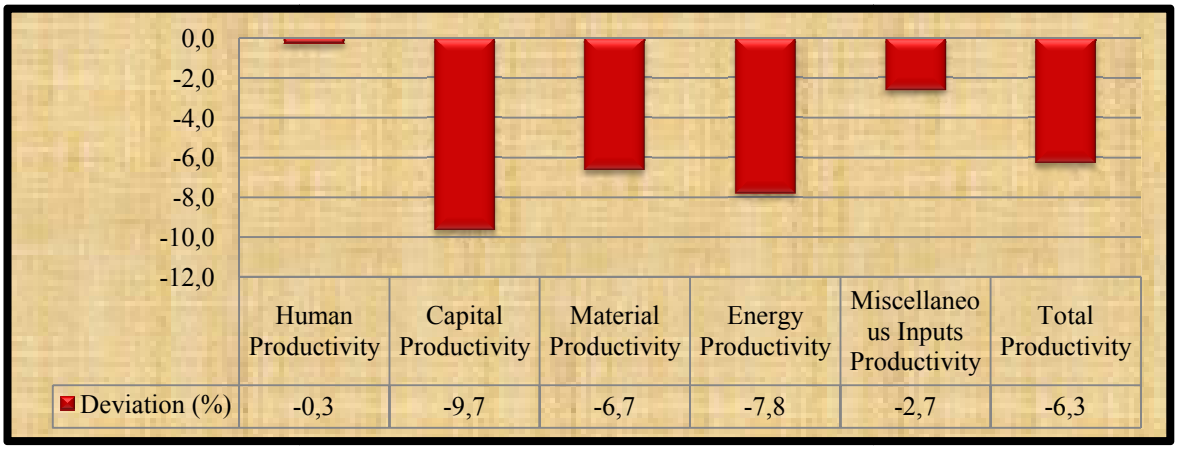

Figure 4.7: Productivity analysis bar chart against target

As shown in table 4.9 and figure 4.7, the actual measurement value of partial and total productivity indicators of the company show under target productivity performance when compared to the target.

4.12.2-Surrogate Productivity Analysis

The surrogate productivity analysis is done by comparing the measurement value of surrogate productivity indicators with the proposed targets. The targets are proposed by referring the company's international benchmarking system and through discussion.

Table 4.10: Surrogate productivity analysis against proposed target

S.No.	Indicators	Target	Actual	Deviation (%)	Status
1	Employee Satisfaction Rate (%)	90	8	-1,025	Decreased
2	Motivation Rate (%)	90	26.7	-237	"
3	High Skill Rate (%)	80	40	-100	"
4	Absenteeism Rate (%)	1	1.5	33.3	Increased
5	Turnover Rate (%)	3	5.1	41.2	"
6	Human Hour Utilization (%)	95	90.8	-4.6	Decreased
7	Machine Hour Utilization (%)	98.5	97.2	-1.3	"
8	Material Quality Rate (%)	100	100	0	No Change
9	Marker Efficiency (%)	90	86	-4.7	Decreased
10	Product Quality Rate (%)	98	91.2	-7.5	"

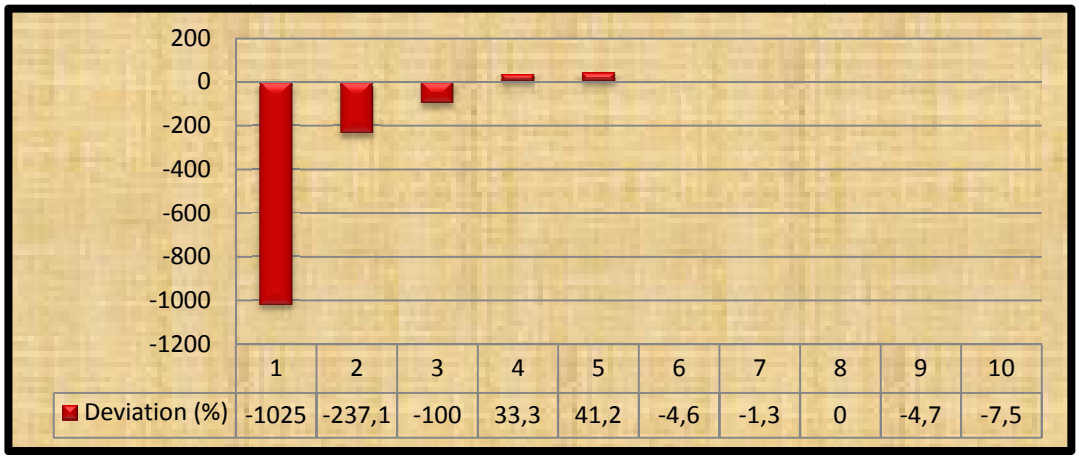

Figure 4.8: Surrogate productivity analysis bar chart against proposed target

As shown in table 4.10 and figure 4.8, except material quality rate, all other surrogate productivity indicators show poor status.

4.12.3-Process Indicator Analysis

The process indicator analysis is also done by comparing the measurement value of process indicators with the proposed targets. The targets are proposed by referring the company's international benchmarking system, improving the layout and through discussion.

Table 4.11: Process indicator analysis against proposed target

S.No.	Indicators	Target	Actual	Deviation (%)	Status
1	Capacity Utilization (%)	90	47.8	-88.3	Decreased
2	Rejection Rate (%)	0	0	-	No Change
3	Rework Rate (%)	2	8.8	77.3	Increased
4	Scrap Rate (%)	10	14	28.6	"
5	Work In Process Rate (%)	3	34.9	91.4	"
6	Standard Time (min)	22	25.5	13.7	"
7	Lead Time (min)	17.6	20.4	13.7	"
8	Waiting Time Rate (%)	1	1.8	44.4	"
9	Transfer Time Rate (%)	6.1	7.7	20.8	"
10	Downtime Rate (%)	1	2.8	64.3	"
11	Setup Time Rate (%)	2	3.5	42.9	"
12	Internal Transport (m)	700	882	20.6	"

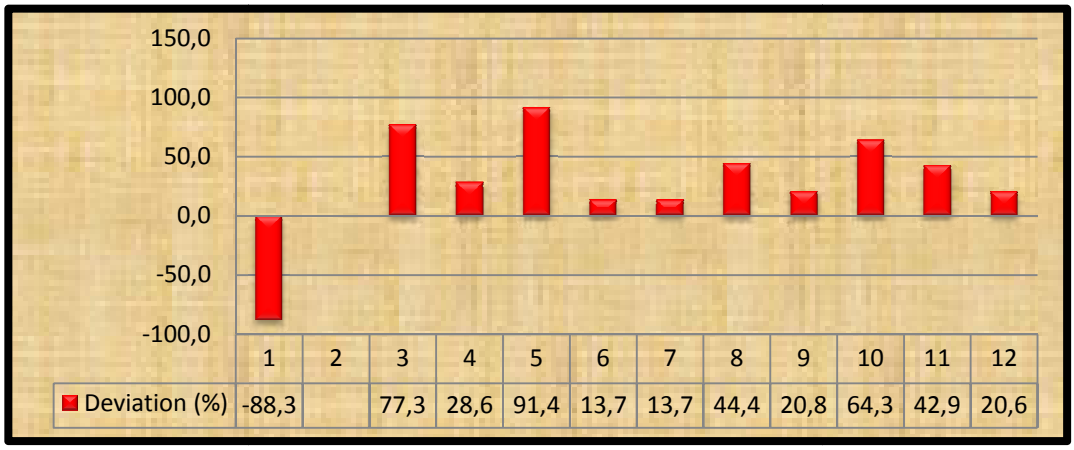

Figure 4.9: Process indicator analysis bar chart against proposed target

As shown in table 4.11 and figure 4.9, except rejection rate, all other process indicators show poor status.

4.13-Intervention Areas

As mentioned earlier, there are several productivity factors which affect productivity of the company. All these productivity factors do not have equal impact on productivity. In addition, the resources are limited to solve all the problems associated with the productivity factors. Therefore, deciding the intervention areas which are potential for productivity improvement is very important. To decide the intervention areas, the productivity factors are located in the four fields based on the effort (i.e. resource requirement) and the impact on productivity. The current status of productivity factors has been used to estimate the effort required and impact on productivity.

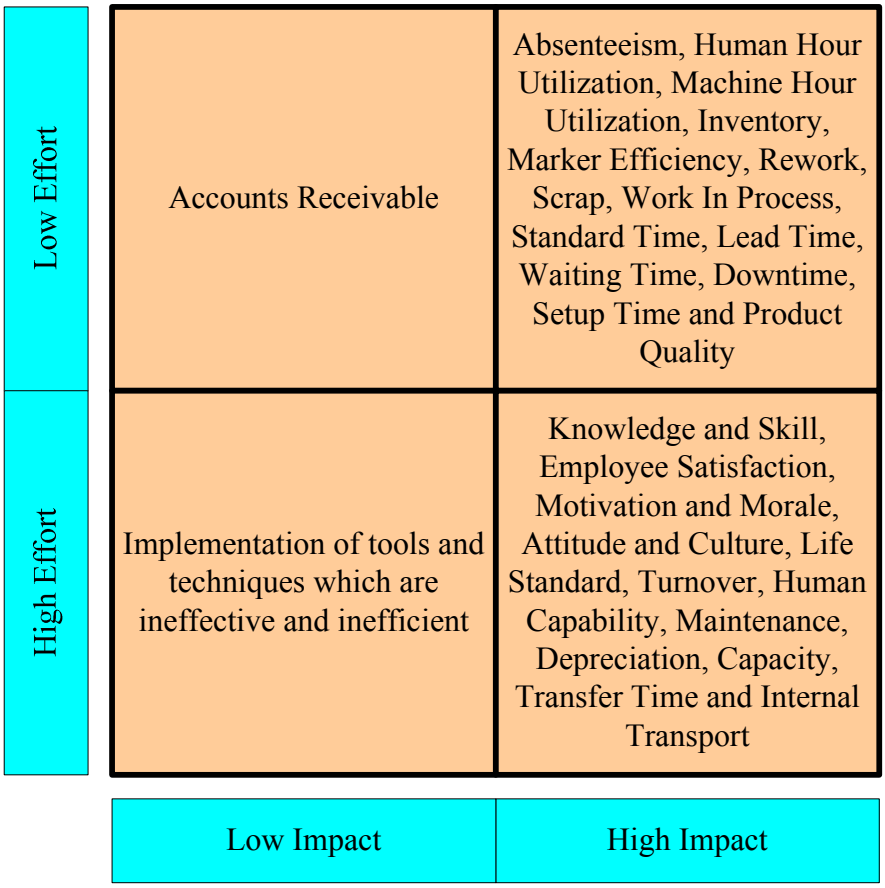

Figure 4.11: Intervention areas using four fields

As shown in 4.11, there are four fields namely, low effort-low impact, low effort-high impact, high effort-low impact and high effort-high impact. The low effort-high impact is most preferred field whereas the high effort-low impact is least preferred field. Low effort-low impact and high effort-high effort could be preferred fields.

Productivity factors in the fields low effort-low impact, low effort-high impact and large effort-large impact can be taken as intervention areas but the productivity factors within low effort-high impact field should be given first priority. Therefore, decreasing absenteeism, increasing human and machine hour utilization, managing inventory, increasing marker efficiency, minimizing rework, scrap and work in process, decreasing standard time, lead time, waiting time and setup time, and improving product quality are potential for productivity improvement at low effort.

4.14-Proposed Solution

In general, the results obtained from the assessment of EGIs and the case company show that the productivity of EGIs and the case company is low when it compared with the best practices and target value. The human productivity of EGIs is lower than the best practice by

100%. The human, capital, material, energy, miscellaneous inputs and total productivity of the case company are decreased by 0.3%, 9.7%, 6.7%, 7.8%, 2.7% and 6.3% from the target values respectively. In addition, most of the productivity indicators of the case company show poor status. The productivity factors are multidimensional ranging from human to capital to material to method to control to process to product factors. The intervention areas are related human, capital, material and process. And this requires organized and sustainable productivity improvement program to solve the problems associated with productivity. Therefore, a PIM[7] based on this requirement has been developed.

[7] The principal basis of the PIM is improvement approaches by Grunberg (2007), Attia et al. (2006) and Sumanth (1979, 1998).

Chapter Five

5-The Productivity Improvement Method

5.1-Introduction

The PIM aims to improve productivity of garment industry.

The important characteristics which make the PIM preferable are compatibility with knowledge and skill of the user (i.e. easy to use); compatibility with existing tools and techniques; addressing the possible productivity factors; being continuous improvement tool based on Deming cycle (i.e. plan-do-check-act); having clearly defined productivity targets setting, measurement and analysis framework; and flexibility to apply from operation to firm level.

The PIM needs management commitment for its implementation. The target user groups of this method are all processes of the company.

5.2-Overview of the PIM

The PIM is formulated after analyzing the following sources:

- ☞ Literature survey
- ☞ Assessment of EGIs
- ☞ Case study

The method has been divided into ten steps.

Step 1-Define Processes of the Firm: For making productivity manageable, classifying the firm into defined processes, the process in to sub-processes and the sub-process into operations is essential. It also focuses on defining the major functions, and identifying critical success factors and productivity indicators.

Step 2-Assess Productivity Factors: Identifying the productivity factors, and defining status of the productivity factors.

Step 3-Set productivity targets: Setting productivity target for productivity indicators.

Step 4-Map the process: Making the process maps of each defined process, sub-process and operation so that to have a clear picture for further actions.

Step 5-Collect and organize data: The required data for productivity measurement and analysis are collected and organized.

Step 6-Measure productivity: Measuring productivity by defining formula for the productivity indicators to know the productivity level.

Step 7-Analyze productivity: Productivity analysis is done to know whether the productivity is grown or declined, and over or under performance.

Step 8-Formulate productivity improvement plan: Performing cause and effect analysis, deciding intervention areas, and developing action plan for productivity improvement.

Step 9-Implement productivity improvement plan: Implementing the action plan by allocating reasonable amount of resources.

Step 10-Evaluate results: Evaluating the results gained in order to get feedbacks for next round.

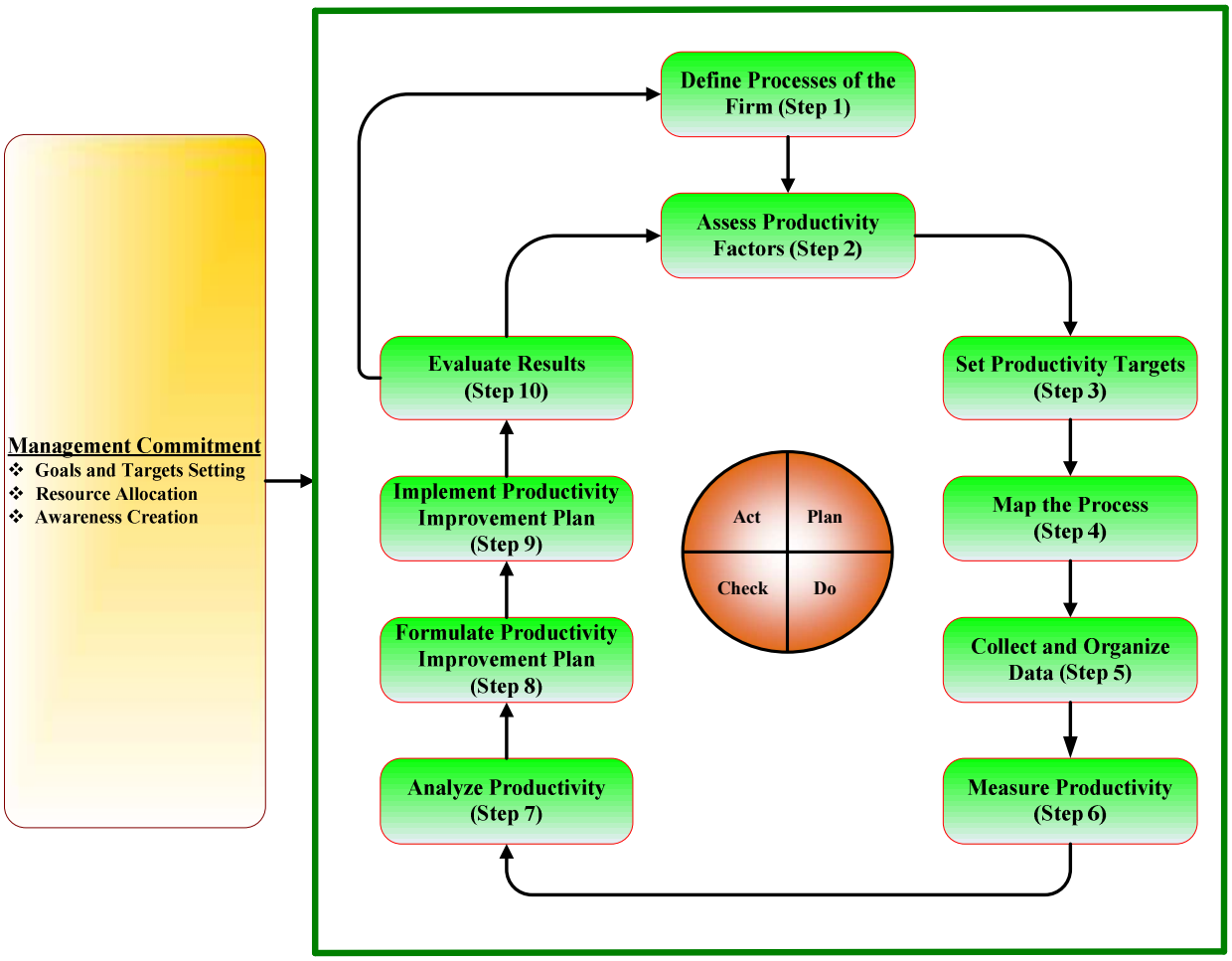

Figure 5.1: The PIM with ten steps

6.3-Detials of the PIM

Here, the ten steps are discussed in detail to give the users a comprehensive guide how to use the PIM. The details of the PIM consist of major tasks of each step, various formats and templates, and formulas for productivity measurement and analysis. The details of the PIM can be considered as user manual of the PIM.

6.3.1-Define Processes of the Firm

This is the first step of the PIM which involves four major tasks. Task 1-to classify the firm into defined processes, task 2-to define major functions of the process, task 3-to identify critical success factors of the process and task 4-to identify productivity indicators of the process. The ultimate goal of this step is to make productivity manageable.

6.3.1.1-Classify the Firm into Defined Processes

The purpose of classifying the firm into processes is to make productivity manageable. Based on the overall activities performed and organizational structure, the firm can be classified into defined processes using template 1.

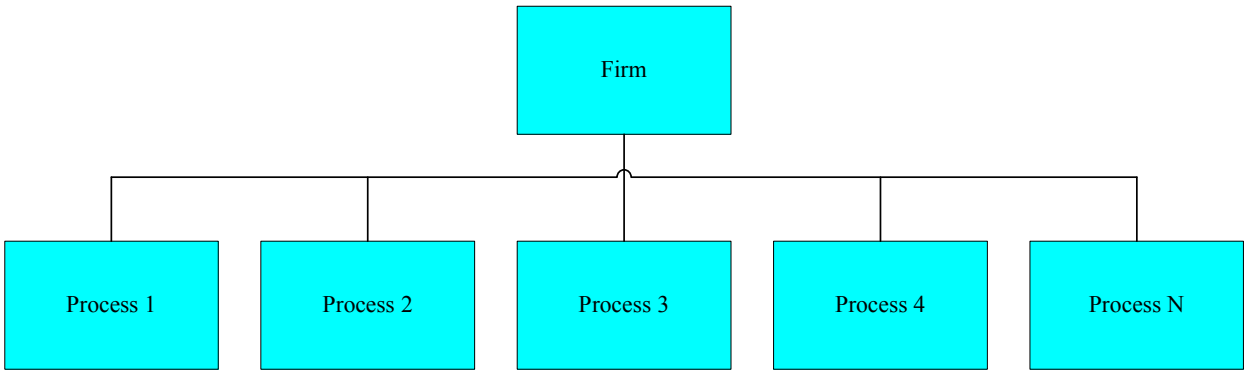

Figure 5.2: Template 1 to classify processes of the firm

Using template 1, the firm can be divided into the following processes as shown below.

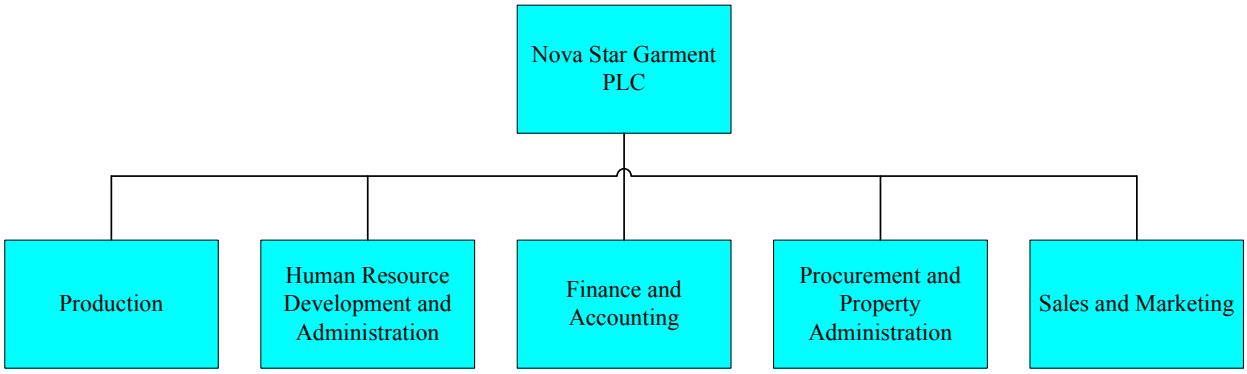

Figure 5.3: Processes of the firm using template 1

Analogously, a process can be classified into sub-processes and a sub-process into operations using template 1. Production process of Novastar Garment PLC has three sub-processes namely, cutting, sewing and finishing.

5.3.1.2-Define Major Functions of the Process

5.3.1.2.1-Production Process

The major functions of this process are production of products, production planning and control, maintenance planning and control, and quality control.

5.3.1.2.2-Human Resource Development and Administration Process

Proper utilization of employee, hiring necessary employee based on human resource planning, conducting training to upgrade skills of employee, preparing job description for individual employees, giving clinical, transportation and office services, creating conducive working areas, follow up the proper implementation of human resource management policies, procedures and manuals, and performance appraisal of each department and individual employees are the major functions of this process.

5.3.1.2.3-Finance and Accounting Process

The major functions of this process are proper utilization of finance, preparing interims and yearly financial statements, collecting and paying accounts, follow up the proper implementation of financial as well as cost and budget manuals, and controlling the bank reconciliation activities.

5.3.1.2.4-Procurement and Property Administration Process

Procuring and supplying of materials, organizing and controlling the materials movement and the materials handling, purchasing the right materials from right place at the right time, right price and right quality, establishing maximum and minimum stock level, and identifying the fast and slow moving items are the major functions of this process.

5.3.1.2.5-Sales and Marketing Process

The major functions this process are conducting different market research, increase sales volume, expanding marketing segment, promoting the sales activities, receiving sales orders from customers, following up the orders, and delivering the products at right quantity, quality and time.

In addition to the above functions of the processes, the sub-processes and operations can have their own functions.

5.3.1.2.6-Relationship among Processes

To perform overall activities of the firm the above processes should be integrated. When the productivity of production process increases, the other processes can function well. When human resource development and administration process hires relevant employees, gives adequate training and establish accident minimization program, productivity of the processes can be increased. When finance and accounting process allocates adequate cash and budget by controlling the finance, the productivity of the processes can be increased. By purchasing the right material from right source at right quantity, quality, time and price and implementing inventory control system, using procurement and property administration process can increase the productivity of the process. The sales and marketing process which is responsible for conducting market research and selling the right product at right quantity, time and price, the productivity of the processes can be increased.

From the above it is concluded that the relationship among processes is directly proportional. In other words when one process possesses weak performance, it will retard the performance of other processes; and vice versa. The relationship is presented by the following diagram.

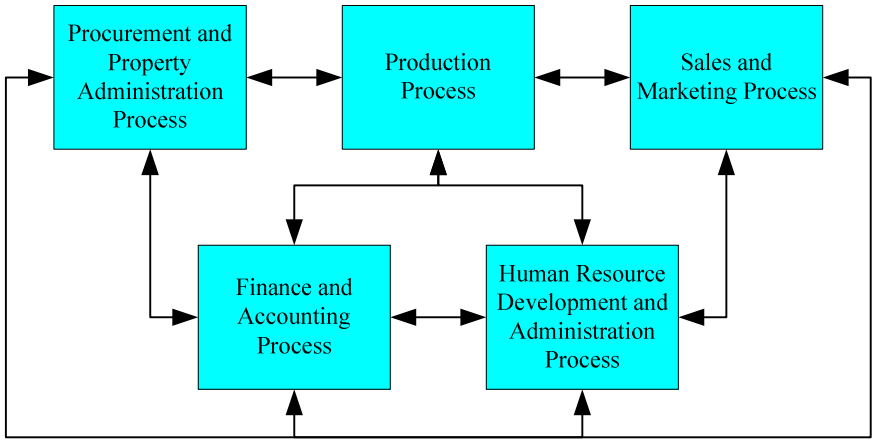

Figure 5.4: Relationship diagram among processes

In current business environment firms are customer driven (i.e. customers take the upper hand). In the firm more values to the customer are added by production process. And hence this thesis focuses on one of the defined processes (i.e. production process).

5.3.1.3-Identify Critical Success Factors of the Process

The critical success factors of production process can be productivity, production efficiency, production volume, employee satisfaction, quality and lead time. The critical success factors can be done using the format in annex 8.1.

5.3.1.4-Identify Productivity Indicators of the Process

Productivity indicators can be identified at firm, process, sub-process or operation level. The productivity indicators can be partial, total and surrogate.

5.3.1.4.1-Partial and Total Productivity Indicators

Partial productivity indicators are the measure of partial inputs and they are directly measured as ratio of output to input. Each processes of the firm utilize five partial inputs to deliver outputs. The inputs are human, capital, material, energy and miscellaneous input which are tangible. Finished product and partial (semi-finished) products produced for sale and internal use are tangible outputs of the production process. Other processes of the firm deliver services which considered as intangible outputs.

The partial and total productivity indicators for period t are human productivity (HP_t), capital productivity (CP_t), material productivity (MP_t), energy productivity (EP_t), miscellaneous inputs productivity (XP_t) and total productivity (TP_t).

5.3.1.4.2-Relationship between Partial and Total Productivity Indicators

Partial inputs affect the total productivity. In other words the total productivity depends on the partial productivity. Total productivity can be found as weighted value of one of the partial productivity indicators. Mathematically, $TPF_t = W_H*HP_t = W_C*CP_t = W_M*MP_t = W_E*EP_t = W_X*XP_t$

5.3.1.4.3-Surrogate Productivity Indicators

Surrogate productivity indicators are the measure of surrogate factors and they are not measured directly as ratio of output to input. Focusing on the production process, the surrogate productivity indicators considered are Employee Satisfaction Rate (ES_t), Motivation Rate (M_t), Skill Level Rate (SL_t), Absenteeism Rate (A_t), Turnover Rate (T_t), Human Hour Utilization (HHU_t), Speed Loss Rate (SL_t), Machine Hour Utilization (MHU_t), Quality of Material Rate (QM_t), Marker Efficiency (ME_t) and Quality of Product Rate (QP_t).

5.3.1.4.4-Relationship between Partial and Surrogate Productivity Indicators

The productivity of each partial input depends on two or more surrogate factors. Hence partial productivity measures are dependent variable; and surrogate productivity measures are independent variable.

For example human productivity (HP) can be affected by employee satisfaction, motivation, absenteeism, skill level, turnover and human hour utilization ; capital productivity (CP) by speed loss (SL) and machine hour utilization; and material productivity (MP) by quality of material and marker efficiency.

The productivity indicators of the process can be identified using template 2:

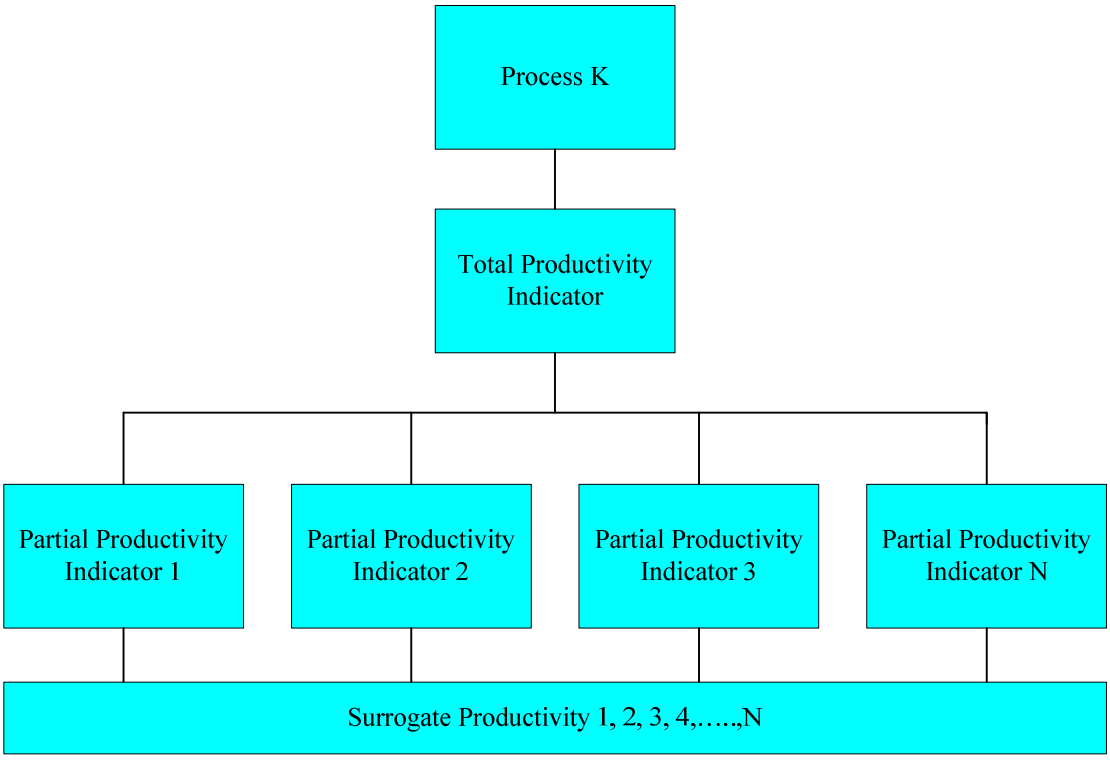

Figure 5.5: Template 1 to identify productivity indicators

5.3.2-Assess Productivity Factors

This step of the PIM which involves two major tasks, namely task 1-to identify the productivity factors and task 2-to define the status of productivity factors. This step is used to find the productivity improvement potentials.

5.3.2.1-Identify the Productivity Factors

This major task focuses on identifying and categorizing the productivity factors with their explanation and measurement. This task can be done using the format in annex 8.2.

5.3.2.2-Define the Status of Productivity Factors

Here the status of each productivity factors is defined by using colors. And comments are given to each productivity factors status. Knowing the status of productivity status is important whether there are problems associated with the factor or not.

Table 5.1: Colors for defining status of productivity factors

	If there are no problems associated with the factor
	If there are problems associated with the factor
	Not Applicable

The format in annex 8.3 can be used for defining the status of productivity factors.

5.3.3-Set Productivity Targets

In order to analyze and improve productivity, first setting productivity targets is very crucial. Productivity target setting can be done at firm, process, sub-process or operation level. The major task of this step is productivity target setting.

Productivity targets can be done by trend analysis and by using forecasting techniques for each productivity measures.

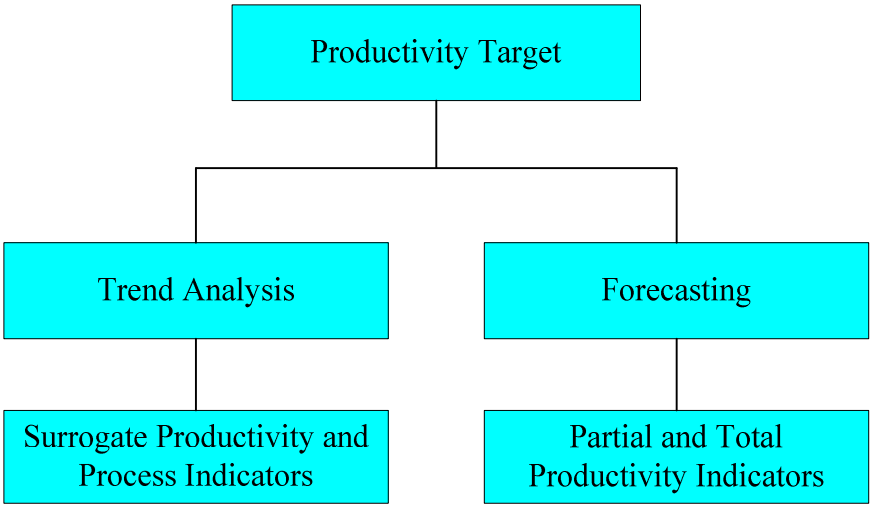

Figure 5.6: Productivity targets setting framework

5.3.3.1-Trend Analysis

Here productivity targets are based on historical data. The targets can be set by experts and management. This technique can be used to set targets for surrogate productivity and process indicators.

5.3.3.2-Forcasting

Productivity targets can be also set by using forecasting techniques especially exponential smoothing. This technique is used to found the forecasted values of partial and total productivity. The forecasted value of productivity for period t is given as follows.

$P'_{t+1} = \alpha P_t + (1-\alpha)P'_t$

$\alpha = [2/(m+1)]$

Where: P'_{t+1} is the forecasted value of productivity for next period; P_t is actual current period productivity; P'_t is the current period forecasted value of productivity; α is smoothing constant lies between 0 and 1; and m is number of periods.

The target values of partial, total, surrogate productivity and process indicators can be summarized by the format in annex 8.4.

5.1.4-Map the Process

Process mapping is useful tool to visualize and understand how processes, sub-processes or operations are organized to deliver products and services. It assists to indentify inputs and outputs of each process, sub-process or operation, and non-value activities performed in the processes, sub-processes or operations. Process mapping of a process, sub-process or operation can be done using template 2.

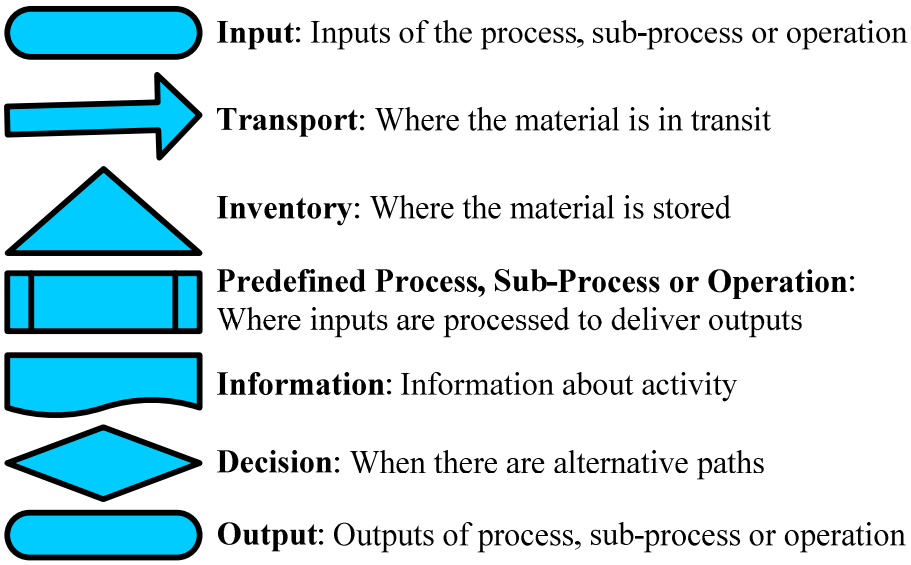

Figure 5.7: Template 2 for process mapping

5.1.5-Collect and Organize Data

In order to measure productivity the required data should be collected and organized. The major task of this step is to collect and organize data of productivity indicators by using different formats from annex 8.5 to 8.25.

5.3.6-Measure Productivity

The major task of this step is to measuring productivity in order to know the productivity level for productivity analysis and improvement. Productivity measurement is done for

partial, total, surrogate productivity and process indicators at firm, process, sub-process or operation level.

5.3.5.1-Partial Productivity Measurement

The partial productivity of this process for period t is given below.

5.3.5.1.1-Human Productivity

Human productivity can be measured monetary and physically for general and specific case respectively.

General monetary measurement of human productivity,

Human Productivity (HP_t) = Value of Outputs/Value of Human Inputs

Specific physical measurement of human productivity,

Human Productivity (HP_t) = Volume of Outputs/Volume of Human Inputs

Human Productivity (HP_t) = Volume of Outputs/Human Hour of Human Inputs

Where: Human inputs involve operators, supporting staffs, checkers, experts and managers. Supporting staffs involve co-operators, material handlers, clerks, maintenance crews and the like.

5.3.6.1.2-Capital Productivity

Capital productivity can be also measured monetary and physically for general and specific case respectively.

General monetary measurement of capital productivity,

Capital Productivity (CP_t) = Value of Outputs/Value of Capital Inputs

Specific physical measurement of capital productivity,

Capital Productivity (CP_t) = Volume of Outputs/Volume of Machine Inputs

Capital Productivity (CP_t) = Volume of Outputs/Machine-Hour of Machine Inputs

Where: Capital inputs involves both working and fixed capital. Fixed capital involves land, buildings, machines, tools, equipment, amortized costs and the like. And working capital involves inventory, cash, accounts receivable, note receivable and the like.

5.3.6.1.3-Material Productivity

Material productivity can be also measured monetary and physically for general and specific case respectively.

General monetary measurement of material productivity,

Material Productivity (MP_t) = Value of Outputs/Value of Material Inputs

Specific physical measurement of material productivity,

Material Productivity (MP_t) = Volume of Outputs/Volume of Material Inputs

Where: Material inputs involve raw materials (fabrics) and purchased parts (accessories). Purchased parts (accessories) involve threads, buttons, elastics, zippers, labels, tags, packing materials and the like.

5.3.6.1.4-Energy Productivity

Energy productivity can be also measured monetary and physically for general and specific case respectively.

General monetary measurement of energy productivity,

Energy Productivity (EP_t) = Value of Outputs/Value of Energy Inputs

Specific physical measurement of material productivity,

Energy Productivity (EP_t) = Volume of Outputs/Volume of Energy Inputs

Where: Energy inputs involve electricity, water, fuel and the like.

5.3.6.1.5-Miscellaneous Inputs Productivity

Miscellaneous inputs productivity can be generally measured monetary.

Miscellaneous Inputs Productivity (XP_t) = Value of Outputs/Value of Miscellaneous Inputs

Where: Miscellaneous inputs of garment production process involves travel, tax, marketing, product development, office supplies, information, consultants, general administration and the like for base period t.

5.3.6.2-Total Productivity Measurement

Total productivity the firm can be measured using two approaches: as function of total output to total inputs and as a function of partial productivity.

5.3.6.2.1-Total Productivity as a Function of Total Outputs to Total Inputs

Total productivity for period t as a function of its total outputs and total inputs is given by:

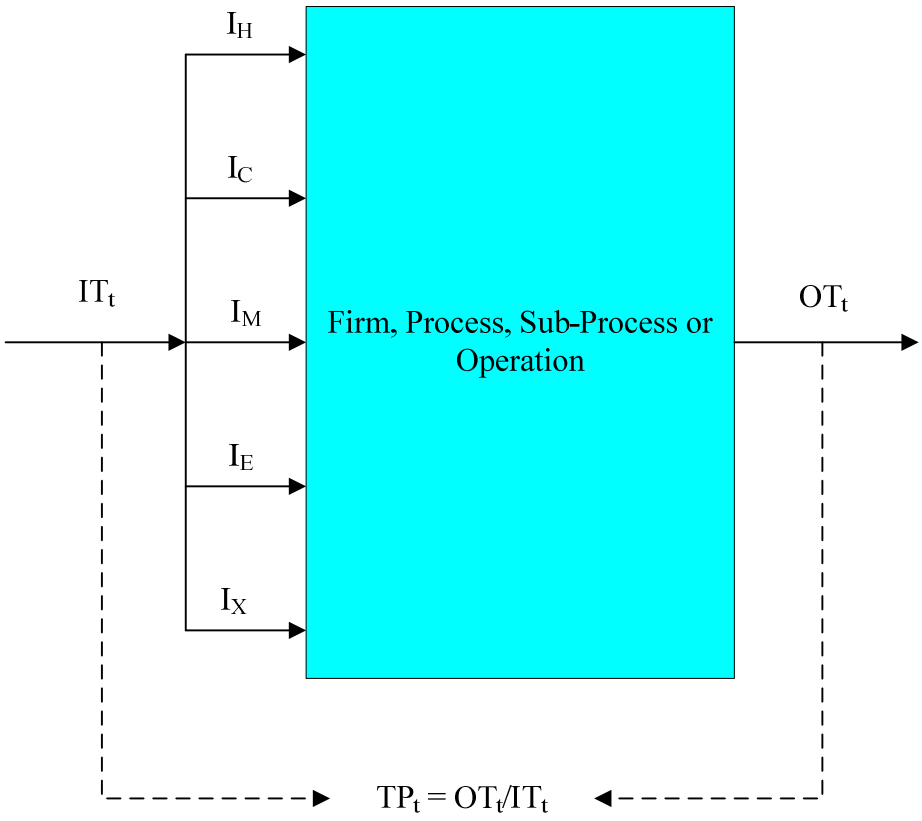

Figure 5.8: Total productivity measurement framework as a function of total outputs to total inputs

TP_t = Total outputs/Total inputs

TP_t = (Value of Outputs)/(Value of I_H + Value of I_C + Value of I_M + Value of I_E+ Value of I_X)

Where: OT_t and IT_t are value of total outputs and total inputs for period t respectively; I_H, I_C, I_M, I_E and I_X are value of human input, capital input, material input, energy input and miscellaneous input for period t respectively; and TP_t is total productivity for period t.

5.3.6.2.2-Total Productivity as a Function of Partial Productivity

The total productivity for period t as function of partial productivity is given as follows:

$$TP_t = W_j PP_{jt}$$

W_j = Value of Partial Inputs j/Value of Total Inputs

$W_j = I_{jt}/IT_t$

Where: IT_t is total inputs for period t; I_{jt} is value of partial inputs for period t; PP_{jt} is partial productivity for period t; TP_t is total productivity period t; and W_j depicts the weight corresponding to partial inputs.

5.3.6.3-Surrogate Productivity Measurement

Here the measurement of the following surrogate productivity indicators is made indirectly.

5.3.6.3.1-Employee Satisfaction Rate

For period t, the employee satisfaction rate (ES_t) is given by:

ES_t = Number of Satisfied Employees/Total Employees

The target to improve labor productivity is to increase ES_t.

5.3.6.3.2-Motivation Rate

For period t, the employee satisfaction rate (M_t) is given by:

ES_t = Number of Motivated Employees/Total Employees

The target to improve productivity is to increase M_t.

5.3.6.3.3-Skill Level Rate

For period t, the high skill rate (HS_t), medium skill rate (MS_t) and low skill rate (LS_t) are given by:

MS_t = Number of High Skill Employees/Total Employees

MS_t = Number of Medium Skill Employees/Total Employees

LS_t = Number of Low Skill Employees/Total Employees

The target to improve productivity is to increase HS_t, and decrease MS_t and LS_t.

5.3.6.3.4-Absenteeism Rate

The absenteeism rate for period t (A_t) is given by:

A_t = Absenteeism/Total Human-hours

The target to improve labor productivity is to decrease A_t.

5.3.6.3.5-Turnover Rate

The turnover rate for period t (T_t) is given by:

T_t = Turnovers/Total Number of Employees

The target to improve productivity is to decrease T_t.

5.3.6.3.6-Human Hour Utilization

The human hour utilization for period t (HHU_t) is given by:

HHU_t = Utilized Human Hour/Total Human Hour

The target to improve productivity is to increase HHU_t.

5.3.6.3.7-Machine Hour Utilization

The Machine hour utilization for period t (MHU_t) is given by:

HHU_t = Utilized Machine Hour/Total Machine Hour

The target to improve productivity is to increase MHU_t.

5.3.6.3.8-Speed Loss Rate:

The speed loss rate for period t (SL_t) is given by:

SL_t = (Current Production Rate – Previous Production Rate)/Current Production Rate

The target to improve productivity is to decrease SL_t.

Where: Production Rate = Total Amount of Products/Production Time

5.3.6.3.9-Material Quality Rate

The material quality rate for period t (QM_t) is given by:

QM_t = Total Fabrics Pass without Reject/Total Inspected Fabrics

The target to improve productivity is to increase QM_t.

5.3.6.3.10-Marker Efficiency

The marker efficiency for period t (ME_t) is given by:

ME_t = Area of Pattern in the Marker Plan/Total Area of the Marker Plan

The target to improve productivity is to increase ME_t.

5.3.6.3.11-Product Quality Rate:

The product quality rate for period t (QP_t) is given by:

QP_t = Total Fabrics Pass without Reject/Total Inspected Products

The target to improve productivity is to increase QP_t.

5.3.6.4-Process Indicator Measurement

In order to know the level of process indicators, process indicator measurement is done for the following process indicators.

5.3.6.4.1-Capacity Utilization

The capacity utilization for period t (CU_t) is given by:

CU_t = Attained Capacity/Attainable Capacity

The target to improve productivity is to increase CU_t.

5.3.6.4.2-Rejection Rate

The rejection rate for period t (Rj_t) is given by:

Rj_t = Total Rejects/Total Inspected Products

The target to improve productivity is to decrease Rj_t.

5.3.6.4.3-Rework Rate

The rework rate for period t (Rw_t) is given by:

Rw_t = Total Reworks/Total Inspected Products

The target to improve productivity is to decrease Rw_t.

5.3.6.4.4-Scrap Rate

The scrap rate for period t (Sc_t) is given by:

Sc_t = Total Scraps/Total Consumed Fabrics

The target to improve productivity is to decrease Sc_t.

5.3.6.4.5-Work In Process Rate

The work in process rate for period t (WIP_t) is given by:

WIP_t = Number of Work In Process/Total Number of Inputs

The target to improve productivity is to decrease WIT_t.

5.3.6.4.6-Standard Time

The standard time for period t (K_t) is given by:

K_t = [Normal Time + Allowance]

Where: Normal Time = Average Value of Observed Time.

5.3.6.4.7-Lead Time

For period t, the lead time (L_t) is given by:

L_t is the sum of all times elapsed between placing and receiving the order.

The target to improve productivity is to decrease L_t.

5.3.6.4.8-Waiting Time Rate

For period t, the waiting time rate (W_t) is given by:

W_t = Total Waiting Time/Total Human Hour

The target to improve productivity is to decrease W_t.

5.3.6.4.9-Transfer Time Rate

For period t, the transfer time rate (Tr_t) is given by:

Tr_t = Total Transfer Time/Total Material Handlers Hour

The target to improve productivity is to decrease Tr_t.

5.3.6.4.10-Downtime Rate

For period t, the waiting time rate (D_t) is given by:

D_t = Total Downtime/Total Machine Hour

The target to improve productivity is to decrease D_t.

5.3.6.4.11-Setup Time Rate

Setup time affects productivity of production process. For period t, the setup time rate (Su_t) is given by:

Su_t = Total Setup Time/Total Human Hour

The target to improve productivity is to decrease Su_t.

5.3.6.4.12-Internal Transport

Internal transport affects the productivity of production process. The internal for period t (IT_t) is given by the sum of all distances covered by the flow of material from input destination to output destination.

The target to improve productivity is to decrease IT_t.

After measuring productivity, the values can be summarized by the format in annex 8.26.

5.3.6-Analyze Productivity

The major function of this step is to evaluate and interpret productivity. The productivity analysis can be done by comparing the current productivity with previous productivity, the productivity targets and best practices. It is shown below.

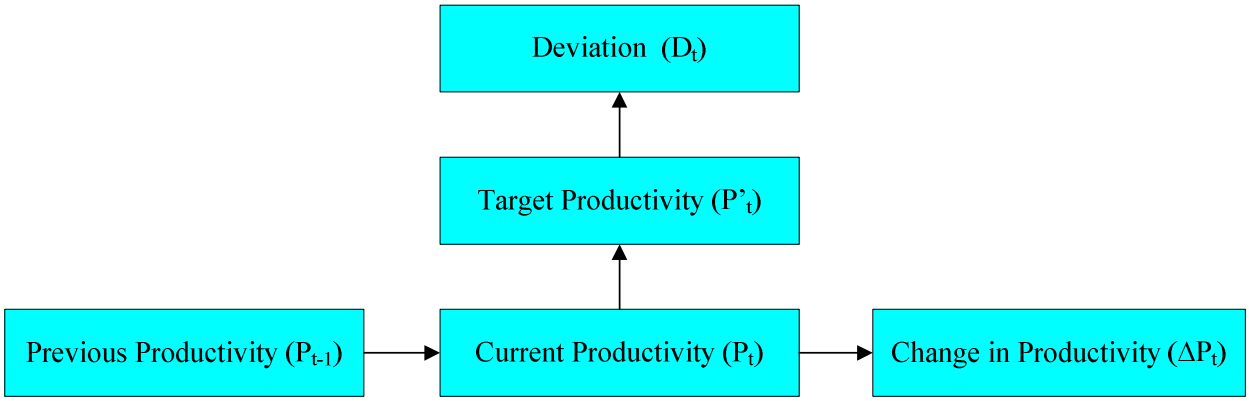

Figure 5.9: Productivity analysis framework

From the above framework, change in productivity and deviation are used to evaluate and interpret the productivity for period t. They are given as follows.

5.3.6.1-Change In Productivity

Change In Productivity (ΔP_t) = Current Productivity (P_t) – Previous Productivity (P_{t-1})

ΔP_t indicates productivity growth, no productivity change or productivity decline. To know by how much percent the productivity is grown or declined, the following formula is used.

$[\Delta P_t/P_t]*100$

5.3.6.2-Deviation

Deviation (D_t) = Current Productivity (P_t) – Target Productivity (P'_t)

D_t tells that whether there is over target productivity performance, exact target productivity performance or under target productivity performance. To know by how much percent the productivity is over or under target, the following formula is used.

$[D_t/P_t]*100$

The result of productivity analysis can be summarized by the format in annex 8.27.

5.3.8-Formulate Productivity Improvement Plan

To improve productivity by achieving the goals and targets, productivity improvement plan should be formulated. The major tasks of this step are task 1-cause and effect analysis, task 2-to decide intervention areas and task 3-to develop action plan.

5.3.8.1-Cause and Effect Analysis

After finding the difference between current productivity and previous productivity, current productivity and target productivity and current productivity with best practice, the causes for the deference is identified. The cause and effect analysis can be done using template 4.

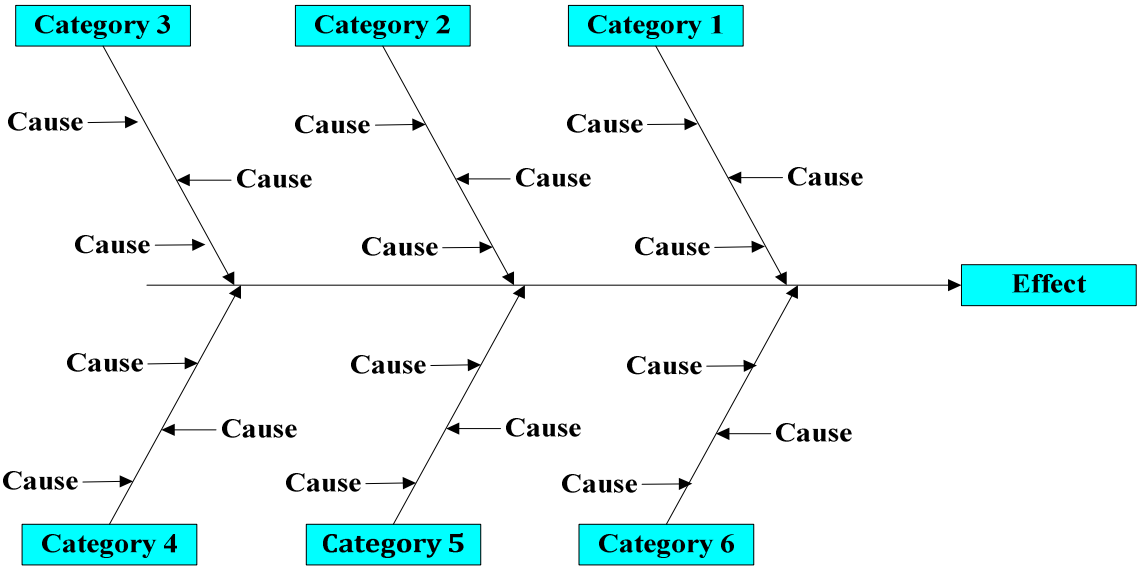

Figure 5.10: Template 4 for cause and effect analysis

5.3.8.2-Decide the Intervention Areas

After identifying the causes using cause and effect analysis, they should be organized and prioritized based on their significance and contribution to productivity improvement. Four fields and Pareto analysis are two management tools for this purpose. Template 5 and template 6 below are used for four fields and Pareto analysis respectively.

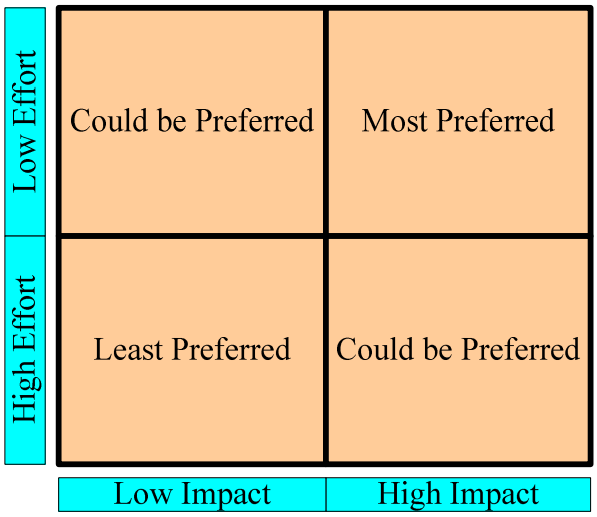

Figure 5.11: Template 5 for four fields

In four fields a factor is evaluated by its impact and the effort required for solving the problems.

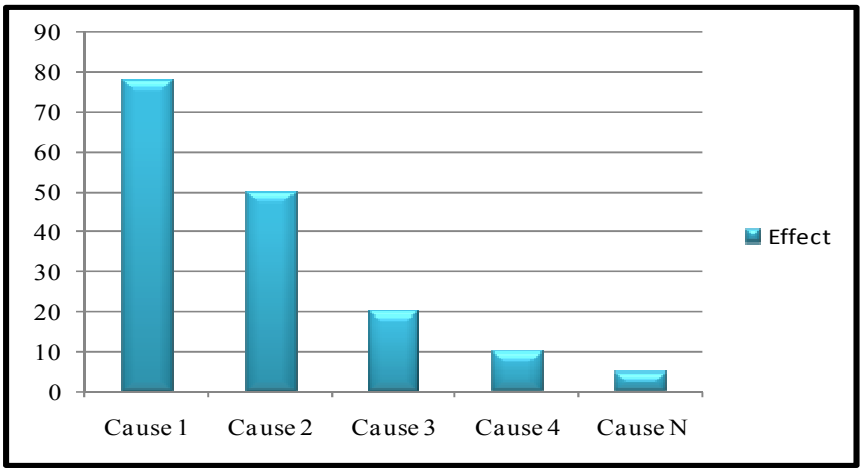

Figure 5.12: Template 6 for four field method

In Pareto analysis different factors effect on productivity is evaluated then the vital few factors are selected from the trivial many factors.

5.3.8.3-Develop Action Plan

After deciding the intervention areas, action plan is developed to take preventive and corrective actions.

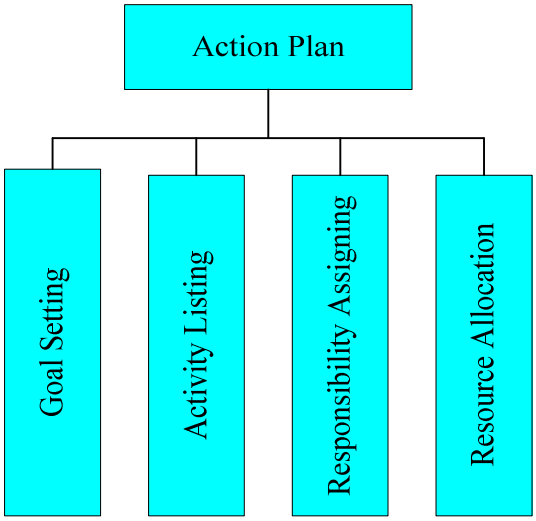

Figure 5.13: Action plan framework

The action plan should be developed by setting goals, clear objective, defining activities, assigning responsibility, allocation reasonable amount of resources (finance, people, material and time). The format in annex 8.28 can be used for developing the action plan.

5.3.9-Implement Productivity Improvement Plan

Once the productivity improvement plan has been formulated, top management should be committed to it and should implement it in practice. Continuous support from top management in setting goals and targets, allocating resources and creating awareness is essential to the success of its implementation. Effective implementation requires a sound understanding of the underlying principles and ideas of the productivity improvement plan. In order to ensure success of implementation, it is critical to educate and train relevant employees involved. In addition, reasonable amount of resources should be provided for implementing the plan. Note that the productivity improvement plan is nothing if it cannot be implemented by the company.

5.3.10-Evaluate Results

This is the final step of one full cycle of the PIM. By evaluating the results gained from the PIM, it is possible to learn and prepare for further improvement in the next round. To evaluate the results, the format in annex 8.29 can be used.

5.4-Benefits of the PIM

The PIM is used to define the processes, sub-processes and operations to make productivity manageable, identify critical success factors, productivity indicators, productivity factors and intervention areas, and for productivity target setting, measurement and analysis. The PIM can improve partial and total productivity by enhancing effective utilization resources like human, capital, material, energy and miscellaneous inputs; improve quality by minimizing rates of rejection, rework and scrap; increase capacity by increasing human hour utilization and machine hour utilization; increase both internal and external customer satisfaction; and reduce cost by minimizing waste of resources. For academicians and researchers, the PIM can be used as guideline how to develop a method that supports productivity improvement of manufacturing company.

Chapter Six

6-Conclusion and Recommendation

6.1-Conclusion

Based on the data analysis and presentation, the following concluding remarks have been made.

- ☞ In today's global market, success and survival of manufacturing firms demands on competitiveness. Productivity is one of the major determinants that enable manufacturing firms to compete in the global market. So, improving productivity can be taken as critical task of a manufacturing firm.

- ☞ Garment is one of the basic needs of mankind. Garment industry in today's modern market place is a truly global industry. Therefore, EGIs and the case company face high competition within this global industry.

- ☞ The results obtained from the assessment of EGIs and the case company show that the EGIs and the case company possess low productivity. This low productivity makes them to face challenges in the global competition.

- ☞ The human productivity of EGIs is lower than the best practice by 100%. The human, capital, material, energy, miscellaneous inputs and total productivity of the case company are decreased by 0.3%, 9.7%, 6.7%, 7.8%, 2.7% and 6.3% from the target values respectively. In addition, most of the productivity indicators of the case company show poor status.

- ☞ The productivity factors are multidimensional ranges from human to capital to material to method to control to process to product factors. But all these factors do not have equal effect on productivity. And the resources are limited to solve all the problems associated with the productivity factors. Therefore, deciding the intervention areas which are potential for productivity improvement is very important.

- ☞ Decreasing absenteeism, increasing human and machine hour utilization, managing inventory, increasing marker efficiency, minimizing rework, scrap and work in process,

decreasing standard time, lead time, waiting time and setup time, and improving product quality are potentials for productivity improvement of the case company at low effort.

- ☞ Currently EGIs and the case company uses disorganized and reactive problem solving approach. Lack of understanding where to start productivity improvement, lack of identifying critical success factors, lack of addressing the possible productivity factors, lack of defining, measuring and analyzing productivity indicators (except human productivity), and lack of identifying the intervention areas for productivity improvement are the main reasons for not applying organized and sustainable productivity improvement.

- ☞ The PIM developed can be considered as organized and sustainable productivity improvement program since it has clear defined user manual that states where to start productivity improvement, how to identify critical success factors, how to address the possible productivity factors, how to define, measure and analyze productivity indicators, and how to identify the intervention areas for productivity improvement.

- ☞ Compatibility with the knowledge and skill of the user (i.e. easy to use), compatibility with the existing tools and techniques, addressing the possible productivity factors, being continuous improvement tools, having clearly defined productivity targets setting, measurement and analysis framework, and flexibility to apply from operation level to firm level are the important characteristics of the PIM which make it preferable to apply.

- ☞ Implementing the PIM can improve partial and total productivity by enhancing effective utilization resources like human, capital, material, energy and miscellaneous inputs; it can improve quality by minimizing rates of rejection, rework and scrap; it can increase capacity by increasing human hour utilization and machine hour utilization; it can also increase both internal and external customer satisfaction; and it can reduce cost by minimizing waste of resources.

6.2-Recommendation

From the results of study, the following points have been recommended.

- ☞ Productivity is one of the major determinants of competitiveness. Therefore, EGIs and the case company should manage their productivity in organized and sustainable way so that to compete in the market place.

- ☞ Currently EGIs and the case company apply single partial productivity indicator (i.e. human productivity) only. This overemphasizing one input factor to the extent that the effect of the other input factors has been underestimated or even ignored, leading to incorrect judgments and costly mistakes. Hence this may misdirect productivity improvement efforts. Therefore, EGIs, in addition to human productivity, should focus on capital productivity, material productivity, energy productivity, miscellaneous productivity, total productivity, surrogate productivity and process indicators.

- ☞ It is recommended that EGIs and the case company will be beneficiary if they use the newly developed PIM. Because the PIM is organized and sustainable productivity improvement program developed to improve productivity from operation to firm level.

- ☞ Productivity improvement through the PIM should be considered as normal task of every employee within the company. For better coordination of the PIM, EGIs and the case company should formulate a standing productivity committee. The proposed members of this committee are general manager as chair of person, representatives from each major process as member, and industrial engineer as member and secretary. The committee should facilitate the implementation of the PIM, evaluate the results and report to management.

- ☞ Management of EGIs and the case company should be committed in setting goals and targets, awareness creation and allocation of reasonable resource to implement the PIM.

- ☞ By involving government, stakeholders, academicians and researchers, EGIs and the case company should struggle to mitigate external (national level) factors that affect their productivity.

- ☞ Currently EGIs and the case company uses disorganized and reactive problem solving approach even though there are multidimensional productivity factors needing organized and sustainable productivity improvement program. So, the case company is strongly advised to use the PIM by involving all its employees.

- ☞ It is better for the case company to give priority on decreasing absenteeism, increasing human and machine hour utilization, managing inventory, increasing marker efficiency, minimizing rework, scrap and work in process, decreasing standard time, lead time, waiting time and setup time, and improving product quality for its productivity improvement at low effort.

- ☞ The case company is advised to implement the improved layout (refer annex 7) to decrease distance traveled and time taken by 50m/trip and 2m/trip respectively. And to improve working condition.

- ☞ Currently the case company does not have research and development process, so it is recommended to have this process for the design and development of different types of garment styles by identifying customers' needs and requirements, and for introducing new tools and techniques.

6.3-Future Research Work

Manufacturing and service organizations are basic economic elements of a nation. Therefore, developing a generic method that supports productivity improvement of both manufacturing and service giving industries of Ethiopia is the research area that should be considered in the future.

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Annexes

Annex 1-Survey Questionnaire

School of Graduate Studies

Addis Ababa Institute of Technology

Department of Mechanical Engineering

Industrial Engineering Graduate Program

Thesis Title: "*Design of Productivity Improvement Method for Ethiopian Garment Industries*"

Survey Questionnaire for Ethiopian Garment Industries

By: Azemeraw Tadesse, Mobile: +251910536237, Email: azemeraw.tadesse@yahoo.com

Objective of the Survey Questionnaire:

The general objective of this survey questionnaire is to assess existing productivity measurement and improvement practices of Ethiopian garment industries and the factors that affect their productivity.

Acknowledgement to the Respondent:

Hereby, I would like to express my gratitude for your dedicated cooperation. Had it not been your genuine cooperation of filling this questionnaire, it would have not been to conduct this thesis.

This questionnaire is conducted for the purpose of M.Sc. thesis. Therefore, I assure you that the information obtained from this questionnaire will be kept confidential and will not be transferred to other parties for any other purpose. For other questions pertaining to this survey questionnaire, please contact the thesis advisors.

Advisor:

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Terminologies:

*"**Productivity** is effective and efficient utilization of resources used to produce products/services that meet customer requirements continuously by applying appropriate methods and by controlling the parameters." (Azemeraw Tadesse)*

*"**Partial productivity** is the ration of output to one class of input. For example labor productivity (the ratio of output to labor input) is a partial measure. Similarly, machine productivity (the ratio of output to machine input); material productivity (the ratio of output to material input); energy productivity (the ratio of output to energy input); and miscellaneous productivity (the ratio of output to energy input) are examples of partial productivity.*

*"**Multifactor productivity** is ratio of output to a bundle of inputs. For example the ratio of output to labor and machine input; the ratio of output to labor and material input; the ratio of output to machine and material input; the ratio of output to labor, machine and material input; and the like."*

*"**Total productivity** is the ratio of total output to the sum of all input factors. Thus a total productivity measure reflects the joint impact of all inputs in producing the output. It is a kind of a higher level of productivity assessment combining several or many partial productivity measures."*

*"**Surrogate productivity** is used to measure productivity indirectly. It considers surrogate factors like customer satisfaction (both internal and external customer), skill level, education level, absenteeism, turnover, speed loss, standard time, downtime, waiting time, lead time, transfer time, work in process (WIP), rejection level, rework level, scrap level, internal transport and the like."*

"***Human inputs** involve operators, supporting staffs, checkers, experts and managers. Supporting staffs involve co-operators, material handlers, clerks, maintenance crews and the like."*

"***Capital inputs** involve fixed capital and working capital. Fixed capital involves land, buildings, machines, tools, equipment, amortized costs and the like. And working capital involves inventory, cash, accounts receivable, note receivable and the like.*"

"***Material inputs** involve raw materials and purchased parts. Purchased parts involve threads, buttons, elastic, zippers, packing materials and the like."*

"***Energy inputs** involve electricity, water, fuel and the like.*"

"***Miscellaneous inputs** involve travel, tax, marketing, product development, office supplies, information, consultants, administration and the like.*"

"***Outputs** of garment manufacturing industry involve finished and partial (semi-finished products produced for sale and internal use.*"

I-Respondent Information:

1-Position:_____

2-Qualification:_____

3-Work experience in this company:_____

II-Company Information:

4-Company name:_____

5-Year of establishment:_____ G.C.

6-Market segment: Local ☐ Export ☐ Local and Export ☐

7-Number of total employees: Permanent:_____, Temporary:_____

8-Average working days per year:_____

9-Average working days per month:_____

10-Average working days per week:_____

11-Number of working shifts per day:_____

12-Number of working hours per shift:_____

III-Assessment of Existing Productivity Management Practices of Ethiopian Garment Manufacturing Industries:

13-Does the company establish its clear vision for its productivity? Yes ☐ No ☐

14-Does the company set its goals and its targets for its productivity? Yes ☐ No ☐

15-Does the company measure and evaluate its productivity regularly? Yes ☐ No ☐

16-Does the company identify problems of its productivity improvement? Yes ☐ No ☐

17-Please indicate the productivity awareness status of the following workforces? Use the symbol (**x**) to indicate. Where 1 = have awareness and basic understanding and 0 = have no awareness and basic understanding)

S.No.	Workforces	0	1
1	Top Managers		
2	Middle Managers		
3	Lower Managers		
4	Experts		

5	Checkers		
6	Supporting Staffs		
7	Operators		

18-Please give the performance data of your company for the last five years.

Item	1998 E.C.	1999 E.C.	2000 E.C.	2001 E.C.	2002 E.C.
Sales Volume (Pieces)					
Sales Value (Birr)					
Local Market Share (%)					
Foreign Market Share (%)					
Production Cost (Birr)					
Net Profit (Birr)					
Volume of Finished Products (Pieces)					
Value of Finished Products (Birr)					
Volume of Partial Products (Pieces)					
Value of Partial Products (Birr)					
Value of Human Inputs (Birr)					
Value of Capital Inputs (Birr)					
Value of Material Inputs (Birr)					
Value of Energy Inputs (Birr)					
Value of Miscellaneous Inputs (Birr)					

19-What is/are the company's working definition of productivity? Please use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Possible Definitions of Productivity	0	1
1	Value of Outputs/Value of Human Inputs		
2	Volume of Outputs/Man-hour of Labor Inputs		
3	Value of Outputs/Value of Labor Inputs		
4	Value of Outputs/Value of Capital Inputs		
5	Volume of Outputs/Volume of Machine Inputs		
6	Volume of Outputs/Machine-hour of Machine Inputs		
8	Volume of Outputs/Volume of Material Inputs		
9	Value of Outputs/Value of Material Inputs		
10	Volume of Outputs/Volume of Energy Inputs		
11	Value of Outputs/Value of Energy Inputs		
12	Value of Outputs/Value of Miscellaneous Inputs		
13	Value of Outputs/Value of a Bundle of Inputs		
14	Value of Total Outputs/Value of Total Inputs		

Others:_____

_____

20-Please indicate which of measurements applied by your company. Use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Productivity Measurement Practices	0	1
1	Human Productivity		
2	Capital Productivity		
3	Machine Productivity		
4	Material Productivity		
5	Energy Productivity		
6	Miscellaneous Inputs Productivity		
7	Multifactor Productivity		
8	Total Productivity		
9	Customer Satisfaction (considers both internal and external customers)		
10	Skill Level		
11	Education Level		
12	Absenteeism		
13	Turnover		
14	Speed Loss		
15	Standard Time		
16	Downtime		
17	Waiting Time		
18	Lead Time (the time passing between ordering and receiving goods)		
19	Transfer Time		
20	Work In Process (WIP)		
21	Rejection Level		
22	Rework Level		
23	Scrap Level		
24	Internal Transport (considers flow of material with in the production process)		

Others:_____

21-How do you rate the productivity of the following workforces? Please use the symbol (**x**) to indicate.

S.No.	Workforces	High	Medium	Low
1	Top Managers			
2	Middle Managers			
3	Lower Managers			

4	Experts			
5	Checkers			
6	Supporting Staffs			
7	Operators			

22-Do you have standard time for each garment style for all tasks required?

Yes ☐ No ☐

23-Please give the following labor productivity measurement.

S.No.	Garment Type	Number of Pieces /Operator/Machine/Shift
1	T-shirt with Long Sleeve	
2	T-shirt with Short Sleeve	
3	Shirt with Long Sleeve	
4	Shirt with Short Sleeve	
5	Polo Shirt with Long Sleeve	
6	Polo Shirt with Short Sleeve	
7	Police Uniforms	
8	Military Uniforms	
9	Civil Uniforms	
10	Sport Wears	
11	Pajamas	

24-Please give an average percentage of the following data in your company.

S.No.	Material Inputs	Rejection (%)	Rework (%)	Scrape (%)
1	Raw Materials			
2	Purchased Parts			

25-Is the company compares its productivity with its previous performance, national and international standards.

Yes ☐ No ☐

26-Please indicate which of productivity improvement techniques implemented by your company. Use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Productivity Improvement Techniques	0	1
1	Computer Applications		
2	Computer Aided Design (CAD)		
3	Computer Aided Process Planning (CAPP)		
4	Computer Aided Manufacturing (CAM)		
5	Group Technology		
6	New Production Lines/Machines		
7	Rebuilding Old Machines		

8	Maintenance Planning and Control		
9	Layout Improvement		
10	Inventory Control		
11	Material Requirement Planning (MRP)		
12	Material Handling Improvement		
13	Material Reuse/Recycling		
14	New Material Utilization		
15	Research and Development (R&D)		
16	Product Design		
17	Product Reliability Improvement		
18	Value Engineering		
19	Financial Incentives		
20	Training and Education		
21	Quality Circles		
22	Brain Storming		
23	Working Conditions Improvement		
24	Communication Improvement		
25	Job Rotation		
26	Work Study		
27	Job Evaluation		
28	Job Safety		
29	Human Factor Engineering (Ergonomics)		
30	Computer Aided Data Processing		
31	Scheduling		
32	Operation Research		
33	Theory of Constraint		
34	Marketing Management		
35	Production Management		
36	Quality Management		
37	Cost Management		
38	Maintenance Management		
39	Material Management		
40	Resource Management		
41	Business Process Reengineering (BPR)		
42	Bench Marking		
43	Balanced Score Card (BSC)		
44	Just In Time Manufacturing		
45	Lean Manufacturing		
46	Reducing Administration Cost		
47	Increasing Value Addition		

48	Increasing Contribution		
49	Increasing Profit		

Others:_____

_____

_____

_____

IV-Assessment of Factors Affecting Productivity of Ethiopian Garment Manufacturing Industries:

27-Please rate the impact of each process on the productivity of your company using three scales. Use the symbol (**x**) for each process with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

S.No.	Processes	1	2	3
1	Production			
2	Sales and Marketing			
3	Procurement and Property Administration			
4	Human Resource Development and Administration			
5	Finance and Accounting			
6	Research and Development			

28-Please rate the impact of each partial input on the productivity of your company using three scales. Use the symbol (**x**) for each partial input with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

S.No.	Partial Inputs	1	2	3
1	Human Inputs			
2	Capital Inputs			
3	Material Inputs			
4	Energy Inputs			
5	Miscellaneous Inputs			

29-Please rate the impact of each factor on the productivity of your company using three scales. Use the symbol (**x**) for each factor with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

S.No.	Factors	1	2	3
1	Knowledge and Skill			
2	Motivation and Morale			
3	Employee Satisfaction			
4	Attitude and Culture			
5	Life Standard			
6	Absenteeism			
7	Turnover			

8	Human Capability			
9	Technical Capability			
10	Technological Capability			
11	Process Capability			
12	Maintenance			
13	Depreciation			
14	Speed Loss			
15	Rejection			
16	Rework			
17	Scrap			
18	Shortage			
19	Rules and Regulations			
20	Procedures			
21	Work Instructions			
22	Working Formats and Templates			
23	Incentive Schemes			
24	Ergonomics (deals with relationship between employees and their working environment.)			
25	Work Study (assessment of methods of working so as to achieve maximum productivity.)			
26	Other Productivity Improvement Techniques			
27	Quality Control			
28	Inventory Control			
29	Production Control			
30	Process Control			
31	Environment Control			
32	Standard Time			
33	Lead Time			
34	Waiting Time			
35	Transfer Time			
36	Downtime			
37	Setup Time			
38	Internal Transport			

Others:_____

_____

_____

_____

THANK YOU FOR YOUR COOPERATION!!!

Annex 2-Results of the Survey Questionnaire

Company Information:

1-Year of establishment: 58.3% before 2000 and 41.7% after 2000 G.C.

2-Market segment: Local: 26.7% Export: 20% Local and Export: 53.3%

3-Number of total employees: Permanent: On average 188, Temporary: On average 35

4-Average working days per year: 295

5-Average working days per month: 26

6-Average working days per week: 5.5

7-Number of working shifts per day: 1

8-Number of working hours per shift: 7.5

Assessment of Existing Productivity Measurement and Improvement Practices of Ethiopian Garment Manufacturing Industries: Pleas use the symbol (x) to indicate.

	Yes	No
9-Does the company establish its clear vision for its productivity?	80%	20%
10-Does the company set its goals and its targets for its productivity?	80%	20%
11-Does the company measure and evaluate its productivity regularly?	66.7%	33.3%
12-Does the company identify problems of its productivity improvement?	100%	0%

13-Please indicate the productivity awareness status of the following workforces? Use the symbol (**x**) to indicate. Where 1 = have awareness and basic understanding and 0 = have no awareness and basic understanding)

S.No.	Workforces	0	1
1	Top Managers	7.1%	92.9%
2	Middle Managers	0%	100%
3	Lower Managers	14.3%	85.7%
4	Experts	0%	100%
5	Checkers	35.7%	64.3%
6	Supporting Staffs	57.1%	42.9%
7	Operators	50%	50%

14-What is/are the company's working definition of productivity? Please use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Possible Definitions of Productivity	0	1
1	Value of Outputs/Value of Human Inputs	21.4%	78.6%
2	Volume of Outputs/Man-hour of Labor Inputs	7.1%	92.9%
3	Value of Outputs/Value of Labor Inputs	42.9%	57.1%
4	Value of Outputs/Value of Capital Inputs	57.1%	42.9%
5	Volume of Outputs/Volume of Machine Inputs	21.4%	78.6%
6	Volume of Outputs/Machine-hour of Machine Inputs	50%	50%
8	Volume of Outputs/Volume of Material Inputs	35.7%	64.3%
9	Value of Outputs/Value of Material Inputs	57.1%	42.9%
10	Volume of Outputs/Volume of Energy Inputs	92.9%	7.1%
11	Value of Outputs/Value of Energy Inputs	85.7%	14.3%
12	Value of Outputs/Value of Miscellaneous Inputs	78.6%	21.4%
13	Value of Outputs/Value of a Bundle of Inputs	50%	50%
14	Value of Total Outputs/Value of Total Inputs	42.9%	57.1%

15-Please indicate which of measurements applied by your company. Use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Productivity Measurement Practices	0	1
1	Human Productivity	0%	100%
2	Capital Productivity	40%	60%
3	Machine Productivity	20%	80%
4	Material Productivity	13.3%	86.7%
5	Energy Productivity	80%	20%
6	Miscellaneous Inputs Productivity	53.3%	46.7%
7	Multifactor Productivity	73.3%	26.7%
8	Total Productivity	40%	60%
9	Customer Satisfaction	40%	60%
10	Skill Level	13.3%	86.7%
11	Education Level	46.7%	53.3%
12	Absenteeism	13.3%	86.7%
13	Turnover	40%	60%
14	Speed Loss	53.3%	46.7%
15	Standard Time	40%	60%
16	Downtime	40%	60%
17	Waiting Time	66.7%	33.3%
18	Lead Time	40%	60%
19	Transfer Time	53.3%	46.7%
20	Work In Process (WIP)	40%	60%
21	Rejection Level	53.3%	46.7%
22	Rework Level	33.3%	66.7%

23	Scrap Level	46.7%	53.3%
24	Internal Transport	80%	20%

16-How do you rate the productivity of the following workforces? Please use the symbol (**x**) to indicate.

S.No.	Workforces	High	Medium	Low
1	Top Managers	64.3%	28.6%	7.1%
2	Middle Managers	50%	50%	0%
3	Lower Managers	50%	35.7%	14.3%
4	Experts	64.3%	28.6%	7.1%
5	Checkers	50%	42.9%	7.1%
6	Supporting Staffs	14.3%	35.7%	50%
7	Operators	42.9%	35.7%	21.4%

17-Do you have standard time for each garment style for all tasks required?

Yes	40%	No	60%

18-Is the company compares its productivity with its previous performance, national and international standards?

Yes	71.4%	No	28.6%

19-Please indicate which of productivity improvement techniques implemented by your company. Use the symbol (**x**) to indicate. Where 1 = applied and 0 = not applied. (You can select one or more of the following)

S.No.	Productivity Improvement Techniques	0	1
1	Computer Applications	20%	80%
2	Computer Aided Design (CAD)	66.7%	33.3%
3	Computer Aided Process Planning (CAPP)	93.3%	6.7%
4	Computer Aided Manufacturing (CAM)	93.3%	6.7%
5	Group Technology	73.3%	26.7%
6	New Production Lines/Machines	6.7%	93.3%
7	Rebuilding Old Machines	20%	80%
8	Maintenance Planning and Control	53.3%	46.7%
9	Layout Improvement	13.3%	86.7%
10	Inventory Control	6.7%	93.3%
11	Material Requirement Planning (MRP)	26.7%	73.3%
12	Material Handling Improvement	40%	60%
13	Material Reuse/Recycling	60%	40%
14	New Material Utilization	40%	60%
15	Research and Development (R&D)	93.3%	6.7%
16	Product Design	26.7%	73.3%
17	Product Reliability Improvement	40%	60%

18	Value Engineering	73.3%	26.7%
19	Financial Incentives	33.3%	66.7%
20	Training and Education	33.3%	66.7%
21	Quality Circles	60%	40%
22	Brain Storming	46.7%	53.3%
23	Working Conditions Improvement	53.3%	46.7%
24	Communication Improvement	40%	60%
25	Job Rotation	46.7%	53.3%
26	Work Study	26.7%	73.3%
27	Job Evaluation	33.3%	66.7%
28	Job Safety	33.3%	66.7%
29	Human Factor Engineering (Ergonomics)	73.3%	26.7%
30	Computer Aided Data Processing	66.7%	33.3%
31	Scheduling	46.7%	53.3%
32	Operation Research	73.3%	26.7%
33	Theory of Constraint	73.3%	26.7%
34	Marketing Management	13.3%	86.7%
35	Production Management	6.7%	93.3%
36	Quality Management	13.3%	86.7%
37	Cost Management	20%	80%
38	Maintenance Management	40%	60%
39	Material Management	26.7%	73.3%
40	Resource Management	20%	80%
41	Business Process Reengineering (BPR)	86.7%	13.3%
42	Bench Marking	46.7%	53.3%
43	Balanced Score Card (BSC)	80%	20%
44	Just In Time Manufacturing	73.3%	26.7%
45	Lean Manufacturing	100%	0%
46	Reducing Administration Cost	33.3%	66.7%
47	Increasing Value Addition	13.3%	86.7%
48	Increasing Contribution	33.3%	66.7%
49	Increasing Profit	13.3%	86.7%

Assessment of Factors Affecting Productivity of Ethiopian Garment Manufacturing Industries:

20-Please rate the impact of each process on the productivity of your company using three scales. Use the symbol (**x**) for each process with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

S.No.	Processes	1	2	3
1	Production	7.1%	14.3%	78.6%
2	Sales and Marketing	21.4%	35.7%	42.9%

3	Procurement and Property Administration	21.4%	50%	28.6%
4	Human Resource Development and Administration	21.4%	35.7%	42.9%
5	Finance and Accounting	14.3%	78.6%	7.1%
6	Research and Development	21.4%	71.4%	7.1%

21-Please rate the impact of each partial input on the productivity of your company using three scales. Use the symbol (**x**) for each partial input with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

S.No.	Partial Inputs	1	2	3
1	Human Inputs	14.3%	7.1%	78.6%
2	Capital Inputs	14.3%	50%	35.7%
3	Material Inputs	14.3%	21.4%	64.3%
4	Energy Inputs	14.3%	50%	35.7%
5	Miscellaneous Inputs	21.4%	64.3%	14.3%

22-Please rate the impact of each factor on the productivity of your company using three scales. Use the symbol (**x**) for each factor with respect to each scale. Where, 3 = high impact, 2= medium impact and 1 = low impact.

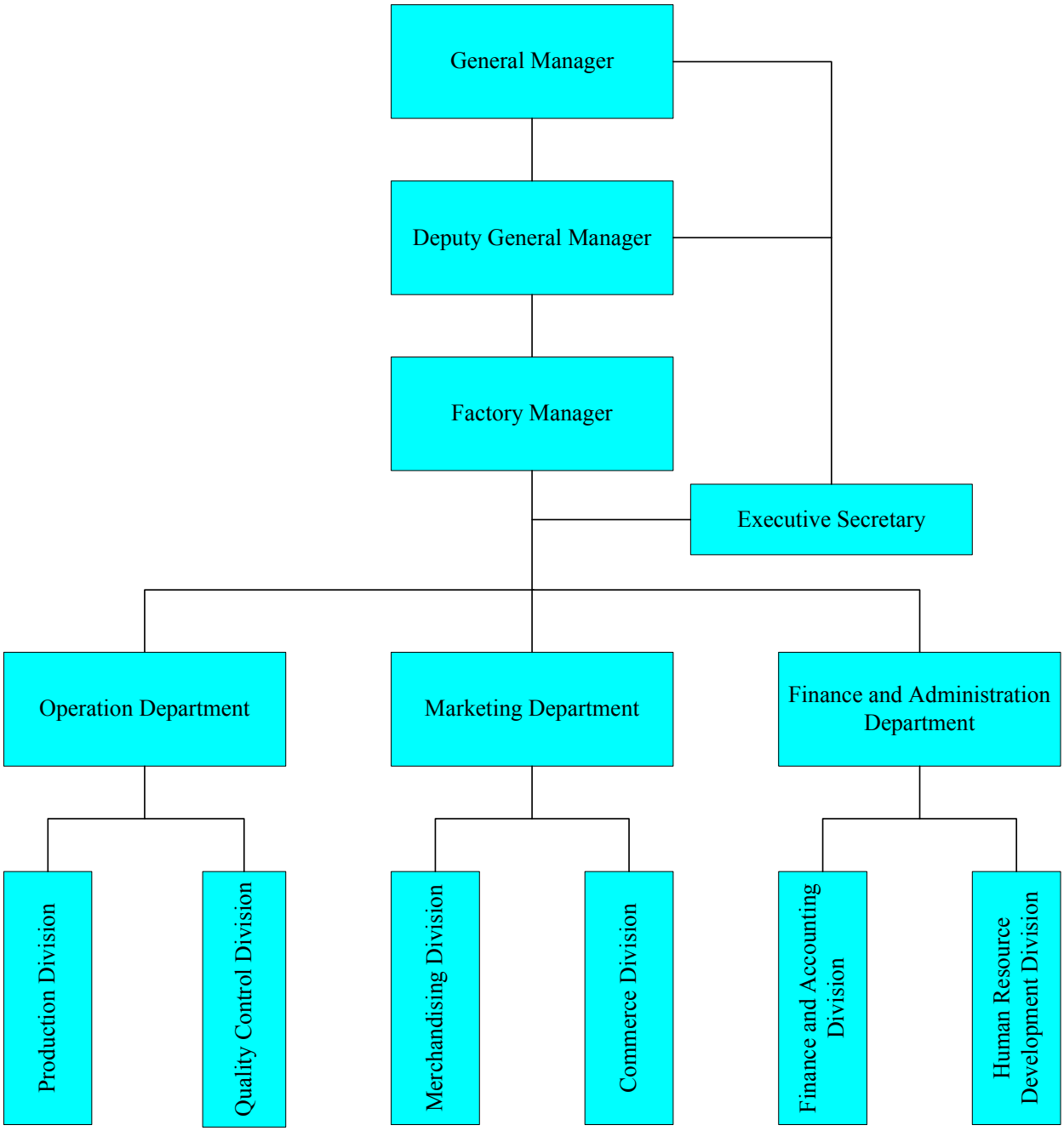
S.No.	Factors	1	2	3
1	Knowledge and Skill	21.4%	21.4%	51.1%
2	Motivation and Morale	7.1%	28.6%	64.3%
3	Employee Satisfaction	7.1%	35.7%	51.1%
4	Attitude and Culture	14.3%	42.9%	42.9%
5	Life Standard	0%	64.3%	35.7%
6	Absenteeism	14.3%	28.6%	57.1%
7	Turnover	28.6%	35.7%	35.7%
8	Human Capability	14.3%	35.7%	50%
9	Technical Capability	14.3%	21.4%	64.3%
10	Technological Capability	7.1%	28.6%	64.3%
11	Process Capability	7.1%	28.6%	64.3%
12	Maintenance	7.1%	28.6%	64.3%
13	Depreciation	7.1%	57.1%	35.7%
14	Speed Loss	14.3%	35.7%	50%
15	Rejection	14.3%	42.9%	42.9%
16	Rework	7.1%	50%	42.9%
17	Scrap	28.6%	50%	21.4%
18	Shortage	21.4%	28.6%	50%
19	Rules and Regulations	7.1%	35.7%	57.1%
20	Procedures	7.1%	57.1%	35.7%
21	Work Instructions	7.1%	28.6%	64.3%
22	Working Formats and Templates	14.3%	50%	35.7%

23	Incentive Schemes	14.3%	14.3%	71.4%
24	Ergonomics	7.1%	21.4%	71.4%
25	Work Study	14.3%	21.4%	64.3%
26	Other Productivity Improvement Techniques	14.3%	50%	35.7%
27	Quality Control	14.3%	50%	35.7%
28	Inventory Control	14.3%	50%	35.7%
29	Production Control	14.3%	21.4%	64.3%
30	Process Control	14.3%	14.3%	71.4%
31	Environment Control	14.3%	50%	35.7%
32	Standard Time	7.1%	21.4%	71.4%
33	Lead Time	7.7%	38.5%	53.8%
34	Waiting Time	0%	61.5%	38.5%
35	Transfer Time	0%	61.5%	38.5%
36	Downtime	0%	23.1%	76.9%
37	Setup Time	0%	69.2%	30.8%
38	Internal Transport	7.7%	69.2%	23.1%

Annex 3-List of Contacted Garment Industries

S.No.	Company Name	Location	Questionnaire Distribution	Response
1	Addis Garment Share Company	Old Air Port, Addis Ababa	Through Internet	No
2	Adei Ababa Yarn Share Company	Saris, Addis Ababa	Physically	No
3	Akaki Garment Share Company	Akaki, Addis Ababa	Physically	Yes
4	Almeda Textile PLC	Mekelle, Tigray	Through Internet	No
5	Ambassader Garment and Trading PLC	Yerer, Addis Ababa	Physically	Yes
6	Ayka Addis Textile and Investment Group	Sebeta, Oromiya	Physically	Yes
7	Best Garment PLC	Addis Ababa	Through Internet	No
8	Birhanu Sahile Garment PLC	Lafto, Addis Ababa	Physically	No
9	Concept International PLC	Saris, Addis Ababa	Physically	Yes
10	Edget Garment PLC	Addis Ababa	Through Internet	No
11	Etab Enter Garment PLC	Addis Ababa	Through Internet	No
12	Feleke Garment PLC	Lafto, Addis Ababa	Physically	Yes
13	Garment Evolution PLC	Yerer, Addis Ababa	Physically	Yes
14	GG Super Garment PLC	Debre Zeit, Oromiya	Through Internet	No
15	GMM Garment PLC	Lafto, Addis Ababa	Physically	No
16	Gullele Garment Share Company	Gullele, Addis Ababa	Physically	Yes
17	Haile Garment PLC	Lafto, Addis Ababa	Physically	Yes
18	Knit to Finish Factory	Gelan, Oromiya	Physically	Yes
19	MAA Garment Factory	Mekelle, Tigray	Through Internet	No
20	Mulat Garment PLC	Saris, Addis Ababa	Physically	No
21	Nazareth Garment Share Company	Adama, Oromiya	Through Internet	No
22	Novastar Garment PLC	Gelan, Oromiya	Physically	Yes
23	Oasis Abyssinia Garment PLC	Saris, Addis Ababa	Physically	Yes
24	Progress Garment and General Import PLC	Gergi, Addis Ababa	Physically	Yes
25	Ras Dashen Textile and Garment Factory	Addis Ababa	Through Internet	No
26	Tays Garment PLC	Addis Ababa	Through Internet	No
27	Wossi Garment Design Factory	Saris, Addis Ababa	Physically	Yes
28	Wow International PLC	Gelan, Oromiya	Physically	Yes
29	Yonis Garment PLC	Saris, Addis Ababa	Physically	Yes
30	Zefmesh Garment PLC	Addis Ababa	Through Internet	No

Annex 4-Organizational Structure of Novastar Garment PLC

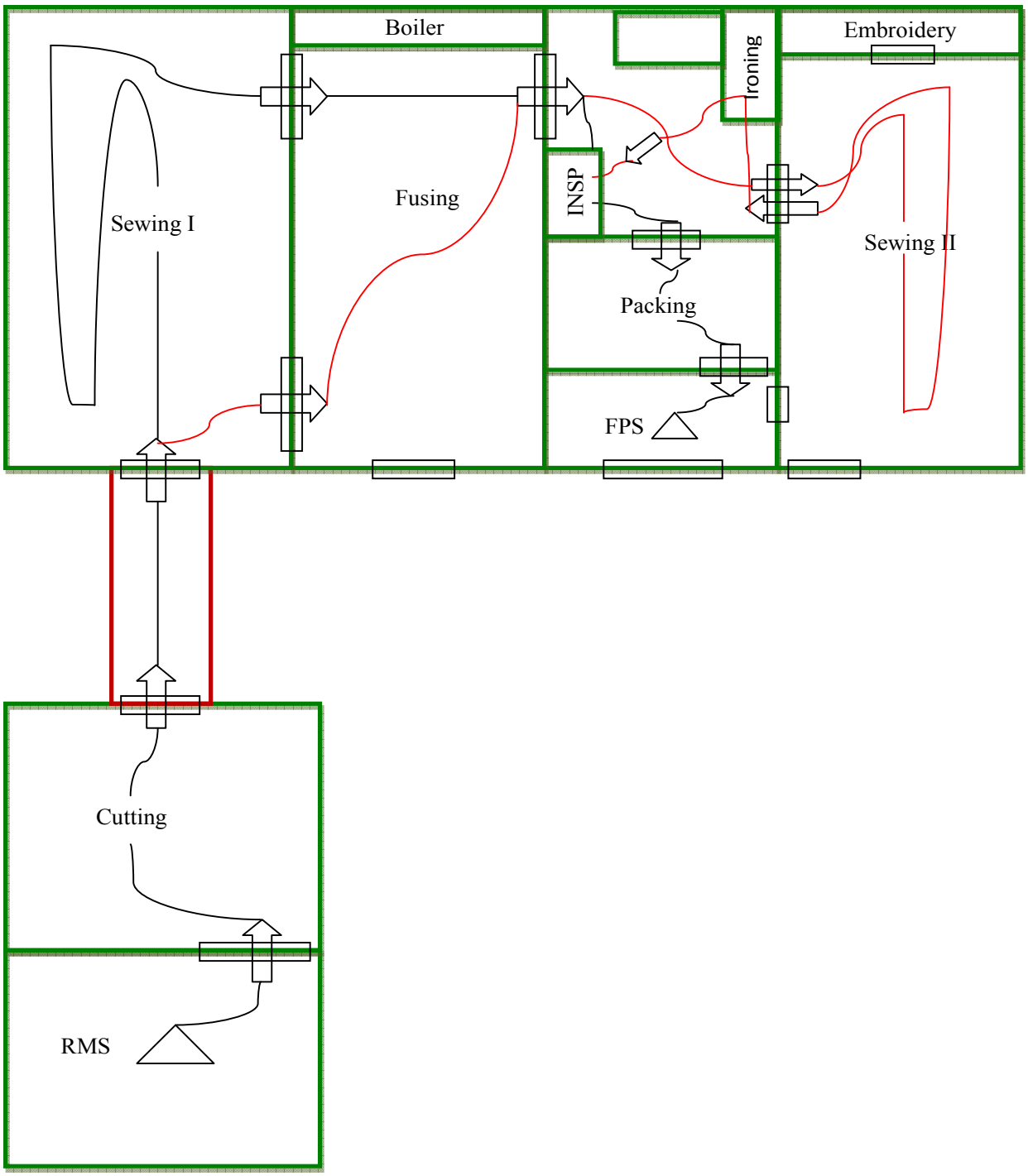


Annex 5-Benchmarking Analysis of Novastar Garment PLC

S.No	Performance Indicators	Unit	International Benchmark Value	Jan, 2011		Feb, 2011		Mar, 2011		Apr, 2011		May, 2011		Average	
				Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual
1	Manual Pattern Making	hours/style	0.5-1	<1	0.48	<1	0.46	<1	0.46	<1	0.46	<1	0.46	<1	0.46
2	CAD Pattern Making	Min/style	10-20	10	32	10	31	10	31	10	31	10	30	10	31
3	Average Sampling Making Lead Time	days	2-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	Marker Efficiency (Woven)	%	90%	90	84	90	84	90	84	90	84	90	83	90	83.8
5	Marker Efficiency (Knit)	"	90%	90	78	90	83	90	86	90	83	90	84	90	82.8
6	Edge Wastage (Woven)	cm/spreading	2-4	<2.5	3	<2.5	3	<2.5	3	<2.5	3	<2.5	3	<2.5	3
7	Edge Wastage (Knit)	cm/spreading	2-4	<3	4	<3	5	<3	5	<3	5	<3	5	<3	5
8	Manual Cutting Productivity (Knit)	pcs/shift/person	300-400	400	212	400	300	400	321	400	375	300-400	247	390	291
9	Manual Cutting Productivity (Woven)	pcs/shift/person	250-300	300	174	300	165.5	300	179	300	191	300	65	300	154.9
10	Working Minutes	min/day	480	460	460	460	460	460	460	460	460	460	460	460	460
11	Sewing Standard Time (Knitted T-Shirt)	min/pcs	5	5	12.89	5	22.39	5	10.05	5	9.33	5	7	5	12.3
12	Sewing Productivity (Knitted T-Shirt)	pcs/operators/shift	86	86	35.62	86	20.55	86	43.34	86	51.34	86	62	86	42.6
13	Sewing Efficiency (Knitted T-Shirt)	%	90	90	68.62	90	62.4	90	50.4	90	59.7	90	72.09	90	62.6
14	Sewing Standard Time (Knitted Trouser)	min/pcs	18-22	20	21.04	20	29.26	20	25	20	24	20	19	20	23.7
15	Sewing Productivity (Knitted Trouser)	pcs/operators/shift	23	23	21.83	23	19.04	23	19.70	23	19.87	23	18	23	19.7
16	Sewing Efficiency (Knitted Trouser)	%	90	90	68.62	90	82.78	90	85	90	86.39	90	78.26	90	80.21
17	Sewing Standard Time (Woven Trouser)	min/pcs	18-22	20	30.22	NA	NA	20	56.1	20	NA	20	18.5	20	34.9
18	Sewing Productivity (Woven Trouser)	pcs/operators/shift	23	23	15.08	NA	NA	23	7.76	23	NA	23	14	23	12.3
19	Sewing Standard Time (Woven Top)	min/pcs	18-22	20	34.13	20	34.43	20	30.86	20	36.29	20	25.3	20	161
20	Sewing Productivity (Woven Top)	pcs/operators/shift	24	24	13.35	24	12.85	24	14.11	24	13.21	24	18.3	24	14.4
21	Sewing Standard Time (Woven Work Wear)	min/pcs	18-26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
22	Folding and Packing Productivity (T-shirt)	pcs/operators/shift	300	300	201	300	279	300	281	300	307	300	274	300	268.4
23	Manual Ironing Standard Time (Woven T-shirt)	Min/pc	0.8-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
24	Manual Ironing Standard Time (Woven Trouser)	"	0.8-1	<1	2.25	<1	2.23	<1	2.34	<1	2.28	<1	2.75	<1	2.4
25	Manual Ironing Productivity (Woven)	pcs/operators/shift	460	460	213.13	460	215	460	205	460	210	460	167	460	202

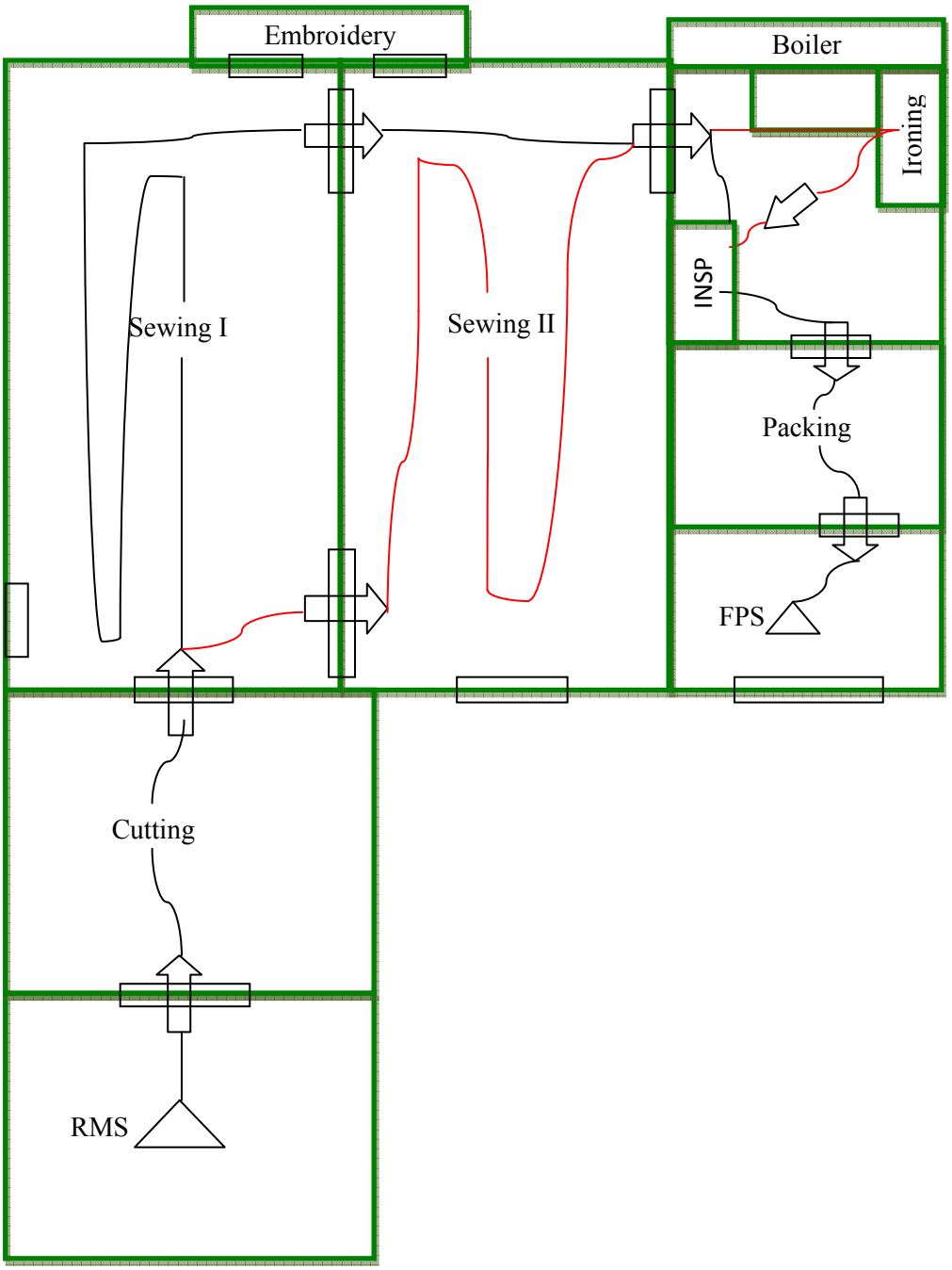
26	Overall Efficiency (Knit)	%	90-92	90	68.62	90	83.77	90	84.45	90	89.6	90	82.4	90	81.8
27	Overall Efficiency (Woven)	"	85-90	85	55.58	85	64.87	85	64.02	85	69.75	85	68.6	85	64.6
28	Rework Rate (knit)	"	<2	<2	9	<2	9	<2	18	<2	10	NA	10	<2	11.2
29	Rework Rate (Woven)	"	<2	<2	13	<2	11	<2	12	<2	10	NA	12	<2	11.6
30	Rejection Rate (Knit)	"	2	0	0	0	0	0	0	0	0	NA	0.3	0	0.08
31	Rejection Rate (Woven)	"	2.5	0	0	0	0	0	0	0	0	NA	0	0	0
32	Absenteeism	"	<1	<1	1.17	<1	1.61	<1	1.68	<1	0.95	NA	2	<1	1.5
33	Turnover	"	10	<3	4.05	<3	3.8	<3	3.59	<3	5.9	NA	7	<3	4.9
34	Marketing Lead Time	weeks	4-6	4-6	6-8	4-6	6-8	4-6	6-8	4-6	6-8	NA	6-8	5	7
35	Number of customers	#	> 5	5	2	5	2	5	2	5	2	NA	2	5	2
36	Average Lead Time for Price Quotation FOB	days	1	1	3-5	1	3-5	1	3-5	1	3-5	NA	3-5	1	4
37	Average Lead Time for Price Quotation CMT	days	1	1	1	1	1	1	1	1	1	NA	1	1	1
38	Profit Margin FOB	%	7-15	15	10	15	10	15	NA	15	NA	NA	10	15	10
39	Profit Margin CMT	"	10	10	10	10	10	10	10	10	10	NA	10	10	10

Annex 6-Existing Layout[8] of Novastar Garment PLC Production Process



[8] The existing layout is a sketch which has been drawn to determine internal transport and transfer time. Internal transport and transfer time are productivity factors. Considering the product BP3, the distance travelled and time taken are 126m and 5.04 minutes per trip respectively. Note that, one trip covers distance from raw materials store (RMS) to finished products store (FPS) across sewing I.

Annex 7-Improved Layout[9] for Novastar Garment PLC Production Process



[9] The improved layout is also a sketch which is drawn to determine internal transport and transfer time. Considering the product BP3, the distance travelled and time taken are 100m and 4 minutes per trip respectively.

Annex 8-Various Formats Formulated for the PIM

Annex 8.1-Format for Critical Success Factors

S.No.	Critical Success Factors	Reasons	Potential Benefits	Measured Values	Target Values
1					
2					
3					
4					
N					
Total					

Annex 8.2-Format for Identifying Productivity Factors

S.No.	Productivity Factors	Explanation	Measurement
1	**Category 1**		
1.1			
1.2			
1.N			
2	**Category 2**		
2.1			
2.2			
2.N			
M	**Category M**		
M.1			
M.2			
M.N			

Annex 8.3-Format for Defining Status of Productivity Factors

S.No.	Productivity Factors	Status	Comments
1	**Category 1**		
1.1			
1.2			
1.N			
2	**Category 2**		
2.1			
2.2			

2.N			
M	**Category M**		
M.1			
M.2			
M.N			

Annex 8.4-Format for Productivity Targets Setting

S.No.	Indicators	Unit	Targets
1	Human Productivity	%	
2	Capital Productivity	"	
3	Material Productivity	"	
4	Energy Productivity	"	
5	Miscellaneous Inputs Productivity	"	
6	Total Productivity	"	
7	Employee Satisfaction Rate	"	
8	Motivation Rate	"	
9	High Skill Rate	"	
10	Medium Skill Rate	"	
11	Low Skill Rate	"	
12	Absenteeism Rate	"	
13	Turnover Rate	"	
14	Human Hour Utilization	"	
15	Speed Loss Rate	"	
16	Machine Hour Utilization	"	
17	Quality of Material Rate	"	
18	Marker Efficiency	"	
19	Quality of Product Rate	"	
20	Capacity Utilization	"	
21	Rejection Rate	"	
22	Rework Rate	"	
23	Scrap Rate	"	
24	Work In Process Rate	"	
25	Standard Time	min	
26	Lead Time	"	

27	Waiting Time Rate	%	
28	Transfer Time Rate	“	
29	Downtime Rate	“	
30	Setup Time Rate	“	
31	Internal Transport	m	

Annex 8.5-Format for Collecting Production Data

S.No.	Product Type	Volume (pcs)		Value (birr)	
		Plan	Actual	Plan	Actual
1	**Local Products**				
1.1					
1.2					
1.N					
Total					
2	**Export Products**				
2.1					
2.2					
2.N					
Total					
Grand Total					

Annex 8.6-Format for Collecting Human Input Data

S.No.	Human Inputs	Volume (#)	Value (birr)
1	Managers		
2	Experts		
3	Checkers		
4	Supporting Staffs		
5	Operators		
Total			

Annex 8.7-Format for Collecting Capital Input Data

S.No.	Capital Inputs	Value (birr)
1	**Fixed Capitals**	
1.1	Land	

1.2	Building	
1.3	Machines	
1.4	Tools and Equipment	
1.5	Amortized Costs	
1.6	Others	
Total		
2	**Working Capitals**	
2.1	Inventory	
2.2	Cash	
2.3	Accounts Receivable	
2.4	Notes Receivable	
2.5	Others	
Total		
Grand Total		

Annex 8.8-Format for Collecting Material Input Data

S.No.	Material Inputs	Unit	Volume	Value (birr)
1	**Raw Materials (Fabrics)**			
1.1		m2		
1.2		"		
1.N		"		
Total		"		
2	**Purchased Parts (Accessories)**			
2.1		pcs		
2.2		"		
2.N		"		
Total		"		
Grand Total		"		

Annex 8.9-Format for Collecting Energy Input Data

S.No.	Energy Inputs	Unit	Volume	Value (birr)
1	Electricity	kwh		
2	Fuel	lits		
3	Water	m^3		

4	Others	NA		
			Total	

Annex 8.10-Format for Collecting Miscellaneous Inputs Data

S.No.	Miscellaneous Inputs	Value (birr)
1	Travel	
2	Tax	
3	Marketing	
4	Product Development	
5	Office Supplies	
6	Information	
7	Consultants	
8	General Administration	
9	Others	
	Total	

Annex 8.11-Format for Data Summary of Partial and Total Productivity Indicators

S.No.	Items	Amount	Remark
1	Production (pcs)		
2	Production (birr)		
3	Human Input (#)		
4	Human Input (birr)		
5	Capital Inputs (birr)		
6	Material Input (m^2)		
7	Material Input (pcs)		
8	Material Input (birr)		
9	Energy Input (kwh)		
10	Energy Input (lits)		
11	Energy Input (m^3)		
12	Energy Input (birr)		
13	Miscellaneous Input (birr)		

Annex 8.12-Format for Collecting Employee Satisfaction and Motivation Data

S.No.	Employees	Total (#)	Satisfied (#)	Motivated (#)
1	Managers			
2	Experts			
3	Checkers			
4	Supporting Staffs			
5	Operators			
Total				

Annex 8.13-Format for Collecting Skill Level Data

S.No.	Employees	Total (#)	High Skilled (#)	Medium Skilled (#)	Low Skilled (#)
1	Managers				
2	Experts				
3	Checkers				
4	Supporting Staffs				
5	Operators				
Total					

Annex 8.14-Format for Collecting Absenteeism, Turnover and Human Hour Data

S.No.	Employees	Total (#)	Total Human Hour (hrs)	Utilized Human Hour (hrs)	Absenteeism (hrs)	Turnover (#)
1	Managers					
2	Experts					
3	Checkers					
4	Supporting Staffs					
5	Operators					
Total						

Annex 8.15-Format for Collecting Machine Hour Data

S.No.	Machine Group	Total (#)	Total Machine Hour (hrs)	Utilized Machine Hour (hrs)
1				
2				
3				
4				
N				
Total				

Annex 8.16-Format for Collecting Scrap and Material Quality Data

S.No.	Fabric Type	Inspected (m^2)	Reject (m^2)	Scrap (m^2)	Fabrics Pass without Reject (m^2)
1					
2					
3					
4					
N					
Total					

Annex 8.17-Format for Data Summary of Surrogate Productivity Indicators

S.No.	Items	Amount	Remark
1	Total Employees (#)		
2	Satisfied Employees (#)		
3	Motivated Employees (#)		
4	High skill employees (#)		
5	Medium Skill Employees (#)		
6	Low Skill Employees (#)		
7	Total Human Hour (hrs)		
8	Utilized Human Hour (hrs)		
9	Absenteeism (hrs)		
10	Turnover (#)		
11	Total Machine Hour (hrs)		
12	Utilized Machine Hour (hrs)		
13	Total Inspected Fabrics (m^2)		
14	Rejected Fabrics (m^2)		
15	Total Fabrics Pass without Reject (m^2)		
16	Total Products Pass without Rework (m^2)		

Annex 8.18-Format for Collecting Capacity Data

	Product Type	Attainable Capacity (#)	Actual Capacity (#)
1	**Local Products**		
1.1			
1.2			
1.N			
2	**Export Products**		

2.1			
2.2			
2.N			

Annex 8.19-Format for Collecting Rejection, Rework and Product Quality Data

S.No.	Product Type	Inspected (pcs)	Reject (pcs)	Rework (pcs)	Products Pass without Rework (pcs)
1	**Local Products**				
1.1					
1.2					
1.N					
Total					
2	**Export Products**				
2.1					
2.2					
2.N					
Total					
Grand Total					

Annex 8.20-Format for Collecting Data for Standard Time

S.No.	Operations	Time 1	Time 2	Time 3	Time 4	Time 5	Average (mins)
1	Operation 1						
2	Operation 2						
3	Operation 3						
4	Operation 4						
N	Operation N						
						Normal Time	
						Allowance	
						Standard Time	

Annex 8.21-Format for Collecting Data for Lead Time

S.No.	Operations	Time 1	Time 2	Time 3	Time 4	Time 5	Average (mins)
1	Operation 1						
2	Operation 2						
3	Operation 3						
4	Operation 4						
N	Operation N						
Total							

Annex 8.22-Format for Collecting Waiting Time and Setup Time Data

S.No.	Workstations	Waiting Time (min)	Setup Time (mins)
1	Workstation 1		
2	Workstation 2		
3	Workstation 3		
4	Workstation 4		
N	Workstation N		
Total			

Annex 8.23-Format for Collecting Transfer Time and Internal Transport Data

S.No.	Operations	Distance (m)	Transfer Time (mins)
1	Internal Transport 1		
2	Internal Transport 2		
3	Internal Transport 3		
4	Internal Transport 4		
N	Internal Transport N		
Total			

Annex 8.24-Format for Collecting Downtime Data

S.No.	Downtime Reasons	Downtime (mins)
1	Material Shortage	
2	Absenteeism	
3	Human Resource Shortage	
4	Machine Breakdown	
5	Spare Part Shortage	
6	Power Cut	
7	Product Style Change	
8	By Order	
9	Others	
Total		

Annex 8.25-Format for Data Summary of Process Indicators

S.No.	Parameters	Amount	Remark
1	Attainable Capacity (pcs)		
2	Attained Capacity (pcs)		
3	Total Inspected Products (pcs)		
4	Total Rejects (pcs)		
5	Total Reworks (#)		
6	Total Scraps (m^2)		
7	Standard Time (mins)		
8	Total Lead Time (mins)		
9	Total Waiting Time (mins)		
10	Total Transfer Time (mins)		
11	Total Downtime (mins)		
12	Total Setup Time (mins)		
13	Total Internal Transport (m)		

Annex 8.26-Format for Productivity Measurement

S.No.	Indicators	Unit	Targets
1	Human Productivity	%	
2	Capital Productivity	"	
3	Material Productivity	"	
4	Energy Productivity	"	
5	Miscellaneous Inputs Productivity	"	
6	Total Productivity	"	
7	Employee Satisfaction Rate	"	
8	Motivation Rate	"	
9	High Skill Rate	"	
10	Medium Skill Rate	"	
11	Low Skill Rate	"	
12	Absenteeism Rate	"	
13	Turnover Rate	"	
14	Human Hour Utilization	"	
15	Speed Loss Rate	"	

16	Machine Hour Utilization	“	
17	Quality of Material Rate	“	
18	Marker Efficiency	“	
19	Quality of Product Rate	“	
20	Capacity Utilization	“	
21	Rejection Rate	“	
22	Rework Rate	“	
23	Scrap Rate	“	
24	Work In Process Rate	“	
25	Standard Time	min	
26	Lead Time	“	
27	Waiting Time Rate	%	
28	Transfer Time Rate	“	
29	Downtime Rate	“	
30	Setup Time Rate	“	
31	Internal Transport	m	

Annex 8.27-Format for Productivity Analysis

S.No.	Indicators	Unit	Target	Previous	Current	Change (%)	Deviation (%)
1	Human Productivity	%					
2	Capital Productivity	“					
3	Material Productivity	“					
4	Energy Productivity	“					
5	Miscellaneous Inputs Productivity	“					
6	Total Productivity	“					
7	Employee Satisfaction Rate	“					
8	Motivation Rate	“					
9	High Skill Rate	“					
10	Medium Skill Rate	“					
11	Low Skill Rate	“					
12	Absenteeism Rate	“					
13	Turnover Rate	“					
14	Human Hour Utilization	“					
15	Speed Loss Rate	“					
16	Machine Hour Utilization	“					
17	Quality of Material Rate	“					
18	Marker Efficiency	“					
19	Quality of Product Rate	“					
20	Capacity Utilization	“					
21	Rejection Rate	“					
22	Rework Rate	“					
23	Scrap Rate	“					

24	Work In Process Rate	“					
25	Standard Time	min					
26	Lead Time	“					
27	Waiting Time Rate	%					
28	Transfer Time Rate	“					
29	Downtime Rate	“					
30	Setup Time Rate	“					
31	Internal Transport	m					

Annex 8.28-Format for Action Plan

Goals:						
S.No.	**Activities**	**Responsibility**	**Resource**			
			Finance	**People**	**Material**	**Time**
1						
2						
3						
4						
N						
		Total				

Annex 8.29-Format for Evaluation of the Results

S.No.	**Results Gained**	**Problems Encountered**	**Actions to be Taken**
1			
2			
3			
4			
N			