Addis Ababa Institute of Technology
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INVESTIGATION OF FACTORS AFFECTING THE PRODUCTIVITY OF ETHIOPIAN MANUFACTURING FIRMS

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DECLARATION

I hereby declare that the work which is being presented in this thesis entitle “Investigation of Factors Affecting the Productivity of Ethiopian Manufacturing Firms” is original work of my own, has not been presented for a degree of any other university and all the resources of materials used for the thesis have been duly acknowledged.

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Abstract

Fierce and ever increasing global competition has made the business organizations and policy makers turn their attention to such critical issues as productivity and quality. Productivity improvement should be a concern of every industry regardless of the type of production, economic or political system since there is no human activity that does not benefit from improved productivity. The common definition of productivity, the ratio of output value to input value, remains the same for every sector. Productivity can either be improved through increasing the output value by increasing the quality or quantity of products, or through decreasing the input value by utilizing the resources effectively & efficiently.

The success of a productivity improvement program mainly depends on systematic identification and analysis of all the factors that affect productivity of the manufacturing systems. This study investigates the factors that affect the productivity of Ethiopian manufacturing firms. Thus, the purpose of this paper is to find out productivity related problems with regard to both internal and external productivity factors; identify the root causes for the troubles; and propose suitable solutions for improvement.

Acknowledgement

First for most, I would like to thank Allah for the courage he has given me to complete this thesis work. I also would like to express my deep gratitude to my families for their full support and encouragement throughout this study.

I am grateful to express my deepest and heartfelt thanks to my advisor Dr.Ing-Daniel Kitaw and for my co-advisor Ato Amare Matebu for their unreserved and continuous assistance while doing the thesis. Their encouragement, excellent guidance, creative suggestions and critical comments have greatly inspired me finalizing the entire work.

Finally, I pass warm thanks for my colleagues for their supportive ideas and materials that add essential values to my work.

Chapter 1

Introduction

1.1 Background

The worldwide economic competition is intensifying and improvements in transportation and communication makes nations seem closer together. As one nation becomes aware of the products and services available in the world at large, demand for those items and services tends to increase.

The manufacturing sector of Ethiopia produces construction materials, metal, and chemical goods, in addition to basic consumer goods such as foods, beverages, clothing, and textiles. The agriculture-based national economy of the country indicates that the number of manufacturing firms and their productivity level is very limited. The local as well as global customers need high quality products in the required volume at the due time and premium price. The country is subjected to import a large amount of foreign products to satisfy the aggregate demand of the local customers. This is mainly due to the relatively low productivity of the local manufacturing firms. It is generally agreed that productivity represents one of the major areas reflecting the term performance, especially for an organization or a production unit. Other performance criteria include profitability, innovation, quality, effectiveness, and efficiency. Productivity also represents an essential component of Harper's performance measurement concept that includes unit cost, price, factor proportion, cost proportion, product mix, and input allocation (Harper, 1984).

Nowadays, the manufacturers in the glob are striving to effectively utilize their competitive advantages to the maximum possible extent in order to have the lion's share in the market. Improving total productivity, which is one of the major competitive advantages for manufacturers, ensures the reduction of total cost/unit, and this should be the primary goal in any productivity management process so that profits can be made not by random price increases (which causes price inflation) but rather by holding the prices at current levels or even decreasing them to increase market share (Price/unit = total cost/unit + profit margin/ unit.).

Manufacturing productivity needs a major emphasis for the Ethiopian firms to upgrade their competitive advantages.

This thesis work involves the investigation of determinant factors that potentially render the productivity of Ethiopian manufacturing industries and find out the root caused for the problems and develop a suitable model that enable to solve the problems and improve productivity.

1.2 Statement of the Problem

It has been stated that the low level of productivity in manufacturing firms implies a low growth of national as well as organizational economy. This in turn means low income, which leads to low standard of living and a low level of saving, resulting in low level of investment.

Overcoming all these interrelated problems and raising productivity requires, primarily, the investigation of determinant factors which potentially influence the productivity of concerned firms. The following fundamental problems are related to the productivity of Ethiopian manufacturing firms:

- The existing productivity status of the manufacturing firms is not well identified. This creates a handicap on various researches made to obtain the required statistical data for further improvement purposes.
- The low level of manufacturing economic growth mainly indicates low productivity of the firms. Moreover, up-to-date productivity improvement can be achieved only through the detailed analysis of the existing manufacturing variables and behaviors. Analysis and interpretation of disruptive factors for productivity improvement need to be well defined.

Based on these critical problems the researcher would like to address the following questions

- What is the existing productivity level of the Ethiopian manufacturing firms and how often they are improving themselves with this regard?
- Which factors do significantly affect the existing productivity of the firms?
- What could be the major causes for productivity reduction in the Ethiopian manufacturing firms?
- Which potential opportunities have to be utilized to maximize the existing level of the firms` productivity?

This thesis tends to find out suitable analytical solutions for the productivity related problems in Ethiopian manufacturing firms addressing the above and similar questions on the sight of adapted industrial engineering and management approaches.

1.3 Objectives of the Study

General objective

- To investigate and understand the most frequent determinant factors that affect the productivity of Ethiopian manufacturing firms and find out the potential solutions that help to improve the productivity.

Specific objectives

- To create awareness on the basics of productivity and considerable factors that affect productivity.
- To identify the main factors and analyze the root causes for low productivity that may exist in Ethiopian manufacturing firms.
- To assess productivity improvement practices in Ethiopian manufacturing firms.
- To find out the potential solutions that can be introduced into the manufacturing systems of the companies for productivity improvement.

1.4 Scope and Coverage of the Study

The scope of this thesis is confined to the medium and large manufacturing establishments and covers representative samples from both public and private industries in the country. Here, a significant regional emphasis is provided for Addis Ababa since majority of the large firms exist in it.

1.5 Methodology

The research applies the following methods to achieve its objectives:

i. Literature Review

Literatures in such areas as productivity factors, manufacturing industry behaviors, production functions, productivity analysis, quality and productivity, productivity measurement and improvement approaches, etc are surveyed from various sources including previous researches, training materials, hand books, the internet and other electronic and non- electronic sources.

ii. Data Collection

Both the primary and secondary data sources are used to undertake this study. The primary data sources contain original, raw and non-interpreted information about the subject matters of the thesis. The secondary data sources are mainly technical documents and annual reports that help to reinforce the primary information and to find out more details concerning the study. Questionnaires and interviews are the major techniques used for gathering the primary data.

The questionnaire is designed so as to encompass all possible information from the manufacturing firms. It includes the interpretation of productivity in the firms, trends in productivity growth, major factors that probably affect productivity, productivity measurement and improvement practices. Special emphasis is given for productivity affecting factors and the various aspects of each factor. While developing the questionnaire, I have used some of the best model questionnaires developed internationally as a benchmark to standardize its contents. Furthermore, pilot test is undertaken within ten enterprises to introduce the required modifications that probably improve the overall quality of the questionnaire.

The collected data have both quantitative and qualitative natures. In other words, some data are expressed numerically while the others, which can not inherently be expressed in numbers, are presented in words.

iii. Data Analysis , problem identification, and conclusive solution

The collected data is properly analyzed by using compatible tools; the results are interpreted; and then implications are clearly stated in such a way that the specific and general objectives of the study are to be achieved. Furthermore, the major problems, which critically affect the productivity of the manufacturing firms, are identified and suitable remedial solutions are proposed following conclusive discussions.

Chapter 2

Basic Concepts and Importance of Productivity

2.1 The Concept of Manufacturing Productivity

Various writers defined a manufacturing system in different approaches. To cope with this study, we have taken the definition that *a manufacturing system* is a collection of integrated equipment and human resources, whose function is to perform one or more processing and/or assembly operations on a starting raw material, part, or set of parts [2]. It is where the value-added work is accomplished on the part or product. The integrated equipment includes production machines and tools, material handling and work positioning devices, and computer systems. The human resource is required either full time or periodically to keep the system running. Alternate terms commonly used to represent manufacturing systems are factory, production system and fabrication facility. Subsets of manufacturing systems, which are themselves systems, are sometimes called cells, work centers or work stations.

The concept of productivity has been applied in many different situations, particularly in relation to economic system, at various levels of aggregation. Productivity is simply the relationship between the outputs (goods and services) generated from a system and the inputs provided to create those outputs. Inputs include labor, capital (physical assets), energy, materials, and information that are brought into a system. Productivity is the ratio of what is produced by an operation of process to what is required to produce it, or put simply the ratio of actual output to input over a period of time.

Productivity can also be defined as the relationship between results and the time it takes to accomplish them. Time is often a good demonstrator since it is a universal measure, and it is beyond the human control. The less time taken to achieve the desired result, the more productive the system is.

Formally defined, productivity is a summary measure of the quantity and quality of work performance with resource utilization considered. Regardless of the type of production, economic or political system, the definition of productivity remains the same. Thus, though productivity may mean different things to different people, the basic concept is always the

relationship between the quality and quantity of goods or service produced and the quantity of resource used to produce them. It can be measured at the level of the individual, group, or organization. From a manager's perspective, productivity in all cases reflect success or failure in producing goods and services in quantity, of quality, and with a good use of resources. In short it is the ratio of output value to input value [4].

$$\text{Productivity} = \text{Output value} \,/\, \text{Input value}$$

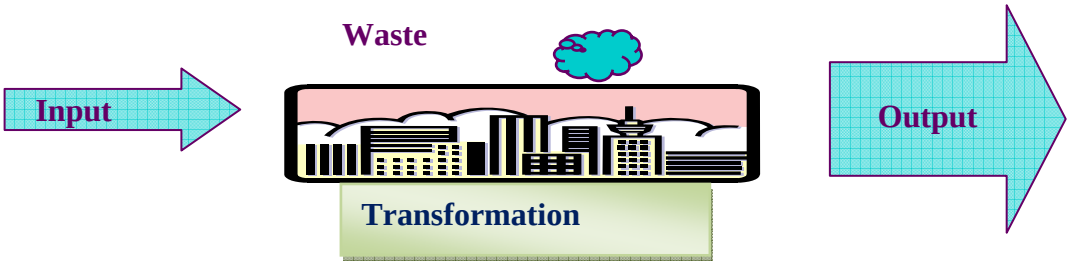

Fig.2.1. Input/output transformation model of a manufacturing system

The change in manufacturing productivity may come by altering the denominator of the objective function, i.e., the resources or values of inputs. The equation shows the productivity rises, keeping other things constant, when the quantity of outputs increase, the quality of output increases, and/or the cost of resources (input) utilized decreases. On the other hand, an increase in production does not necessarily by itself indicate an increase in productivity. Therefore, higher productivity means to produce more with the same expenditure, or with a minimum increase in expense, or the same amount is produced at less cost in terms of resources.

In industrial engineering, productivity is generally defined as the relation of output (produced goods) to input (consumed resources) in the manufacturing transformation process. However, there are numerous variations on this basic ratio which is often too wide, a definition to be useful in practice.

The three broad categories of the basic content, that seems to be the same in many definitions of productivity, are:

a. the *technological concept*: the relationship between ratios of output to the inputs used in its production;
b. the *engineering concept*: the relationship between the actual and the potential output of a process; and

c. the *economist concept*: the efficiency of resource allocation.

However, there are some difficulties to deal with productivity for the following three reasons:

1. The outputs are usually expressed in different forms to the inputs. Outputs are often measured in physical terms such as units (e.g. cars produced, tones of paper, kilowatts of electricity, or value (dollars)). However the inputs are usually physically different and include measures of people (numbers, skills, hours worked or costs) or materials (tones and costs) for example.
2. The ratio by itself tells us little about performance. A ratio of 0.75 is of little value unless it is compared with previous time periods, or a benchmark, or the potential productivity of the operation.
3. Many different ratios can be used (both financial and nonfinancial, that can be used to create productivity ratios).

2.2 Productivity, Quality, and Utilization

The concept of productivity is also increasingly linked with quality of output, input, and process itself. Taking the definition of quality as conformance to requirements of the customer, productivity decreases as the quality of the output decrease. For example, in leather products, quality means leather without any defect on it. According to the number of this defect per square feet the grade of leather decreases from first grade to second grade, third grade, etc. The value of the leather produced dramatically decreases as the grade of it decreases from 1, 2, 3…. This quality problem may come from skin disease during the animal life, improper slaughtering and skinning, bad preservation and improper processing in the factory. Therefore, the quality of the input and the process itself also affect productivity.

Productivity is also linked with how the resources are utilized in the company. It is the function of achieving the maximum possible with minimum resource. The resources are manpower, material, equipment, spares and building, capital and time. The responsibility of achieving higher productivity rests on managing these resources efficiently. By definition productivity doesn't come from working harder. This may increase output, but it also increases labor input. Similarly, using more capital or other production factors do not necessarily increase productivity. Productivity growth comes from working smarter. This means adopting new technologies or new techniques for production [4].

Generally, productivity should be considered as a comprehensive measure of how organizations satisfy the following criteria.

- Objective: the degree to which they are achieved.
- Efficiency: how efficient resources are used to generate useful output.
- Effectiveness: what is achieved compared with what is possible.
- Comparability: how productivity performance is recorded over time.

2.3 The Importance of Productivity

The significance of productivity in increasing national welfare is now universally recognized. There is no human activity that does not benefit from improved productivity [10]. This is important because more of the increase in gross national income, or GDP, is produced by improving the effectiveness and quality of manpower than by using additional labor and capital. In other words, national income, or GDP, grows faster than the input factors when productivity is improved.

Productivity improvement, therefore, results in direct increases in the standard of living under conditions of distribution of productivity gains according to contribution. At present, it would not be wrong to state that productivity is the only important worldwide source of real economic growth, social progress and improved standard of living.

Thus, changes in productivity are recognized as a major influence in many social and economic phenomena, such as rapid economic growth, higher standard of living, improvements in a nation`s balance of payments, inflation control, and even the amount and quality of leisure. These changes influence wage levels, cost/price relationships, capital investment needs and employment.

Productivity also largely determines how competitive a country`s products are internationally. If labor productivity in one country declines in relation to productivity in other countries producing the same goods, a competitive imbalance is increased. If the higher costs of production are passed on, the country`s industries will lose sales as customers turn to the lower cost suppliers. But if the higher costs are absorbed by industries, their profit will increase. This means that they have to decrease production or keep production costs stable by lowering real wages.

Some countries that fail to keep pace with productivity levels of competitors try to solve their problems by devaluing their national currencies. But this lowers real income in such countries by making imported goods more expensive and by increasing domestic inflation.

Thus, low productivity results in inflation, an adverse balance of trade, poor growth rate and unemployment. Figure 2.2 presents a simplified causal relationship between many variables and factors affecting productivity.

It is clear, then, that the vicious circle of poverty, unemployment and low productivity can be broken only by increasing productivity. Increased national productivity not only means optimal use of resources, but also helps to create a better balance between economic, social and political structures in the society. Social goals and government policy largely define the distribution and utilization of national income. This in turn influences the social, political, cultural, educational and motivational work environment which affects the productivity of the individual and the society.

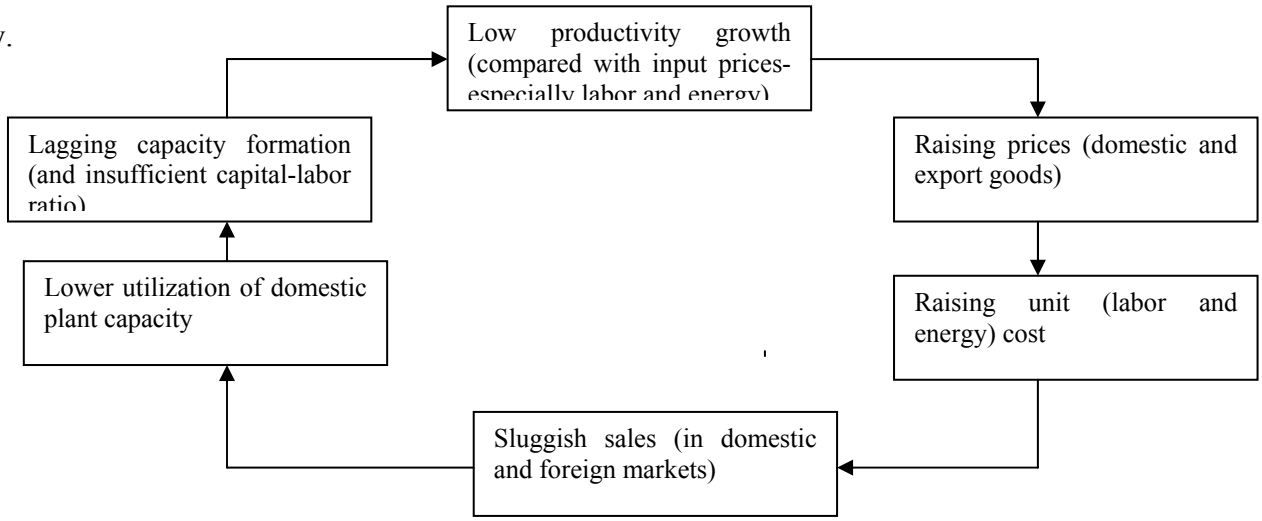

Figure 2.2 Model for a low-productivity trap

Chapter 3

Productivity Determinant Factors

3.1 Introduction

The production process is a complex, adaptive, on-going social system. The inter-relationships between labor, capital and the socio-organizational environment are important in the way they are balanced and co-ordinate into an integrated whole. Productivity improvement is not just doing things better: more importantly, it is doing the right things better [10]. Productivity improvement depends upon how successfully we identify and use the main factors of the socio-production system. It is important, in connection with this, to distinguish three main productivity factor groups: job-related; resource related; and environment-related.

3.2 Classification of Productivity Factors

There are a number of ways to classify productivity factors. Among those the most general one is classifying it in to *external* and *internal* factors. The external factors are those, which are not controllable by the organization itself and the internal factors are those within its control. Thus the first step towards improving productivity is to identify problem area within these factor groups. The next step is to distinguish those factors, which are controllable.

The external factors that affect productivity are the economical, political, social, and other infrastructure factors, which influence the effectiveness and decision making process of the enterprise management. However, the management cannot control these external factors in short run. The internal factors, which can be controlled, in short run, are product, equipment, technology, materials, energy, people, organization and management style.

Factors which are external and not controllable for one institution are often internal to another. Factors external to an enterprise, for example, could be internal to governments, national or regional institutions, associations and pressure groups. Governments can improve tax policy, develop better labor legislation, provide better access to natural resources, improve social infrastructure, price policy, and so on, but individual organizations cannot.

Factors external to an enterprise are of interest to that enterprise because an understanding of them can motivate certain actions which might change an enterprise`s behavior and its

productivity in the long run. The integrated scheme of factors constituting a major source of productivity improvement is shown in figure 3.1. Each factor is discussed briefly below.

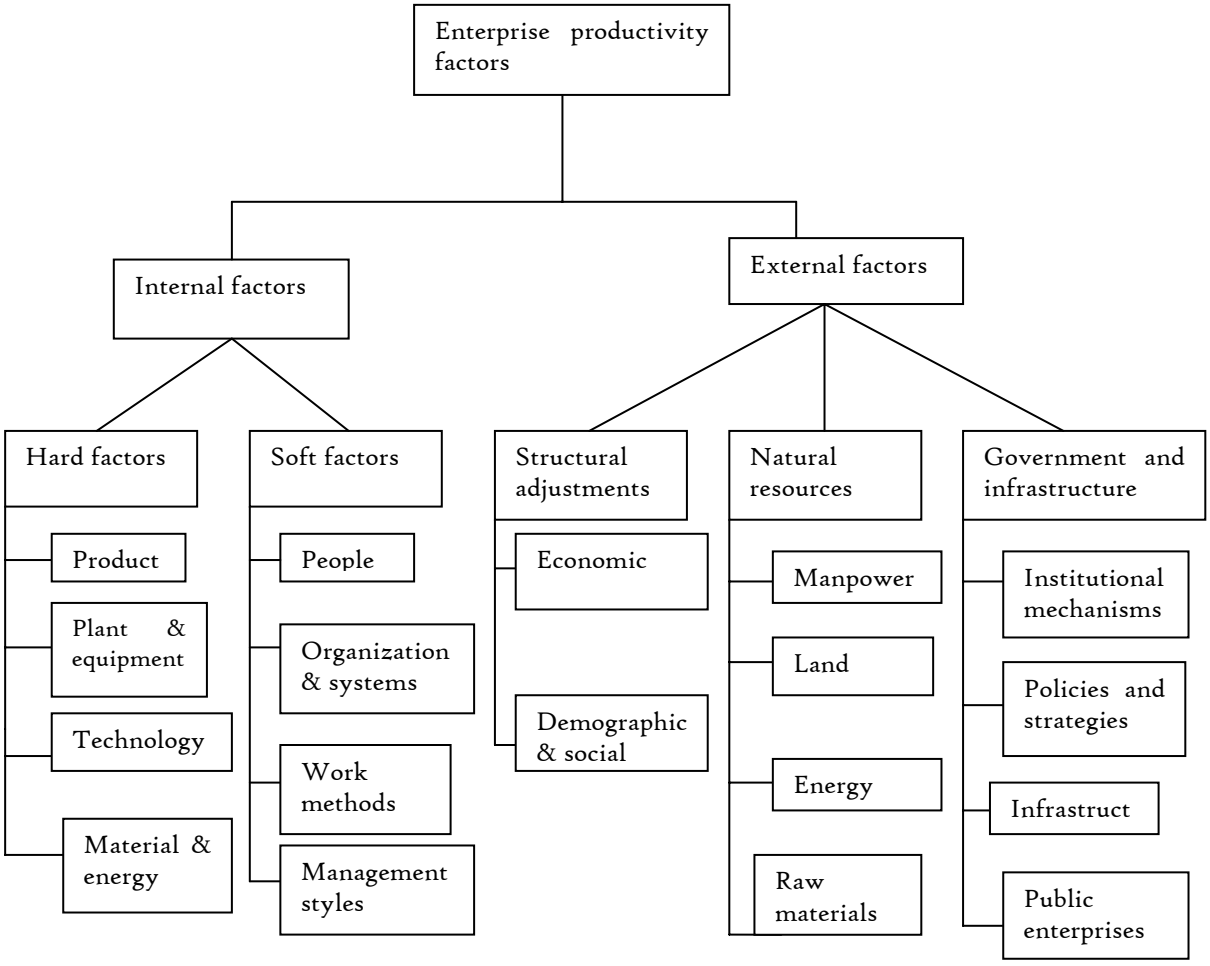

Figure 3.1. An integrated model of enterprise productivity factors

3.3 Internal Factors Affecting Enterprise Productivity

Since some internal factors are more easily changed than others, it is useful to classify them in to two groups: hard (not easily changed) and soft (easily changed) [10]. The hard factors include products, technology, equipment and raw materials, while the soft factors include the labor force, organizational systems and procedures, management styles and work methods.

This classification helps us build priorities- which factors can easily be dealt with and which factors require stronger financial and organizational interventions. A brief description of some key aspects of each internal factor follows.

3.3.1 Hard Factors

Product

Product as a factor of productivity means the extent to which the product meets the output requirements. The amount that the customer is prepared to pay for a product of given quality is determined by the product *use value*. The use value of the product can be improved by better design and specifications. Many companies around the world fight a constant battle to incorporate technical excellence into marketable products. Breaking down the walls between research, marketing and sales has become a major productivity factor. For example, leading Japanese companies continually redesign products which are on the market. The availability of the product at the right place (*place value*), at the right time (*time value*) and at the reasonable price (*price value*) can also be important factors that affect the overall productivity. The *volume factor* in particular gives us a better notion of the economies of scale through increased volume of production. Finally, the *cost-benefit factor* can be enhanced by increasing the benefit for the same cost or by reducing the cost for the same benefit [10].

If, through better product design, a product can be simplified by eliminating some of its parts; it is obvious that the material these pieces are made of will no longer be needed. Nor will the equipment, tooling, and labor to make them be required. *Value analysis* can bring out many product design changes that improve productivity.

R & D is a vital contributor to improved product design. Standardization of the product and the use of group technology are other design factors that make possible greater productivity in the factory [8].

Plant and equipment

Once the product is designed, then how it is made offers the next opportunity for productivity improvement. The plant and equipment used-machines, tools, conveyors, robots, the way the factory is laid out-all are important.

Plant and equipment productivity can be improved through: operating the plant and equipment in optimum process condition, good maintenance, eliminating bottle-necks, reducing idle time, and

making more effective use of available machines and plant capacity. Plant and equipment productivity can be improved by attention to utilization, age, modernization, cost, investment, internally produced equipment, capacity maintenance and expansion, inventory control, production planning and control, and so on.

Computer has helped to design the products (CAD), it helps operating complicated machine tools (CNC machines) and it controls the inventory of material and parts. It has become an essential ingredient in productivity improvement.

Technology

The major factor in long range continuing productivity improvement is technology, and new technology depends on Research & Development. Technological innovation constitutes an important source of higher productivity. Increased volume of goods and services, quality improvement, new marketing methods, etc., can be achieved through increased automation and information technology. Automation can also improve materials handling, storage, communication systems and quality control.

During the past 25 years, considerable productivity increases have been realized through the use of automation and current developments in information technology suggest great improvements to come. Significant examples of the application of this technology are the development of automatic downtime recording systems and automatic lubrication systems which have reduced the idle time of men and machines, and reduced overtime expenditure. New technology is normally introduced as a result of such productivity improvement programs as fighting obsolescence, process design, R & D and the training of scientists and engineers [10].

Materials and energy

The amount of materials and energy used can significantly affect the productivity of an enterprise. Even small efforts to reduce materials and energy consumption can bring remarkable results. These vital sources of productivity include raw materials and indirect materials such as process chemicals, lubricants, fuel, spare parts, and engineering materials.

Important aspects of materials productivity include: material yield (output of useful product or energy per unit of material used), which is dependent upon selection of the right material, its quality, process control and control of rejects; use and control of wastage and scraping; upgrading of materials by initial processing to improve utilization in the main process; use of

lower grade and cheaper materials; import substitution; improving inventory turnover ratio to release funds tied up in inventories for more productive uses; improved inventory management to avoid holding excessive stock; and developing sources of supply.

Electrical or other source of energy must also be optimized to increase productivity. Processing industries like leather uses chemicals intensively, thus the total cost of these industries can be decreased by reducing this input. For example, it is possible to save 60,000Birr/annum in Ethiopia Tannery S. Co. by reusing the exhausted chrome through chrome recovery plant [4].

3.3.2 Soft factors

People (Human resource)

As the principal resource and the central factor in productivity improvement drives, the people in an organization all have a role to play-as workers, engineers, managers, entrepreneurs and trade union members. Each role has two aspects: application and effectiveness.

Application is the degree to which people apply themselves to their work. People differ not only in their *ability* but also in their *will* to work. This is explained by a law of behavior: motivation decreases if it is satisfied or blocked from satisfaction. For example, workers may do their jobs without working hard (no motivation), but even if they did work to their full capacity they would not be satisfied (motivation is blocked from satisfaction).

In order to stimulate and maintain motivation, the following few factors should be considered:

A set of *values* conductive to higher productivity should be developed in order to bring about changes in the *attitude* of managers, engineers, and workers.

Motivation is basic to all human behavior and thus to efforts in productivity improvement. Material needs are still predominant, but this does not mean that non-financial incentives are not effective or have no place. Workers` success in increasing productivity should be reinforced immediately by rewards, not only in the form of money, but also by improving recognition, involvement and learning opportunities, and, finally, by the complete elimination of negative rewards.

If management can plan and execute effective incentive schemes, then the result is invariably a significant improvement in productivity. Wage incentives must always be related to the amount of change accomplished [10].

It is also possible to improve productivity by eliciting co-operation and participation from workers. Labor participation in goal-setting, for example, has been quite successful in many countries. Human relations can be improved by reducing the complexity of communication procedures and by minimizing conflicts. Labor productivity can be tapped only if management encourages workers to apply their creative talents by taking a special interest in their problems and by promoting a favorable social climate.

Standard of performance plays an important role in productivity. It should be set at a high but realizable level. Management expectations of high performance need to be considerably raised in many cases. However, standards should always be achievable to maintain confidence and the "will to do".

The *will-to-do* is affected by job satisfaction which managers can enhance by making jobs interesting, challenging and bigger, more worthwhile and self-contained. Job enrichment and job enlargement can influence job satisfaction and motivate higher productivity.

The second factor in the role played by the people involved in a productivity drive is *effectiveness*. Effectiveness is the extent to which the application of human effort brings the desired results in output and quality. It is a function of method, technique, personal skill, knowledge, attitude and aptitude-the "ability to do". The ability to do a productive job can be improved through training and development, job rotation and placements, systematic job progression (promotion), and career planning.

Firms with new capital stock have a higher demand for educated workers relative to uneducated workers because skilled workers are able to implement innovations more quickly and thereby reduce a firm's costs of adjustment. The trained and experienced worker can do the same job in a much shorter time and with far greater effectiveness than a new one. However, even the well-trained employees must be motivated to be productive [8].

To summarize, the following key approaches, methods and techniques can be used to improve labor productivity: wages and salaries; training and education; social security-pensions and health plans; attitudes to work, to supervision and to change; motivation to higher productivity; co-operation; organization development; improved communications; suggestion systems; career planning; attendance; turnover; job security.

Organization and systems

An organization needs to be dynamically operated and led towards objectives and must be maintained, serviced, and reorganized from time to time to meet new objectives [10]. The well-known principles of good organization such as unit of command, delegation and span of control are intended to provide for specialization and division of work and co-ordination within the enterprise.

One reason for the low productivity of many organizations is their *rigidity*. They fail to anticipate and respond to market changes; ignore new capacities in the labor force, new developments in technology and other external (environmental) factors. Rigid organizations lack good horizontal communication. This slows down decision-making and inhibits delegation of authority close to the point of action, encouraging inefficiency and bureaucracy.

Compartmentation according to professional groups or functions also inhibits change. For example, the decision-making steps may have been designed for a particular existing technology, for a definite product or service mix. Things have now changed, but procedures have survived because managers want to minimize change.

No system, however well designed, is efficient in all situations. Dynamism and flexibility should be incorporated into the system design in order to maximize productivity.

Management styles

There is a view that in some countries management is responsible for 75 percent of productivity gains, because management is responsible for the effective use of all resources under enterprise control. There is no perfect management style. Effectiveness depends upon when, where, how and to whom a manager applies a style. Management styles and practices influence organizational design, personnel policies, job design, operational planning and control, maintenance and purchasing policies, capital cost (working and fixed capital), sources of capital, budgeting systems and cost control techniques[10].

Generally, the model of internal productivity factors serves as a checklist for identifying the most promising productivity areas for management analysis planning and intervention.

3.4 External Factors Affecting Enterprise Productivity

The external factors that affect the individual enterprise productivity cannot be actively controlled by the organizations concerned. These factors include: government policies and

institutional mechanisms; political, social and economic conditions; the business climate; the availability of finance, power, water, transport, communications, and raw materials.

Though uncontrollable, these factors should be understood and taken into consideration by management when planning and implementing productivity programs. What is outside the control of individual enterprises in the short term might be controllable at higher levels of society`s structures and institutions. Bearing in mind all the social, political, economic and organizational links between consumers, workers, managers, government, and different pressure groups, and between institutions and organizational infrastructure, it is useful to discuss here the main macro productivity factors which speed or hinder productivity improvement processes. Because productivity largely determines real income, inflation, competitiveness and peoples well-being, policy-makers try hard to discover the real reasons for productivity growth and decline. A general classification of the three main groups of macro-productivity factors is shown in figure 3.2.

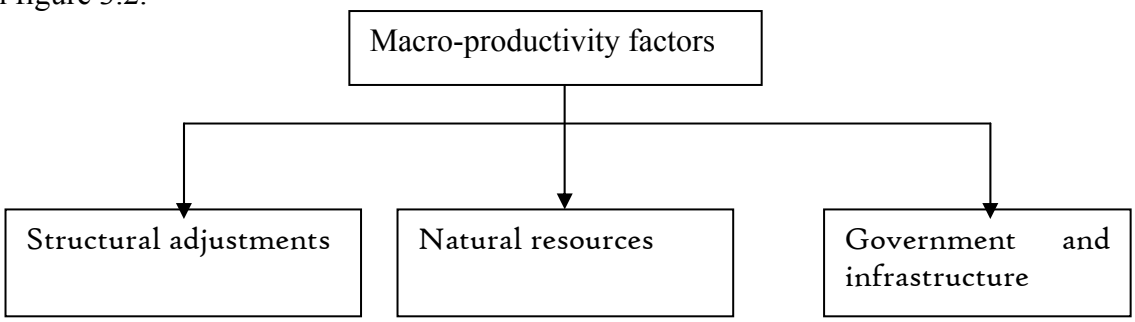

Figure 3.2. Main macro-economic factors

3.4.1 Structural Adjustments

Structural changes in society often influence national enterprise productivity independently of enterprise management. However, in the long term this interaction is two-way. Just as structural changes affect productivity, productivity changes also modify structure. Such changes are not only the result, but also a cause, of economic and social development.

Understanding these changes helps improve government policy, makes enterprise planning more realistic and purpose-oriented and helps develop the economic and social infrastructure. The most important structural changes are economic, and social & demographic.

Economic changes

The most important economic changes are in employment patterns and the composition of capital, technology, scale and competitiveness.

Employment shifts from agriculture to manufacturing industry have caused an economy-wide increase in productivity that has surpassed productivity growth within any one sector in developed countries. The number of people employed in agriculture, forestry and fisheries in these countries has now become so small that this historical source of productivity growth has very limited potential as a source of future growth. However, in many developing countries these shifts will continue to be a source of high growth of productivity in future, since more people will move from the low productivity agricultural sector into manufacturing.

A second historical structural change is *the move from manufacturing into service industries*. These include wholesale and retail trade, finance, insurance, real estate, personal and business services, and a number of others. Even in Japan, with its heavy emphasis on manufacturing, employment and consumer spending have shifted to the service sector, which now accounts for more than one-half of each. In the United States nearly three-quarters of all non-farm employees work in services [10]. The effect on productivity of this second major wave of structural change is controversial, since productivity in the service sector has tended to climb more slowly than productivity in general. However, it has held down the price of labor relative to the rapidly escalating price of capital and raw materials. As a result, in many countries wages declined absolutely during the late 1990s. This stimulated the shift of capital and energy away from equipment into investment in the labor force. Thus, the productivity of other production factors was enhanced at the expense of labor productivity.

Variations in the *composition of capital*, its relative intensity, age and kind also affect productivity. The growth of capital depends on saving and investment. The age of the capital stock also influences the diffusion of innovations to the extent that technological change is embodied in new investment goods. However, above average capital input per worker does not necessarily increase output per worker. Some manufacturing industries achieve high productivity with relatively low capital intensity, barely exceeding that of commerce.

A wide discrepancy between productivity and capital intensity often indicates unused capacities in the economy, over the conventionally measured capacity, which could be tapped by better management.

The structural impact of *R&D technology* is another important factor in productivity improvement at the macro-level. The management of R&D and technology and the implementation of new methods, techniques, products and processes can significantly influence productivity and at the same time change structure: examples are the introduction of assembly lines, computers, and microprocessors, and modern communications equipment. Foreign investment is often an important factor in the introduction of new technology.

However, indiscriminate imports of technology can injure countries. There is a growing awareness of the need for indigenous technological competence and research within the countries and industries concerned.

Economy of scale or scale of production is also closely related to productivity and the industrial structure. Small and medium-sized enterprises can be fully competitive if they specialize and have long production runs. Some developing countries such as India, Indonesia, the Philippines and Thailand have deliberately promoted decentralized cottage, rural and other small-scale industry to introduce and adapt important technology and improve economic variability. In this sector, capital productivity can be high and innovative. Even reverse engineering-and technology- transfer from the small to the large-scale sector can be effective.

Industrial competitiveness affects the productivity of both the economy and individual enterprises. The European Management Forum defines industrial competitiveness as "the immediate and future ability of, and opportunities for, entrepreneurs to design, produce and market goods within their respective environments whose price and non-price qualities form a more attractive package than those of competitors abroad or in domestic markets".

The major factors affecting competitiveness:

- The dynamism of the economy measured by criteria such as growth rates, monetary strength, industrial production and per capita performance.
- Industrial efficacy, which involves direct and indirect employee costs, per capita output, employee motivation, turnover and absenteeism.
- The dynamics of the market, when efforts to improve competitiveness are increased and better directed to more intensive market forces.
- Financial dynamism that is the strength and importance of the commercial banking sector, stock and bond markets and their ability to provide capital.

- Human resources that is the dynamism of the population and the labor force, employment, unemployment, executive quality and motivation.
- The role of the State in fiscal policies and other regulations.
- Resources and infrastructure (transport and communication facilities), domestic energy and raw materials sources.
- Outward orientation, the will to promote trade actively, buying and selling goods, service-related investments or any other form of international exchange.
- Innovative forward orientation which emphasizes national research and development efforts, corporate and government attitudes to exploiting new ideas, products and production processes.
- Socio-political consensus and stability, the degree to which strategies and policies reflect a society's aspirations.

Demographic and social changes

Structural changes in the labor force are both demographic and social. The high birth rates and low mortality rates of the post-war period sent world population soaring from 2.5 thousand million in 1950 to 4.4 thousand million in 1980. By the mid-1960s, the post-war baby boom was beginning to reach the job market [10]. At the same time, the number of women entering the labor force was steadily rising. In addition to this, workers in the industrialized countries have increasingly had to compete not only with each other but also with labor from the developing countries. Productivity and wages in the developing countries tend to be lower and the total cost of production is competitive. Two different and somewhat contradictory pressures influence productivity. Producers in the more developed countries must try to increase productivity in order to hold down production costs; on the other hand, the restraining influence of competition on wages encourages producers to use more labor, rather than investing heavily in capital equipment. This tends to reduce the growth of productivity. These demographic changes have an impact on jobseekers, on worker experience and useful work kills, and on the demand for goods and services. Geographic shifts of the population will probably also affect productivity as population density varies from region to region.

Among the social factors, special attention should be paid to the increasing percentage of women in the labor force. Women's participation in the labor force is still well below that of men but it

is increasing. A change in the ratio of working men to women affects earnings. Men currently have a higher average income than women. Much of this difference has been attributed to education, full or part-time work and length of work experience. As these facts change, so, most likely, will productivity and income structure. The retirement age may drift upward, as health and longevity improve. Economic pressures may also persuade many older people to stay in the labor force.

All aspects of education affect productivity. Over the past few decades, educational spending has grown significantly. By the end of the 1970s educational expenses in Canada, for example, represented 8 percent of GDP, and government spending on education accounted for 22 percent of total government expenditure.

Cultural values and attitudes can promote or hinder productivity. For example, the Chinese are known for their belief in hard work, their entrepreneurial spirit and their propensity to save. The Japanese are famous for their ability to seek, accept, assimilate and adapt to changing needs and circumstances for their team spirit and discipline. In some countries, greater respect is traditionally given to brain power than to manual work; in others, the elderly are valued, not merely tolerated.

It is important to study and understand these beliefs, attitude and traditions, all of which change with new technology and economic development. The countries that have become development-oriented are under increasing pressure to upgrade their development policy and institutionalize social change through education and the media.

3.4.2 Natural resources

The most important natural resources are *manpower, land, energy and raw materials*. A nation's ability to generate, mobilize and use these resources is crucially important to productivity improvement and is, unfortunately, often overlooked.

Manpower

People are the most precious natural resource. Several developed countries such as Japan and Switzerland, which lack land, energy and mineral resources, have found that their most important source of growth is people, their skills, education and training, attitude and motivation, and development. Investment in these factors improves the quality of management and of the labor force. Such countries take great care to invest in education and training their manpower.

Countries with higher per capita GDP generally have a better trained and educated population. Attention to health and leisure has resulted in a tremendous saving due to less illness, longer life expectancy and increased vitality. The general quality of labor has improved with improving health.

Land

Land requires proper management, development and a national policy. For example, industrial expansion and intensive farming have become aggressive consumers of the most fundamental material input, land. Pressure to increase farm productivity per worker and per hectare can accelerate soil erosion. Such land loss can often be masked by using more fertilizer, but at increasingly high cost and at risk of environmental pollution. The rising cost of energy-intensive agricultural input, the limited availability of new land and the urgent need for more careful husbandry to prevent serious erosion, all argue for more prudent use of available land.

Energy

Energy is the next important resource. The drastic change in energy prices during the 1970s was the single most important cause of declining productivity and economic growth. Much of the capital investment that took place during that decade did little to raise labor productivity since it was directed towards retooling the economies to adjust to higher energy prices.

As the price of a barrel of oil rose from US$3 in 1973 to about US$36 in 1980, before dropping back in 1985, a considerable amount of capital stock became obsolete and urgently needed to be replaced or used less intensively. As producers cut back on energy use and capital investment, their only recourse was to use more labor. Thus, demand for labor tends to follow energy prices upwards. However, though more hours are worked, total output may not rise commensurately.

Thus, the supply of energy influences capital/labor combinations and increases or decreases productivity. This fact should be learned, understood and taken into consideration by industrial and enterprise management.

Raw materials

Raw materials are also an important productivity factor. Raw materials prices are subject to the same kind of fluctuations as oil prices, though in less extreme forms. As the richest and most accessible sources of minerals are mined out, the need to exploit lower grades of ore in more difficult locations has called for more intensive use of capital and labor. This reduces

productivity growth in mines despite increasing automation in many countries. The exploitation of increasingly marginal mines decreases productivity further.

As the costs of materials rises, the economic rationale for repair, re-use and recycling becomes more compelling since, though productivity in the strictly conventional sense is lower for such work, it is less expensive for society as a whole than buying new materials.

3.4.3 Government and infrastructure

Government policies, strategies and programs greatly affect productivity through:

- Practices of government agencies;
- Regulations (such as price control, income and wage policies);
- Transport and communications;
- Power;
- Fiscal measures and incentives (interest rates, tariffs, taxes).

Many structural changes that affect productivity result from laws, regulations or institutional practices. In addition, the whole area of government productivity itself is extremely important because it enables governments to render more services with the same resources or to provide the same services at low cost.

Here, we have considered the major internal and external productivity factors or areas for improvement and we would like to stress again that the internal factors are those under the full control of enterprise management. However, to design good policies, plans or programs for productivity improvement, all the external factors should be analyzed, understood and considered. The best way to do this is to introduce sound productivity measurement systems at all levels of society. The next chapter of this paper will focus on some aspects of productivity measurement and improvement techniques.

Chapter 4

Productivity Measurement and Improvement Techniques

4.1 The Need for Productivity Measurement

The success of productivity measurement and analysis depends largely upon a clear understanding of *why* productivity measurement is important for the effectiveness of the organization. Productivity measurement indicates where to look for opportunities to improve and also shows how well improvement efforts are faring.

Productivity indices help us to evaluate economic performance and quality of social and economic policies which influence level of technological development, the maturity of management and labor force, planning, incomes, and wages and price policies and taxation. Productivity measurement helps to identify factors affecting income and investment distribution within different economic sectors, and helps to determine priorities in decision-making. Productivity indices are also used by local and central authorities to detect problem areas and to evaluate the impact of national development programs. They provide valuable, objective information for directing public resources.

In enterprises productivity is measured to help analyze effectiveness and efficiency. Its measurement can stimulate operational improvement: the very announcement, installation and operation of a measurement system can improve labor productivity, sometimes by 5 to 10 per cent, with no other organizational change or investment [10].

Productivity indices also help to establish realistic targets and check-points for diagnostic activities during an organization development process, pointing to bottle-necks and barriers to performance. Furthermore, there can be no improvement in industrial relations or proper correspondence between productivity, wage levels and gains-sharing policies without a sound measurement system.

Productivity indices are also useful in inter-country and inter-firm comparisons designed to direct factors accounting for economic growth. That is why productivity measurement should be among the first priorities for any productivity improvement project manager, both at the national and enterprise level. To achieve a balance between productivity, profits and prices, a sound

productivity measurement system must be an integral part of the management information system.

4.2 Causes of Productivity Decline in Companies

Mali [1978, pp. 24-32] discusses in length 12 causes for the decline of productivity in firms:

1. Inability to measure, evaluate, and manage the productivity of white-collar employees. This causes a shocking waste of resources.
2. Rewards and benefits given without requiring the equivalent in productivity and accountability. This causes spiraling inflation.
3. Diffused authority and inefficiency in complex organizations, thereby causing delays and time lags.
4. Organizational expansion that lowers productivity growth. This results in soaring costs.
5. Low motivation among a rising number of affluent workers with new attitudes.
6. Late deliveries caused by schedules that have been disrupted by scarce materials.
7. Unresolved human conflicts and difficulties in team work, resulting in the firm's ineffectiveness.
8. Increased legislative intrusions or antiquated laws, resulting in constrained management options and prerogatives.
9. Specialization in work processes resulting in monotony and boredom.
10. Rapid technological changes and high costs, resulting in a decline in new opportunities and innovations.
11. Increasing demand of leisure time causing disruption of time commitments.
12. Practitioners' inability to keep pace with latest information and knowledge.

4.3 Productivity Measurement Methods

While it is easy to define, it is notoriously difficult to measure productivity, especially in the modern economy. In particular, there are two aspects of productivity that have increasingly challenged precise measurement: *output*, and *input*. Properly measured, output should include not just the number of product coming out of a factory, but rather the value created for consumers. In today's economy, value depends increasingly on product quality like appropriateness, customization, convenience, variety and other intangibles.

Similarly, a proper measure of inputs includes not only labor hours, but also the quantity and quality of capital equipment used, materials and other resources consumed, worker training and education, even the amount of organizational capital required, such as supplier relationships cultivated and investments in new business processes.

At the macro-level, productivity measurement means the evaluation of the absolute level of productivity and its historical trends expressed through a series of indices. Without such measurement Gross Domestic Product (GDP), Gross National Product (GNP), National Income (NI) or Value Added (VA) may not reflect a true picture of the nation's or sector's economic health [10]. For example, GDP may increase year after year, but productivity may actually be on the decline when cost of input has increased faster than output.

Two types of productivity ratio can be used to measure productivity in all economic levels.

$$\text{Total productivity} = \text{Total output} \,/\, \text{Total input}$$

$$\text{Partial productivity} = \text{Total output} \,/\, \text{Partial input}$$

Total productivity

Total productivity is the ratio of the total output of all products and services to the total resource inputs which can be disaggregated into separate product and service productivity.

Total productivity can be measured by the formula:

$$P_t = O_t / (L + C + R + Q)$$

Where P_t = total productivity, O_t = total output, L= labor input factor, C= capital input factor, R= raw material and purchased parts input, Q = miscellaneous goods and services input factor.

Considering the impact of all input factors on the output in a tangible sense, total productivity in firm level and total productivity of products are defined as below.

$$\text{Total productivity} = \text{Total tangible output} / \text{Total tangible inputs}$$

$$\text{Total productivity in a firm} = \text{Total output of the firm} / \text{Total input of the firm}$$

$$\text{Total productivity of product i, } TP_i = \text{Total output of product i} / \text{Total input for product i}$$

Total tangible output includes value of finished units produced, value of partial units produced, dividends from securities, interest from bonds, and other income. Total tangible input includes value of human, material, capital, energy and other expense inputs used.

For a better detail, types of tangible inputs are listed as follow:

- Human - Workers, Managers, Professionals, Clerical staff.

- Fixed capital - Land, Plant (buildings and structures), Machinery, Tools and equipment, and others
- Working capital - Inventory, Cash, Accounts receivable, Notes receivable.
- Materials - Raw materials, Purchased parts
- Energy - Oil, Gas, Coal, Water, Electricity etc.
- Other expense -Travel, Taxes, Professional fees, Marketing, R&D, etc.

The multi-factor productivity measurement model (MFPMM) was developed for measuring productivity and price recovery, and for explicitly relating these results with profitability at the organizational/ functional levels (Sink, 1985).Its primary focus is on a manufacturing/production unit with tangible outputs and inputs. It is suitable for a process that is stable, implying not-so-often changes in products being offered. Figure 4.1shows the major components of the model.

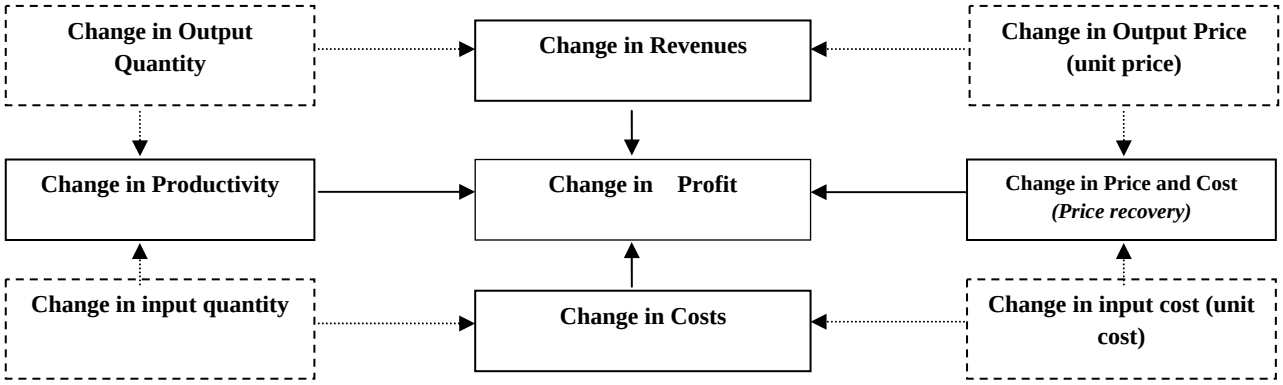

Fig 4.1: The basic component for MFPMM.

Total productivity is the average of labor and capital productivity weighted and adjusted to price fluctuations. It can be calculated either by a labor-time or by a financial method.

Labor-time methods

All materials, depreciation, services and final products can be converted into manpower equivalents by dividing the output by input in financial terms, this being divided again by the national (or sectoral) average annual income per employee, i.e.:

Sale output / (Total number of employees + (Capital + External expenses) / (Average earnings per annum))

To overcome the complexity of the above indices net output, or value added per worker, can be used as a measure for productivity where VA represents the value added to materials by the production process.

Net output per employee = (Added value per annum / Total number of employees) = VA / $L_{y.}$

Value added is obtained by subtracting input from output, or

VA = S – X, where S= Total sales, and X = external expenses.

In some cases "work-hours completed" might be a better unit to use than "number employed" since we are measuring the effectiveness of the workers.

Financial Methods

Where productivity indices cannot be obtained directly, financial ratios can be used

Value added = Sales – (R_m + B + W + D)

Total productivity is:

P_t = Added value / Conversion costs = **(Sales- (R_m + B + W + D)) / (L + S_c + R_m + B + W + D + S_a)**

Sales	Raw materials consumed	R_m	External expenses
	Bought-out items	B	
	Work services	W	
	Depreciation	D	
	Labor costs	L	Added value
	Salary costs	S_c	
	Selling, administration and distribution costs	S_a	
	Profit	P_r	

Figure 4.2. Elements of output used in calculating total productivity

Components of a productivity measurement system

Irrespective of the kind of organization (manufacturing, mining, service, government-profit seeking or nonprofit seeking) a productivity measurement system has the following basic components to be applied.

1. A statement of the objectives of the organization.
2. A list of the units of output of the organization.
3. Standard time, standard cost, raw material use, equipment use, tool use etc., for each kind of output.
4. A method of building a zero base budget using forecasts of outputs, standard times and forecasts of the productivity.
5. A means of computing the productivity indexes at selected intervals.
6. A means of comparing output forecasts with actual output at selected intervals.

7. A means of adding resource usage data and associated productivity indexes in a meaningful fashion related to outputs to reduce the details in reports as data go to higher-and higher-level managers.

Labor productivity

At the national level, labor productivity is computed by taking the *entire economically active population* as the input and the *total value of goods and services produced* as the input.

National productivity = GNP / Population

National or sectoral labor productivity is often measured in terms of physical output per work-hour. However, this measure is generally unsatisfactory because the amount of work required to produce a unit of output varies for different products. For this reason *labor-time* methods of measurement (hour, day or year) are better. Here, output is converted into "units of work", which are commonly defined as the amount of work that can be performed in one hour by a qualified worker working at standard performance.

Total productivity and the *profit/total investment index* seem to be the most appropriate approaches to measuring the productivity of the manufacturing sector. Using the total productivity approach, two measures of output are normally adopted: total production and gross value added. Total production is defined as the sum of the producers' shipments and net inventory stock changes; the gross value added is the difference between total production and intermediate input. Capital input is measured in terms of gross capital stock for which no adjustment is made. For labor input, the number of workers is taken as basic information. Average annual cash earnings and hours worked are taken from the sectoral statistics. The relative share of labor can be derived from the ratio of annual cash earnings to gross value added at constant prices and capital. To calculate total factor productivity, labor input is measured in two ways: the number of employed persons and work-hours.

The total factor productivity index is defined as: $P_t = V_t / I_t$ where V_t and I_t are total output and total input indices respectively.

It is very important in manufacturing industries to measure the productivity of indirect labor. For example, the productivity of materials handlers or maintenance men may be measured by the equation:

Productivity index = (No. of indirect labor hours to serve direct labor) / (No. of direct labors hours)

4.4. Productivity Improvement Techniques

4.4.1 Industrial Engineering Techniques and Economic Analysis

Work Study

Work study is a term that denotes the techniques of *method study* and *work measurement* which are employed to insure the best possible use of all the available resources, labor and material, in carrying out a specific activity. It is specifically concerned with productivity since it is used to increase the amount produced from a given quantity of resources without further capital investments. Hence, work study is of interest to a manager, because it is concerned with all the resources a management process, and their systematic improvement so that they are efficiently and effectively utilized.

The aim of work study is to improve productivity and not to make the worker be more work harder. That is productivity will not always need working harder but smarter. Moreover, work study needs to be applied continually to update and bring for further improvement.

Method study is the systematic recording and critical examination of existing and proposed ways of doing work in order to develop and apply easier and more effective methods and to reduce costs. Its philosophy is that there is always a better way of doing things. It consists of systematic analysis of the present method and bringing about improvement through critical examination. The steps are:

- Select the work to be studied.
- Record from direct observation everything that happens.
- Examine the recorded fact critically and challenge everything that is done.
- Develop the best method under the present prevailing conditions.
- Install the method chosen as standard practice.
- Maintain the standard practice by regular checks.

Better layout of workplace, improved utilization of resources and improved working condition are some of method study contributions.

Continuous Improvement Methods

These methods include, lean manufacturing, TQM, TOCs, agile manufacturing and six sigma. Japanese manufacturing techniques, also known as JIT method, and more recently popularized

under the name of ‘lean manufacturing’, are considered to be the leading edge of manufacturing strategy and are being adopted by companies throughout the world.

4.4.2. Management through Value Analysis

These improvement techniques include Cost-Benefit Analysis, Zero-based Budgeting, Cost-Productivity Allocation, Behavioral Techniques, Organization Development, Brainstorming, Force-Field Analysis, Nominal Group Technique.

4.5. Productivity Improvement Strategy

Productivity strategy is the pattern of decisions in the organization that determine its objectives, procedure and principal policies and plans for achieving long-term productivity improvement goals. A good productivity improvement strategy should: develop a clear and easily communicated definition of the productivity improvement concept; explain why organizational improvement is important; evaluate and reason out the current operating status; develop model for excellence; and develop improvement policies and plans.

Overcoming internal and external problems and raising productivity needs a considerable effort from both the government and the plant. The lines of approach to solving the problems can be divided into three strategies, namely short term, medium term, and long term strategies:

Short Term Strategies

The first short term action involves *improving organizational planning and control*. An effort, made in this line, to implement planned maintenance of machinery and effective production system in plants would show an increase in machine productivity and reduction in maintenance cost. Increasing manpower *efficiency* and *effectiveness* at all levels through motivation, training and education is a second action for improvement. This method has proved itself successful in Japan. And the third short term line of attack is *improving operation methods*. The techniques of method study involve breaking a process into detailed components. The study may result in elimination of an activity, combination of several activities, change of sequence of activities, shortening duration of activities etc. As Frederik Taylor said "*Most of us can do three or four times as much as we ordinarily do without lengthening working hours or even driving ourselves to exhaustion by the day`s end*". In fact, to achieve this, effective implementation of the method engineering is required [7].

Medium Term Strategies

At this stage the firm may require capital to simplify and improve the products, and reduce variety. The analysis consists of common sense questions to come up with effective solutions like substitution of alternative materials, elimination of parts where special designs have been specified, redesign, etc.

Long Term Strategies

This certainly requires capital to provide more improved physical means of production and improve basic processes by R&D. Properly selected new machineries, well organized departments and proper layout will undoubtedly contribute to an increase in productivity. Furthermore, research and development is the backbone for productivity increment. It is believed that developed countries are spending 3 per cent of the per capita income to R&D while the developing countries are devoting 0.2 per cent of the low per capita income they earn. With these kinds of importance given to R & D the technology gap continues to increase at a very high rate.

4.6. Global Trends in Productivity Improvement

The productivity of firms in developing countries appears to be extremely low. Table 4.2 reports GDP per capita, and average firm-level sales per employee in manufacturing – commonly known as labor revenue productivity - across a sample of countries from a new international firm database (ORBIS). While there are some data comparability issues, the broad message seems clear: developing country firms have lower levels of labor productivity.

Table 4.1 Average firm labor revenue productivity across countries

Country	GDP per capita, dollars	Sales per employee, dollars
U.S.	42,736	433,884
U.K.	37,886	457,674
Japan	35,699	428,336
France	35,100	393,024
Germany	33,838	379,341
Greece	22,410	320,859
Poland	7,967	178,525
Brazil	4,787	144,831
Colombia	3,170	150,198
Ecuador	2,814	71,263
Morocco	1,952	105,271

China	1,761	66,885
Indonesia	1,249	80,203
Philippines	1,090	102,975
India	741	120,656
Ethiopia	153	-

Notes: GDP per capita from the IMF 2005 in $PPP. Sales / Employee in current $, across all firms in the ORBIS database, using the most recent accounts.

Why do firms in developing countries have low productivity? [11]

Prior work has highlighted a set of issues around *infrastructure, informality, regulations, trade policies, and human capital* that reduce the productivity of firms in developing countries. In addition, there are three other areas which require recent emphasis: *management practices, financial constraints and the delegation of decision making.*

To summarize, we find evidence that firms in developing countries are often badly managed, which substantially reduces their productivity. This appears particularly important in larger firms (100+ employees), which are operationally complex so that effective coordination and motivation require formalized management practices. We also find that financial constraints are a binding factor for growth, notably in smaller firms. In larger firms, which often appear to have already overcome financing constraints, another growth constraint arises in the inability of firms to successfully decentralize decision making. In developing countries owners tend to make almost all major management decisions because of fears of expropriation by their managers. But, because the owners' time is limited, they only have the capacity to make decisions for firms up to a certain size. Thus, without delegating decision-making these firms find that growth becomes unprofitable, or even impossible, because decisions are constrained by their owners' time. This suggests that productive firms in developing countries like India and China do not expand as rapidly as their US counterparts is due to a mix of financial factors (particularly for smaller firms) and organizational factors (particularly for larger firms).

4.7. Major Differences between This Research and Earlier Works

Previously made researches on the areas of manufacturing enterprise productivity, especially in Ethiopian context, are very limited. The existing research papers do not have a deep look at in the internal and external factors of productivity for the country wide manufacturing

establishments. Most of the available papers focus on productivity improvement aspects in some specific systems or enterprises.

Trends of the manufacturing enterprises with regard to their value addition, labor force utilization, and material usage is covered in this work to observe the performance of the enterprises.

This paper, unlike the other previous works, is devoted to investigate, analyze, and address the most critical factors that significantly affect the productivity of Ethiopian manufacturing enterprises especially those that are in medium and large scales of production. Moreover, the study finds out the root causes for decline in productivity in the existing manufacturing industries.

The other special features of this paper include coverage of the representative experiences of most of the manufacturing industries that exist in Ethiopia, their productivity level, critical success factors, major obstacles, and potential capabilities with regard to productivity improvement.

Chapter 5

Data Collection and Analysis

5.1. Overview of the Ethiopian Manufacturing Industries

Manufacturing, in Ethiopian Central Statistical Agency (CSA) context, is defined according to International Standard Industrial Classification as "the physical or chemical transformation of materials or components into new products, whether the work is performed by power-driven machines or by hand, whether it is done in the factory or in the workers' home, and whether the products are sold at wholesale or retail. Assembly of the component parts of manufactured products is also considered as manufacturing activities." [14]

According to the Ethiopian Central Statistical Agency Survey Report [15], manufacturing establishments in Ethiopia are generally divided into three major groups. These are:-

1) Large and Medium Scale Manufacturing Establishments, engaging 10 or more persons and using power-driven machinery.
2) Small Scale Manufacturing Establishments, engaging less than 10 persons and using power driven machinery.
3) Cottage/Handicraft Manufacturing Establishments, performing their activities by hand (i.e., using non-power driven machinery).

The statistical survey conducted in 2007/08 indicates that there are more than 43,300 small scale manufacturing industries in Ethiopia, engaging nearly 139,000 people [15]. The establishments are classified into 14 industrial groups, out of which grain mills (53.2%), furniture manufacturers (19.8%), fabricated metal manufacturers (10.1%) and wearing apparel, dressing & dyeing of fur (7.2%) constitute the most significant share in number. The remaining 9.7% includes the manufacturers of food products, textiles and other non-metallic mineral products.

The survey further shows that gross value of production (GVP) and value added (VA) in the stated period amounted to birr 2.79 billion and birr 1.14 billion respectively. The significant amount of VA indicates the contribution of the small scale establishments to the gross domestic product (GDP) or the national economy during the year.

On the other hand, the total number of large and medium scale manufacturing establishments for the country as a whole stood at 1930 in 2007/08, engaging 133,673 people all together [14]. The

data that illustrates the distribution of large and medium scale industries and number of persons engaged by major industrial groups in 2003/04(1996 E.F.Y) & 2007/08(2000E.F.Y) is presented in Table 5.1.

Table 5.1 Distribution of Large and Medium scale Industries and Number of Persons Engaged by Major Industrial Groups in 2003/04 & 2007/08 (1996 & 2000E.F.Y)

S/N	Manufacturing Industrial Group	No. Industries		No. People Engaged		Peop. to Ind. ratio	
		2003/04	2007/08	2003/04	2007/08	2003/04	2007/08
1.	Food products and beverages	322	485	31,589	41,681	98.10	85.94
2.	Tobacco products	1	1	785	1,254	785	1254
3.	Textiles	38	25	22,914	12,095	603	483.8
4.	Wearing Apparel, Except Fur Apparel	37	39	3,840	7,635	103.79	195.77
5.	Tanning and Dressing of Leather; Manufacture of Footwear, Luggage and Handbags	65	83	7,718	8,650	118.74	104.22
6.	Wood and of Products of Wood and Cork, Except Furniture	20	70	1,639	3,231	81.95	46.16
7.	Paper, Paper Products and Printing	98	143	6,955	8,941	70.97	62.52
8.	Chemicals and Chemical Products	46	80	5,075	7,778	110.33	97.23
9.	Rubber and Plastic Products	42	82	4,412	8,751	105.05	106.72
10.	Other Non-Metallic Mineral Products	123	488	9,266	17,687	75.33	36.24
11.	Basic Iron and Steel	13	15	1,700	1,329	130.77	88.6
12.	Fabricated Metal Products Except Machinery and Equipment	78	101	3,516	5,237	45.08	51.85
13.	Machinery and Equipment N.E.C.	11	4	267	206	24.27	51.5
14.	Motor Vehicles, Trailers & Semi-Trailers	8	15	1,132	1,727	141.5	115.13
15.	Furniture; Manufacturing N.E.C.	172	299	5,343	7,471	31.07	24.99
Total		**1,074**	**1,930**	**106,151**	**133,673**	**98.84**	**69.26**

The total number of manufacturing firms shows a significant increase of nearly 80% within the five years [2003/04-2007/09] trend. Similarly, the number of employees engaged in each industrial group shows a visible increase except in the manufacturers of textiles, basic metals (iron & steel), and machinery & equipment N.C.E, which indicate a decline in employees engagement. The number of people engaged in the manufacturing firms show, in average, 26% increase within the considered five years period.

Another important aspect to be observed in the Table 5.1 is the trend for the number of people to industry ratio of the manufacturing firms within the specified five years period. All industrial groups faced a decrease in this ratio except the manufacturers of tobacco products, wearing apparel, fabricated metal products, machinery and equipment N.E.C. and rubber and plastic products, which collectively show increased values. In average, the engaged people to industry

ratio for the entire manufacturing firms indicates a decline (i. e. 69) in 2003/04 as compared to the value (99) in 2007/08.

Here, by considering the engaged people to industry ratio together with the amount value added in the same period (Table 5.3), it can be implied that the manufacturing industries are introducing some degree of automation into their manufacturing systems which caused the reduction of labor force engagement and increment of value added.

5.2. Trends in the Gross Value of Production

Considering all the manufacturing categories, the gross value of production in the firms is shown in Table 5.2. From the table it can be observed that the total sum of gross values is increasing seriously from birr 8,133.1 millions in the fiscal year 1992 to birr 22,986.4 millions in 2000 except for the year 1994 E.F.Y, which shows a declined value of birr 8,091.7 millions.

On average, roughly half (48%) of the gross value of production is contributed from the two manufacturing categories, namely, food products & beverages (37%) and other non-metallic mineral products (11%). The least values are contributed from the manufacturers of machinery and equipments N.E.C. (0.2%), wood and products of wood and cork except furniture (0.5%), and wearing apparels except fur apparel (1%).

Table 5.2. Gross Value of Production by Industrial Group 1999/2000 (1992 E.F.Y) - 2007/2008 (2000 E.F.Y)

S/N	Manufacturing Industrial Group	Gross Value of Production [in 000,000's Birr]										
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Average**	**% Aver.**
1.	Food products and beverages	3,337.2	3,335.5	3,136.3	3,577.4	3,996.1	4,418.4	5,403.8	5,975.9	8,751.4	4659.1	36.9
2.	Tobacco products	261.5	250.4	256.8	256.8	364.0	324.6	415.2	467.3	568.7	351.7	2.8
3.	Textiles	603.3	699.9	675.4	751.9	956.4	897.3	918.4	1,098.0	693.6	810.5	6.4
4.	Wearing Apparel, Except Fur Apparel	62.7	55.7	57.6	73.1	86.5	62.6	80.5	273.2	388.4	126.7	1.0
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	591.3	840.0	825.3	790.5	813.1	984.7	1,022.7	1,213.8	1,447.2	947.6	7.5
6.	Wood and of Products of Wood and Cork, Except Furniture	34.3	40.4	41.2	61.2	58.4	58.0	71.8	91.1	118.7	63.9	0.5
7.	Paper, Paper Products and Printing	344.2	379.2	431.2	433.7	612.9	780.2	795.9	964.8	1,236.5	664.3	5.3
8.	Chemicals and Chemical Products	468.5	518.0	513.5	573.4	726.4	788.8	930.0	1,156.9	1,733.4	823.2	6.5
9.	Rubber and Plastic Products	380.6	439.1	467.1	488.1	557.3	688.2	983.1	1,064.8	1,484.5	728.1	5.8
10.	Other Non-Metallic Mineral Products	599.3	635.5	694.4	1,022.8	1,179.6	1,163.8	1,675.7	2,513.9	3,068.9	1394.9	11.1
11.	Basic Iron and Steel	235.5	403.7	454.5	382.7	761.8	1,085.3	1,374.1	1,473.0	1,081.3	805.8	6.4
12.	Fabricated Metal Products Except Machinery and Equipment	116.1	151.4	163.0	218.1	299.6	474.0	527.7	728.2	1,203.5	431.3	3.4
13.	Machinery and Equipment N.E.C.	6.1	5.5	6.0	8.8	14.5	13.7	136.5	15.7	27.9	26.1	0.2
14.	Motor Vehicles, Trailers & Semi-Trailers	965.0	567.5	228.6	190.0	275.3	243.2	422.9	1,237.4	789.9	546.6	4.3
15.	Furniture; Manufacturing N.E.C.	127.4	117.7	140.7	195.7	169.7	333.7	288.6	308.3	392.5	230.6	1.8
	Total	***8,133.1***	***8,439.7***	***8,091.7***	***9,024.2***	***10,871.8***	***12,316.4***	***15,047.1***	***18,582.4***	***22,986.4***	***12,610.3***	***100***

5.3. Trends in the Value Addition

Table 5.3 shows the distribution of the amount value added by major industrial groups in the nine years period (1992-2000E.F.Y). The results in the table indicate that the amount value added has inconsistent trend with more ups and less downs for each industrial group except for the fabricated metal products which shows a continuous increment. More particularly, manufacturers of paper products & printing, non-metallic mineral products and furniture have attained a continuous growth in the amount value added except for the fiscal years 1998, 1997, &1993 respectively, within which decreased values were observed.

Moreover, the table & figure 5.1 summarize that the total value added by the industrial groups for the nine consecutive fiscal years has an increasing trend except in 1994 E.F.Y, which resulted in a slight decline. The total value added by the industries has risen up nearly threefold from Birr 3.3 billion in 1992E.F.Y. to Birr 9.2 billion in 2000 E.F.Y. within the nine years period. It can also be observed from the table that the average annual value added amount by the manufacturing firms is calculated nearly to be Birr 5.02 billion.

The percentage distribution of value added, which indicates the contribution level of large & medium scale manufacturing industries to the total value added in the manufacturing sector by the industrial groups, is summarized in Table 2.4 for the period 1992-2000 E.F.Y. [1999/00-2007/08]. The data in the table shows the fact that the contribution of food & beverages manufacturing industrial groups to the value added was significantly higher than the other industrial groups, throughout the period under review. During 2000E.F.Y, nearly 62 percent of the total manufacturing value added was generated from manufacturers of food & beverages (38.4%) and other nonmetal mineral products (23.1%).

The other non-metallic mineral manufacturing establishments became the second most important industrial group in terms of both employment creation and contributing a significant share in manufacturing value added in 2000E.F.Y.

Table 5.3 Distribution of Value Added by Major Industrial Groups 1992-2000E.F.Y (1999/00-2007/08)

S/N	Manufacturing Industrial group	Value added in the national account concept (at market price) [in '000 Birr]									
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**Average**
1.	Food products and beverages	1,599,752	1,765,658	1,568,373	1,865,215	2,030,009	2,077,748	2,401,699	2,792,055	3,876,935	**2219716**
2.	Tobacco products	173,453	151,088	142,336	241,003	241,003	205,697	261,376	283,167	344,048	**227019**
3.	Textiles	206,988	221,917	192,713	203,285	238,886	267,072	228,940	331,423	195,118	**231815.78**
4.	Wearing Apparel, Except Fur Apparel	21,085	18,571	20,440	31,978	35,004	24,834	30,712	97,940	114,544	**43900.889**
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	140,689	152,448	188,737	147,297	189,159	181,624	242,894	257,955	366,216	**207446.56**
6.	Wood and of Products of Wood and Cork, Except Furniture	16,330	21,418	21,329	35,359	31,244	30,821	36,147	41,799	54,133	**32064.444**
7.	Paper, Paper Products and Printing	154,368	160,786	182,130	185,924	248,991	333,590	313,535	369,239	470,942	**268833.89**
8.	Chemicals and Chemical Products	160,147	156,083	165,251	196,132	259,230	243,776	254,150	365,611	530,710	**259010**
9.	Rubber and Plastic Products	147,090	167,253	197,430	214,906	247,366	231,707	421,618	354,673	445,516	**269728.78**
10.	Other Non-Metallic Mineral Products	266,773	273,347	300,623	439,750	503,801	415,193	784,046	1,397,838	1,707,345	**676524**
11.	Basic Iron and Steel	74,491	94,935	122,554	101,062	202,650	361,192	306,216	325,723	280,055	**207653.11**
12.	Fabricated Metal Products Except Machinery and Equipment	44,145	52,306	63,777	74,911	114,412	153,246	176,434	355,495	442,180	**164100.67**
13.	Machinery and Equipment N.E.C.	2,518	2,549	2,161	2,753	4,189	3,703	28,767	4,796	9,335	**6752.3333**
14.	Motor Vehicles, Trailers & Semi-Trailers	226,257	128,477	69,420	47,051	-1,650	47,736	111,136	347,419	168,299	**127127.22**
15.	Furniture; Manufacturing N.E.C.	49,755	48,689	57,301	70,537	74,756	138,535	118,762	131,382	162,072	**94643.222**
Total		**3,283,842**	**3,415,524**	**3,294,574**	**3,758,495**	**4,419,050**	**4,716,433**	**5,716,433**	**7,456,516**	**9,167,447**	**5,025,368.2**

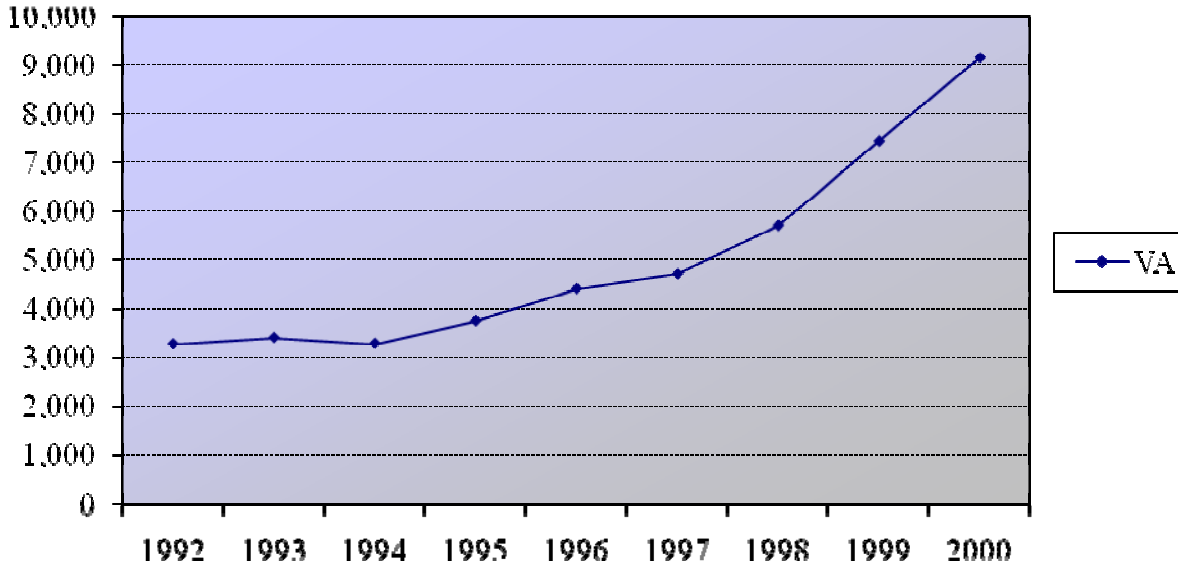

Figure 5.1 Average value added by major industrial groups (nine years trend)

Table 5.4 Percentage Distribution of Value Added by Major Industrial Groups 1992-2000E.F.Y (1999/00-2007/08)

S/N	Manufacturing Industrial group	Value added in the national account concept (at market price) [in Percent]									
		1992	1993	1994	1995	1996	1997	1998	1999	2000	Average
1.	Food products and beverages	45	50.8	45.3	46.9	45	41.9	40.3	36.5	38.5	43.36
2.	Tobacco products	4.6	2.8	4.1	3.5	5.3	3.4	3.7	2.8	3.5	3.74
3.	Textiles	5.8	5.9	4.9	4.2	4.3	5.7	3.4	4.2	1.5	4.43
4.	Wearing Apparel, Except Fur Apparel	0.7	0.6	0.6	0.9	0.7	0.5	0.6	1.2	1.2	0.78
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	4.5	4.8	6.8	4.4	5	4.5	4.4	3.1	4.4	4.66
6.	Wood and of Products of Wood and Cork, Except Furniture	0.6	0.7	0.8	1	0.9	0.9	0.8	0.7	0.7	0.79
7.	Paper, Paper Products and Printing	5.8	5.9	6.6	5.5	6.2	8	5.3	5.5	5.5	6.03
8.	Chemicals and Chemical Products	5.2	4.6	5.3	5.7	6.7	5.4	4.9	4.9	6	5.41
9.	Rubber and Plastic Products	4.6	5.7	6.1	6	6.2	5.5	8.9	4.6	4.5	5.79
10.	Other Non-Metallic Mineral Products	8.9	8.6	9.7	13.6	12.4	8.7	15.7	22.1	23.2	13.66
11.	Basic Iron and Steel	2.1	2	3.1	2.4	3.7	7.9	3.9	2.8	2.5	3.38
12.	Fabricated Metal Products Except Machinery and Equipment	1.4	1.6	2	1.9	2.7	3.4	3	5.4	3.9	2.81
13.	Machinery and Equipment N.E.C.	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.12
14.	Motor Vehicles, Trailers & Semi-Trailers	8.9	4.3	2.5	1.6	-1.2	0.5	2.4	4	2.4	2.82
15.	Furniture; Manufacturing N.E.C.	1.8	1.6	2.1	2.3	2	3.6	2.4	2.1	2.1	2.22
	Total	100	100	100	100	100	100	100	100	100	100

Figure 5.2 Average Percentage Distribution of Value Added by Major Industrial Groups 1992-2000E.F.Y (1999/00-2007/08)

5.4. Cost of Labor Relative to GVP- As an Indicator of Labor Productivity

The ratio of cost of labor to gross value of production (GVP) for major industrial groups, which roughly measures labor productivity, is treated in Table 5.5. It is evident from the data that the ratio of cost of labor to gross value of production varies across major industrial groups. In the average, the highest (0.255) and the lowest (0.033) ratios were registered in manufacture of wearing apparel and manufacture of basic iron and steel, respectively. Here the smaller value obviously shows the higher labor productivity.

The ratio of cost of labor to gross value of production for all manufacturing industries combined, showed slight fluctuation from year to year during the period under review. The maximum ratio of 0.119 was observed in 1995 E.F.Y; and the minimum ratio of 0.09 was in 1999E.F.Y.

5.5. Major Reasons for the Inefficiency of the Manufacturing Firms

Based on the CSA Survey Reports-2005 & 2009 [13, 14], the percentage distribution of establishments by first two major reasons for: (A) *not being fully operational*, (B) *not working at full capacity* & (C) *operational problems faced* in 2003/2004 (1996 E.F.Y) and 2007/08 (2000E.F.Y) is displayed in Tables 5.6 a and b. In the survey, those establishments that worked less than 12 months, those which were not working at full capacity, and those that faced operational problems during the reference periods were independently asked to state their reasons for the respective inefficiency.

The enterprises forwarded various reasons for the respective questions, among which, shortage of supply of raw materials and spare parts, absence of market demand, shortage of electricity and water supply, lack of working capital, absence of credit facility, frequent machine failure, lack of foreign exchange, government rules & regulations, and lack of adequate skills contributed the lion's share for inefficiency.

Consequently, 31 percent among 299 establishments in 1996 E.F.Y and 38 percent among 704 establishments in 2000 E.F.Y which operated less than 12 months indicated that shortage of supply of raw materials stood as the first major reason for not working the whole year. In the same report, 28 percent of the establishments in 1996 E.F.Y and 9.23 percent of the establishments in 2000 E.F.Y stated, respectively, that the absence of market demand and shortage of electricity & water supply are the second major reasons for operating less than 12 months.

As illustrated in the same table (Table 5.6 a & b), 44 percent among 967 enterprises in1996 E.F.Y reported the shortage of raw materials as the first major reason and 18 percent among 1,712 enterprises in 2000 E.F.Y reported the same reason as the second major cause for not working at their full capacity. On the other hand, absence of market demand is reported as the first major reason by 44 percent of 967 enterprises in 1996 E.F.Y. and as a second major reason by 18 percent of 1,712 enterprises in 2000 E.F.Y for working below capacity.

Similarly, 34 percent among 1,044 enterprises in 1996 E.F.Y and 13 percent among 1,885 enterprises in 2000 E.F.Y, respectively, reported the absence of market demand as the first and the second major reasons for the operating difficulty they faced. Conversely, 27 percent among 1,044 enterprises in 1996 E.F.Y and 34 percent among 1,885 enterprises in 2000 E.F.Y stated,

respectively, that the shortage of supply of raw materials was the second major reason in 2000 E. F.Y and the first in 1996 E.F.Y.

Hence, the above analysis, which is based on the two survey reports [13, 14] conducted in five years interval, implies that the shortage of raw materials is the most frequent and the first major cause for the inefficiency of the Ethiopian manufacturing enterprises. Competently, absence of market demand is also another major reason for enterprise inefficiency followed by shortage of electricity and water supply and shortage of working capital & credit facilities.

Table 5.5 Ratio of Cost of Labor to Gross Value of Production by Major Industrial Group 1992 - 2000 E.F.Y (1999/00 - 2003/04

S/N	Manufacturing Industrial Group	Ratio of cost of labor to GVP									
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	Average
1.	Food products and beverages	0.059	0.066	0.086	0.081	0.076	0.073	0.072	0.073	0.067	**0.073**
2.	Tobacco products	0.038	0.046	0.053	0.053	0.036	0.043	0.055	0.056	0.108	**0.054**
3.	Textiles	0.185	0.162	0.177	0.153	0.154	0.131	0.144	0.122	0.140	**0.152**
4.	Wearing Apparel, Except Fur Apparel	0.243	0.295	0.290	0.294	0.242	0.207	0.316	0.224	0.188	**0.255**
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	0.090	0.072	0.074	0.073	0.067	0.070	0.072	0.060	0.061	**0.071**
6.	Wood and of Products of Wood and Cork, Except Furniture	0.198	0.163	0.177	0.175	0.194	0.183	0.172	0.184	0.196	**0.182**
7.	Paper, Paper Products and Printing	0.123	0.125	0.122	0.125	0.099	0.097	0.107	0.099	0.113	**0.112**
8.	Chemicals and Chemical Products	0.062	0.059	0.073	0.077	0.064	0.072	0.60	0.076	0.061	**0.127**
9.	Rubber and Plastic Products	0.064	0.064	0.069	0.072	0.069	0.069	0.055	0.059	0.054	**0.064**
10.	Other Non-Metallic Mineral Products	0.080	0.085	0.082	0.070	0.063	0.066	0.059	0.044	0.074	**0.069**
11.	Basic Iron and Steel	0.050	0.035	0.037	0.051	0.028	0.026	0.022	0.021	0.025	**0.033**
12.	Fabricated Metal Products Except Machinery and Equipment	0.133	0.129	0.124	0.121	0.100	0.072	0.079	0.062	0.056	**0.097**
13.	Machinery and Equipment N.E.C.	0.199	0.181	0.129	0.174	0.084	0.098	0.078	0.102	0.64	**0.187**
14.	Motor Vehicles, Trailers & Semi-Trailers	0.016	0.026	0.057	0.081	0.071	0.073	0.057	0.037	0.050	**0.052**
15.	Furniture; Manufacturing N.E.C.	0.171	0.189	0.134	0.181	0.170	0.152	0.122	0.136	0.139	**0.155**
Average		**0.114**	**0.113**	**0.112**	**0.119**	**0.101**	**0.095**	**0.134**	**0.090**	**0.131**	**0.112**

Table 5.6 a Percentage distribution of establishments by first two major reasons for inefficiency and Industrial Group

In the table **A** represents the first two major reasons for not being fully operational, **B** represents first two major reasons for not working at full capacity & **C** represents the type of first two major operational problems faced. Similarly, **SSRM** is shorthand for Shortage of Supply of Raw Materials, **AMD** is shorthand for Absence of Market Demand, and **SEWS** is for Shortage of Electricity & Water Supply.

.S/N	Manufacturing Industrial Group	Type of Reasons vs. % out of Concerned No. Firms -1996E.F.Y								
		A			B			C		
		SSRM	AMD	% total	SSRM	AMD	% total	SSRM	AMD	% total
1.	Food products and beverages	23	35	***58***	24	53	***77***	23	38	***61***
2.	Tobacco products	-	-	-	-	100	***100***	-	100	***100***
3.	Textiles	50	17	***67***	40	29	***69***	32	29	***61***
4.	Wearing Apparel, Except Fur Apparel	17	17	***34***	34	34	***68***	22	27	***49***
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	17	46	***63***	30	44	***74***	37	29	***66***
6.	Wood and Products of Wood and Cork, Except Furniture	75	-	***75***	40	25	***65***	40	35	***75***
7.	Paper, Paper Products and Printing	14	14	***28***	24	59	***83***	22	35	***57***
8.	Chemicals and Chemical Products	25	33	***58***	39	27	***66***	29	29	***58***
9.	Rubber and Plastic Products	13	13	***26***	43	29	***72***	31	28	***59***
10.	Other Non-Metallic Mineral Products	51	23	***74***	50	28	***78***	43	28	***71***
11.	Basic Iron and Steel	-	-	-	33	17	***50***	54	-	***54***
12.	Fabricated Metal Products Except Machinery and Equipment	31	8	***39***	21	53	***74***	15	33	***48***
13.	Machinery and Equipment N.E.C.	-	-	-	-	64	***64***	9	64	***73***
14.	Motor Vehicles, Trailers & Semi-Trailers	50	50	***100***	33	67	***100***	29	43	***72***
15.	Furniture; Manufacturing N.E.C.	22	32	***54***	19	46	***65***	23	35	***58***
% Total		**31**	**28**	**59**	**29**	**44**	**73**	**27**	**34**	**61**
Total Number of Reported Establishments		***93***	***84***	***299***	***281***	***429***	***967***	***281***	***351***	***1,044***

Table 5.6 b Percentage distribution of establishments by first two major reasons for inefficiency and industrial group 2007/08 (2000E.F.Y)

In the table **A** represents the first two major reasons for not being fully operational, **B** represents first two major reasons for not working at full capacity & **C** represents the type of first two major operational problems faced. Similarly, **SSRM** is shorthand for Shortage of Supply of Raw Materials, **AMD** is shorthand for Absence of Market Demand, and **SEWS** is for Shortage of Electricity & Water Supply.

S/N	Manufacturing Industrial Group	Type of Reasons vs. % out of Concerned No. Firms --2000E.F.Y								
		A			B			C		
		SSRM	SEWS	% total	SSRM	AMD	% total	SSRM	AMD	% total
1.	Food products and beverages	32	12	***44***	36	24	***60***	26	17	***43***
2.	Tobacco products	-	-	-	-	-	-	-	-	-
3.	Textiles	60	10	***70***	42	8	***50***	36	4	***40***
4.	Wearing Apparel, Except Fur Apparel	20	60	***80***	36	14	***50***	71	8	***79***
5.	Tanning &Dressing of Leather; Manufacture of Footwear, Luggage & Handbags	41	29	***70***	49	9	***58***	33	9	***41***
6.	Wood and of Products of Wood and Cork, Except Furniture	33	13	***46***	58	14	***72***	56	6	***63***
7.	Paper, Paper Products and Printing	38	-	***38***	40	23	***63***	37	15	***52***
8.	Chemicals and Chemical Products	67	-	***67***	57	9	***66***	43	4	***47***
9.	Rubber and Plastic Products	33	11	***44***	40	20	***60***	33	9	***41***
10.	Other Non-Metallic Mineral Products	44	6	***50***	52	7	***59***	44	7	***51***
11.	Basic Iron and Steel	50	25	***75***	54	-	***54***	40	-	***40***
12.	Fabricated Metal Products Except Machinery and Equipment	31	6	***37***	32	9	***41***	29	4	***33***
13.	Machinery and Equipment N.E.C.	-	-	-	25	50	***75***	50	25	***75***
14.	Motor Vehicles, Trailers & Semi-Trailers	33	-	***33***	25	17	***42***	27	7	***34***
15.	Furniture; Manufacturing N.E.C.	16	14	***30***	22	37	***59***	21	26	***47***
%Total		**38**	**9**	**47**	**41**	**18**	**59**	**34**	**13**	**47**
Total Number of Reported Establishments		***267***	***65***	***704***	***698***	***314***	***1,712***	***632***	***243***	***1,885***

5.6. Analysis of Existing Productivity Factors in the Selected Manufacturing Industries

5.6.1. Introduction

Here, the basic primary data collected from the selected manufacturing firms is organized, analyzed and interpreted to obtain conclusive results. A questionnaire was designed and then distributed for a sample of 140 manufacturing firms taken randomly in the country.

Samples are taken from all the manufacturing firm categories to obtain representative and logical results. The basic considerations taken during sampling include product category, data availability, geographical location and production capacity of the companies to include all types of firms from the biggest to the smallest and both public and private industries.

The major issues focused in the questionnaire include interpretation of productivity in the firms, the various aspects of productivity affecting factors, general trends in the productivity growth as well as productivity measurement and improvement practices within the recent three years period [2000-2002E.F.Y]. All the details of the questionnaire are attached in Appendix A.

In order to distribute the questionnaire, I have mainly used the e-mails (soft copy) as well as the physical addresses (hard copy) of the selected enterprises. Responses for the questionnaire are properly completed and collected from 56 manufacturing firms and the remaining companies failed to complete and return the questionnaires for various reasons. The respondents for the items in the questionnaire are mainly the production and technique managers of the selected manufacturing industries.

Therefore, the ongoing presentation, analysis, recommendation and conclusion are performed based on the responses received on the questionnaires and information available in the reliable secondary data sources.

Respondents' profiles

Tables below (5.7a-c) summarize the basic profiles of the respondents who filled the questionnaire, representing their respective company. Majority (73%) of the respondents have a position of production & technique manager or the like in the surveyed companies. About 16% of the respondents work at a foreman, shift leader, expert, or some other position whereas the remaining 11% of the companies did not declare their position.

On the other hand, the qualification level of most (70%) of the respondents, representing the companies, is bachelor's degree (BSc or BA) and nearly 9% of the respondents own a master's

degree (MSc / MA). 11% of the respondents are qualified in a diploma level or below and the remaining 11% did not declare their academic status.

Finally, the work experience of the respondents in the company is assessed and found to be 57% two to five years, 14% five to ten years, 10% above ten years, 11% below two years, and remaining 11% did not state their experience in the company.

The overall profile implies that most of the respondents have a good exposure towards the technical as well as the managerial duties involved in their respective companies; as a result, they can probably provide the required information for all the items included in the questionnaire.

Table 5.7 Outline of the profiles of respondents for the questionnaire

a) Position of the respondent in the company

	No.	In %
Production & technique manager	41	73.2
Shift leader	2	3.6
Others (foreman, expert, etc)	7	12.5
Not Yet Known	6	10.7

b) Qualification level of the respondent in the company

	No.	In %
MSc/MA & above	5	8.9
BSc/BA	39	69.6
College diploma	3	5.4
Below diploma	3	5.4
Not Yet Known	6	10.7

c) Work experience of the respondent in the company

	No.	In %
Above 10 years	4	7.1
5-10 years	8	14.3
2-5 years	32	57.2
Below 2 years	6	10.7
Not Yet Known	6	10.7

5.6.2. Definition, Importance and Drivers of Productivity in the Selected Firms

The distribution of respondent enterprises for the questions related to the interpretation & importance of productivity including the key drivers in is presented in Table 5.8.

It can be observed from the data that 84% of the total (56) respondent companies agree upon the definition of productivity as total output per all the inputs (material, labor & capital) used, which indicates total productivity. However, 10 % of the respondents disagree on the application of this definition. Output per materials used is agreed upon 71% of the respondent enterprises as a working definition of productivity, indicating materials productivity, although 23% do not apply this definition. Similarly, 59% of respondent companies consider the interpretation of productivity as the total output per capital used (capital productivity); but 23% of the respondents refuse this application. Labor productivity (output per worker) is considered in 54% of the respondent companies, which is ignored in 32% of the total respondents. Productivity is defined as outputs per work hours by 63% of the respondent firms but 23% of respondents oppose this definition. On the other hand, job completed per jobs scheduled is used by 50% of respondents to define productivity. Output per labor cost and sales per employee are relatively the least recognized definitions of productivity by the 13% and 14% of the companies, respectively.

Recognition of the importance of productivity growth in the manufacturing companies is assessed and found that 88% of respondent enterprises believe that higher productivity allows greater returns to the company owners; 52% of the companies believe that higher productivity helps their company to sustain higher wages to its employees. On the other hand, 30% of the companies believe that high productivity determines sustained improvements in the country's standard of living and only 18% of the companies responded as it supports spending on social programs, education, and the environment.

Evaluation of the key drivers of productivity in the selected companies indicates that 79% of the companies believe the investment in machinery & equipment as a key driver where as 14% of respondents refuses this consideration. Planned utilization of raw materials and/or education & training of employees is considered as a key driver by 77% of the companies. Least significantly, 16% and 9% of the companies, respectively, suppose innovation and government spending are the key drivers for their productivity.

This implies that there is no a unique and uniformly agreed definition of productivity in the companies. A company can probably define productivity from various perspectives mainly including labor, material, capital and some or all of the three factors together.

It can also be observed that the companies have no common understanding on the importance of productivity growth. As a result, 70% of the companies do not certainly agree on high productivity as a means of sustained improvements in the country's standard of living and 82% do not accept the importance of productivity as a decisive factor to support spending on social programs, education, and the environment.

However, it is clearly stated that there is no human activity that does not benefit from improved productivity [10]. Thus, changes in productivity are recognized as a major influence in many social and economic phenomena, such as rapid economic growth, higher standard of living, improvements in a nation`s balance of payments, inflation control, and even the amount and quality of leisure. All these changes influence wage levels, cost/price relationships, capital investment needs and employment.

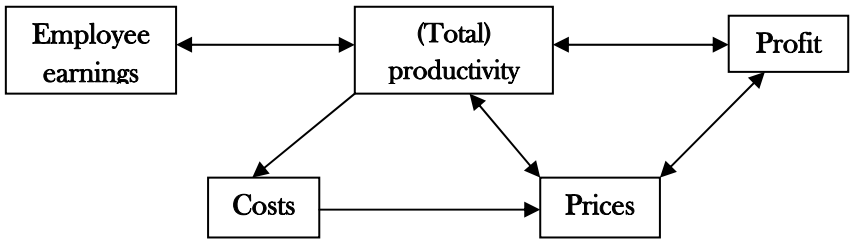

Fig. 5.3 The productivity benefit model [15]

The improvement of total productivity of a product results in the reduction of the total cost per unit since *price/unit = cost/unit + profit margin/unit* (fig 5.3). Therefore, improving the total productivity results in two favorable management strategies:

1. Reduce the selling price of a product or service without sacrificing the present profit margin.
2. Increase the profit margin without reducing the selling price.

If strategy 1 is adopted, as a result of improvement in total productivity

i. The *consumers* will benefit through savings by purchasing the product or service at lower prices for the same quality or even better quality in some cases.

ii. The *organization* will most likely benefit through a gain in market share, and this might, in turn, create greater revenue-generating opportunities and take advantage of the economies of scale.

iii. The *employees* of the organization will benefit through increases in real wages, or salaries (when the organization sincerely shares the productivity gains with its employees).

If strategy 2 is followed, as a result of total productivity improvement:

iv. The *shareholders or owners* of the organization will benefit through larger dividends on their shares. Also, the organization will have a better chance of reinvesting the profits in new products, services, processes, and ventures.

Therefore, the companies should understand the fact that improved productivity results in direct increases in the standard of living under conditions of distribution of productivity gains according to contribution. Nowadays, it would not be wrong to state that productivity is the only important worldwide source of real economic growth, social progress and improved standard of living.

In addition, based on the agreement of more than 77% of the respondents, we can state that the key driving forces for productivity improvement in the companies are investment made on machines and technology, education and training conducted for the employees, and planning the utilization of raw materials.

Table 5.8 Definition, importance and drivers of productivity in the firms

S/N	Description	#Disagree	#Neutral	#Agree
1.	As a working definition, productivity in the firm is:			
	Output per worker	18	8	30
	Output per capital	13	10	33
	Output per materials	13	3	40
	Output per all inputs (material, labor & capital)	5	4	47
	Sales per employee	39	9	8
	Jobs completed per jobs scheduled	17	11	28
	Output per labor cost	36	13	7
	Output per work hours	13	8	35
2.	High productivity in the company is recognized as it:			
	Allows greater returns to the owners	2	5	49
	Allows the company to sustain higher wages to its employees	10	17	29
	Determines sustained improvements in the country's standard of living	16	23	17

	Supports spending on social programs, education, and the environment	21	25	10
3.	The key driver of productivity in the company is:			
	Investment in machinery and equipment	8	4	44
	Education and training of employees	8	5	43
	Planned utilization of raw materials	5	8	43
	Innovation	28	19	9
	Government spending and security	36	15	5

5.6.3. Major Factors Affecting the Productivity of the Manufacturing Firms

Respective number of respondent enterprises for the questions on the major factors that influence their manufacturing productivity is presented in Table 5.9. The major factors possibly incorporated on the questionnaire to be rated by the manufacturers include labor force, materials, machineries, technology, management, marketing conditions, energy, organizational structure, infrastructures, physical environment and government regulations. The impact of each of these factors is evaluated in various perspectives. Analysis of the effects of all the above productivity factors is discussed as follow.

Table 5.9 Summary of respondent enterprises for the questions on major productivity factors
LE = Low Effect ***ME*** = Medium Effect ***HE*** = High Effect ***MCE*** = Most critical effect

S/N	Description	*#LE*	*#ME*	*#HE*	*#MCE*
Rating the effect of major productivity factors					
1.	Labor force (availability, knowledge, skill, attitude, management, etc)	2	4	22	28
2.	Materials (availability, quality, timeliness, import substitutes etc)	-	1	23	32
3.	Machineries (relevance, quantity, accuracy, speed, maintainability, age, etc)	2	3	35	16
4.	Technology (innovation, research & development, automation, IT, etc)	10	33	9	4
5.	Management (plans & schedules, instructions, ability to adjust staff size & duties, balancing of material flow, supervision etc)	4	5	33	14
6.	Existing marketing conditions	8	9	28	11
7.	Energy	4	15	27	10
8.	Physical environment	30	19	6	1
9.	Government regulations	33	16	6	1
10.	Infrastructures (transport facilities, means of communication etc)	9	25	16	6
11.	Organizational structure and culture	12	15	23	6
12.	Demographic & social changes	36	16	2	2

1. The effect of labor force on manufacturing productivity

As shown in the figure 5.4, 50% of the companies responded the effect of human resource, as a factor of productivity, to be the most critical. Whereas 39% of the respondents answer the same

question saying human resource has high effect. However, only 11 % of the total respondents rated the effect to be medium to low. Here by the effect of human resource we mean all the attributes related to the labor force including availability, knowledge, skill, attitude, communication and coordination.

In this survey, roughly 55% (Table 5.10) of the companies have faced one or both of such challenges as dissatisfied and unmotivated employees and high rate of labor turnover. More seriously, above 61% of the respondent companies have faced some or the entire of the following major problems: lack of well skilled labor in the market, absence of well established human resource training & development practices, and ignorance of workers when setting company goals & plans.

Moreover, nearly 43% of the respondent companies have faced some or all of the following challenges: inadequate job security, salaries & incentives; absence of reliable standard to measure employees' performance; lack of the proper application of job rotation, promotion and career planning; and low degree of job enrichment and enlargement.

At the existing level of manufacturing capacity utilization some industries may have adequate availability of human resources. However, highly labor intensive sectors such as textile and garment industries, metal industries, and food industries face constraints with respect to finding adequate number of skilled workers.

Highly sophisticated technology in primary manufacturing needs highly skilled supervisory and technical/engineering staff as well as management. With sector improvement being predicted, there is a need for younger and skilled workforce to be inducted into the industries.

Increased emphasis on exports requires a different set of workers with ability to meet international standards of efficiency and productivity and customer service. A dearth of skilled operators, which face the industries, results in poaching of skilled operators by newer factories from the established ones.

The manufacturing industries in Ethiopia have certain strengths and weaknesses with respect to human resources. Among their strengths are availability of some experienced management and supervisory staff who have been in the industries for several years. Some of the companies operate with budgeting and costing systems managed by skilled middle level staff. The areas where weaknesses are visible and where there would be a need to upgrade the skills set at

various levels of the organizations. There is a need to improve the ability of the existing supervisory staff to acquire skills to carry out the task efficiently. Improvement of attitudinal skills is another area for middle managers.

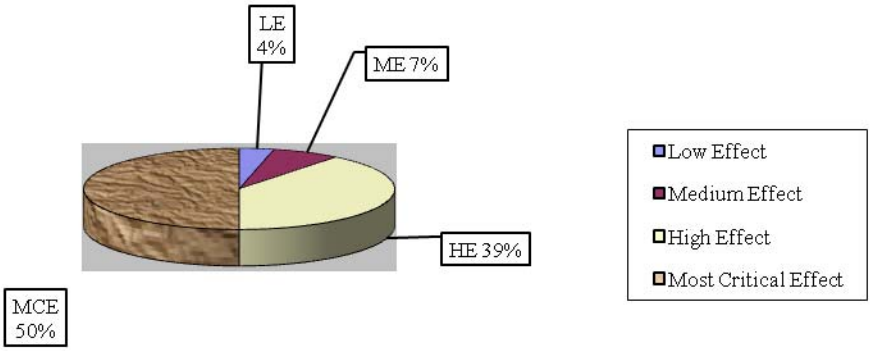

Fig.5.4 Distribution of respondent enterprises for the effect of labor on their productivity

Table 5.10 Summary of respondent enterprises for the questions on labor force factors affecting productivity

Basic attributes of labor force as a productivity factor	***#Disagree (%)***	***#Neutral (%)***	***#Agree (%)***
There is lack of skilled labor in the market	34.5	3.4	62.1
Frequency of labor turnover is high	33.3	12.3	54.4
Misconducts (alcoholism, absenteeism, strikes, & conflicts etc) are common at workplace	64.3	32.1	3.6
Employees lack adequate knowledge, skill & good attitude for their jobs	55.4	7.1	37.5
There is no good relation, communication & suggestion systems across employees	66.1	14.3	19.6
Job security, salaries & incentives are generally inadequate	44.6	12.5	42.9
Workers are ignored when setting company goals & plans	33.3	6.1	60.6
There is no reliable standard to measure employees' performance	51.8	7.1	41.1
Low degree of job enrichment and job enlargement	44.6	14.3	41.1
Employees are dissatisfied and unmotivated	32.7	10.9	56.4
Human resource training & development is not well practiced	28.6	10.7	60.7
Job rotation, promotion and career planning are not applied properly	39.3	14.3	46.4

2. The effect of materials and energy on manufacturing productivity

As indicated in the figure 5.5 that 57% of the companies consider the effect of materials, as a factor of productivity, to be the most critical. Whereas 41% of the respondents answer the same question saying materials have high effect. However, only 2% of the total respondents rated the effect to be medium. Here by the effect of materials we mean all the attributes related to the material resources including availability, quality, timeliness, import substitutes etc.

Table 5.11 indicates 48% of the companies have faced lack of reliable supply source for raw materials. Moreover, about 42% of the respondent companies stated that required materials are not timely available for production and only 18% of the respondents strive for import substitution for material sources. Efficient material yield through the minimization of amount of wastages and rejects is achieved within 56% of the respondent companies.

On the other hand, 18% of the respondents consider the effect of energy supply, as a factor of productivity, to be the most critical and 48% of the companies believed it to have a high effect (fig. 5.6). Only about 29% of the respondent companies agreed up on the availability of optimum energy sources.

Fig.5.5 Distribution of respondent enterprises for the effect of materials on their productivity

Fig. 5.6. Distribution of respondent enterprises for the effect of energy supply on their productivity

Table 5.11 Summary of respondent enterprises for the questions on material and energy factors affecting productivity

Basic attributes of materials & energy as a productivity factor	***#Disagree (%)***	***#Neutral (%)***	***#Agree (%)***
Required materials are timely available for production	41.8	14.5	43.7
Congestions & Incidences (breakdowns, planning errors) are well controlled	39.3	37.5	23.2
Efficient material yield is achieved & wastages and rejects are well controlled	25.8	18.2	56.0
The company strives for import substitution for material sources	50	32.1	17.9
Reliable supply source is developed	48.2	17.9	33.9
Electrical and other energy consumptions are optimized	42.9	28.6	28.5

3. The effect of machineries and technology on manufacturing productivity

It is shown in the figure 5.7 that 29% of the respondents believe machineries to have an extreme effect on manufacturing productivity and 62% rated its effect to be high. On the other hand, only 23% of the companies consider the effect of technology on productivity to be high to most critical, but 77% believe it to have medium to low effect (fig 5.8). Here by technology we mean automation, IT, and innovations from R & D of the company.

Proper application of machine maintenance is available within 58% of the companies (table 5.12). Similarly, 54% of the companies believe to have a decreasing trend in machine idle times. More than 57% of the respondent companies strictly believe to have no progressive modernization of machineries through time and only 15% of the companies responded that they have an automated material handling system. Optimum production plans & processing conditions are available within 42% of the companies.

This implies that the performance and maintenance of machineries used in the manufacturing establishments have a great influence on their productivity. Frequent machine failures, technologically old machines, lack of multipurpose manufacturing systems, and low machine capacity utilization are the main causes for reduced machine productivity.

Fig. 5.7 Distribution of respondent enterprises for the effect of machineries on their productivity

Fig.5.8 Distribution of respondent enterprises for the effect of technology on their productivity

Table5.12 Summary of respondent enterprises for the questions on machinery and technology factors affecting productivity

Basic attributes of machineries and technology as a productivity factor	***#Disagree (%)***	***#Neutral (%)***	***#Agree (%)***
1. Production plans & processing conditions are optimum	30.9	27.3	41.8
2. Machines are properly maintained	10.9	30.9	58.2
3. The company expands from time to time	41.8	10.9	47.3
4. Production bottle-necks and idle times are decreasing	17.9	28.6	53.5
5. Material handling systems are automated	72.7	12.7	14.6
6. Machines are modernized through time	57.2	10.7	32.1
7. R & D focuses on product development & productivity improvement	85.2	5.6	9.2
8. Production activities are automated	80	3.6	16.4
9. IT is used in the manufacturing and support activities	66.1	10.7	23.2

4. The effects of management, organizational structure & systems on productivity

As stated earlier, effectiveness of an enterprise depends largely upon when, where, how and to whom a manager applies a style. Since management styles and practices influence

organizational design, personnel policies, job design, operational planning and control, maintenance and purchasing policies, capital cost and its sources, budgeting systems and cost control techniques, it has an exceptional effect on the state of manufacturing productivity.

Rigidity has been identified as one of the reasons for the low productivity of many organizations. Such enterprises fail to anticipate and respond to market changes; ignore new capacities in the labor force, new developments in technology and other external factors. They also lack good horizontal communication, which slows down decision-making and inhibits delegation of authority close to the point of action, encouraging inefficiency and bureaucracy.

This survey indicates that 25% of the companies perceive the effect of management on productivity to be the most critical; on the other hand, 59% of the respondents recognize its effect to be high (figure 5.9). However, 9% & 7% of the companies undertake the effect to be medium & low, respectively. Similarly, 11% of the respondents considered organizational structure to be the most critical factor that affects productivity and 41% of the companies believe it to have high effect (fig. 5.10).

Nearly half (48%) of the companies do not rely on the capability of their managers, because they lack the required managerial & technical knowledge, skill and attitude which is equivalent to their position in the company (table 5.13).

More than 56% of the companies are using systems which are not flexible to anticipate and respond to changes and they faced difficulty of decision-making especially due to delegation of responsibility away from the point of action and existence of unneeded bureaucracy.

In fact, there is no system, however well designed, is efficient in all situations. Importantly, dynamism and flexibility should be incorporated into the system design of the companies in order to maximize productivity.

Nearly 54% of the respondents believe that company policies regarding personnel, purchasing, etc are not reliably good & productive. On the other hand, about 51% of the respondents believe that jobs are not well designed considering man-machine capabilities and limitations. Furthermore, lack of recognition for new capacities is faced for 50% of the companies.

Recognition & payment of overtime works exists within 62% of the companies and proper management of the material & machine inventories is found in 54% of surveyed enterprises. Other major problems related to management include stoppage of work orders due to accidents,

disputes, regulations, etc (44%); absence of reliable capital sources, budgeting systems & cost control techniques (58%); lack of efficiently planed & controlled operations (60%), insignificant practices on scheduling and coordination (41%).

Fig.5.9 Distribution of respondent enterprises for the effect of their management on their productivity

Fig.5.10 Distribution of respondent enterprises for the effect of their organizational structure on their productivity

Table 5.13 Summary of respondent enterprises for the questions on the effects of management, organizational structure and systems on productivity

Basic attributes of management, organizational structure and systems as a factor of productivity	***#Disagree (%)***	***#Neutral (%)***	***#Agree (%)***
1. Managers have the required managerial & technical knowledge, skill and attitude	21.4	26.8	51.8
2. Overtime works are recognized & paid	23.6	14.5	61.9
3. Material and machine inventories are managed properly	30.4	16.0	53.6
4. There is no disruption of power/water supply	64.3	7.1	28.6
5. Stoppage of work orders due to accidents, disputes, regulations, etc are rare	37.5	7.1	55.4
6. Scheduling and coordination practices are appreciable	12.5	28.6	58.9
7. Company policies (regarding personnel, purchasing, etc) are good & productive	33.9	19.6	46.4
8. Jobs are designed considering man-machine capabilities and limitations	53.6	5.4	41.0

9. Operations are planed & controlled efficiently	27.3	32.7	40
10. Capital sources, budgeting systems, & cost control techniques are reliable	46.4	12.5	41.1
11. Systems are not flexible to anticipate and respond to changes	35.7	7.1	57.2
12. Lack of recognition for new capacities	39.3	10.7	50
13. Difficulty of decision-making (delegation away from point of action and unneeded bureaucracy)	38.2	5.5	56.3

5. The effects of other factors on manufacturing productivity

Figure 5.11 indicates that 20% of respondents believe that the existing marketing conditions affect productivity most critically; however, 50% of the companies rate the effect to be high. On a similar basis, 11% and another 29% of respondents, respectively, rate the effect of infrastructures to be most critical & high (fig. 5.12).

It is found that 50% of the companies (table 5.13) believe to have adequate energy supply, transportation and communication facilities; but 30% of the companies believe to have adequate raw materials at optimum cost & quality. Only 34% of the companies state that their company invests in education and training to develop manpower. Other problems commonly exist in the companies include retirement and ageing of employees (35%), unmotivating cultural values, beliefs, and attitudes (29%), lack of good management & development policy (41%).

Fig. 5.11 Distribution of respondent enterprises for the effect of marketing conditions on their productivity

Fig. 5.12 Distribution of respondent enterprises for the effect of infrastructures on their productivity

Table 5.13 Summary of respondent enterprises for the questions on demographic and social factor affecting productivity

Basic attributes of demographic and social factor for productivity	***#Disagree (%)***	***#Neutral (%)***	***#Agree (%)***
1. The ratio of working men to women is unbalanced	16.0	28.6	55.4
2. Retirement and ageing of employees is common	52.2	13.0	34.8
3. Cultural values, beliefs, attitudes and traditions are not motivating	62.5	8.9	28.6
4. The company invests in education and training to develop manpower	53.6	12.5	33.9
5. There is a floor-space management & development policy	41.1	10.7	48.2
6. Energy supply, transportation and communication facilities are adequate	38.9	11.1	50
7. Adequate raw materials are available at optimum cost & quality	55.6	14.8	29.6
8. Regulations (such as price control, income and wage policies) are not motivating	55.4	25	19.6

5.6.4. Summary of Critical Factors that Affect Manufacturing Productivity

Results obtained in the above analysis indicate that materials (availability, quality, timeliness, import substitutes etc), labor force (availability, knowledge, skill, attitude, management, etc), machineries (relevance, quantity, accuracy, speed, maintainability, age, etc), management (plans & schedules, instructions, ability to adjust staff size & duties, balancing of material flow, supervision etc), existing marketing conditions, and energy are rated by the respondents to be the top five most critical factors affecting their productivity in the same order. Therefore, it is vital to emphasize the root causes for productivity decline related to these factors and develop an improvement model to troubleshoot their effect.

5.6.5. Manufacturing Productivity Measurement & Improvement Trends

Several companies, which are addressed in this survey, believe to have practiced some measurement and improvement mechanisms for partial and/or total productivity. However, most of these respondents could not express the mechanisms/techniques that they have used to do so. It is shown on table 5.14 that 39% of the companies believe to have employed a measurement technique for labor productivity, another 39% for material productivity, 29% for capital productivity and 32% for total productivity measurement. On the other hand, 32% of the companies believe to have employed an improvement technique for labor productivity, 21% for material productivity, 18% for capital productivity and 25% for total productivity improvement.

Table 5.15 indicates that 72% of the companies have an increasing trend in total productivity within the past 3 years (2000-2002EC) period. Similarly, 66-68% of the companies believe to have an increasing trend in partial productivity factors, namely labor, material, and total factor productivity. In addition, 66% of the companies have growing fashion in total productivity in the specified time period.

On the other hand, 9-11% of the companies have a decreasing trend in some or all of the following productivity factors; namely, capital productivity, total factor productivity, and total productivity. 5% of the companies responded as they have a decreasing trend in either or both of the labor productivity &/or material productivity.

Collectively, 20-28% of the respondents believe to have a constant trend in some or all productivity (labor, material, capital, total factor, total) aspects of productivity growth within the past three years period.

Finally, the companies were asked for the availability of a well established R & D department and only 12% of them responded "yes", but 88% of the companies have no a department involved in such research and development duties to find out and introduce innovative methods and technologies that can improve productivity.

Table 5.14 Summary of productivity measurement and improvement trends in the selected manufacturing firms

LP= labor productivity MP= material productivity CP= capital productivity TFP= Total factor productivity TP= total productivity

From the past three years (2000-2002EC) experience		LP	MP	CP	TFP	TP
1.	Number of companies having methods to measure productivity	22	22	16	13	18
2.	Number of companies having methods to improve productivity	18	12	10	9	14

Table 5.15 Summary of respondent firms on the trends of productivity growth
DG = Decreasing CT = Constant IG = Increasing

S/N	Description	DG	CT	IG
The general trend in the productivity growth within the past 3 years (2000-2002EC)				
1.	Labor Productivity	3	15	38
2.	Capital Productivity	6	15	35
3.	Material Productivity	3	16	37
4.	Total Factor Productivity	5	14	37
5.	Total Productivity	5	11	40

Chapter 6

Proposed Solutions for the Existing Productivity Related Problems

6.1. Major Causes for Productivity Decline in the Firms

It has been stated in table 5.15 that nearly 29% of the manufacturing companies have either a decreasing or a constant trend in the total productivity growth within the reference 3 years period (2000-2002EC). Moreover, 32-37% of the firms believe to have either a decreasing or constant trend in the partial productivity factors (labor, capital, & material) within the same period. In addition, table 5.9 shows 90-98% of the companies confirmed that materials, labor and machineries have the most critical or at least high effect on their productivity. Similarly, 66-84% of respondents defined the effects of management, marketing conditions, and energy supply on their manufacturing productivity to be the most critical or at least high.

Therefore, it is essential to identify the root causes for the declined or stagnant productivity in the firms and find out both technical as well as managerial solutions that can eradicate or at least minimize the sever effects of the existing productivity related problems. Figure 6.1 summarizes the major causes for the productivity related problems that exist in the firms. The diagram is developed based on the information obtained from the surveyed companies provided that due emphasis is given for the major factors that significantly affect the productivity of the firms. In the figure, the major factors are integrated into five categories, namely, material and energy related, human resource related, machinery & technology related, design & manufacturing methods, and management related; and the primary causes are identified in a reasonable fashion.

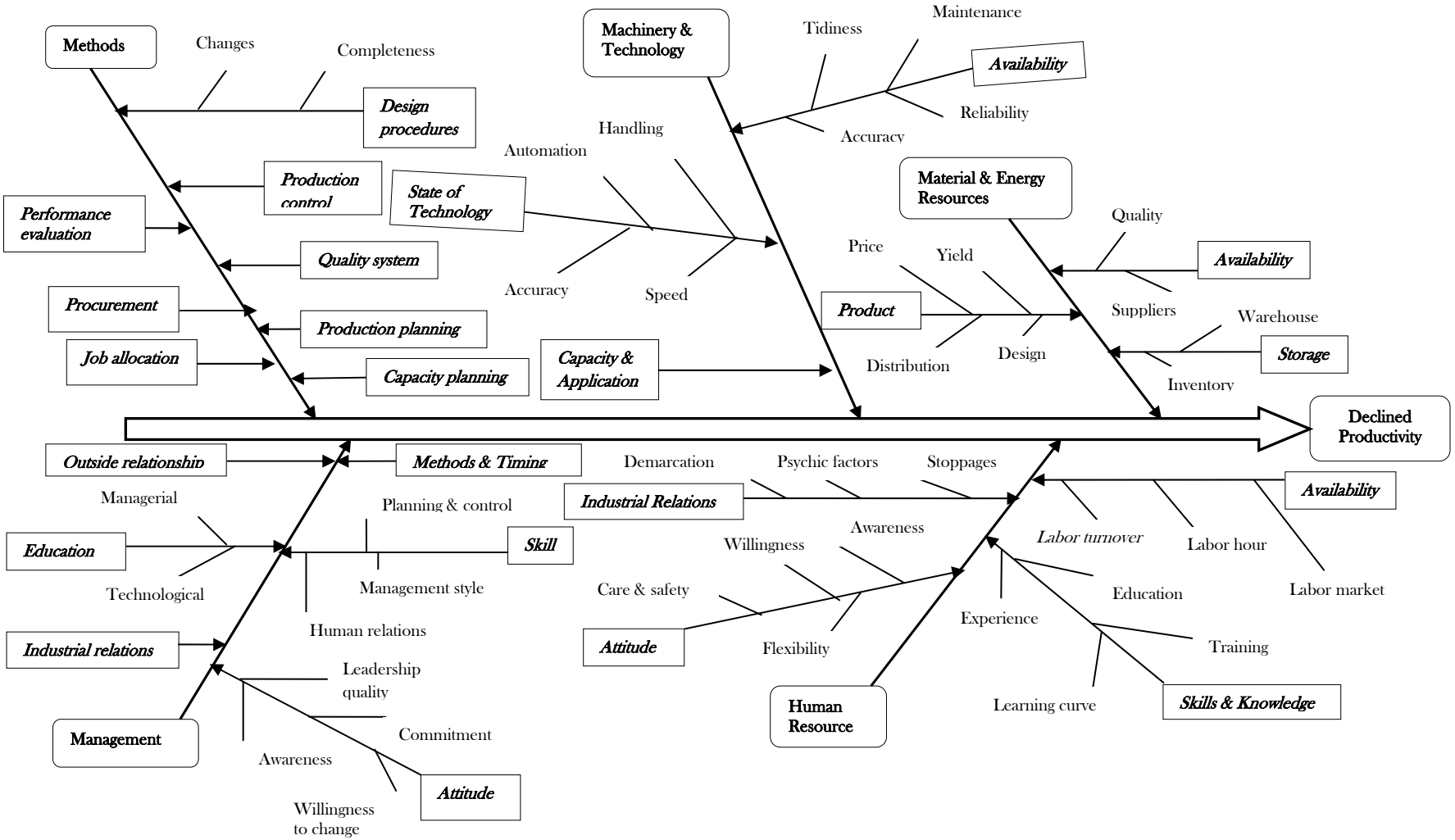

Figure 6.1 Cause-and-Effect-Diagram for the Productivity of Ethiopian Manufacturing Firms

6.2. Development and Application of Productivity Improvement Model

6.2.1. Selection of Productivity Improvement Techniques

It is found from the survey of literatures that more than 50 different techniques of productivity improvement are identified and cataloged. These techniques are classified into five basic types, namely: material-based, employee-based, technology-based, product-based, and process-based (Table 6.1). These techniques are summarized as in the section 6.3.3. Any other techniques can be classified under one of these five basic categories. These categories cover techniques based on traditional industrial engineering, marketing, systems control, operations research, computer engineering, management, psychology, behavioral science, and many other disciplines.

Often, it has been found that just a few of these techniques are popular at any given time. Managements should and often approve the installation of a technique, primarily because of a technical and economic feasibility study. The impact of an approved technique on the total productivity of an organization is rarely studied; the result of such a conventional approach may be an unexpected increase in the inputs of labor, material, capital, energy, and /or other expenses and the corresponding unit costs. The bottom line in any management's efforts should be the reduction of the total cost of manufacture and distribution, so that profits can be made not by random price increases (which causes price inflation) but rather by holding the prices at current levels or even decreasing them to increase market share. (Price/unit = total cost/unit + profit margin/ unit.) Improving total productivity ensures the reduction of total cost/unit, and this should be the primary goal in any productivity management process.

What we need is a model for productivity improvement, based on a *scientific* selection of a set of techniques for a given time period to achieve a given level of total productivity. The model should be such that we can perform a sensitivity analysis to determine how the selection of the productivity improvement techniques will vary according to the target level of total productivity, the availability of funds to install the techniques, and the payback associated with such a selection.

Table 6.1 Summary of Productivity Improvement Techniques

Productivity Improvement Techniques				
Material-based	**Labor-based**	**Technology-based**	**Product-based**	**Task-based**
Inventory control	Financial incentives (individual & group)	Maintenance management	Value engineering	Methods engineering
Materials Requirement Planning (MRP)	Fringe benefits	Rebuilding old machinery	Product diversification	Work measurement
Materials management	Employee promotions	Energy conservation	Product simplification	Job design
Quality control	Job enrichment, enlargement, and rotation	Computer-aided design (CAD)	Research and development	Job evaluation
Materials handling systems improvement	Worker participation	Computer-aided manufacturing (CAM)	Product standardization	Job safety design
Material reuse & recycling	Skill enhancement	Computer-integrated manufacturing (CIM)	Product reliability improvement	Human factors engineering (Ergonomics)
	Management by objectives (MBO)	Robotics	Advertising and promotion	Production scheduling
	Learning curve	Laser beam technology		Computer-aided data processing
	Training & Education	Energy technology		
	Communication	Group technology		
	Working condition improvement	Computer graphics		
	Role perception	Emulation		
	Supervision quality			
	Recognition			
	Punishment			
	Quality circles			
	Zero defects			

6.2.2. Analytical Productivity Improvement Model (APIM)

A six-step procedure is proposed for improving the total productivity of the manufacturing enterprises based on an analytical model:

1. Data collection
2. Computation of productivity changes and data file compilation
3. Determination of productivity improvement coefficients
4. Evaluation of the productivity improvement coefficients and technique usage
5. Final selection of the productivity improvement techniques
6. Implementation of the selected techniques

This procedure is summarized in the flowchart shown in Fig. 6.2.

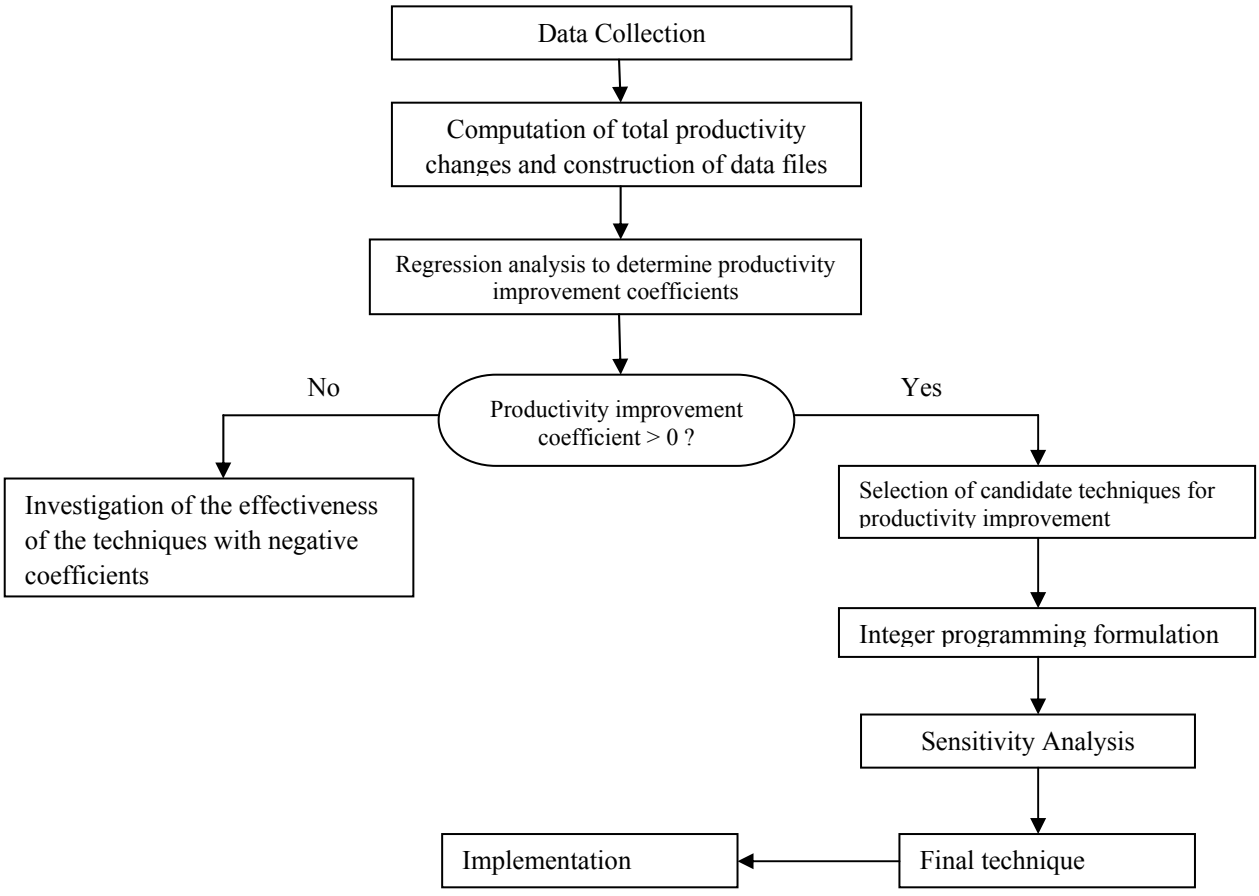

Figure 6.2 Flowchart for the analytical productivity improvement model

Data collection- A survey questionnaire is used to collect two types of information from an organization:

1. Total sales and total expenses for several time periods in the past (the time periods can be months, quarters, half-years, years, etc.). These are used as estimates of total output and total input, respectively.
2. Productivity improvement techniques used in the corresponding time periods (a number of techniques listed in section 6.3 are used as a guideline).

The first type of information comes readily from the financial statements, while the second type of information is available from industrial engineering or operations departments.

Computation of productivity changes and data file compilation- The next step is to calculate the percentage change in total productivity between consecutive time periods *t* and *t - 1*:

$$PC_t = \frac{TP\,t - TP\,t-1}{TP\,t-1}$$

Where PC_t = percentage change in total productivity between t-1 and t

$$TPt = \frac{(Output)t}{(Input)t}$$

$$TPt-1 = \frac{(Output)t-1}{(Input)t-1}$$

The total output and total input are expressed in constant dollars with respect to a base period.

A data file structure is then prepared, showing the percent change in total productivity and the technique of productivity improvement used in the various time periods. We denote the *k* th technique by T_k, where $k = 1,2, \ldots, K$ ($K = 54$, according section 6.3).

In the matrix of Table 6.1 “1” is entered if a technique is used in a given time period; if not, a "0" is entered.

Table 5.15 Summary of respondent firms on the trends of productivity growth

Table 6.1. Data file structure for step 2

Time period (t)	PC_t	T_1	T_2	T_3	-	-	T_k	T_K
1	PC_1	0 or 1						
2	PC_2	0 or 1						
3	PC_3	0 or 1						
-				0 or 1				
-								
t	PC_t						T_{kt}	
-								
-								
n	PC_n							

Determination of productivity improvement coefficients- Assuming that there is a linear relationship between the change in total productivity and the usage of the productivity improvement techniques in a given period, we can express PC_t as follows:

$PC_t = A_{ot} + A_{1t}T_{1t}, + A_{2t}T_{2t} + ... + A_{kt}T_{kt} + ... + A_{54t}$

Where $T_{kt} = 1$ if technique *k* is used in period *t* or $T_{kt} = 0$ if technique *k* is not used in period *t.*

A_{kt} = Productivity improvement coefficient for technique k in period t. The coefficients A_{kt} are determined by a multiple regression routine, using standard statistical packages such as SPSS or BMO.

Evaluation of the productivity improvement coefficients and technique usage- Those techniques that are associated with negative productivity improvement coefficients may be noted in order to determine the reasons for their not contributing to the organization's total productivity.

A frequency distribution of the usage of the techniques for different time periods is also prepared in order to indicate the consistency with which some of these techniques have been yielding positive productivity changes.

The techniques that are associated with positive coefficients are selected as a preliminary set; we shall call these the "candidate techniques," subject to a quantitative analysis in the next step.

Final selection of the productivity improvement techniques- A final selection of the techniques for productivity improvement is made by formulating an integer programming model for a given time period.

Maximize $\sum_{k=0}^{K} AkTk$

Subject to: $\sum_{k=0}^{r} f_k T_k \leq F$

$b_k T_k \leq B$, for k = 1,2,3,…,r

$m_k T_k \leq M$, for k = 1,2,3,…,r

$\sum_{k=0}^{r} s_k T_k \geq S$

$T_k = 0, 1$

Where T_k = 1 if technique *k* is selected or T_k = 0 if technique *k* is not selected. A_k = productivity improvement coefficient for technique k, f_k = fund requirement for technique k, F = maximum available funds, b_k = payback period for technique k, B = maximum allowable payback period as per organizational policy, m_k = time required to install technique k, M = maximum allowable installation time, S_k = savings from using technique k, r = number of candidate techniques

S = minimum acceptable total savings.

Implementation of selected techniques- The techniques selected in step 5 above are the ones to be implemented for maximum possible improvement in the total productivity level of the organization. A plan of action must be drawn up for such an implementation. Of course, once the implementation is done, the results of the anticipated productivity improvement will be known by measuring the total productivity level again. This then leads us back into the next round of the productivity process.

6.2.3 Principles of Productivity Improvement

The following principles must not be considered as a cure-all for all the productivity problems in an organization, but rather as some guidelines for sound management of productivity. Also, these principles must not be viewed as an exhaustive list of all possible strategies. Finally, these principles are not listed in any relative order of importance.

1. Microprocessor Principle: Whenever and wherever possible, design products and processes with microprocessor control.
2. Global-Market Principle: Design and manufacture products for global markets.
3. Learning Curve Principle: Wherever possible, plan productivity levels and product costs on a learning curve.
4. Secrecy principle: Productivity improvement strategies that are novel when compared to the competitors must be kept secret.

5. Product-Mix Principle: Develop a product mix that consistently shows the largest gains in total productivity and market share.
6. Emulation Principle: Take the best of at least three competitors' technologies in product design, development, and production.
7. Productivity Gain-Sharing Principle: Always, share the gains in productivity improvements with everyone directly or indirectly responsible for it, particularly employees and customers.
8. Leading Competitor Principle: Be the leading competitor for as many products/services as possible.
9. Harmony Principle: Seek harmony in human relations at all levels of management from the topmost executive down to the production/ operations level employee.
10. International Outlook Principle: Keep an international perspective in management activities related to planning, research and development, marketing, operations/ production, and technology transfer.
11. Cooperative Research Principle: Work closely with universities and generic research establishments to bring in ideas for productivity improvement.
12. Productivity Process Principle: Productivity improvement must be an ongoing, day-to-day process and not a one-time program or project.

6.3 Productivity Improvement Techniques

6.3.1. Material-based Productivity Improvement Methods

Figure 6.1 indicates that shortage of quality materials, lack of well designed warehousing system, deficiency of reliable inventory planning and control system, and absence of efficient material utilization, product design, distribution and price setting practices are found to be the main causes for materials and energy related productivity problems. Here we need to have a model for productivity improvement, based on a scientific selection of a set of techniques for a given time period to achieve a given level of total productivity. Materials-based productivity improvement techniques include inventory control, materials requirement planning (MRP), materials management, quality control, materials handling systems improvement, and material reuse & recycling. All these techniques can effectively be applied

for productivity improvement based on materials; however the basic description of the first three techniques is given to substantiate the subject matter.

1. **Inventory control systems**

This is concerned with two basic questions: *when* to order and *how much* to order. An effective inventory-control system will:

- Ensure that sufficient materials are available
- Identify excess as well as fast & slow-moving items
- Provide accurate, concise, and timely reports to management
- Incur the least amount of cost in accomplishing these three tasks

A comprehensive inventory-control system involves the following six areas:

1. Development of demand forecasts, the treatment of forecast errors
2. Selection of inventory models
3. Measurement of inventory costs
4. Methods to record and account for items
5. Methods for receipt, handling, storage, and issue of items
6. Information procedures to report exceptions

The degree of complexity, precision, and sophistication of the inventory models will not alone contribute to the efficient operation of an inventory control system, unless the information to feed into the models is available at acceptable cost. In many situations, complex control systems are avoided because of lack of accurate and timely data. It must be emphasized again that *all* of the above six vital areas must be considered important for an inventory-control system to result in productivity gains.

Types of Inventory-Control Systems

Although it is difficult to classify the various inventory-control systems in a c1earcut fashion, we can distinguish among the systems that are most commonly used.

Systems which usually apply to end items:

1. Fixed-order size systems (quantity-based)
2. Fixed-order quantity, variable review period
3. Fixed-order interval systems (time-based)
4. Fixed review period, variable-order quantity

System which usually applies to materials and component parts used to produce an end item:

5. Derived-order quantity system (production-based)

Order quantity is variable and review period can be fixed or variable.

The quantity-based systems are continually checked with each demand to determine whether an order should be placed. With time-based system, a count of stock is made on a periodic basis (i.e., on designated review dates). In production-based systems stock is ordered only to preplanned manufacturing schedules. These five systems of inventory control are briefly discussed, next.

i. **Perpetual inventory system-** Under this system, whenever the stock drops to the reorder level or below, an order is triggered for a quantity equal to the economic order quantity (EOQ). *Advantages* of this system are efficient & meaningful order size, safety stock is needed only for the lead time period, relative insensitivity to forecast and parameter changes, less attention for slow-moving items, excellent for high-cost items needing close control. *Weaknesses* of this system include if managers do not take the time to study inventory levels of individual items, order quantities tend to be established by clerks; reorder points, order quantities, and safety stocks may not be restudied or changed for years; delays in posting transactions can make the system ineffectively; clerical errors or mistakes in posting transactions can impair the validity of the system; numerous independent orders can result in high transportation and freight costs; large combined orders, which can frequently result in supplier discounts based on money value, must be forgotten. The perpetual system requires an inventory clerk, daily records, material issue and receiving slips, and a guarded or locked storeroom.

ii. **Two-bin** inventory system, which is a simplified version of the perpetual inventory system, and has the following advantages: paperwork is reduced to a considerable extent; records are *not* maintained for each transaction; reorder point is determined by visual observation; the system can be operated even with one bin by using appropriate markings; well suited for items of low value, fairly consistent usage, and short lead time-for example, office supplies, nuts, bolts, washers, etc.

iii. **Periodic** inventory system in which, the inventory position is checked only at specified time intervals, unlike the perpetual inventory system. The advantages of this system

are: since items are processed under a single order, a reduction in ordering cost may be possible; lumping several items on one order can make the discounts from suppliers possible; shipping costs may be significantly reduced through bulk-ordering; well suited when the supply sources are few or the source is a central warehouse. Weaknesses of the periodic system are: larger safety stocks are required than with the perpetual inventory system, because the safety stock is for absorbing demand fluctuations both during the review period and the lead time, whereas in the perpetual system, the safety stock is only to absorb the demand fluctuations during the lead time period; the additional safety stock makes this system more expensive than the perpetual system unless the advantages of bulk-order discounts and lower transportation costs outweigh the extra stock costs.

iv. **Optional replenishment inventory (min-max) system.** This is a hybrid of the perpetual and periodic systems. In this system, stock levels are reviewed at regular intervals, but orders are not placed until the inventory position has fallen to a predetermined reorder point. The maximum inventory level E is established for each item, and, if the inventory level is above the reorder point on the review date, no order is placed; if not, an order is placed. The order quantity will be the maximum inventory level minus the inventory level at the review period. The optional replenishment system is defined by three parameters: length of review period *(t),* maximum inventory level *(E),* and reorder point *(B).* The advantages of this system are: Orders can be placed in efficient quantities, thereby reducing ordering costs (fewer but larger orders are placed); the best features of both perpetual and periodic systems are incorporated; The weakness is: safety stocks are very high, since they must be covering demand fluctuations for two order intervals plus the lead time.

2. ABC Analysis

Since there may be as many as several hundreds of thousands of inventory transactions each year in even medium-sized companies, it is uneconomical, and perhaps unproductive to apply a detailed inventory-control system to all the items carried in inventory. The ABC analysis helps classify the items into three categories-A, B, and C, where A equals high-value items, B equals medium-value items, and C equals low-value items. This way, tight inventory control can be exercised on the A items, moderate control on the B items, and loose control on the C items. Thus, the ABC analysis separates the "vital few" from the "trivial many." The

A items represent about 15 to 20 percent of the total items, while accounting for 75 to 80 percent of the value of the total inventory. The B items account for about 10 to 15 percent of the value of the inventory, while representing 20 to 25 percent of the items. The C items account for only 5 to 10 percent of the inventory value, but 60 to 65 percent of the inventory items. It must be noted that ABC is only an arbitrary classification; we can have further groups or divisions.

The ABC analysis is primarily intended for end items that are characterized by demand independent of other end items. As such, the ABC system does not apply to dependent demand items controlled under an MRP system. It must also be pointed out that, before items can be classified into arbitrary categories, factors other than financial ones must be considered. These include difficult procurement problem (long and unpredictable lead time); likelihood of theft; difficult forecasting problem (large changes in demand); short shelf life (due to deterioration and obsolescence); too large a storage space requirement (very bulky); and operationally, the item is critical.

3. Materials requirements planning (MRP) inventory system

MRP is a management planning and control technique. Its initial processing function is to work backward from planned quantities and completion dates for end items on a master production schedule to determine what and when individual parts should be ordered. This system functions by working backward from the scheduled completion dates of end products or major assemblies to determine the dates and quantities of the various component parts and materials that are to be ordered. The system works well when *(a)* a specific demand for an end item is known in advance, and *(b)* the demand for an item is tied in a predictable fashion to the demand for other items. Material requirement planning (MRP) has been a popular technique for management control of manufacturing operations. However, unless an MRP system is thoroughly planned before installation, the expense, time, and effort may seem to be too much.

MRP is not just a bill-of-material explosion to get material requirements time phased so that orders are placed within a proper lead time. Instead, MRP is sometimes referred to as "time-phased requirements planning" because "time phasing" involves working the material requirements backward based on the lead time for each item. While any company that wants

to do a better job of controlling material priorities and capacity can employ MRP; companies that manufacture complex assemblies are ideal for MRP. Thus, while MRP can be effective in pharmaceutical, food, textile, and chemical companies, which are not "assembly" operations, the technique can be extremely powerful in automotive, electronic, and other assembly oriented companies.

The MRP works with the following three data inputs:

i. The demand for end items (an end item may be a final product, a product module, or a major assembly) is scheduled over a number of time periods and recorded on a master production schedule (MPS). The MPS tells-us how many of and when each item is wanted. It is developed from the end item forecasts and customer orders. It must project a realistic plan of production so as to accommodate the available capacity. Thus, the MPS is not the same as the forecast because (a) the forecast may exceed the plant capacity, (b) it may be desirable to increase or decrease inventory levels, or (c) the forecast may fluctuate while the firm may desire to operate uniformly using inventory as a buffer.

ii. The bill-of-materials (BOM) records, also known as the "product structure records" contain the bills of materials for the end items in levels representing the way they are actually manufactured: from raw materials to subassemblies to assemblies to end items. The BOM is stored conveniently in a data file on a computer.

iii. The "inventory status records" are the third source of data input for the MRP. They contain on-hand balances of items in inventory, open orders, lot sizes, lead times, and safety stocks.

The MRP takes the master production schedule for end items and determines the gross quantities of components required by using the product structure records (bill of materials), wherein the gross quantities are obtained by "exploding" the end item product structure records into its lower level requirements. Next, by using the inventory status records, the net quantities required are determined by subtracting the available inventory quantities from the gross requirements. Finally, the time periods when the parts should be made available are determined by time phasing (setting back) the lead times for each of them.

The MRP produces "planned order releases," so that purchase orders, work orders, and reschedule notices can be prepared. MRP is an excellent planning and scheduling tool that

can prevent shortages and overages by predicting them ahead of time. It attempts to minimize inventory investment. It keeps order priorities up-to-date.

4. Materials management

Materials management is broader in scope than just inventory control or MRP. Materials management is concerned with controlling the kind, amount, location, movement, and timing of the various commodities used and produced by the industrial enterprise, and this specifically includes material handling. In other words, materials management is composed of all material-related functions, such as purchasing, transportation, logistics, production control, inventory, and sometimes even quality.

The complexity of today's products and processes necessitates a formal technique such as materials management for improving the total productivity in manufacturing plants, suppliers' facilities, and distribution warehouses. The broad scope of materials management helps to integrate the purchasing, storing, manufacturing, and distributing functions by computer-controlled information systems. The complexity of the materials management process in a company depends upon the type of product, the quality and reliability levels demanded, the percentage of the product manufactured within the company and the percentage of the product procured from suppliers, the storage capabilities for purchased and manufactured parts, subassemblies and finished products, the material-handling systems available, the manufacturing and distribution processes, the level of knowledge of the users of the materials management system, and so on.

Obviously, the determination of the impact of materials management on total productivity is not an easy task because of the overlapping nature of the elements involved. Materials management serves as a tool for improving total productivity & list below are some of the major tasks involved in it:

1. Selection of component parts and subassemblies that must be purchased from outside (whether it is from another plant or division within the same company or from other vendors/suppliers), and those that must be manufactured in-house.
2. Determining the production and supply capabilities of in-house facilities and outside sources to match the specification requirements.
3. Coordinating the procurement of the parts and subassemblies on time

4. Controlling the inventories of raw materials, semi-finished component parts, subassemblies, and finished products

5. Planning and controlling the movement of all the raw materials, work in process, and finished goods

6.3.2 Employee-based Productivity Improvement Methods

No matter how sophisticated the technology a company has at its disposal, the human beings working for the company are its greatest asset for one simple reason: Until there are totally automated, fully integrated factories, at least some human help is necessary in the design of such automated plants, let alone their operation. More than 26 employee-based productivity improvement techniques have been identified from the points of view of human productivity and total productivity. The major ones are financial incentives (individual as well as group), fringe benefits, employee promotions, job enrichment, job enlargement, job rotation, worker participation, skill enhancement, management by objectives (MBO), learning curve, communication, working condition improvement, training, education, role perception, supervision quality, recognition, punishment, quality circles, and zero defects

1. Financial Incentives (Individual & Group)

a) Individual financial incentives

Several *individual* financial incentive plans have been used in companies, businesses, and other organizations to increase labor productivity. Some of the more well-known and applied plans are: piecework plan, standard hour plan, measured day work plan, Emerson plan, Halsey plan, 100 percent plan, and Bedeaux plan. Piecework plan, the standard hour plan, and the measured day work plan are used relatively more often.

Piecework plan

Pay is directly proportional to the number of units produced. Minimum daily rate is guaranteed in most cases. The earnings generated in the PWP is given by

$$E_{PW} = \sum (N_i)\,(PWR_i)$$

Where N_i = number of pieces of type i produced, PWR_i = piecework rate for type i item (birr per piece), SPR_i = standard production rate for type i item (pieces per hour) WR_i = wage rate for type i item (birr per hour)

$$PWRi = \frac{WRi}{SPRi}$$

Standard Hour Plan

The standard hour plan overcomes the problems with the piecework plan by using standard hours per piece instead of dollars per piece. The earnings in this plan are given by

$$Esh = \sum(SHEi)(WRi)$$

Where SHEi = standard hours earned for item type i

$$SHEi = \frac{Ni}{SPRi}$$

The advantages of the SHP are: standards are never changed (as long as the methods have not changed), even if the base wage rates are changed; the earnings are easy to compute; also this plan helps to provide merit differential since, for the same standard, there may be different wage rates. The only *disadvantage* in this plan is that the individual incentive is not as high as in the PWP.

b) Group financial incentives

The second type of financial incentive system is the *group* incentive plan. Some well-known group plans include the following: Scanlon plan, Rucker plan, Kaiser plan, Tonnage plan, Dollar sales plan, Profit sharing, and Improshare. Brief description of Scanlon plan follows to exemplify the group financial incentive plans.

Scanlon Plan

This plan, which encourages employee participation in solving production problems, received a tremendous amount of publicity. The plan has been used by many companies over the years and it works as follows:

1. Set up a target ratio (or norm). TR = (Labor cost or wage bill) / (SVOP) by estimation using past data, where SVOP = sales value of production = value of receipts for goods sold + value of goods in stock
2. Each month, compute the sales value of production (SVOP) at the selling price.
3. Compute allowable labor cost: (TR) (SVOP).
4. Compile actual labor cost.
5. Compute savings in labor cost: Allowable labor cost - actual labor cost.

6. Share the labor cost savings in an agreed proportion. (A common proportion used is 25/75; that is, 25 percent to the company and 75 percent to the workers.)

   Out of the share to workers, usually 75 percent is paid to them as a cash bonus. The remaining 25 percent is set aside in what is called the employee bonus reserve fund.

7. At the end of a year, if the reserve balance is positive, pay it to the employees; if not, wipe out the deficiency by using the reserve fund.

   The plan is popular, but one of the main disadvantages is: if workers suggest automation and capital investment, there is a substitution of capital for labor and management has to adjust the target ratio. If no standards exist, such an adjustment becomes difficult. It may be suggested that the percentage of return on additional capital be deducted from the total savings before the bonus is determined. Another problem with this plan is that the target ratio is not necessarily fixed over time. Changes in the prices of the final output, or prices of raw materials, or changes in the capital/labor ratio, may warrant a change in the norm.

2. Fringe Benefits

Many organizations find it necessary to provide incentives to management and supervisory people just as in the case of blue-collar workers. However, in many cases, apart from the regular bonuses, or profit sharing, companies come up with some intangible means of rewarding and encouraging a management employee. These benefits are usually referred to as the "fringes." Some typical forms of fringe benefits include: Medical insurance, Disability insurance, Entertainment expenses, Relocation expenses, Subsidies for buying or renting a home, Free airfares for family and employees, Free company car, telephone, newspaper, and/ or chauffeur, Marriage subsidy, Free educational trips abroad, Free or subsidized higher education. At the top management level, fringe benefits take on very novel form.

Apart from the above, a general manager of a company or the chief executive officer of a firm may be given a very expensive car, boat, or motor home. Vacations around the world at company's expense are another form of recognition and reward for top management officials. All these are good forms of motivation for management people as long as such fringe benefits are administered within reasonable bounds, making sure that the other expense input is not increased unduly for a proportionately smaller increase in the total productivity.

3. Employee promotion

Employee promotion is both a financial and nonfinancial form of motivation to enhance human productivity. It involves the upgrading of an employee's status, and is a natural way of recognizing an employee's skills, knowledge, proficiency, and effort at his/ her present job.

At the blue-collar level, employee promotion may be from machine operator to machine setup operator or foreman; at the clerical staff level, it may be from clerk to administrative assistant; at the management level, it may be from manager-manufacturing to vice president-manufacturing; and so on.

According to Maslow's theory of hierarchy of needs [1954] only unsatisfied needs can motivate a worker to higher human productivity. Also, the lowest level of unsatisfied need becomes an important factor. Thus, for example, if the physiological, safety and security, and belongingness needs of an employee are satisfied, but self-esteem (self-approval, prestige) is not satisfied, then the self-esteem need becomes the employee's main concern, and, by improving the self-esteem need, his or her productivity can be enhanced. The highest level in the hierarchy of needs is self-actualization (realization of one's potential).

While Maslow's theory was assumed by many to be too simplistic, Herzberg's two-factor theory was considered controversial. Lawler, Vroom, and others have proposed their own motivational concepts. There is no consensus as to which is the "best" in the contemporary world.

Whether employee promotion is indeed a productivity improvement tool may be as controversial as some of the motivation theories themselves. However, at least for a short period of time after employee promotion, there may be an increase in an individual's enthusiasm to perform better, but much more research needs to be done in this area.

In the Japanese style of management, employees are promoted strictly on a seniority basis, granted that all of them are motivated to perform well. A 25-yearold brilliant engineer may have to wait to be promoted not because of ability, skill, and knowledge, but because of the number of years he or she has been with the company. Needless to say, in the United States and other Western countries, this is not the case. Whether it is just the "culture" element or something else that plays part in the Japanese style of management is not thoroughly established. Further research is needed in this area.

4. Worker Participation

Participation is an approach to overcoming resistance to change through employee involvement in planning and implementing the change. It is the mental and emotional involvement in a group situation that encourages the person to contribute to group goals and to share responsibility in them [Davis, 1957). There are several participation approaches to improving partial or total productivity. These include: Quality-control (QC) circles, Productivity quality (PQ) teams, Productivity action teams, Productivity circles, Productivity maintenance groups, and Employee participation groups (EPGs).

The principle behind all these approaches is the basic premise that group wisdom is better than individual knowledge, and that employees know their job better than anyone else. The PQ team concept is an extension of quality circles in some respects, but is different in some basic features.

5. Skill Enhancement

Skill enhancement is a formalized technique to increase the skills needed to perform a job. Skill training or coaching may be needed for an employee when the employee's attitude toward the job is positive but his or her abilities are low.

There is a certain amount of training cost involved whenever skill enhancement has to occur. Also, this technique may yield productivity improvement more on a long-term than a short-term basis. Therefore, the other expenses input may go up in terms of training expenses, though there must be a corresponding increase in the output.

With the advent of computers, robotics, fiber optics, and other advanced technologies, there is a great need for skill enhancement at all levels of management and operation of a company, not only to train new employees in these technologies but also to train those displaced from other jobs due to the introduction of these technologies.

6. Management by Objective

Management by objectives (MBO) is a managerial motivation technique that has received worldwide attention. The MBO process aids motivation of all participants by having superior and subordinate managers jointly identify common goals, carefully define them, and together monitor progress toward achieving results.

We can see that a person is more enthusiastic when the goal is plainly seen and progress toward it is easily measured. By coordinating or matching the personal goals of employees with those of the company, employees are likely to improve productivity more than when the goals of the employees and management are not congruent.

The goals set by the MBO strategy are of four basic types: routine goals, problem-solving goals, innovative goals, and personal-development goals. Corresponding to each of these goals, objectives are written. In setting up the goals, care must be taken not to set goals which are simplistic, without adequate resources, and harsh that cause resentment.

If properly administered, MBO can create joint goals and can help in teambuilding. MBO goals provide fairness to both the employer and the employee; and can also help in evaluating group performance. The MBO technique has often been cited as one of the ones more commonly used for productivity improvement.

7. Communication

Communication refers to the adequate and timely flow of information with a feedback mechanism. The purpose of *effective* communication is to achieve mutual understanding between the employees and management, and to help establish the social conditions that will motivate the employee to improve productivity.

When the employees and management of an organization communicate *consistently, openly,* and with *mutual trust,* a certain amount of loyalty develops, and this loyalty is not something that can be purchased simply by paying higher salaries or wages. The terms "consistently," "openly," and "mutual trust" have been emphasized intentionally, since so many new productivity programs fail because the initial enthusiasm in communications between top, middle, and lower management and the employees fade after some weeks or months. To "sell" a program, management will be open about disclosing even the financial status of the company; but when productivity gains start occurring, management hesitates to give the good picture for fear that employees will ask for higher wages. Of course, a management that truly preaches and practices productivity distribution will not find openness of communication a problem at all. Mutual trust between employees and management and within the management ranks can be enhanced only when both sides make sincere efforts to define the organizational goals and match them with the employees' goals in order to make them congruent. If both

their goals are not the same, it will be like going in two separate directions while trying to reach the same destination.

One distinct feature of many successful Japanese companies is that they keep even the lowest level employee well informed of their financial status, realizing that all the employees and management are part of one company-family whose objective it is to produce products or services at the most competitive price and the best quality level possible. The employees know that if this is not achieved, there will be no company and they would not have their jobs.

The communication technique may not have short-term impact on total productivity, but it will certainly have a positive effect on it in the long run.

8. Working Condition Improvement

Working condition improvement is another employee-based productivity improvement technique that is often emphasized but rarely applied consistently. This technique involves a detailed audit of the working conditions at each of the operations, designing improved conditions of working, and installing & maintaining improvements in the working conditions.

The factors that must be audited to assess the present working conditions at each workplace area are:

1. Temperature, light, and humidity
2. Noise
3. Colors of the surroundings
4. Extent of handling hazardous materials, parts, or products
5. Extent of manual handling of heavy items

The level of safety for operators depends on the extent to which these five factors are in the satisfactory zone.

With the advent of robotics, working conditions for blue-collar workers in a manufacturing-type environment should be improved considerably. For example, robots can operate under severe temperature, humidity, noise, and weight-handling situations. Not only can the robots cope up with these conditions but they can do so 24 hours a day, 365 days a year, without fatigue or accidents. All this translates not only into improved human productivity but also improved energy and material productivity, in view of the fact that material wastage due to hazardous working conditions is reduced, as is energy usage because most robots do not

require lighting, air conditioning, and other utility expenses. The net effect of this should be improved total productivity.

9. Training

Training seeks to achieve improved human productivity by increasing the ability levels of the workforce. It seeks to meet the demands of growth and change [Jucius, 1963]. Some of the common forms of training are on-the-job training, apprenticeship training, internship training, outside courses, visitation training (i.e., visits to other organizations, both domestic and foreign).

Training must be an on-going feature if total productivity is to be improved on a consistent basis. The necessity for training increases to a greater extent when new technologies emerge. Again, the best example is robotics. When the computer technology started taking shape in the 1950s, there was fear of losing jobs; but today, several millions of jobs are created because of the computer industry and the several related industries that use computer technology. A similar situation exists today with respect to robotics.

Although there is the fear that robots might take away jobs, in the long run there will be more jobs created because of the robotics industry than will be lost to robots. The level of sophistication and capabilities of the robots manufactured depend upon the extent computer technology is used in these robots. There is going to be a great need for training in robot-programming in order to use robots effectively.

Managements that plan ahead for such training (and, perhaps, retraining) would be better off if they quickly absorbed the latest technologies. Training may actually decrease the total productivity initially (because the other expense input will increase when training expenses are incurred) without offering an immediate increase in the output. However, the long-term effect of training on human productivity and on total productivity should be favorable.

10. Education

Education refers to the level of high school, college, or vocational training acquired by an employee. It is believed that a worker who has acquired a good and sufficient education, *and* is able to *apply* it, is more capable of effecting a positive change in productivity. A company or organization can play a great role in increasing an employee's level of education by providing programs that support such employees while they are serving the company. Such

programs are usually provided in the form of evening courses in local high schools or colleges.

Although we do not have positive evidence that education level and total productivity are related, there may be a definite impact of education on human productivity because of the ease of learning new procedures, methods, or techniques as a result of the educational base. After all, one main result of education is the development of analytical abilities to solve a problem or encounter a situation.

Employees, whether blue collar workers on the shop floor or engineers in management, have a certain level of *formal* or *informal* education. They have, however, different levels of analytical skills, and that makes the difference in analyzing a particular problem or situation. Different solutions to a given problem are proposed by different people because of their "education" level. This education is the level of knowledge one possesses from visual observations, mental thinking, and perceptions of the surrounding world. Some of the so-called uneducated people (from a formal-education point of view) have developed some of the greatest objects of beauty and utility. From a philosophical viewpoint, everyone right from childhood, whether human or animal, has been educated about its surroundings and environment. It is just that some have different levels of discretion in using the knowledge gained through education depending on their wants or needs in a given situation.

The term education used in our context as a productivity improvement technique refers more *to formal* education. The question we must ask is: Do the level of formal education and human productivity go together?

The relationship between formal education level and human productivity and total productivity has not been established scientifically. Until then, let us try educating the people we work with, under the assumption that we can improve both human productivity and total productivity.

6.3.3 Technology-based Productivity Improvement Techniques

Primarily, it is appropriate to clarify the meaning of technology in the context of this topic. The term *technology* has been defined in diverse ways. For the purpose of this topic, we refer to technology as the application of new scientific methods for handling specific technical problem(s).

The productivity improvement techniques heavily dependent upon new technologies are numerous. But the following are the better known ones which can be understood from the point of view of their impact on both partial and total productivities: maintenance management, rebuilding old machinery, energy-conservation technology, computer-aided design (CAD), computer-aided manufacturing (CAM), computer-integrated manufacturing (CIM), robotics laser technology, energy technology, group technology, and computer graphics.

The first three approaches are concerned with productivity improvement by effectively utilizing what a company already has in terms of plant and equipment rather than new technologies. These three techniques are emphasized here in brief**.**

1. Maintenance management

Maintenance management is a formalized approach to maintaining the currently available machinery and equipment to help them function according to the maintainability and reliability characteristics. It is a management tool often neglected. Yet it can be a very effective means of cutting down maintenance costs and increasing human productivity, fixed capital productivity, and energy productivity, in most cases.

In light metalworking and fabric-producing plants, maintenance employees may account for about 4 percent of the workforce, but in processing plants, heavy industry, and plants with complex equipment, maintenance personnel can represent as much as 40 percent [Merrihew, 1971]. Maintenance management results in many benefits, including the following:

1. Machine-availability time for production goes up, resulting in higher outputs and lower machine costs per hour.
2. Labor productivity in production areas goes up.
3. Breakdown maintenance is reduced, and with it human input in terms of dollars.
4. Because of a general reduction in overtime, the cost of maintenance operation itself goes down.

In fact, in one case, by applying computerized controls to maintenance management, scheduled repairs went up, breakdown maintenance and lost production time went down, worker productivity went up while the backlog went down, and the cost of maintenance operations went down 30 percent.

Maintenance management is an effective technique to get the most out of the existing machinery and equipment. Therefore, it is almost always likely to increase the output and decrease the human input.

2. Rebuilding Old Machinery

Quite often company managements do not realize the potential in modifying the existing machinery and their tooling, but instead purchase brand-new machinery. The greater the initial cost of the machine being remodeled, the greater are the savings in fixed capital input.

Many large corporations have their own machine-building departments where the remodeling is undertaken very methodically. This can certainly payoff. Of course, the remodeling effort can be made easier if the shop floor employees are encouraged to suggest the modifications themselves. Companies that have participatory management, say, with quality control circles, can take up the redesign of existing machinery and tools. After all, workers on the shop floor know more about their machines' capabilities than anyone else-at least in most cases. This technique can have a positive effect in the long run (for the most part) on total productivity.

3. Energy Conservation Technology

The energy-conservation technique is concerned with making the best use of the existing technology of energy in a particular company at a given time. This energy-conservation technique is often referred to as "energy management," although the latter is a broader term. Basically, our objective is to minimize the consumption of energy in all forms without lowering the quantity or quality of output.

Energy-conservation technology (ECT) deals with several aspects of energy management, including the decision and performance of energy audits, economic analysis of energy-related projects, design and effectiveness of monitoring the energy reporting, redesign of existing products and processes for better energy consumption and the integration of energy conservation devices in the processes of manufacture or deliveries of services.

Energy-conservation technology is a very systematic technique that identifies the potential areas of energy savings in the operations of a facility, order-ranks these potential areas in the order of magnitude of possible savings, studies and analyzes, in depth, these order-ranked areas, develops a set of energy-conservation measures for each of them, implements the conservation procedures, monitors the progress of the implemented conservation procedures,

reports to the productivity-engineering department the changes in human material, capital, energy, and other expense inputs as a result of the energy conservation procedures.

The potential areas that can be explored for energy savings vary depending upon the nature of the activities in a facility, but generally the following areas are worth looking at for large savings in one or more of the five basic input factors:

1. Material-handling equipment (excessive consumption of propane gasoline, diesel fuel, and electricity; improperly charged batteries, lack of metering systems, etc.)
2. Lighting (of unnecessary areas, for periods longer than necessary, and with candle power greater than necessary)
3. Air-conditioning and heating equipment (lack of replacement of filters, clogging of ducts and vents, improper placement of vents, improper temperature settings, improper distribution of cool air/ hot air, improper air balance and air handling, etc.)
4. Motors, boilers, and other primary sources of power (lack of preventive maintenance, higher power ratings than necessary, lack of time-delay switches to turn off devices; absence of preheating for boiler feed water, lack of automatic boiler blow down controls, lack of power correction equipment, lack of insulation of condensate, steam, and chilled water lines, etc.)
5. Entrances to and exits from air-conditioned areas (lack of double doors or strip curtain doors, lack of adjustable dock cushions, etc.)
6. Pollution at the source (causing clean-up problems elsewhere)
7. Car pools
8. Energy controls for machinery, etc.

The effect of ECT on productivity depends upon the savings/ investment ratio; the greater this ratio, the greater the chances of a positive effect on total productivity.

6.3.4 Product-based Productivity Improvement Techniques

The range of techniques used for product based productivity improvement include: value analysis/ value engineering, product diversification, product simplification, product standardization, research and development, reliability improvement, emulation, and advertising and promotion.

1. Value analysis/ value engineering

Although value analysis and value engineering are used interchangeably, there is a subtle difference between them. *Value analysis* (V A) is concerned with the modification of the existing design of a product or service with the objective of reducing the overall cost of manufacturing or delivering of the service. On the other hand, *value engineering* (VE) is concerned with the development of a new design for a product or service with particular emphasis on the ease of use and cost of manufacturing or delivering. In the case of both value analysis and value engineering, the primary objective is to design for functional value. Improvements in the design of the products or service without sacrificing the functional value in terms of quality, reliability, and functional capabilities are most likely to decrease total input for the same amount of output.

In value analysis, the purchase manager works closely with the design or industrial engineer. In value engineering, the role of the design engineer is greater. Depending upon the type of product for which value engineering is being applied, there may be as few as one or two individuals to a large group on a VE team from design engineering, research and development, marketing, and purchasing.

Value analysis and value engineering involve two basic features: component elimination and material substitution.

2. Product diversification

Product diversification involves the addition of new product types or models to the existing ones. Generally speaking, the reasons for product diversification may include one or more of the following:

1. The competition introduced a new product recently
2. The existing models of products are not sustaining the market share
3. The consumers' perception of quality for the existing products has been poor in recent months and years
4. Raw materials, component parts, and energy supplies have unexpectedly become scarce
5. The company has developed a product that is far ahead of the competition
6. The new product is needed for national defense purposes
7. No one offers the new product at the present time
8. Penetration into the international market is necessary
9. Penetration into the competitors' markets is essential for survival and growth
10. The company is granted an exclusive contract to offer the new product

Although each of these reasons may be viewed as important enough for product diversification in a traditional sense, the managements must look at one other factor: the potential for total productivity growth.

The total productivity of a firm is the weighted sum of the total productivities for each of the products or services the firm offers. That is to say, $TPF = W_1 TP_1 + W_2 TP_2 + ... + W_n TP_n$ if the firm offers *n* products or services.

A firm must attempt to diversify into products or product groups that can generate the highest possible levels of total productivity for a particular planning horizon. The introduction of the productivity dimension into the strategic decisions of product diversification can provide valuable information that might be particularly important when such decisions may have long-term effects on a firm's financial performance.

3. Product simplification

Product simplification essentially involves the elimination of extraneous or marginal lines, types, and models of products [Riggs et al., 1979]. It includes a reduction in the range of materials and component parts used, and a reduction in the complexity of methods and processes of manufacture.

In the evolution of an organization over a period of several years, a number of "unnecessary" product lines, models, and materials accumulate, not necessarily because of technical reasons, but often because they are the creations of some "key" people in the organization.

Product engineers tend to have their own product lines and projects that become "white elephants." Depending upon the amount of influence and power they wield in top management, there may be situations where some of these products and services are offered at a loss because the "big bosses" do not want these creations to die as long as the engineers are working for the organization. Of course, such companies invariably have other product lines that are profitable, thus compensating for these "white elephants."

4. Product standardization

One often overlooks the savings in processing costs and inventories as a result of product standardization-a powerful productivity improvement technique.

Product standardization is a systematic effort on the part of design engineers, industrial engineers, and marketing managers to create a product mix that minimizes manufacturing, distribution, selling, and maintenance costs.

One of the famous European scooter manufacturers has had a scooter consisting of several hundreds of component parts, but the entire scooter can be disassembled and reassembled using less than four sizes of wrench! The standardization is as superb as that! But what does this mean as far as productivity improvement is concerned? First, the manufacturing tools, jigs, and fixtures become much easier and less expensive to make. Second, inventories of component parts are controlled at lower costs. Third, retailers can make spare parts available more rapidly and at lower unit costs. Finally, customers can maintain their product at lower cost because of built-in reliability as a result of component standardization and because of ease in repair and ease of spare part procurement.

Product standardization does not occur in a systematic fashion unless the top management emphasizes this technique as an on-going philosophy of its operation.

5. Research and development

Research and development (R&D) takes two forms: basic and applied. Basic research tends to focus on the development of fundamental knowledge, while applied research attempts to explore the potential applications for the fundamental knowledge so developed. Although business organizations mostly emphasize applied research, there are many organizations that invest to a considerable extent in basic research.

If productivity improvement has to be an on-going, continuous, competitive process for the survival and growth of an organization, R&D becomes an important and effective technique that should be introduced formally. Half-hearted commitments to R&D are tantamount to lip service and do not lead to sustained and competitive productivity growth.

Generally speaking, companies that are heavily dependent upon new technological breakthroughs are more willing to invest in R&D. When the R&D investment is amortized over a period of time-say, 10 to 20 years-the other expense input factor in the total productivity ratio must be expressed appropriately. The increases, if any, in outputs and the decreases, if any, in other input factors must also be noted to show such changes equitably

in a given period of time in order to indicate the positive or negative changes in total productivity.

6. Reliability improvement

Reliability refers to the probability of a product, component, or system functioning successfully over a period of time. *Reliability improvement* is, therefore, an intentionally enforced technique at the very first stage of a product, component, or system development, namely, the design phase. When a product is designed with built-in reliability, it is bound to perform without failure for a longer time than otherwise.

With respect to product or system reliability, the following points may be noted:

- Reliability generally improves with a smaller number of parts because the chances of a product failure increase when there is a large number of component parts.
- Not only should we strive to have fewer parts, but we should try as far as possible to have less complex parts. That is, a product or system with a large number of simple items is preferable to a set with a small number of complex parts.
- Flexibility of design must go along with built-in reliability rather than making the design too inflexible.
- Those parts that are likely to be the most vulnerable to failure must be supported by a built-in redundancy to increase the overall system's reliability.
- Some mechanism must be provided in the system to indicate the approaching failure mode.
- Provision must be made to absorb any disastrous situations.

7. Emulation

Emulation refers to the copying of the best ideas from other companies within the same industry. Companies do not have to be originators or inventors of new methods to be successful in improving productivity.

Copying the best ideas includes products, processes, materials, technology, and management policies. However, with respect to products, emulation is a very effective productivity improvement technique simply because of the time it generally takes to perfect a product from scratch by taking advantage of the ideas already implemented for the product by competitors.

Emulation techniques can and must be applied systematically, as suggested below:

1. Procure as many as, but at least three, of the competitor's products of *similar* technical specifications. The competitors must be the most reputed worldwide, if the product is sold all over the world.
2. Have a small group of design or product engineers meticulously record the similarities and dissimilarities in the component parts of each of these products. For critical component parts, record all important characteristics-including physical, chemical, metallurgical, aesthetic, functional, quality, degree of manufacturing difficulty, extent of availability of competitor's technology to produce the part, and degree of standardization.
3. On a pilot-run basis, incorporate the best features of the competitors' products into the product you are comparing with.
4. On a regular basis, determine the impact of step 3 in increasing the total productivity or decreasing the total unit cost of production.
5. If step 4 above is favorable from the point of view of total productivity or total unit cost, implement the "emulated product" in regular production.
6. Let the search for perfection in product quality and manufacturing cost be on-going and continuous.

8. Advertizing and Promotion

Advertising and promotion is an effective technique to improve the total productivity for a product or service. Although, for the most part, it is emphasized by organizations when their sales are declining or when the product or service is being introduced into the market for the first time, the potential impact of this technique on productivity is rarely understood by marketing departments.

One of the major impacts of advertising and promotion for an existing product or service is to increase the demand, which, in turn, is likely to improve the capacity utilization of manufacturing and service operations. Improvement in capacity utilization should generally have a positive impact on both fixed capital productivity and total productivity. Also, employee layoffs may be prevented if there is more work as a result of the increased demand through advertising and promotion.

Minimizing employee layoffs is beneficial for an organization in the long run because, if the organization lays off employees and cannot get them *all* back; new hirings must involve the additional costs of hiring and training. In addition, the morale of the employees not laid off is affected when they see their colleagues sent away because of poor capacity utilization. Thus, the net effect of advertising and promotion might be a long-term reduction in human input factor in the total productivity equation.

Another benefit of advertising and promotion when there is an acute capacity utilization problem is the avoidance of excessive re-start-up and maintenance costs. For example, a company may close down a part of its manufacturing facilities for extended periods of time due to lack of sufficient demand, sometimes for as long as six months or one year. When the demand position improves later and this part of the plant has to be restarted, maintenance crews spend considerably more time and effort to get the whole plant going again. Obviously, all this translates into cost terms, increasing the total input.

In times of low demand and prolonged periods of plant shutdowns, inventories of raw materials, purchased component parts, and unsold finished goods build up, which again means money locked up unused, thus raising the working capital input factor in the total productivity equation.

Clearly, advertising and promotion, if planned and executed well in times of low demand and low capacity utilization, might be an effective tool for improving the total productivity and the profit position. Many companies typically spend about 3 to 5 percent of total sales on advertising and promotion. When the demand goes down drastically, the general tendency is to spend lavishly on advertising and promotion for a short period of time; and if the demand does not pick up substantially, there is a tendency to stop the promotion activity, with the result that the market share is lost and the capacity utilization is further reduced.

6.3.5 Task-based Techniques

Task-based productivity improvement techniques include methods engineering, work measurement, job design, job evaluation, job safety design, human factors engineering (ergonomics), production scheduling, and computer-aided data processing. These techniques can be applied for the manufacturing enterprises in order to, significantly, increase their productivity.

Chapter 7

Conclusion and Recommendations

7.1 Conclusion

Foods & beverages and nonmetallic mineral products have the major contribution of value added in manufacturing in Ethiopia as compared to the remaining manufacturing groups.

There is lack of awareness in some of the firms concerning the significance of productivity since only 30% of the surveyed companies accept the fact that high productivity determines sustained improvements in the country's standard of living.

International competitiveness of our products is largely determined by our productivity; however, failure to keep pace with productivity levels of competitors and trying to solve our problems by devaluing our national currencies lowers the real income in the country by making imported goods more expensive and by increasing domestic inflation.

All the surveyed companies define productivity from various perspectives mainly including labor, material, capital and some or all of the three factors together. Here it has been found that 84% of the respondent companies use the working definition of productivity to be total output per all the inputs (material, labor & capital) used i.e. total productivity.

Although they could not clearly state the method they really use, nearly 40% of the companies believe to have employed measurement as well as improvement techniques for partial (labor, material, capital) and/or total productivity. In addition, about 72% of the companies agreed that they have an increasing trend in total productivity within the recent three years period. This shows that the companies are not working in scientific techniques to measure and improve their productivity.

The top five most critical factors affecting productivity of Ethiopian manufacturing firms are found to be materials, labor force, machineries, management, existing marketing conditions, and energy in the same order of effect. A critical emphasis is required to analyze the root causes resulted from these factors and solve related problems that decline firm-level as well as national productivity.

A number of reasons have been identified for low labor productivity since more than 55% of the companies believe that unmotivated employees, lack of well skilled labor in the market,

absence of well established human resource training & development practices, ignorance of workers when setting company goals & plans, and high rate of labor turnover are the main problems that result in low labor productivity.

With regard to material-related problems, lack of adequate and timely supply of quality materials, traditional material handling and storage practices, and inefficient utilization of material resources are the main ones that faced the companies. Here also are only limited efforts to analyze and improve the design, manufacturing mechanisms and distribution systems of the products within the companies.

There is no any department in majority (88%) of the surveyed companies which is well established and responsibly involved in research and development duties to find out and introduce innovative methods and technologies that can improve their manufacturing productivity.

Most of the firms have no progressive emphasis on proper utilization, maintenance, modification, and modernization of the machinery and technology which is required to minimize productivity loss.

Proposed Analytical Productivity Improvement Model is a visible solution to improve the productivity of manufacturing firms in Ethiopia when it is applied based on the improvement techniques and the productivity improvement principles.

7.2 Recommendations

The company owners, managers, and employees should be aware of their working definition, significance and basic principles of manufacturing productivity. Here it is important to have education and training for the managers as well as blue collar workers on the basic concepts of productivity, its importance for themselves, for the company as well as for the country as a whole. In addition, they should to be well informed the role they can play for productivity growth.

The companies should pay a greater emphasize for total productivity than partial productivity improvement since partial productivity leads to overemphasizing one input factor to the extent that the effect of the other inputs is underestimated or even ignored, leading to erroneous judgments and costly mistakes; whereas total productivity includes all the tangible (i.e. inherently /directly/ measurable) output and tangible input elements.

The manufacturing enterprises should implement scientific methods to measure and evaluate their productivity status since measurement is the foundation to begin improvement and sound productivity measurement systems need to be an integral part of the management information system to achieve a balance between productivity, profits and prices.

The companies should apply material-based productivity improvement techniques such as inventory control systems, MRP, materials management, quality control, material handling systems improvement and material reuse and recycling to eradicate or at least minimize material-related productivity problems.

Employee-based productivity improvement techniques should be effectively used to avoid labor-based productivity problems and maximize labor productivity. Financial incentives (individual & group), fringe benefits, employee promotions, worker participation, skill enhancement, communication, working condition improvement, training, education, job enrichment (enlargement and rotation), management by objectives (MBO) and learning curve are some of the techniques that can be properly applied to improve productivity of the labor force.

Similarly, technology-based techniques especially maintenance management, rebuilding old machinery, emulation and energy conservation technology should be applied to improve productivity of the companies; moreover, the firms should objectively strive for the introduction of latest manufacturing technologies such as CAD, CAM, CIM, robotics, laser beam technology, energy technology, group technology, and computer graphics.

Likewise, the companies should implement the product-based and task-based productivity improvement techniques which can avoid the sever effects of the problems related to management and manufacturing methods.

The proposed analytical productivity improvement model should be used as a general framework to adapt and implement in the companies based on the stated productivity improvement techniques by considering its technical and economical feasibility.

Finally, further studies should be conducted in the firms concerned with productivity measurement, evaluation, planning, and improvement in manufacturing.

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Appendix A

The Questionnaire Distributed for the Manufacturing Firms

I. PERLIMINARY INFORMATION

Respondent Profile

1. Your current position in the company……..
2. Qualification level: Below diploma ☐ College diploma ☐ BA/BSc ☐ MA/MSc & Above ☐
3. Your work experience in this company: Below 2 years ☐ 2-5 years ☐ 5-10 years ☐ Above 10 years ☐

Company Profile

4. Name of your company.....
5. Start-up year (established in).....
6. Three main products of the company.....
7. Number of employees currently working in the firm: Direct labor.... Indirect labor…
8. Latest capital assets (Birr).....

II. CONSIDERATIONS AND INTERPRETATIONS OF PRODUCTIVITY IN THE FIRM

Please tick (✓) or circle the number that applies

Rating scale:

Disagree	Undecided	Agree
1	2	3

1. In your opinion, the working definition of productivity in the firm is:

1.	Output per worker	1	2	3
2.	Output per capital	1	2	3
3.	Output per materials	1	2	3
4.	Output per inputs of material, labor & capital (plant, equipment, technology, etc)	1	2	3
5.	Sales per employee	1	2	3
6.	Jobs completed per jobs scheduled	1	2	3
7.	Output per labor cost	1	2	3
8.	Output per work hours	1	2	3

Other, (please specify)……

2. How does your company characterize the importance of productivity?

1.	Higher productivity allows greater returns to the company owners	1	2	3
2.	Higher productivity allows the company to sustain higher wages to its employees	1	2	3
3.	It determines sustained improvements in the country's standard of living	1	2	3
4.	It supports spending on social programs, education, and the environment	1	2	3

Others, (if any)……..

3. The key driver of productivity in your company is:

1.	Investment in machinery and equipment	1	2	3

2.	Education and training of employees	1	2	3
3.	Planned utilization of raw materials	1	2	3
4.	Innovation	1	2	3
5.	Government spending and security	1	2	3

Other, if any ……

III. FACTORS AFFECTING THE PRODUCTIVITY OF THE COMPANY

Definitions

Here **productivity** is defined as the relationship between the amount of **output** produced (goods and services) **relative to** the amount of **inputs/resources** (labor, machinery, equipment, raw materials, energy, etc) used. Three concepts of productivity are used:

i. **Partial productivity (**output relative to one class of input). This includes **Labor productivity** (output produced relative to labor resources used – number of labor hours or number of persons); **Capital productivity** (output produced relative to capital input); and **Material productivity** (output produced relative to materials used)

ii. **Total factor productivity** (the ratio of net output to the sum of associated labor and capital (factor) inputs). By "net output," we mean total output minus intermediate goods and services purchased. Notice that the denominator of this ratio is made up of only the labor and capital input factors.

iii. **Total productivity** (the ratio of total output to the sum of all input factors used). Thus, a total productivity measure reflects the joint impact of all the inputs in producing the output.

1. Over the past 3 years (2000-2002EC) indicate [with a ✓ mark] the general trend in your enterprise.

		Decreasing	Constant	Increasing
	Labor Productivity	☐	☐	☐
	Capital Productivity	☐	☐	☐
	Material Productivity	☐	☐	☐
	Total Factor Productivity	☐	☐	☐
	Total Productivity	☐	☐	☐

2. Does your company have a well organized & equipped department which is involved in research and development (R & D) duties to find out and introduce innovative methods and technologies that can improve productivity? Yes ☐ No ☐

3. How do you rate the effect of the following factors on the productivity of your company [put ✓ mark on the number that applies]?

Rating scale:

Low Effect	Medium Effect	High Effect	Most critical
1	2	3	4

	Factors affecting productivity				
1.	Human resource *(Labor force -availability, mix, knowledge, skill, attitude, management, etc)*	1	2	3	4
2.	Materials *(raw materials & accessories -availability, quality, timeliness, import substitutes etc)*	1	2	3	4
3.	Machineries & equipments *(relevance, quantity, accuracy, speed, maintainability, age, etc)*	1	2	3	4
4.	Technology*(innovation, research & development, automation, information technology, etc)*	1	2	3	4
5.	Management*(plans & schedules, instructions, ability to adjust staff size & duties, coordination & balancing of material flow, supervision etc)*	1	2	3	4

6.	Infrastructures *(transport facilities, means of communication etc)*	1	2	3	4
7.	Organizational structure and culture	1	2	3	4
8.	Physical environment	1	2	3	4
9.	Government regulations	1	2	3	4
10.	Existing marketing conditions	1	2	3	4
11.	Energy	1	2	3	4
12.	Demographic & social changes	1	2	3	4

4. From your experience, rate the extent of your agreement on the following aspects of productivity factors which may affect the productivity of your enterprise over the past three years (2000-2002EC) [Please, tick [✓] the number that applies]. **Rating scale:**

Disagree	Undecided	Agree
1	2	3

1.	**Product Related Factors**			
	Price of your product is increasing through time.	1	2	3
	Your product is sold at the right place, time & price	1	2	3
	Value analysis is applied to modify product design	1	2	3
	Benefits of your product are relatively higher than its price	1	2	3
	Variety and production volume of your product is increasing	1	2	3
	Overall quality of your product is increasing through time	1	2	3
2.	**The Machinery and Equipment Factors**			
1.	Production plans & processing conditions are optimum	1	2	3
2.	Machines are properly maintained	1	2	3
3.	The company expands from time to time	1	2	3
4.	Production bottle-necks and idle times are decreasing	1	2	3
5.	Material handling systems are automated	1	2	3
6.	Machines are modernized through time	1	2	3
7.	CAD/CAM systems are introduced	1	2	3
3.	**Technology Factors**			
1.	R & D focuses on product development & productivity improvement	1	2	3
2.	Production activities are automated	1	2	3
3.	IT is used in the manufacturing and support activities	1	2	3
4	**Materials & Energy Factors**			
1.	Required materials are timely available for production	1	2	3
2.	Congestions & Incidences (breakdowns, planning errors, etc) are well controlled	1	2	3
3.	Efficient material yield is achieved	1	2	3
4.	Wastages and rejects are well controlled	1	2	3
5.	The company strives for import substitution for material sources	1	2	3
6.	Reliable supply source is developed	1	2	3
7.	Electrical and other energy consumptions are optimized	1	2	3
5.	**Labor Force Factors**			

1.	There is lack of skilled labor in the market	1	2	3
2.	High rate of labor turnover is frequent	1	2	3
3.	Misconducts (Alcoholism, Absenteeism, Strikes, & Conflicts etc) are common at workplace	1	2	3
4.	Employees have no adequate knowledge, skill & good attitude for their jobs	1	2	3
5.	There is no good relation, communication & suggestion systems across employees	1	2	3
6.	Job security, salaries & incentives are generally inadequate	1	2	3
7.	Workers are ignored when setting goals & plans	1	2	3
8.	There is no reliable standard to measure employees' performance	1	2	3
9.	Low degree of job enrichment and job enlargement	1	2	3
10.	Employees are dissatisfied and unmotivated	1	2	3
11.	Human resource training & development is not well practiced	1	2	3
12.	Job rotation, promotion and career planning are not applied properly	1	2	3
6.	**Organization and Systems**			
1.	Systems are not flexible to anticipate and respond to changes	1	2	3
2.	Lack of recognition for new capacities	1	2	3
3.	Difficulty of decision-making (delegation away from point of action and unneeded bureaucracy)	1	2	3
7.	**Management factors**			
1.	Managers have the required managerial & technical knowledge, skill and attitude	1	2	3
2.	Overtime works are recognized & paid	1	2	3
3.	Material and machine inventories are managed properly	1	2	3
4.	There is no disruption of power/water supply	1	2	3
5.	Stoppage of work orders due to accidents, disputes, regulations, etc are rare	1	2	3
6.	Scheduling and coordination practices are appreciable	1	2	3
7.	Company policies (regarding personnel, purchasing, etc) are good & productive	1	2	3
8.	Jobs are designed considering man-machine capabilities and limitations	1	2	3
9.	Operations are planed & controlled efficiently	1	2	3
10.	Capital sources, budgeting systems, & cost control techniques are reliable	1	2	3
8.	**Demographic and social changes**			
1.	The ratio of working men to women is unbalanced	1	2	3
2.	Retirement and ageing of employees is common	1	2	3
3.	Cultural values, beliefs, attitudes and traditions are demotivating	1	2	3
4.	The company invests in education and training to develop manpower	1	2	3
5.	There is a floor-space management & development policy	1	2	3
6.	Energy supply, transportation and communication facilities are adequate	1	2	3
7.	Adequate raw materials are available at optimum cost & quality	1	2	3
8.	Regulations (such as price control, income and wage policies) are demotivating	1	2	3

IV. PRODUCTIVITY MEASUREMENT AND IMPROVEMENT PRACTICES

1. Have you introduced any method (model) ***to measure*** *productivity* within the past 3 years (2000-2002EC)?

		Yes	No	If your answer is "Yes" please specify
1.	Labor productivity	☐	☐	
2.	Material productivity	☐	☐	
3.	Capital productivity	☐	☐	
4.	Total Factor Productivity	☐	☐	
5.	Total Productivity	☐	☐	

If your answers are 'No', please indicate the reason(s)

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2. Have you introduced any method (model) ***to improve*** *productivity* within the past 3 years (2000-2002EC)?

		Yes	No	If your answer is "Yes" please specify
1.	Labor productivity	☐	☐	
2.	Material productivity	☐	☐	
3.	Capital productivity	☐	☐	
4.	Total Factor Productivity	☐	☐	
5.	Total Productivity	☐	☐	

If your answers are 'No', please indicate the reason(s)

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3. Tick [✓] the number that applies using the rating scale:

Disagree	**Undecided**	**Agree**
1	**2**	**3**

The productivity level and its growth are positively correlated with:

1.	Research and development spending per worker	1	2	3
2.	Machinery and equipment spending per worker	1	2	3
3.	Number of employees with the right knowledge, skill and attitude	1	2	3

Others (specify if any) ……..

4. In your opinion, what can be done by the following agencies to enhance manufacturing productivity in Ethiopia?

a. Government_____
b. Trade Unions & Manufacturing firms _____
c. Private Sectors & NGOs_____
d. Any other agency (please specify) _____