SAINTY MARY'S UNIVERSITY

SCHOOL OF GRADUATE STUDIES

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IDENIFYING PRODUCTIVITYMEASURMENT MODEL FOR PHARMACEUTICAL INDUSTRY

A CASE STUDY OF ADISS PHARMACEUTICAL FACTORY SC

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ADDIS ABABA, THIOPIA

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DECLARATION

I, the undersigned, declare that this project report entitled "Identifing of Productivity Measurement Model for Ethiopian pharmaceutical industry. A case study on Addis pharmaceutical factory" is the result of my own research carried out under the guidance of Dr. Tesfaye Weldu . It has not been presented as a thesis in any other university and all source of material used for this thesis are duly acknowledged.

________________________ ________________________

Tesfaye Nigussie Date

TABLE OF CONTENTS

ii
ACKNOWLEDGEMENT
ABSTRACT iii
LIST OF FIGURES vi
LIST OF TABLES vii
ABBREVIATIONS viii
CHAPTER ONE 1
1. INTRODUCTION 1
1.1. BACKGROUND OF THE STUDY 1
1.2. PROBLEM STATEMENT 3
1.3. HYPOTHESIS 4
1.4. RESEARCH QUESTIONS 5
1.5. OBJECTIVE OF STUDY 5
1.5.1. General objective 5
1.5.2. Specific Objectives 5
1.6. SIGNIFICANCE OF THE STUDY 6
1.7. DELIMITATION OF THE STUDY 6
1.8. LIMITATION OF THE STUDY 7
7
CHAPTER TWO 8
2. RELATED LITERATURE REVIEW 8
2.1 Conceptual Review
2.2 Operational Definition 8
2.1. The concept of productivity 8
2.1.1. Types of productivity measures 9
2.1.2. Productivity Measurement Models 11
2.1.3. Difference between production and productivity 13
2.1.4. factors affecting productivity 13
2.2. Productivity in the pharmaceutical industry 15
2.3. The Ethiopian pharmaceutical industry and market 16

CHAPTER THREE 20
3. RESEARCH METHODOLOGY 20
3.1. Research design 20
3.2. Study Population/sample 20
3.3. Data collection Sources and method 21
3.4. Data analysis methods 22
CHAPTER FOUR 23
4 RESULT AND DISCUSSION 23
4.1. Productivity measurement model for pharmaceutical industry 23
4.2. The case company 26
4.2.1. Total factor productivity measure 27
4.2.2. Multifactor productivity measure 31
4.2.3. Single factor measure 33
4.3. Evaluation of the productivity measurement model 38
CHAPTER FIVE 40
5. CONCLUSIONS AND RECOMENDATIONS 40
5.1. Conclusions 40
5.2. Recommendations 41
REFERENCES 43

LIST OF FIGURES

Figure	**page**
Figure 1. Productivity measurement model based on single, multi and total factor productivities	24
Figure 2. Scatter plot for total factor productivity and net income	29
Figure 3. total factor productivity and index	30
Figure 4. Chart for multi Factor Productivity	31
Figure 5. Graph for Material Productivity and index	35
Figure 6. graph for labor productivity and index	35
Figure 8. energy productivity and index	36
Figure 9. miscellaneous productivity and index	36
Figure 10. single factor productivity indexes	36
Figure 11. pie chart for percent share of different inputs in total resources	37
Figure 12. Pareto analysis for percent share of different inputs in total resources	37

LIST OF TABLES

Table	**Page**
Table 1. total factor productivities	28
Table 2. total factor productivity and net income correlation	29
Table 3. Annual output and resource consumption in Addis pharmaceutical factory	30
Table 4. Inflation adjusted Annual output and resource consumption	30
Table 5. Multifactor and total factor productivity	32
Table 6. standard for Multifactor and total factor productivity	32
Table 7. Multifactor and total factor productivity index	33
Table 8. Single Factor Productivity	34
Table 9. standard value for Single Factor Productivity	34
Table 10. Single Factor Productivity Index	34
Table 11. percent share of different inputs in total resources	37

ABBREVIATIONS

WHO	World health organization
cGMP	Current Good Manufacturing Practice
GTP	Growth and transformation plan
EFFORT	Endowment Fund For Rehabilitation For Tigray
APF	Addis Pharmaceutical Factory
OECD	Organization for economic co-operation and development
SRP	Single Resource Productivity

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ABSTRACT

The main objective of the study was to develop and propose an appropriate single, multi, total factor productivity and productivity index measurement model for Ethiopian pharmaceutical industry in general and for Addis pharmaceutical factory in particular. An appropriate single, multi, total factor productivity and productivity index measurement model for Ethiopian pharmaceutical industry was developed and the model was tested with five consecutive year's data obtained from Addis pharmaceutical factory i.e., a case company.Simple and multiple regression analysis was used to develop the relationship between total factor productivity and company's performance (net income), and hence coefficient of correlation (r=0.867) showed that there is strong positive relationship between company's performance and total factor productivity and for any increment in total factor productivity there will be progress in net income. The coefficient of determination: $R^2 = 0.75$*, clearly illustrated that 75% variation in net income can possibly be explained by the variation in total factor productivity. Thus, it can be concluded that the study had achieved the general and specific objectives and all research questions and hypotheses are addressed. Therefore, the developed productivity model can be appropriate for Ethiopian pharmaceutical industry.*

Keyword

Productivity model, single, multi and total productivity measurement, company performance, Net income.

CHAPTER ONE

1. INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Productivity measurement is a precondition for productivity improvement and plays a major role in management of productivity. Productivity measurement determines whether an organization is progressing or not. It also provides an information on how a business firm manages its available resources effectively and efficiently (Spring Singapore,2011).

The productivity measurement is an important aspect in manufacturing firms and currently productivity improvement, particularly in developing countries becoming central for manufacturing firm leaders, corporate governors, strategic planners and government policy makers (Arturo, 2004).

A productivity measurement model is a method which is used in practice for measuring productivity and it must be able to calculate ratio of output to input (productivity model, 2016). Productivity is one of the best performance measures of a company or an industry and larger value of productivity is associated with better performance. For manufacturing firms characterized by low utilization of their resources, productivity measurement and improvement is increasingly becoming a requirement for organizational survival (Wazed and Shamsuddin, 2008).

Productivity is defined as a ratio of output to input:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Measures of Output

Output can be in the form of goods produced or services rendered and it can be expressed in Physical quantity or monetary value.

Measures of Input

Input consists of the resources used to produce output. The most common types of input are labor, material, capital, energy and miscellaneous. Labor refers to all categories of employees in an organization and it can be measured in number of hours worked, number of workers engaged or cost of labor. Material refers to items used in the primary production or manufacturing of goods and it can include raw materials, chemicals, consumables, *etc*. Capital refers to physical assets such as machinery and equipment, land and buildings, and inventories that are used by the organization in the production of goods or provision of services. Capital can be measured in physical quantity (*e.g*. number of machine hours) , in financial value or net of depreciation. Energy inputs include electricity and fuel where as miscellaneous inputs include taxes, advertisement cost, insurance, *etc* (Productivity Model, 2016).

According to Ministry of Health and Ministry of Industry (2015), Ethiopia became among the fastest growing economies in Africa, with an average growth of around 10.9% for the past 10 years. The Ethiopian government has aspiration to become middle-income country status by 2020–2025. Meanwhile, the progress of the Ethiopian local pharmaceuticals manufacturing industry has been very much limited in terms of manufacture capability, technology transfer and acquisition, creation of expected employment opportunity and investment. Most of the local pharmaceutical manufacturers are not compliant with international current good manufacturing practice (cGMP), and no single product has been prequalified by WHO (Ministry of Health and Ministry of Industry, 2015).

It has also been projected that the annual pharmaceutical market growth in Ethiopia wroth US$ 400 to US$ 500 million and growing at a rate of 25% per year (Ministry of Health and Ministry of Industry, 2015).

There are about 200 importers of pharmaceutical products and medical consumables in Ethiopia and the sector comprises 22 pharmaceutical and medical suppliers and manufacturers, with 9 involved directly in the manufacture of pharmaceutical products. Those manufacturing firms are poor in their resource utilization, and low productivity is a common feature for most of them, they operate below their capacities and supply only about 20% of the local market. Local manufacturers have limited product portfolios and are thought to be able to supply only 90 of the more than 380 products on the national essential medicines list. For example in 2014, the Ethiopian industry exported pharmaceutical products worth almost US$ 2 million, which was far below the GTP-I target of US$ 20 million. The ownership of the companies is diverse and ranges from two large companies to smaller entities that are joint ventures between Ethiopian entrepreneurs and foreign investors from China, India, Saudi Arabia, Sudan and the United Arab Emirates (Ibid, p 2).

Addis Pharmaceutical Factory share company (APF) is one of the 9 local pharmaceutical manufacturers in Ethiopia and established in June 1997. The company is located at Adigrat, in Tigray Regional State of the country. It is also one of the companies of EFFORT Corporation.

APF has been engaged in the production and distribution of about 134 pharmaceutical products such as tablets, capsules, dry suspension for reconstitution, syrups, suspensions, elixir and dermatological preparations. Moreover, it produces intravenous infusions with its large volume parental manufacturing plant cited in Akaki sub city, South East of Addis Ababa. Currently the annual production capacity of the company is estimated to be about 800,000 birr and it has a total market share of 40% in the local market.

1.2. PROBLEM STATEMENT

The precondition for improvement of productivity of a particular pharmaceuticals manufacturing company or the industry as a whole is to measure its productivity status. There is a saying that "you can't improve what you can't measure!." To conduct productivity measurement an appropriate productivity measurement model is vital. Productivity of any industry can possibly measure the level of production and employment (Asiya, Mohammed & Neshat, 2016).

According to National Strategy and Plan of Action for Pharmaceutical Manufacturing Development in Ethiopia (2015), Ethiopian manufacturing firms are supplying only about 20% of the local market demand and they are thought to be able to supply only 90 of the 380 proclaimed national essential medicines. The pharmaceutical industry unable to play notable role in Ethiopian economy and characterized by minimal contribution to industrial output, revenue generation, and export earnings. Since the utilization rate of each resource is not well known, this creates a problem to the pharmaceutical industry for further improvement and progress. Due to the high cost of production, local pharmaceutical manufacturers are incapable to compete with India, china Cyprus and turkey based companies. Because of this Ethiopian Government procurement systems give a 25% price preference to local pharmaceutical companies and offer advanced payment of up to 30% of the value of orders.

The current productivity status of the pharmaceutical industry in Ethiopia is not well identified and there is no defined and reliable productivity measurement model and currently the Ethiopian pharmaceutical industry has no a comprehensive productivity improvement strategy to overcome the challenges.

The literature review showed that very few studies have been undertaken so far on productivity model development for pharmaceutical industry around the globe as well as in Ethiopia.

When we come to specific issue, Addis pharmaceutical factory is suffering from higher wastages, machineries downtimes and lower output yield. For example the factory proclaimed its output yield to be not less than 97% for every product, however, the current average yield of its products is about 86% and for some of its products, the yield variance ranges from -7% to -38% (company's products yield variance, 2015). On average the downtimes of the company are 550 hours per year (company's annual performance report, 2016).

According to performance audit report of the company (2015) the company purchased mistakenly substandard, out of specifications and poor quality raw and packaging materials from suppliers which costs about 8,000,000 birr in 12 years time. The materials have direct impact on productivity and cost structure of the company.

Hence the problems mentioned above are believed to be the main challenges of the industry and these inefficiencies can be an indication of poor productivity and performance of the industry and/or the company under investigation. Therefore, the above mentioned problems motivate the researcher to develop productivity measurement model that helps to analyze productivities in the pharmaceutical industry that will lead to improvement activities.

1.3. HYPOTHESIS

The research had the following three hypotheses.

A. Whether or not the proposed productivity model was appropriate for Ethiopian pharmaceutical industry when evaluated with the help of the following six criteria *i.e*. validity, completeness, comparability, inclusiveness, timeliness and cost effectiveness.
B. There is a relationship between productivities and organizational profitability or there is not relationship between productivity and organizational profitability.
C. There was relationship between single and total factor productivities or there was no relationship between single and total factor productivities.

1.4. RESEARCH QUESTIONS

This study attempted to answer the following basic research questions:

1. Was the selected productivity measurement model suitable and appropriate to Ethiopian pharmaceutical industry and the case company?
2. Was the Productivity Measurement Model to be proposed identify the area of poor resource utilization?
3. How different productivities and productivity indices can be measured for pharmaceutical industry?

1.5. OBJECTIVES OF THE STUDY

1.5.1. General Objective

The general objective of the study was to develop and propose an appropriate single, multi, total factor productivity and productivity index measurement model for Ethiopian pharmaceutical industry in general and for Addis pharmaceutical factory in particular. After the model has been tested with five consecutive year's data and evaluated with the help of criteria such as validity, completeness, comparability, inclusiveness, timeliness and Cost-effectiveness, at the case company, it can be applied in other firms in the industry.

1.5.2. Specific Objectives

The specific objectives of this study were to examine the relationship between productivities and organizational profitability, to establish a relationship between total factor productivities and single factor productivities, to identify the area of poor resource utilization, to explore and select the variables to measure productivities, to measure and evaluate the productivities of Addis pharmaceuticals factory with the help of the developed model and to conduct a trend analysis of the productivities of the case company in the past five years.

1.6. SIGNIFICANCE OF THE STUDY

The organization, which was taken up as a case study, will get at least some idea on what productivity measurement is along with improvement measure and related activities. The outcomes of this study will be considerable in various respects: Based on the research findings, the other pharmaceutical factories in the industry can adopt, further improve and use the productivity measurement model to measure, design and implement productivity improvement packages in their organizations.

Hopefully, this research will motivate other industries engaged in manufacturing of goods to develop productivity measurement model and use it to improve their operational productivity. This thesis will also be starting point for researchers that may engage in productivity research for pharmaceutical or other industries.

1.7. DELIMITATION OF THE STUDY

The researcher proposed productivity measurement model for Ethiopian pharmaceutical industry and tested it by taking past five year's data from Addis pharmaceutical factory. The researcher had chosen Addis pharmaceutical factory because it is one of the largest producer of pharmaceuticals in the country and has current 40% local market share and hence testing the model in the rest 8 firms was beyond the scope of this research.

Even though there were different productivity measurement models, this research adopted and used productivity accounting model. Based on secondary data single factor, multifactor and total factor productivities were measured. To see the relationship between organizational profitability and productivity, net income and total factor productivities were used. However, other performance indicators such as production yield, gross profit, *etc* and other productivities was not considered. Multiple regression analysis was limited to total factor productivities and single factor productivities, however, comparison of multifactor with total factor productivities was beyond the scope of this study.

1.8. LIMITATION OF THE STUDY

The developed productivity measurement model was tested with data obtained from one company and the rest 8 companies were not considered. Lack of cooperation of few management members to access relevant financial and annual performance documents from the case company and time and resource limitation were main constraints.

1.9. OPERATIONAL DEFINITIONS

Current Good Manufacturing Practices: are the practices required in order to conform to the guidelines recommended by agencies that control authorization and licensing for manufacture and sale of food, drug products, and active pharmaceutical products.

Essential Medicines: are those that satisfy the priority health care needs of the population. They are selected with due regard to public health relevance, evidence on efficacy and safety, and comparative cost-effectiveness.

Industry: group of establishments engaged in the same, or similar, kinds of activity.

Multi Factor Productivity: is a measure of economic performance that compares the amount of goods and services produced (output) to the amount of combined inputs used to produce those goods and services.

Pareto diagram: is a type of bar chart in which the various factors which contribute to overall effect are orderly arranged, according to the magnitude of their effect.

Pharmaceutical industry: group of companies engaged in the production of medicinal products.

productivity index: an index that compares actual productivity with standard productivity

Productivity Measurement Model: is a method which is used in practice for measuring productivity and it must be able to calculate Output/Input for many different types of outputs and inputs.

Regression Analysis: is a mathematical equation that describes the relationship between two or more variables.

Single Factor Productivity: refers to the measurement of productivity that is a ratio of output and one input factor.

Total Factor Productivity: compares the amount of goods and services produced (output) to the amount of all inputs used to produce those goods and services.

CHAPTER TWO

2. RELATED LITERATURE REVIEW

2.1 Conceptual Review

Following a review of various research papers and literature on productivity, I found out that productivity analysis and measurement models development were done for industries like steel, paper, sugar, tea, food and service, nonetheless no studies were performed for Ethiopian pharmaceutical industry, specifically to Addis pharmaceuticals factory share company.

2.1.1The concept of productivity

The term productivity was first mentioned by the French mathematician Quesnay in an article in 1766 (Kendrick & John, 1985) and productivity studies using scientific methods could be traced back to the early of 20th century. Frederick Winslow Taylor, the father of scientific management thought, made the first principle that there was one best way to do a job and that way should be scientifically discovered and put into operation (Sharpe, Bradley & Messinger, 2007).

In the Organization for economic co-operation and development manual, productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use (OECD manual, 2001).

The terms productivity and efficiency are often discussed. They are frequently used interchangeably, but this is unfortunate because they are not precisely the same things. Efficiency improvement does not guarantee productivity improvement. People often think that if you improve efficiency, you are more productive. Efficiency is a necessary but not a sufficient condition for productivity (Kendrick, John 1985). Productivity measurement is usually conducted from two perspectives according to the level of productivity and trends in the productivity. The productivity ratio refers to the productivity level at a given point in time expressed as output units delivered per unit of input expended.

It is evident in the literature on productivity that almost all the definitions of productivity center on "outputs" and "inputs". Unfortunately, definition of either output or input or both may sometimes pose more difficulty to the understanding of what productivity is. For output, it is in the form of goods if visible and services if invisible. Input on the other hand is less easily defined. Since production (creation of goods and services) is a team effort thereby making the demand for inputs to be interdependent, various elements (inputs) are involved in the production of output. This makes the definition of input more complex than that of output. To ease this problem of defining inputs, it is a common practice to classify inputs into labor (human resources), capital (physical and financial assets), and material (Gboyega, 2003).

The definition of productivity is too wide. Some people have a fixed definition and feel any other definition is inappropriate. Others realize that there are so many different definitions insisting that only one is correct is not conducive to good communication. However, it is important to be clear on which definition one is using. The definition in this research is the second approach. That is, productivity is a combination of effectiveness and efficiency. Productivity is how well a system uses its resources to achieve its goals. However, this approach can easily accommodate measures of quality, attendance, and any other type of measure that is seen as leading the organization to accomplish its goals. To put it bluntly, the definition of productivity is complex, because it is both a technical and managerial concept. Productivity is a matter of concern to government bodies, trade unions and other social institutions not minding the disagreements over its conceptualization by different groups and individuals. Hence, discussing productivity at all levels is common because of the direct relationship between productivity and the standard of living of a people (Amare Matebu. 2005).

2.1.2Types of productivity measures

There are many different productivity measures. The choice and use of these measures depends on the purpose of the productivity measurement and on the availability of data. Generally, productivity measures can be classified as single factor, multi factor, total factor productivity measures and productivity index.

Single Factor (Resource) Productivity

The first basic measurement is Single Factor (Resource) Productivity (SRP) which measures the productivity ratio of each individual resource broken down into as much detail as possible. To obtain single resource productivity the output of a process, in either units or value is divided by each resource input such as labor, capital, material, *etc*. Productivity measures that use one class of inputs or factors, but not multiple factors, are called partial/single productivities. In practice, measurement in productivity means measures of partial productivity. Interpreted correctly, these components are indicative of productivity development, and approximate the efficiency with which inputs are used in an economy to produce goods and services. However, productivity is only measured partially or approximately. In a way, the measurements are defective because they do not measure everything, but it is possible to interpret correctly the results of partial productivity and to benefit from them in practical situations. At the company level, typical partial productivity measures are such things as worker hours, materials or energy used per unit of production.(Cliff, 2011).

Multifactor Productivity

A multifactor productivity measure utilizes more than a single factor, for instance, both labor and capital or labor and material. Hence, multifactor productivity is the ratio of total output to a subset of inputs. (Kumar and Suresh, 2009).

Total factor productivity

A broader measure of productivity, total factor productivity is measured by combining the effects of all the inputs used in the production of goods and services (labor, capital, raw material, energy, *etc*.). In economics, total-factor productivity (TFP), is a variable which accounts for effects in total output growth relative to the growth in traditionally measured inputs of labor and capital. TFP is calculated by dividing output by the weighted average of labor and capital input, with the standard weighting of 0.7 for labor and 0.3 for capital. If all inputs are accounted for, then total factor productivity (TFP) can be taken as a measure of an economy's long-term technological change or technological dynamism. Total Factor Productivity is often seen as the real driver of growth within an economy and studies reveal that whilst labor and investment are important contributors, Total Factor Productivity may account for up to 60% of growth within economies. (Kumar and Suresh, 2009).

Productivity index

Productivity results are always expressed as a percentage of actual productivity versus standard productivity; results above 100% are positive and results below clearly negative.
Productivity Index= actual productivity/standard productivity (Kumar and Suresh, 2009).

2.1.3 Productivity Measurement Models

Different model for the measurement of productivity at different level like business, national or industry level have been developed and suggested. Though all should satisfy the basic productivity equation which is Productivity = Output ÷ Input.
The different, familiar models for productivity analysis are presented below.

I. Kendrick-Creamer model

Kendrick and creamer introduced this model and the model brought in productivity indices. The model is suitable for calculating productivity index at firm level. The indices are total productivity and partial productivity. But this model is not capable of calculating total productivity index in industry since it does not take into account all the input pertaining to industry such as business services, energy, *etc*. Total productivity index for given period = Measured period output in base period price/Measured period input in base period price and single factor productivity such as labor, capital or material productivity index can be calculated as; partial productivity = Output in base period price/Anyone input in base period price (as cited in Gupta and Dey, 2010, p. 19).

II. Craig-Harris Model

Craig and Harris (1973) defined total productivity measure using the index approach at the company level. This model is suitable to compute productivity of manufacturing firm, service sector and can yield physical productivity. The model define total productivity measure as;
$P_t = Q_t / (L+C+R+Q)$
Where P_t = total productivity, L = labor input, C = capital input, R = raw material input
and Q = miscellaneous input and Q_t = total output (as cited in Gupta and Dey, 2010, p. 19).

But this model is not suitable for pharmaceutical industry because it does not take into consideration all relevant inputs to the industry.

III. American Productivity Centre Model

American Productivity Centre has measured which productivity relates profitability and price factor. It is suitable for accounting productivity at business level and easy to compute productivity with managerial data like profitability and price recovery factor.

American Productivity center has measured that productivity relates profitability and price factor. The measure is given by Profitability =Sales/cost

= [(output quantity) (price)] ÷ [(Input quantity) (unit cost)]

= [(output quantity) ÷ (Input quantity)] × [(price) ÷ (unit cost)]

= (Productivity) (Price recovery factor)

Where productivity = Output / Input

Price recovery factor is a factor which captures the effect of inflation. But it is not suitable for pharmaceutical industry because it does not consider physical quantity of goods produced which may not be properly represented by profitability which depends on the demand of the goods produced (as cited in Gupta and Dey, 2010, p. 19).

IV. Productivity Accounting Model

H. S. Davis introduced this model. This model takes into account all possible outputs and inputs used, keeping aside external factors such as price rise, *etc*. This model is one of the best models. It fulfills almost all the requirements of accounting for productivity. This can be calculated as below.

$$\text{Total productivity} = \frac{\text{Monetary value of production}}{\text{Monetary value of all input required for production}}$$

$$\text{Single factor productivity} = \frac{\text{Monetary value of production}}{\text{Monetary value of any input required for production}}$$

This model has got wide applicability both in manufacturing and service sector (as cited in Gupta and Dey, 2010, p. 19). And the model can be suitable for pharmaceutical industry.

2.1.4 Difference between production and productivity

It is discussed that, production is an organized activity of transforming raw materials into finished products which have higher value but productivity is a ration of output to input. Production of any commodity or service is the volume of output irrespective of the quantity of resources employed to achieve the level of output. Production in an industry can be increased by employing more labor, installing more machinery, and putting in more materials, regardless of the cost of production. But increase of production does not necessarily mean increase in productivity. Higher productivity results when we put in production system an element of efficiency with which the resources are employed. The combined input of a number of factors such as land, materials, machines, capital, and labor gives an output in an industry. The ratio between output and one of these factors of input is usually known as productivity of the factor considered. Productivity may also be considered as a measure of performance of the economy as a whole (Naresh, 2005).

2.1.5 Factors Affecting Productivity

It was found that factors influencing productivity can be classified broadly into two categories: (A) controllable (or internal) factors and (B) un-controllable (or external) factors.

(A) Controllable (or internal) factors

Product factor: In terms of productivity means the extent to which the product meets output requirements of product is judged by its usefulness. The cost benefit factor of a product can be enhanced by increasing the benefit at the same cost or by reducing cost for the same benefit.

Plant and equipment: These play a prominent role in enhancing the productivity. The increased availability of the plant through proper maintenance and reduction of idle time increases the productivity. Productivity can be increased by paying proper attention to utilization, age, modernization, cost, investments *etc.*

Technology: Innovative and latest technology improves productivity to a greater extent. Automation and information technology helps to achieve improvements in material handling, storage, communication system and quality control. The various aspects of technology factors to be considered are:

(*i*) Size and capacity of the plant,

(*ii*) Timely supply and quality of inputs,

(*iii*) Production planning and control,

(*iv*) Repairs and maintenance,

(*v*) Waste reduction, and

(*vi*) Efficient material handling system.

Material and energy: Efforts to reduce materials and energy consumption brings about considerable improvement in productivity.

1. Selection of quality material and right material.
2. Control of wastage and scrap.
3. Effective stock control.
4. Development of sources of supply.
5. Optimum energy utilization and energy savings.

Human factors: Productivity is basically dependent upon human competence and skill. Ability to work effectively is governed by various factors such as education, training, experience aptitude etc., of the employees. Motivation of employees will influence productivity.

Work methods: Improving the ways in which the work is done (methods) improves productivity, work study and industrial engineering techniques and training are the areas which improve the work methods, which in term enhances the productivity.

Management style: This influence the organizational design, communication in organization, policy and procedures. A flexible and dynamic management style is a better approach to achieve higher productivity.

(B) Un-controllable (or external) factors

Structural adjustments: Structural adjustments include both economic and social changes. Economic changes that influence significantly are:

(*a*) Shift in employment from agriculture to manufacturing industry,

(*b*) Import of technology, and

(*c*) Industrial competitiveness.

Social changes such as women's participation in the labor force, education, cultural values, attitudes are some of the factors that play a significant role in the improvement of productivity.

Natural resources: Manpower, land and raw materials are vital to the productivity improvement.

Government and infrastructure: Government policies and programmes are significant to productivity practices of government agencies, transport and communication power, fiscal policies (interest rates, taxes) influence productivity to the greater extent. (Kumar and Suresh, 2009).

2.2. Productivity in the pharmaceutical industry

The pharmaceutical industry has faced massive pressures over the last few decades. Declining revenues, increasing payer pressures and a constantly changing regulatory landscape have forced all companies to identify processes to increase productivity. However, to date, no one agrees on precisely how to measure these attributes or how to interpret the results. It was proposed new measures of productivity that illustrate an increasing trend in productivity within the pharmaceutical industry that has evolved after years of decline. Productivity has historically been measured by the number of FDA approvals or global first launches in a given year, possibly because these numbers are readily accessible and easy to interpret. Although this is a quantitative measure of overall R&D performance, this output measure does little to aid in understanding the current state of the industry and does not lend itself to actionable conclusions (Richard ,2017)

Recent attempts to capture a more granular view lead to varied and conflicting views on productivity and hence the health of the industry. Theory dictates the ratio of output/input over a given period should be sufficient to measure productivity. However, the prolonged period of time to develop and bring drugs to market, up to 12 years from preclinical development, has led many to develop methodologies that try to correct for this time lapse. This correction, heavily relying on built-in assumptions, leaves these calculations open to critique that diverts the focus from interpretation of the metrics to an analysis of the methodology itself. For example, comparing sales of marketed drugs (output) to R&D expenditure offset by cycle time in years (input) is an often quoted metric. It has been argued that cycle time isn't the appropriate number of years to use especially given the industry's varied approaches to drug development along with subjective estimates on inflation which refute any conclusions drawn from the data. Furthermore, the output metrics discussed provide only a historic picture of R&D as for drugs launched recently the development was performed a number of years ago (Richard, 2017).

It has been suggested a simpler, more current view of productivity by drawing conclusions through a review of R&D success rates by phase by year as indicators of R&D productivity. There are a number of ways to calculate success rates by phase but the simplest way is to identify the number of drugs that progressed into the next phase (output) as compared to the number of drugs which progressed to the next phase plus terminated in phase (input). This metric takes into account productivity across the pipeline and does not decrease productivity measurements for programs dropped for non-scientific reasons such as commercial strategy (Richard, 2017).

2.3. The Ethiopian pharmaceutical industry and market

It has been studied that the total annual pharmaceutical market in Ethiopia is estimated to be worth US$ 400 to US$ 500 million and growing at a rate of 25% per year. Steady economic growth, improvements in the delivery of health care, and introduction of social health insurance coverage across the country in July 2015 all lead to growing demand. There are approximately 200 importers of pharmaceutical products and medical consumables in the country. The local industry comprises 22 pharmaceutical and medical suppliers and manufacturers, with 9 are manufacturer of pharmaceutical products. Most of the manufacturers operate below their effective capacities and cover only about 20% of the local market demand. The local manufacturers have limited product mix and currently are able to supply only 90 of the more than 380 products on the national essential medicines list. Around 35–40% of their total output is supplied to the private sector at a price premium of 10%. The annual private pharmaceutical market in Ethiopia is estimated to be worth US$ 100 million. In 2014, the Ethiopian industry exported pharmaceutical products worth almost US$ 2 million, which was far below the GTP-I target of US$ 20 million. The bulk of the exports were accounted for by Sino-Ethiop, which exported empty gelatin capsules. The ownership of these manufacturing companies is diverse and ranges from two large companies to smaller entities that are joint ventures between Ethiopian entrepreneurs and foreign investors from China, India, Jordan, Saudi Arabia, Sudan and the United Arab Emirates (Ministry of Health and Ministry of Industry, 2015).

2.2.1. Health sector development and access to medicines in Ethiopia

Ethiopia is progressively investing in its health sector. The health service coverage has increased from 30% to 89% in 2010. The numbers of health posts and health centers have increased from 4,211 and 600 in 2004-2005 to 14, 416 and 2,999, respectively by 2012. Significant progress has been seen in other key health indicators, such as a drop in HIV prevalence from 3.5% in 2004-2005 to 1.3% in 2012; a decrease in the maternal mortality ratio from 871 per 100 000 in 2005 to 420 per 100 000 in 2014. Ethiopia achieved the Millennium Development Goal (MDG) 4 to cut the mortality rate for children under the age of five years ahead of the 2015 deadline, which is seen as a great achievement. The child mortality rate stands at 64/1000 live births (2013/14). Ethiopia has also achieved most of the MDG 6 targets on AIDS, tuberculosis (TB) and malaria. The public sector, through the Pharmaceuticals Fund and Supplies Agency (PFSA), purchases almost 70% of all the medicines consumed in Ethiopia, but there is still significant out-of-pocket expenditure on health, estimated at 46% by the Ethiopian Food, Medicines, Healthcare Administration and Control Authority (FMHACA). PFSA procurement increased from US$ 27 million in 2007 to US$ 310 million in 2014. (Ibid, p 2).

Government support is important in the short to medium term to encourage growing pharmaceutical industries in developing countries to become competitive and to channel their growth in accordance with the objectives of health policy. The Ethiopian Government provided various kinds of support to the local pharmaceutical industry during the GTP-I and also GTP-II in period to promote import substitution, export growth, transfer of technology and job creation and to increase the production of essential medicines to improve access. The Ethiopian Government believes its support and encouragement to produce value-added products for the export market will increase foreign exchange and lay the basis for more rapid industrial development. Ethiopian Government procurement systems give preference to local pharmaceutical companies and offer advanced payment of up to 30% of the value of orders. In some cases, technical assistance and consultancy support are also given to help companies comply with international drug manufacturing standards. Indirect governmental support includes strengthening of FMHACA, establishing the Food, Beverage and Pharmaceuticals Industry Development Institute (FBPIDI), and laying the groundwork for policies and incentives designed to encourage investment in and development of the sector. Current incentives by the Ethiopian

Government for local production include tax-free loans of up to 70% for new investments (so the investor needs to invest only 30% of the project capital at inception) and up to 60% for upgrading projects during the first five years. These loans are granted by the Development Bank of Ethiopia. There is also a 100% custom duty exemption on the import of all granted capital goods, such as manufacturing plant, machinery, equipment and construction materials. Spare parts at up to 15% of the total value of imported investment capital goods are exempted from customs duty. Companies exporting 50% of their products or services, or supplying 75% of their products or services as production or services input to an exporter, are exempted from income tax for five years. Companies exporting less than 50% of their products or services or supplying only to the domestic market are exempted from income tax for two years. Investors that invest in high-priority areas to produce mainly export products are given land necessary for their investment at reduced lease rates. PFSA grants local manufacturers a 25% price preference and also pre-pays 30% of the tender value on awarding the contract; the 70% balance can be accessed through the Development Bank of Ethiopia if the local company requires additional working capital and is willing to cede the tender to the bank. Product registration for local manufacturers is reduced to an average of one month. On their own, however, these incentives are not enough to encourage development of the industry. Despite support from the Ethiopian Government, the Ethiopian pharmaceutical industry faces significant challenges, including human resource capacity constraints, limited access to foreign currency, and raw material procurement difficulties. Until now, there has been no coherent national vision, strategy or plan to develop the pharmaceutical industry in the long term. (Ibid, p 2).

2.2.2. National policies and institutions relevant to the pharmaceutical industry

A recent detailed analysis of all national policies relevant to the pharmaceutical sector in Ethiopia was conducted by the United Nations Conference on Trade and Development (UNCTAD). The analysis suggests that Ethiopia's overall policy framework exhibits a remarkable level of coherence and complimentarily of policies between sectors. The National Medicine Policy was established in 1993 with the aim to provide universal access to good-quality essential medicines. FMHACA was established in 2009 with the mandate to regulate food, medicines and health care services, and with PFSA to reform and restructure the pharmaceutical supply and regulatory functions. The Industrial Development Strategy (2013–

2025) is designed to mobilize resources and allocate them to the manufacturing sector. It calls for the upgrading and promotion of the pharmaceutical sector and has technology transfer and technology diffusion among its objectives. The Ethiopian Government is actively facilitating foreign direct investment through its investment policy. Ethiopia has not yet acceded to the World Trade Organization. Of particular importance is the FBPIDI, established by the Ethiopian Government in 2013 with the objective to transform the development of food, beverage and pharmaceutical industries through accelerated technological development and transfer by providing these industries comprehensive, knowledge-based, innovative, and accessible support and to make them internationally competitive so that they have a significant contribution towards import substitution as well as exports in terms of variety of goods and volume. (Ibid, p 3).

2.2.3. The pharmaceutical value chain

The pharmaceutical value chain is a spectrum of progressive pharmaceutical operations with increased technological complexity. At one end of the chain is exclusive import of finished pharmaceutical products and at the other end is a research-based pharmaceutical industry. In between are various levels of pharmaceutical manufacturing, including production of active pharmaceutical ingredients (API). Each step potentially leads to the next, with added value, complexity, investment and regulatory requirements. It is critical that an acceptable level of international quality standards is followed at every level. A company at the far end of the chain may incorporate all the earlier levels ; that is, integrated production, which can be the most cost-efficient and competitive operation. In most cases, however, companies practice various kinds of forward or backward integration. From a policy perspective, it is important that the pharmaceutical manufacturing sector in a country is appreciated and facilitated for its progressive development along the value chain.

This approach has huge benefits and positive externalities for a number of other sectors and industries. It contributes to creating a knowledge economy with local skilled professionals, regulatory institutional development, business and market development, science and technology advancement, interdisciplinary confluence and local research and development, including development of traditional medicine. (Ibid, p 5).

CHAPTER THREE

3 RESEARCH METHODOLOGY

3.1 Research design

An appropriate research design is important to any research, as it guides the process for collecting the desired data and the process for analyzing that data. "Research design is a plan or blueprint of how you intend conducting the research" (Mouton, 2001, p 55).

Creswell (2007) explained that, quantitative approach is helpful to quantify the data on the issue under study and provides statistical information about the problem. And hence in this study quantitative approach will be employed.

The research study is secondary quantitative research method in nature. It is analytical in the senses that it involves analytical of collected data information from secondary data extracted from audited financial statements and annual production performances of the case company covering the period from 2012 to 2016.

3.2 Study Population/Sample

The sample used in the study is drawn from the population and it represents the characteristics of the group that is the population. The total population is 9 Pharmaceutical factories in the country. From the nine pharmaceutical factories the researcher had chosen Addis pharmaceutical factory because it is one of the largest producer of pharmaceuticals in the country and has current 40% local market share. Besides data were available and the company was agreeable,since productivity measurements are dependent on past data and information, the present study utilized five years' secondary data.

3.3 Data collection Sources and method

The study has used secondary data extracted from audited financial statements and annual production performances of the case company covering the period from 2012 to 2016. To take into account the quality of the products/output and assure the comparability of the model, deflating the output prices to the base year was performed with inflation rate/price index published by the Ethiopian central Statistical Agency. The year 2012 was taken as the base year so that consecutive years' values were deflated to this particular year. Besides the deflation activities was also applied to all inputs.

The researcher conducted field observations and management discussions to see the overall working environment of the pharmaceutical manufacturing companies to examine work processes and procedures, and to observe their productivity measurement practices. The researcher proposed productivity measurement model for Ethiopian pharmaceutical industry and the model was tested by taking data from Addis pharmaceutical factory. The researcher has chosen Addis pharmaceutical factory from 9 pharmaceutical companies in the industry, because it is the biggest pharmaceutical company in Ethiopia in terms of market share and production capacity. Besides data were available and the company was agreeable. Since productivity measurements are dependent on past data and information, the present study utilized five years' secondary data. To achieve the objectives of the study, data were extracted from audited financial statement and annual performance reports of the selected company for the period of 5 years.

Pareto analysis was used to analyze and present inputs that need the most attention according to the order of importance (associated cost) so that the company can device cost reduction and productivity improvement packages.

3.4 Data analysis methods

From company's five years audited financial statement, computation of productivities and productivity index was conducted. To see the relationship between total factor productivities and profitability regression analysis was used, where as multiple regression analysis was done to see the relationship between single factor and total factor productivities. Bar graphs, tables, line graphs and pie charts were also used to analyze and display data such as decline, growth and productivity trends. Pareto analysis was a choice of method to show inputs that need the most attention so that it will allow the company to give more attention for further improvement.

This research attempted to measure single, multi and total factor productivities and productivity indices with the help of various appropriate variables using the developed Productivity Measurement Model.

The appropriateness of the proposed Model was evaluated with the following six criteria such as; validity, completeness, comparability, inclusiveness, timeliness and cost-effectiveness.
Products in pharmaceutical industry are usually heterogeneous so that the use of common denominator of monetary value was appropriate.

Productivity Accounting Model was the appropriate choice because this model is based on accounting data and takes into account all possible outputs and inputs used in money value. The model avoids the aggregation problem of dissimilar and heterogeneous inputs and outputs by considering the monetary equivalent of output and each input (Gupta and Dey, 2010).

Net income as dependent variable and total factor productivities as independent variables were used to analyze the relationship between organizational profitability and productivities. Multiple regression analysis was used to develop the correlation model between total factor productivities as dependent variable and single factor productivities as independent variables.

CHAPTER FOUR

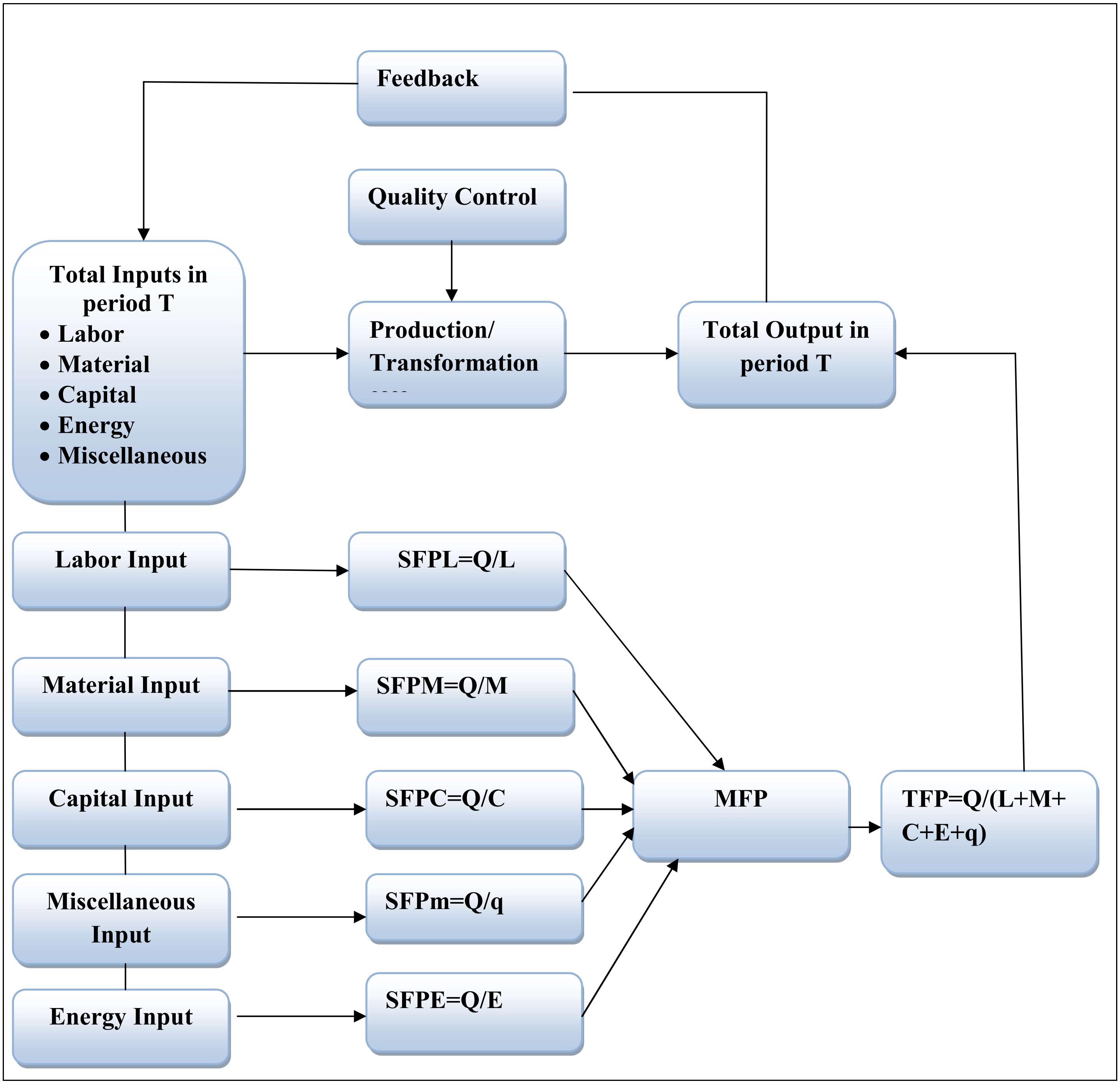
4. RESULT AND DISCUSSION

4.1. Productivity Measurement Model for pharmaceutical industry

The productivity measurement model must realize the criteria to provide both firm and operational level productivity indices, identify or prioritize the problem areas and determine the solutions for improving productivity, resulting in the identification of potential improvements. The model must be complete which refers to the thoroughness with which outputs or results delivered and all inputs or resources consumed are measured and included in the productivity ratio; it should be inclusive, including all activities of the firm; it should show which particular input resources are being utilized inefficiently and it should enable to decide how to reallocate resources; it should determine how well previously established goals were met; it should also point out which operational units are profit making and which are not. The measurement model should offer a way of not only measuring but also evaluating, planning, and improving the overall productivity of an organization as a whole as well as its operational units; it should provide valuable information to strategic planners in making decisions related to diversification and phase outs of products or services (Amare Matebu ,2015).

The development of an effective productivity measurement model is essential for a continuous productivity improvement. What is needed, then, is a productivity measurement system that not only provides a firm-level total productivity index to indicate the productivity health of the firm, but it also points out the growth or the decline in the productivity and the profitability of its products or services (Ibid,p 168). Meanwhile single, multifactor, total factor productivities and productivity indices were considered in this study for measuring productivities.

Figure 1. Productivity measurement model based on single, multi and total factor productivities



4.1.1. Single Factor Productivity

For this measure monetary values of single input of labor (L), material (M), energy (E), capital (C) and miscellaneous (q) and monetary value of output (Q) were used. Single factor productivities were calculated as:

Labor Productivity, SFPL =Q/L

Material Productivity, SFPM =Q/M

Capital Productivity, SFPC=Q/C

Energy Productivity, SFPE =Q/E

Miscellaneous Productivity, SFPm =Q/q

4.1.2. Multifactor productivity

For these measure monetary values of two inputs from labor (L), capital (C), material (M), energy (E), and miscellaneous (q) at a time and monetary value of output (Q) were used. Multi factor productivities were calculated as:

Labor and capital Productivity, MFPLC =Q/L+C

Labor and material Productivity, MFPLM =Q/L+M

Labor and energy Productivity, MFPLE =Q/L+E

Labor and miscellaneous productivity, MFPLm =Q/L+q

Capital and material Productivity, MFPCM=Q/C+M

Capital and Energy productivity, MFPCE =Q/C+E

Capital and miscellaneous productivity, MFPCm =Q/C+q

Material and energy productivity, MFPME=Q/M+E

Material and miscellaneous Productivity, MFPMm =Q/M+q

Energy and miscellaneous Productivity, MFPEm=Q/E+q

4.1.3. Total factor productivity

For these measure monetary values all inputs of labor (L), capital (C), material (M), energy (E), and miscellaneous (q) and output were used. Total factor productivity was calculated as:

Total Productivity, TFP = Q/(L+C+E+M+q)

4.1.4. Productivity index

The productivity indexes were calculated by dividing the actual single, multi and total factor productivities to standard productivities of base year. For calculation purpose, the base year was defined and selected based on its relatively higher productivity value amongst the other five years values. Productivity index was calculated as:

Productivity Index, PI =(Actual Productivity /Standard Productivity of base year) X 100%. productivity index can help to monitor progressive changes in productivity.

Inputs to the model

I. **Labor inputs:** these include the values of salaries and benefits of all employees of the company.

II. **Material inputs:** these include major raw materials, such as active pharmaceutical excipients, inactive excipients packaging and other materials.

III. **Capital inputs**: uniform annual cost of fixed capital.

IV. Energy inputs: these include electricity and fuel.

IV. **Miscellaneous inputs:** these include taxes, advertisement cost, insurance, *etc*.

4.2. The Case Study

The case study is done so to demonstrate how the developed and proposed productivity model can be put into practice in the computation of single, multi, total factor productivity and productivity index for Ethiopian pharmaceutical industry. The study has used secondary data extracted from audited financial statements and annual production performances of Addis pharmaceutical factory covering the period from 2012 to 2016.
To take into account the quality of the products/output and assure the comparability of the model, deflating the output prices to the base year was performed with inflation rate/price index published by the Ethiopian central Statistical Agency. The year 2012 was taken as the base year so that consecutive years' values were deflated to this year. Besides the deflation activity was also applied to all the five inputs.

The monetary equivalent of output was calculated by multiplying the quantity of medicines (output) expressed in price per pieces in the respective year deflated to the base year. The monetary equivalent of products produced can represent variation of quantity and quality of the products.

Table 3 summarizes annual consumption of five inputs and output of five years. While Table-4 presents inflation adjusted annual output and resource consumption. Table 11 also shows percent share of different inputs in total resources.

4.2.1. Total Factor Productivity measure

Total factor productivity measure can provide more accurate representation of the total picture of the company, as it is easily related to total cost, taking into account all quantifiable inputs and outputs.

As shown in the Table-1 and figure-2, the results of total factor productivity in Addis pharmaceutical factory, is more in the year 2014. This value showed 8.93% and 3.4 % increment from 2012 and 2013 fiscal year respectively. However, the higher productivity value of 2014 fiscal year declined with 1.64% in 2015 and 2016. The same trend was also observed on total factor productivity indexes. Total factor productivity and index are same for the year 20015 and 2006.

The total productivity increases due to the rate of increase in total output is higher than total inputs, while total productivity decreases is because the rate of increase in total output is lower than the rate of increase in total inputs.

Multiple regression analysis was used to develop the correlation model between total factor productivity and single factor productivity. Total factor productivity and single factor productivity are related through the regression equation as given below.

The regression line $y = (0.6094)x_1 + (0.01555)x_2 + (0.003229)x_3 + (0.03549)x_4 - 0.4548$

Where,

y-total factor productivity,

x_1-material productivity,

x_2-labor productivity,

x_3-capital productivity and x_4-miscellaneous productivity. Since its impact was minimal, energy productivity was not taken into consideration.

Total factor productivity is dependent variable and single factor productivities are independent variables. From the above equation it is seen that the coefficient of material, miscellaneous and labor productivities are more and hence are the key factors for the total productivity change and capital productivity has the least effect. Since material, miscellaneous and labor productivities have the major influence on total productivity, hence to increase total productivity there must be increase in these productivities by reducing material, miscellaneous and labor cost to the possible extent. The major portion of miscellaneous input includes long term debt and working capital interest paid to creditors. The coefficient of determination: $R^2 = 1$, clearly depicted that 100 % variation in total factor productivity can be explained by the variation in single factor productivities.

year	Total factor productivity (y)	Material productivity, SFPM (x_1)	Labor productivity, SFPL (x_2)	Capital productivity, SFPC (x_3)	Miscellaneous productivity, SFPm (x_4)	Energy productivity, SFPE (x_5)
2012	1.12	1.92	9.89	24.40	4.85	41.04
2013	1.18	1.74	13.15	45.32	6.30	64.83
2014	1.22	1.72	11.2	47.35	8.44	70.22
2015	1.20	1.71	11.08	45.38	8.28	70.61
2016	1.20	1.82	9.04	47.96	7.05	78.20

OUTPUT

The regression line $y = (0.6094)x_1 + (0.01555)x_2 + (0.003229)x_3 + (0.03549)x_4 - 0.4548$

Residual Sum of Squares: $r_{ss} = 0$

Coefficient of Determination: $R^2 = 1$

Table 1. Total factor and single factor productivities

Simple regression analysis was also used to develop the correlation model between total factor productivity and company's performance. Total factor productivity and net income are related with the regression equation as given below.

The regression line y=5126641x-555245

Where,

y-net income,

x-total factor productivity,

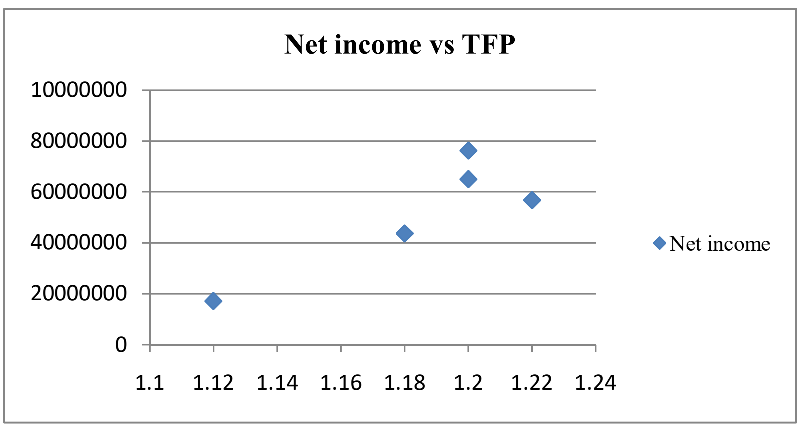
Net income is dependent variable and total factor productivity is independent variable. The coefficient of correlation (r=0.867) showed that there is strong positive relationship between company's performance and total factor productivity and for any increment in total factor productivity there will be progress in net income. On top of that the coefficient of determination: $R^2 = 0.75$, clearly illustrated that 75% variation in net income can possibly be explained by the variation in total factor productivity.

Table 2. Total Factor Productivity and net income correlation

year	Total factor productivity (x)	Net income in birr (y)	Output
2012	1.12	17,081,472	ß=5126641
2013	1.18	43,675,942	α=-55245
2014	1.22	56,756,247	Standard deviation s_x=0.0384
2015	1.20	65,019,415	Standard deviation s_y=227294
2016	1.20	76,209,634	Correlation coefficient=0.867
			Standard error of estimate s_e=130459
			Line; y=5126641x-555245

Source From the case company's Audited Financial statement

Figure 2. Scatter plot for total factor productivity and net income



year	Material input, M (birr)	Labor input, L (birr)	Capital input, C (birr)	Energy input, E (birr)	Miscellaneous inputs, q (birr)	Total inputs (birr)	Total outputs, Q (birr)
2012	106,206,280.00	20,634,356.00	8,367,468.00	4,974,703.00	42,126,920.00	182,309,727.00	204,147,207
2013	218,609,088.00	28,905,510.00	8,387,880.00	5,862,954.00	60,304,191.00	322,069,623.00	380,113,496
2014	257,144,291.00	37,096,868.00	9,339,364.00	6,297,990.00	52,414,488.00	362,293,001.00	442,254,080
2015	295,902,693.00	45,737,922.00	11,168,182.00	7,177,036.00	61,189,063.00	421,174,896.00	506,790,409
2016	342,582,222.00	68,959,052.00	12,991,399.00	7,967,299.00	88,429,251.00	520,929,223.00	623,081,253

Table 3. Annual output and resource consumption in Addis pharmaceutical factory

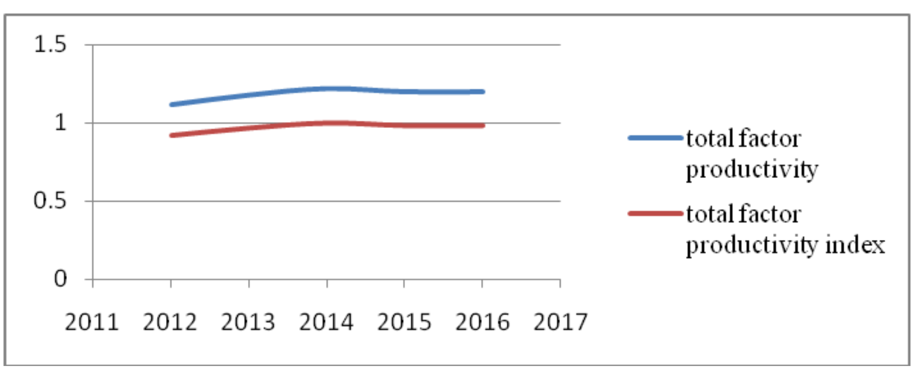
year	Material input, M (birr)	Labor input, L (birr)	Capital input, C (birr)	Energy input, E (birr)	Miscellaneous inputs, q (birr)	Total inputs (birr)	Total outputs, Q (birr)
2012	106,206,280.00	20,634,356.00	8,367,468.00	4,974,703.00	42,126,920.00	182,309,727.00	204,147,207.03
2013	167,542,219.50	22,153,211.22	6,428,479.46	4,493,373.70	46,217,191.14	246,834,475	291,319,356.2
2014	176,029,772.00	25,394,898.69	6,393,321.47	4,311,329.41	35,880,673.60	248,009,995.20	302,747,864.2
2015	189,305,030.40	29,261,033.84	7,144,892.84	4,591,539.89	39,145,968.27	269,448,465.20	324,221,360.8
2016	200,716,089.80	40,402,538.10	7,611,553.2	4,667,974.57	51,809,966.60	305,208,122.20	365,058,151.5

Source From the case Company's Audited financial statement

Table 4. Inflation adjusted Annual output and resource consumption

Source From the case company's Audited Financial statement

Figure 3. Total factor productivity and index

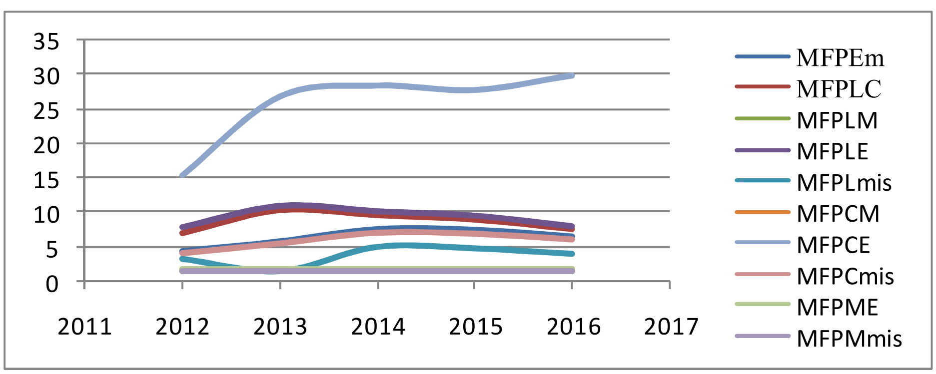


4.2.2. Multi Factor Productivity measure

The multi factor productivity measure is a tool used to identify improvement considering more than one input at a time.

As shown in the Table 5,7 and figure 4, in 2014 fiscal year, both productivities and productivity indexes of energy and miscellaneous, labor and miscellaneous, capital and energy, capital and miscellaneous are higher than other period values. While productivities and productivity indexes of labor and capital, labor and energy of fiscal year 2013 are higher. In 2012 fiscal year both productivities and indexes of labor and material, capital and material, material and energy are higher as compared with other years. Material and miscellaneous productivity and index are higher in 2016. As shown in figure 3, the fiscal year 2014 showed better multifactor productivity results compared with the other fiscal years. Multifactor productivities increase as the rate of increase in total output is higher than inputs and decrease when the rate of increase in output is lower than the rate of increase in total inputs.

Figure 4. Chart for multi Factor Productivity



SN	Productivity	Fiscal year				
		2012	2013	2014	2015	2016
1	Energy and miscellaneous Productivity, MFPEm	4.33	5.74	7.53	7.41	6.46
2	Labor and capital Productivity, MFPLC	7.04	10.19	9.52	8.91	7.60
3	Labor and material Productivity, MFPLM	1.61	1.54	1.5	1.48	1.51
4	Labor and energy Productivity, MFPLE	7.97	10.93	10.19	9.58	8.1
5	Labor and miscellaneous productivity, MFPLm	3.25	1.54	4.94	4.74	3.96
6	Capital and material Productivity, MFPCM	1.78	1.67	1.66	1.65	1.75
7	Capital and Energy productivity, MFPCE	15.30	26.67	28.28	27.63	29.73
8	Capital and miscellaneous productivity, MFPCm	4.04	5.53	7.16	7.00	6.14
9	Material and energy productivity, MFPME	1.84	1.69	1.68	1.67	1.78
10	Material and miscellaneous Productivity, MFPMm	1.38	1.36	1.43	1.42	1.45
11	Total factor productivity, TFP	1.12	1.18	1.22	1.20	1.20

Table 5. Multifactor and total factor productivity

Table 6.

SN	Productivity	Standard value
1	Energy and miscellaneous Productivity index	7.53
2	Labor and capital Productivity index	10.19
3	Labor and material Productivity index	1.61
4	Labor and energy Productivity index	10.93
5	Labor and miscellaneous productivity index	4.94
6	Capital and material Productivity index	1.78
7	Capital and Energy productivity index	29.73
8	Capital and miscellaneous productivity index	7.16
9	Material and energy productivity index	1.84
10	Material and miscellaneous Productivity index	1.45

Standard for Multifactor and total factor productivity

11	Total factor productivity index	1.22

Table 7. Multifactor and total factor productivity index

SN	Productivity	Fiscal year				
		2012	2013	2014	2015	2016
1	Energy and miscellaneous Productivity index	57.50	76.23	100	98.41	85.79
2	Labor and capital Productivity index	69.10	100	93.42	87.44	74.58
3	Labor and material Productivity index	100	95.65	93.17	91.93	93.79
4	Labor and energy Productivity index	72.92	100	93.23	87.65	74.11
5	Labor and miscellaneous productivity index	65.79	31.17	100	95.95	80.16
6	Capital and material Productivity index	100	93.82	93.26	92.70	98.31
7	Capital and Energy productivity index	51.46	89.71	98.49	92.94	100
8	Capital and miscellaneous productivity index	56.42	77.23	100	97.77	85.75
9	Material and energy productivity index	100	91.85	91.30	90.76	96.74
10	Material and miscellaneous Productivity index	95.17	93.79	98.62	97.93	100
11	Total factor productivity index	91.80	96.72	100	98.36	98.36

4.2.3. Single Factor Productivity measure

Single Factor (Resource) Productivity (SRP) can measure the productivity ratio of each individual resource broken down into as much detail as possible. The more detailed the breakdown of input, the greater ability to spot areas needing action.

As shown in the Table 8,9,10 and figure 5 to 10, both material productivity and productivity index reached maximum in 2012 and steadily declined from 2013 to 2015, however in 2016 they again became increasing. Labor productivity and index is peak in 2013 and declined onwards progressively. Capital productivity and index showed an increasing tendency from 2012 onwards and the same trend was observed on energy productivity and index. Productivity and index of miscellaneous input showed progress from 2012 to 2014 and reached maximum in 2014, however, declined for the subsequent fiscal years.

Table 8. Single Factor Productivity

year	Material productivity, SFPM	Labor productivity, SFPL	Capital productivity, SFPC	Energy productivity, SFPE	Miscellaneous productivity, SFPm
2012	1.92	9.89	24.40	41.04	4.85
2013	1.74	13.15	45.32	64.83	6.30
2014	1.72	11.2	47.35	70.22	8.44
2015	1.71	11.08	45.38	70.61	8.28
2016	1.82	9.04	47.96	78.20	7.05

Table 9. Standard value for Single Factor Productivity

SN	productivity	Standard value
1	Material productivity	1.92
2	Labor productivity	13.15
3	Capital productivity	47.96
4	Energy productivity	78.20
5	Miscellaneous productivity	8.44

Table 10. Single Factor Productivity Index

year	Material productivity index (%)	Labor productivity index (%)	Capital productivity index (%)	Energy productivity index (%)	Miscellaneous productivity index (%)
2012	100	75.21	50.88	52.48	57.46
2013	90.63	100	94.50	82.90	74.64
2014	89.58	82.96	98.73	89.80	100
2015	89.06	82.07	94.62	90.29	98.10
2016	94.79	66.96	100	100	83.53

As shown in table 11 and figure 11 & 12, material, miscellaneous and labor inputs accounted for 95.3% share of total cost of the company and material and miscellaneous inputs had a total share of 84.3%.

Figure 5. Graph for Material Productivity and index

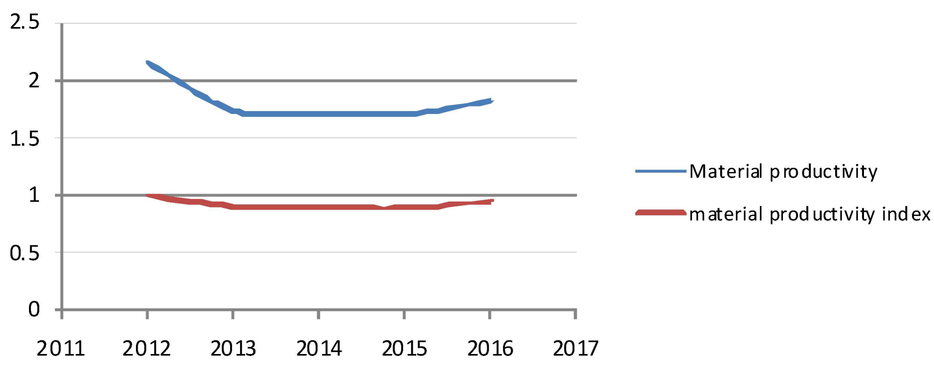


Figure 6. Graph for labor productivity and index

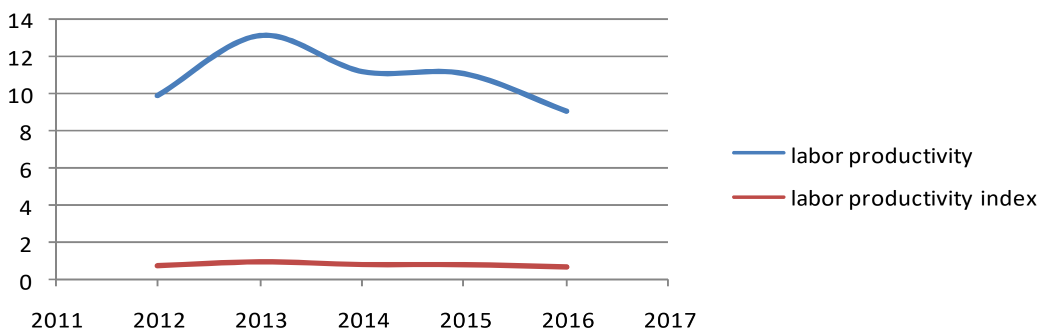


Figure 7. graph for capital productivity and index

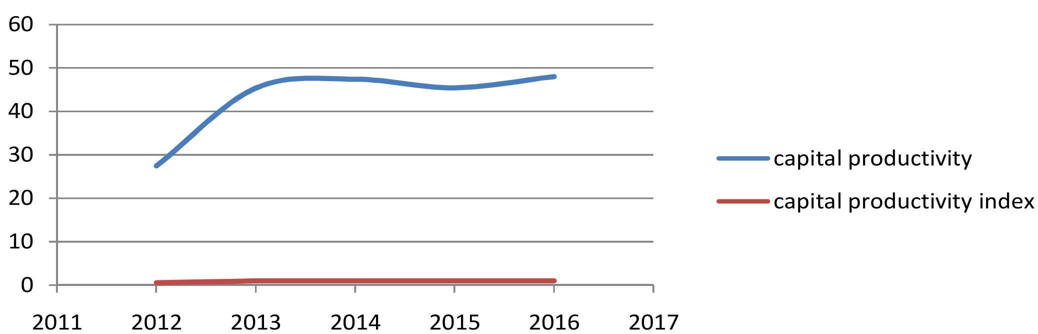


Figure 8. Energy productivity and index

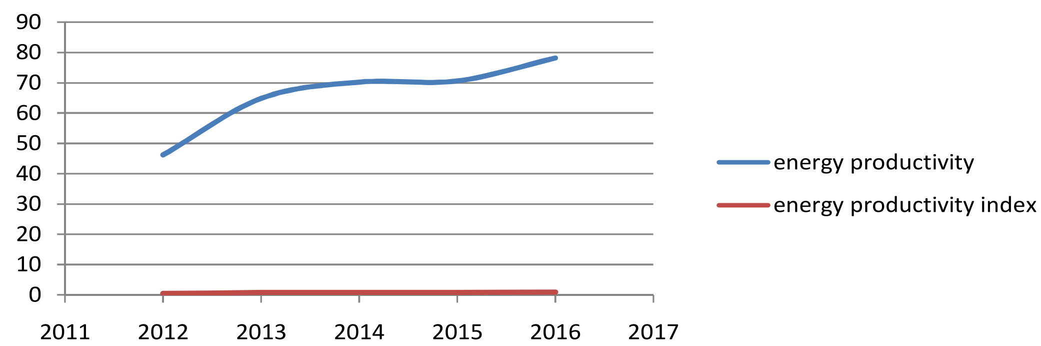


Figure 9. Miscellaneous productivity and index

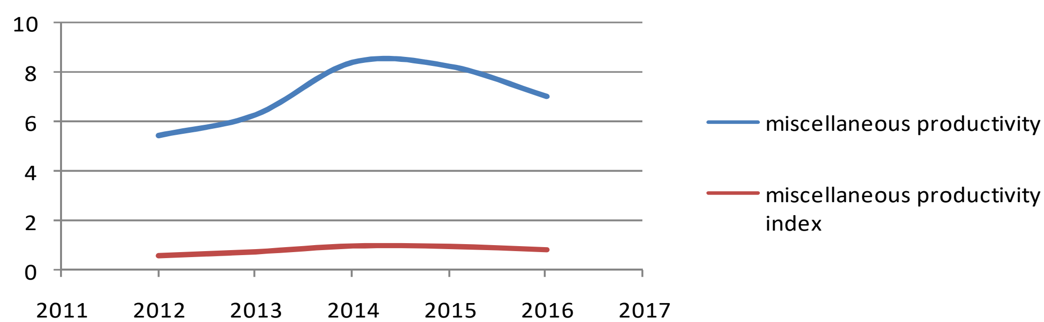


Figure 10. Single factor productivity indexes

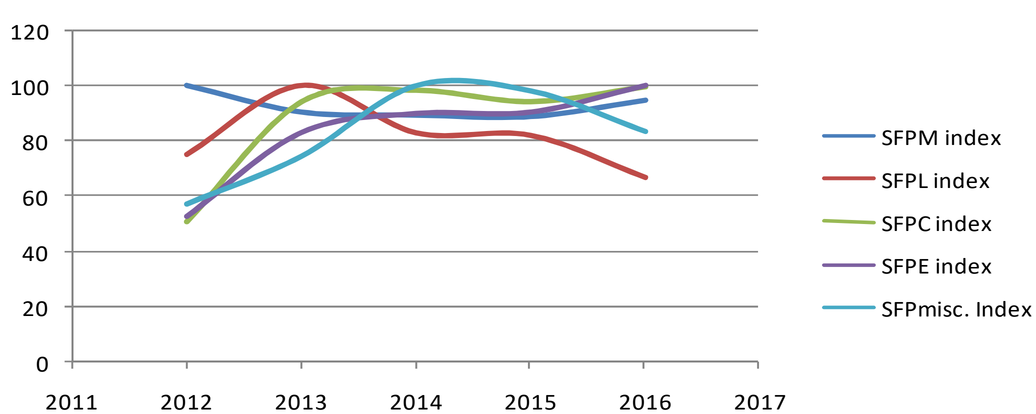


Table 11. percent share of different inputs in total resources

Year	Material input, M (%)	Labor input, L (%)	Capital input, C (%)	Energy input, E (%)	Miscellaneous inputs, q (%)
2012	58.26	11.32	4.59	2.73	23.11
2013	67.88	8.97	2.6	1.82	18.72
2014	71.00	10.24	2.58	1.74	14.47
2015	70.26	10.86	2.65	1.7	14.53
2016	65.76	13.24	2.49	1.53	16.98
Average	**66.63**	**10.93**	**2.98**	**1.90**	**17.56**

Figure 11. pie chart for percent share of different inputs in total resources

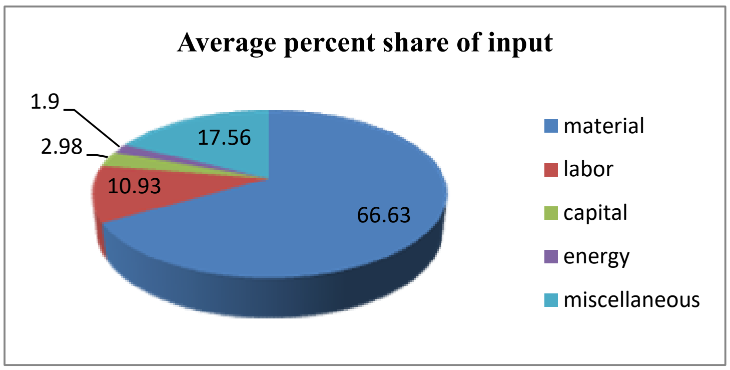
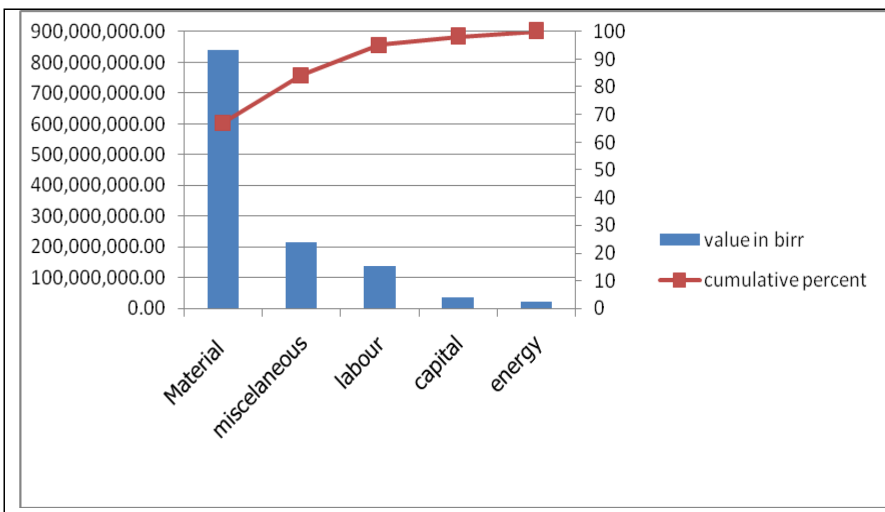


Figure 12. Pareto analysis for percent share of different inputs in total resources



Input	Value In Birr (five years value)	Percent	Percent Cumulative
Material	839,799,391.70	67.1	67.1
Miscellaneous	215,180,719.61	17.2	84.3
Labor	137,846,037.85	11	95.3
Capital	35,945,714.97	2.9	98.2
Energy	23,038,920.57	1.8	100
Total	**1,251,810,784.70**		

4.3. EVALUATION OF THE PRODUCTIVITY MEASUREMENT MODEL

There are several criteria for the evaluation of any measurement system or model and he appropriateness of the proposed productivity model for Ethiopian pharmaceutical industry was evaluated with the criteria; Validity, Completeness, Comparability, Inclusiveness, Timeliness and Cost-effectiveness.

Validity

Validity is defined as the ability of a measurement to measure what it intends to measure (Hannula. 2002). Here the objective was to measure total, multi, single factor productivities and productivity index of the pharmaceutical industry. As a result the question was whether the model be able to measure productivity and productivity index of the pharmaceutical industry or not? Data obtained from the case company were used to compute the productivities and indexes with the help of the model, and hence the model is able to measure what it purports to do. Thence the model is valid.

Completeness

Completeness means the thoroughness with which outputs and all inputs, or resources consumed, are measured and included in the productivity ratio (Wazed and Shamsuddin 2008). The productivity model included the monetary price value of all medicinal products (outputs) and all inputs which are material, labor, capital, energy and miscellaneous inputs. So the model is complete and included all inputs and outputs of the company.

Comparability

Productivity and productivity index between two periods are a relative measure. The output or inputs measured in the pharmaceutical industry can be compared if the prices or costs are free from inflation or other external factors. However, when the price or cost change or the product variety changes, the productivity and productivity index measures have less significance. In case of price rise, the monetary value of the output will rise, even if nothing changes and the productivity and index will indicate a false increase. Since the proposed productivity model used inflation adjusted output and input price and any increase in the monetary value of the output for the same quantity will reflect the increase in the quality. By using inflation adjusted values of inputs and outputs with price indexes, comparability of the model was maintained.

Inclusiveness

The developed productivity model did not only take care of the production activities but also included other activities of the case company such as quality, purchasing, marketing etc.

Timeliness

On timeliness the model can be used for the measurement productivity with higher frequency and can reveal any problem and action could be taken as soon as it was required. The model was also tested with very recent data.

Cost-effectiveness

Cost-effectiveness is defined as the practicality or the benefit-burden ratio of the measurement. It asks the question, is the measurement model worth the effort expended? It is directly connected to the significance of the measurement. If productivity and productivity index being measured are not pertinent, the model is certainly not cost-effective or practical. But productivity is one of the major factors affecting the profitability, performance and overall competitiveness of any firm. Therefore the proposed productivity measurement model is simple, realistic and cost effective.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Key Findings

5.2 Conclusions

The general objective of the study was fulfilled and an appropriate single, multi, total factor productivity and productivity index measurement model for Ethiopian pharmaceutical industry was developed. The spirit of performance measurement in practical is to generate and provide useful information with rational effort. Measurement models should not be too complex to give out realistic needs of a given industry. After the model has been developed, it was tested with five consecutive year's data obtained from a case company. The developed productivity measurement model was also evaluated with six criteria and proved that the model is valid, complete, comparable, inclusive, in timeliness and Cost-effective.

The specific objectives of this study such as examining the relationship between productivities and organizational profitability, establishing a relationship between total factor productivities and single factor productivities, identifying the area of poor resource utilization, exploring and selecting the variables to measure productivities, measuring and evaluating the productivities of Addis pharmaceuticals factory with the help of the developed model and conducting a trend analysis of the productivities of the case company were all achieved.

Simple regression analysis was used to develop the relationship between total factor productivity and company's performance (net income). And hence coefficient of correlation (r=0.867) showed that there is strong positive relationship between company's performance and total factor productivity and for any increment in total factor productivity there will be progress in net income. The coefficient of determination: $R^2 = 0.75$, clearly illustrated that 75% variation in net income can possibly be explained by the variation in total factor productivity, however 25% variation can be other variable that may need further studies.

Multiple regression analysis was used to develop the correlation model between total factor productivity and single factor productivity.

From the equation obtained from regression analysis, it was observed that material, miscellaneous and labor productivities have the major influence on total factor productivity, hence to increase total factor productivity there must be increase in these productivities by reducing material, miscellaneous and labor cost to the possible extent. The major portion miscellaneous input includes long term debt and working capital interest paid to creditors. The coefficient of determination: $R^2 = 1$, clearly depicted that variation in total factor productivity can be explained by the variation in single factor productivities.

Based on Pareto analysis/diagram it was shown that material, miscellaneous and labor inputs accounted for 95.3% share of total cost of the company and material and miscellaneous inputs had a total share of 84.3%. Since the major portion of miscellaneous input includes long term debt and working capital interest paid to creditors.

So, it can be concluded that the study has achieved the objectives set at beginning of the study and all research questions and hypotheses are addressed. Therefore, the developed productivity model can be used by Ethiopian pharmaceutical companies in the industry to measure and monitor productivity performance that improves productivity improvement.

5.3. Recommendations

Currently productivity status of the pharmaceutical industry in Ethiopia is not well identified, the industry has no a comprehensive productivity improvement strategy to overcome the challenges and industry average for various productivities have not been known.

Hence, the researcher recommends the following points to be applied and implemented in Ethiopian pharmaceutical industry for continuous development in productivity and performance improvement.

- ✓ The pharmaceutical product manufacturers should conduct productivity measurement periodically for all the inputs/resources and based on the results that will be obtained from the measurement, they should device improvement strategies.
- ✓ Introduction of management tools like kaizen, total quality management systems etc, in the industry will help for continuous improvement.
- ✓ Government involvement will be very vital in coordinating industry level productivity measurement and productivity standard development.

Addis pharmaceutical factory i.e., the case company should devise improvement strategy on its resource utilization specifically on material, labor and miscellaneous input. On top of that the company should minimize the amount of working capital borrowing from creditors and settle its long term debt.

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