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CANDIDATE'S DECLARATION

I, hereby, declare that the work which is being presented in this thesis entitled "Computerized Activity Based Costing System For Process Industries: A Case Study On Zemilli Paint Factory." is an original work of my own, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

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Date

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

Dr.Ing. Demiss Alemu

(Thesis Advisor)

Date

COMPUTERIZED ACTIVITY BASED COSTING SYSTEM FOR PROCESS INDUSTRIES

A CASE STUDY ON ZEMILLI PAINT FACTORY

By

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Abstract

There is increasing evidence that external and internal pressures are being placed upon companies to acknowledge, characterize and analyses environmental issues, impacts and costs. It has been becoming crucial that companies will increasingly be faced with responsibilities extending outside the factory gate to point of sale and beyond. Companies will need to adopt a life cycle perspective into the decision-making framework, to support managements' decisions regarding the environmental impacts and costs of activities and products.

The manufacturing and process sector has suffered from poor management systems for a long time. In process industries, the need for better cost management systems arises from efficiency problems and lack of resources. With activity-based costing, the processes and the costs of activities become more transparent than earlier.

ABC has highlighted that true understanding of what it costs to provide products/services is at the same time a tool for better management. It helps to better understand and serve as guides in any business process improvement initiatives, and to subject resources to its efficient usage. In a nutshell, it helps to make more effective business process improvement at more transparent cost.

This study is an illustration to point out required changes that could be made during the activity-based costing process in Zemilli paint factory. It shows the benefits and advantages that have come true because of the ABC-process and discuss the problems connected to this process. The ABC-process consists of two phases. The phases and their outcomes are described in chapter four preceded by the basic principle of ABC in chapter three of this study.

The first chapter of the thesis dedicated to introduction, background, the importance, objective and the general outline of the paper. The second chapter of the thesis gives the existing condition of process industries in Ethiopia considering specific attention to Zemilli paint factory. While the third chapter of the thesis is fully dedicated to literature survey and

followed by chapter four which gives emphasis to problem formulation and the Activity Based Costing model developed to the factory.

The thesis is wind up by including chapter five with outline information to the developed visual basic programming using ABC principles. Finally a conclusion and recommendation is drawn out from the executions of the study in chapter six.

The most concrete result of the whole process is a database with visual basic programming working on ABC-model. The model can be used as a tool of daily management. It has been used to find out the costs of each activity and operation. This has enhanced the cost awareness of the unit. The model can also be used for simulation. It can be used to find out the profitability of the operation of the factory.

CHAPTER ONE

1. INTRODUCTION

1.1 Background

In order to get competitive advantage, processes industries have to improve productivity and quality, which lead them to improve production cost. Reduction of production cost can not be carried out as long as the exact production cost of each product is identified. This is especially difficult in process industries having several varieties of products. Exact costing of products will help the industry to identify profitable and non-profitable production in order to increase the share of highly profitable product in the product mix.

In traditional costing system overheads are determined as function value or volume which leads to inaccurate cost information. In contrary, activity based costing system is based on the primary requirement of activity to produce a product and resource throughput of each activity. Thus, activity based costing system a better alternative to determine product cost.

The general objective of the thesis is to demonstrate the role of computerized activity based costing system in performance improvement of processes industries. With activity-based costing, the production process becomes more transparent than earlier. Moreover, the activity costs become clearer for all employees. At the present moment activity-based costing is considered to be a good costing system that can serve as a decision support system (DSS) for management.

Initially, activity-based costing was perceived as overcoming the flaws of the traditional costing systems. Organization were eager to implement the activity costing system which had the great advantage that it could provide a better allocation of indirect costs to products in manufacturing industry.

The accurate cost information on products was the beginning of ABC, in time it grew to be applied to the service sector, as well. In the long run, ABC has proved to be fit for the

allocation of non-production costs, such as distribution costs or selling costs. Stimulated by the practitioners' responses, academics discovered another scope for ABC: application of activity-based costing to customers, in order to study more accurately the profit or loss per individual customer with which the company has trading relationships. Furthermore, ABC allows understanding of cost behavior, due to the fact that it permits the contraction of a cost driver hierarchy that reveals at which level costs are incurred. Finally, ABC can be used as a basis for budgeting process.

As the information systems of organizations evolve, ABC is considered to be very valuable for those organizations that have an ERP system are very fundamental. As a result, ERP implementation needs inclusion of ABC as a module. The ERP systems might overcome some of the problems related to data collection, cost drivers selection, and so forth. Therefore, it is interesting to analyze an activity– based costing case study in the context of financial information systems.

Traditional costing systems allocate overhead costs arbitrarily, primarily based on direct labor hours. However, direct labor hours often do not adequately represent the percentage of indirect resources consumed by a certain cost object in a certain period. As a result, product cost distortion occurs. Activity-based costing provides a solution to this problem by viewing the manufacturing system as being composed of activities. It assigns the costs of these activities to cost objects by using cost drivers that represent the consumption of indirect resources by cost objects more accurately than arbitrary allocation bases. The real power of activity-based costing arises from its ability to support managerial decision [3].

Recently due to the increase of popularity utilizing alternative finishing materials (like glass, gypsum etc.) in construction industry deteriorates paint industries market. Therefore, the principle of ABC model developed for the factory in the case study targeted to counter act the above problems by improving accuracy of costing in bid preparation, recipe and appropriate product selection for promoting profitability.

1.2 Problem Statement

In today's competitive world of business, having accurate information may be the key factor in distinguishing between the loser and the winner. Using more accurate cost information, while determining the optimal product mix of a company may lead management to make better decisions, and as a result, may have a great effect on the success of a company.

For a long-term existence of industries, it is mandatory to have an active control & improvement of every activity of the firm exhaustively. Nowadays, owning to the state of the art sustainable manufacturing technology for an industrial business may not guarantee a long lasting profitability both in the local and global market. This is mainly subjected to globalization pressure. It could be counteracted by an interactive follow-ups and control that ascertains its perpetual improvement and strength against competitors in the market. This can be achieved by proper methodology of product costing system with reference to the activities performed in the production process.

One of the developed practical tools is Activity Based Costing (ABC) that enables factories to determine costs of their products along with why they cost what they do. With this knowledge, the factories can acquire information on profitable product mix, activities of prime improvement importance, better utilization of their capital funds, and better business decision.

1.3 The Elements of the Thesis

1.3.1 The Questions of the thesis

Can a computerized ABC system modeling help to improve product mix decisions and performance of a process system?

1.3.2 The Purpose of the thesis

The purpose of this research is to provide relevant virtual information to managers that will enable them to make better business decisions regarding the target towards performance improvement of the mission of the company in its businesses endeavor.

1.3.3 The Objective of the Thesis

A. Main objectives

The objective of this thesis is to develop and demonstrate an interactive visual basic program model that uses activity-based cost information or principle that can be used by the paint factory.

B. Specific Objectives

a) Considering all the processes in the case study and develop the governing principle to the Activity Based Costing methodology.

b) To assesses and develop method of computation of cost with reference to the accompanied process and activity.

c) To develop a model suitable for implementing Activity Based Costing in Zemilli Paint factory.

d) To develop an interactive visual basic program working on the above objectives.

e) To demonstrate the application of the program to the factory performance improvement.

1.4 Scope of the Thesis

The study entails a literature survey regarding the activity-based costing and the method of ABC model development. In addition, the thesis includes the conceptual development of an activity-based cost model that may help companies to improve their performance which brings pronounced business profitability. A case study is included in this research to demonstrate the use of the developed ABC model and interactive program for the illustration purpose. There has been limited effort to implement the concepts developed in this research in company at hand with real costs, activities, and products. The major difficulty that is expected in real-life implementation of this thesis is to collect the data necessary for the intended development of a model and related program.

First the theoretical framework of the study is introduced preceded by background information about process industries sector and company situation. After that it describes the

two-pronged ABC-process in the paint factory at hand. This part starts with a short introduction of the factory. Then the process is described. This includes the objectives of the two phases, the tools used and the main outcomes of both phases. After that the structure of the ABC-model is described. Finally it introduces the results that this thesis achieved so far. First the numerical results are presented, and then the managerial results and changes that have occurred are clarified. Also the problems arisen in this whole process are discussed. In the end of this study, conclusions are made and some ideas concerning the future development are introduced.

The study was carried out as an experimental case study. The intention was to find out how the activity-based costing works for multi-product process industries especially on a paint factory, The purpose was also to find out what benefits and problems are linked to the implementation process. The study includes literature reviews, interviews, modeling and out put presentation.

1.5 Major Assumptions

a) A batch of a specific product i has to be finished completely once that batch is started to be processed.
b) Even if there is no partition which demarcates physically basic processing machines of the company, they are taken as an independent unit as preferred in the cost center model developed with regard to the production process.
c) Whenever one unit of product *i* is started to be manufactured by using a specific route, all the other parts in that batch must follow the same route.

1.6 Organization of the Thesis

The first chapter introduces the problem and the need for this thesis. It identifies the problems of the thesis, the purpose, the objective, and the scope of this study. A plan of presentation is also included in this chapter.

Chapter two gives sub sector information about processes industries in the country with some specific data of Zemilli paint factory.
Chapter three gives a review of the relevant literature. Specifically, it gives information about the principles of activity-based costing and its possibility to computerization costing approaches. Furthermore, it explains the significance of effective capacity management in the success of a company in today's competitive business environment.

Chapter four develops the proposed model that can be used to develop the interactive program and how it supports the decisions regarding the working situation of the case study. Specifically, this chapter includes problem formulation and explains how the model is developed based on the current literature and how it can be expanded to include several alternatives such as activity flexibility and simulation of production plan.

Chapter five presents the case study to show how to implement the developed model and the computer program. The user friendly graphical interface, the analysis part as well as data management systems are briefly explained.

Chapter six includes the conclusions derived from this study and the contribution it has to the existing working situation of the factory. It also presents a summary of the study and identifies future research opportunities to be continued by others.

CHAPTER TWO

2. BACKGROUND OF PROCESS INDUSTRIES

2.1 Process Industries in Ethiopia

The type of process industries in Ethiopia mainly categorized as Food, Beverages, Sugar, Leather, Chemicals, Pharmaceuticals, Textile, Cement & Lime and Paint etc. Paints industries can be classified in process industries with regard to operational process of the factory but Ministry of Trade industry allocate them to Chemical industries category,(among Pesticides, Soda Ash etc) to give due attention to the main chemical recipes and their limited manufacturing value addition.

As mentioned above, the economy sector of Paint factory is industrial under the chemical & chemical by products sub sector.

2.2 Paint Industries in Ethiopia

2.2.1. Overview of Ethiopian Paint Industries

Ethiopian Paints Factory supplies their products only to the local market. However, preparations are underway to study the market segment and the products (paints) in the neighboring Eastern Africa Countries.

Regarding value distribution of 1997EC(2004-5) total industrial sector, chemical and chemical byproducts sub sector contribute 13%, food & beverages sub sector contribute 45% (has the largest share) and non metallic sector contribute 13% which stood second in the chemical & chemical byproducts sub sector. Therefore, paint factories contribution to the industrial sector is a significant one which needs due attention to its development.

From the 1997 budget year statistical data from the total industrial sector of 102,000 human resources, the chemical sector incorporates about 3,075 workers which is 3% of the total.

Studies form the ministry of trade industry indicates that paint factories weather they are privately owned or publicly they didn't operate at full capacity which is due to shortage of chemical raw material and market.

Paint factories which are found in the country and included in the chemical sector are eight in number. Among them one is owned by the government the others are privately owned. It is estimated that these paint factories incorporate human resource of about 550.

Even though an elaborated sector wise market share studies was not done, the public paint factory five years strategic plan indicates that it has estimated its market share to be around 30% to 40%. This could give some picture of market share condition of other paint factories.

2.2.2. Distribution and Market Facilities for Local Market

The factories have different size whole seller agents in the city of Addis Ababa which distribute their products to retailers. In addition the factories have well established whole seller agents throughout Ethiopia distribute the products through different retailers. The factories also served their customers at sales points (outlets) found at the factory.

2.3 Zemilli Paint Factory

2.3.1. Historical Background:-

Two shareholders established Zemilli Paints Factory as a private company with a capital of Birr 5,000,000 under the name of Mega paints Factory being a part of DH Geda PLC.

The factory and the Head Office are located in different places within the city of Addis Ababa.

Location:- Bole Kifle Ketema, Kebele 10/12 and

Head Office location:- Kirkos Kifle ketema, Kebele 19

2.3.2. Objective of the factory:-

The factory has a mission to raise its production capacity up to a limit it has already set and produce qualitative products to satisfy the local demand and make a thorough preparation in order to enter the export market.

The main objective of Zemilli Paints Factory is to produce and sell different types of paints mainly categorized as water-based and synthetic wood and metal paints.

2.3.3. Main Type of Products/Service/ Activities:-

Its main activities consist of Production & Sales of different types of Paints. Types of products are Water & Plastic paints, varnishes shown as follows:

a) Mega Super
b) Mega Enamel
c) Mega Anti Rust
d) Mega Alkyd Varnish
e) Polyurethane Varnish
f) Mega Black Board
g) Mega Glue
h) Mega Printing Ink
i) Mega Wubet
j) Mega Quartz
k) Mega Primer

2.3.4. Production Capacity:-

Attainable Annual production capacity: - 3 Million liters.

Attained Annual production capacity: - 2 Million liters.

Designed Annual Production capacity: - 2.25 Million liters

2.3.5. Major Local Customers

Zemilli Paints Factory's major local customers are the following:-

⇒ Construction companies
⇒ Garages
⇒ Building material shops
⇒ Painters
⇒ Road Authorities
⇒ Individual households

2.3.6. Organizational Structure of the Factory

The organizational structure of the company is shown on figure 2.1.

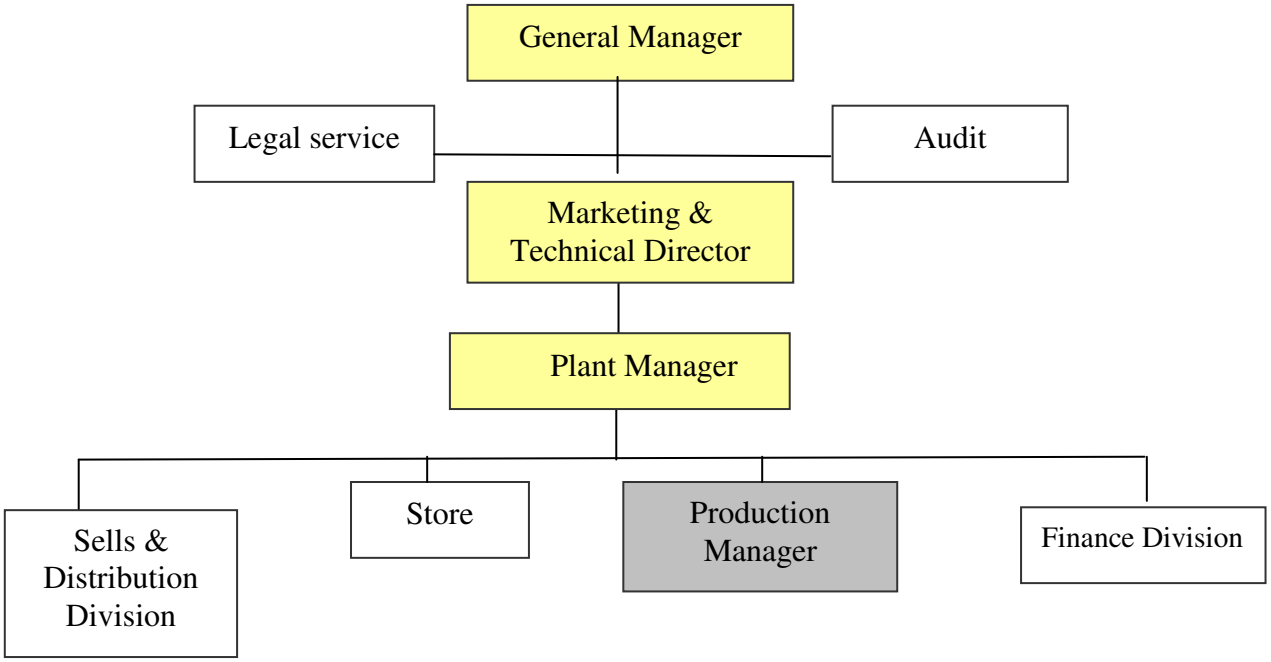


Fig.-2.1. Organizational structure of Zemilli Paint Factory

CHAPTER THREE

3. REVIEW OF LITERATURES

3.1 Activity-Based Costing (ABC) Principles

According to Cooper and Kaplan [8], ABC is an evolutionary extension of the two stage procedure of the modern cost systems that segregates the organization's resource costs by activities, and then uses drivers to assign those expenses to activities.

The emergency of ABC technique was the consequence of the following three factors [4]:

1. The changes in companies' cost structure, meaning the increase of the overheads as opposite to the decrease of the direct labor costs and material costs.
2. The cross-functional behavior within companies has gained ground, more than ever managers becoming aware of the relationships between their departments.
3. The appearance of relational databases that allow the quick data organization.

Unlike traditional cost systems that misallocate the overhead costs, ABC traces costs by using resource and activity drivers that reveal activities and objects consumption patterns on the basis of the cause and effect relation. In activity costing systems, there are three building blocks: the resources, the activities and the cost objects.

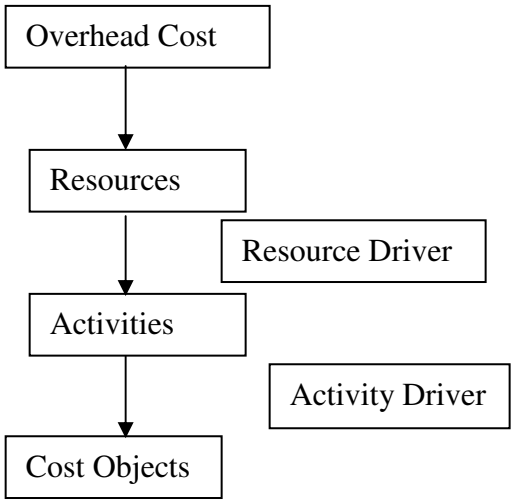


Fig.-3.1. ABC Building Blocks

3.2 ABC Strengths and Weaknesses

At times when direct labor costs used to represent 40 to 60% of the manufacturing costs of a product, the traditional costing systems seemed to be largely used. Among the most important features of the traditional costing systems, the following are the basic ones [11]:

- Direct labor and direct material costs are traceable directly to products.
- Production and non-production overheads are considered indirect costs and are traced to products using predetermined overhead rates. The most common base used to allocate overheads to products has been the direct labor hours.

As changes in companies' cost structures became more and more evident, the traditional costing system shortcomings grew apparent too. Some of these shortcomings are:

- The traditional system can not offer any decision-making support to management;
- The overhead costs are shared among products, thus some products get a higher share of overheads costs, than they should have, according to the amount of costs incurred by their manufacture.
- The costing system focused on production costs, whereas the marketing, selling and other product sustaining costs are not attached to products or customers.

ABC became more and more popular, as organizations realized that ABC can remedy the traditional costing system's weaknesses. The academicians who promoted ABC stated that some of the activities costing advantages are [26]:

- It provides a more accurate method to calculate costs absorption by activities and products.
- ABC is a better decision support system, by providing better product cost information and by allowing transparency in monitoring cost behavior.
- ABC aims at finding a causal relationship between cost objects and the costs incurred.
- ABC offers better information for cost based pricing, product mix and make or buy decisions.
- ABC can be used for inventory valuation for financial statement purposes.

ABC users admit that ABC is not flawless, having few disadvantages such as:

- ABC may not be easily implemented for all products.
- The causal relationship between activities and products is not always clearly identifiable.
- The detailed accounts analysis and the data collection process are time-consuming analytical processes.
- It is static, meaning that any change in business processes entails the reconstruction of the ABC model.

ABC benefits exceed its shortcomings, thing which turned activity based costing into a widely used method of allocating overheads to individual products, customers or services.

3.3 ABC as Resource Usage Model

Cooper and Kaplan [6] emphasized the conventional costing systems flaw regarding the accurate measurement of the costs of resources used to obtain activities outputs, like

products or services. In exchange, ABC systems are models that reflect resources usage, implicitly shedding light on the unused resource capacity within company, for a certain lapse of time.

The measurement of unused capacity provides the critical link between the costs of resources used, as measured by an ABC model, and the costs of resources supplied or available, as reported by the organization's periodic financial statements. The following equation reflects the above-mentioned relationship and should be defined for all the major activities performed by company's resources:

COST OF ACTIVITY SUPPLIED	=	COST OF ACTIVITY USED	+	COST OF UNUSED ACTIVITY

In fact, activity-based costing systems exhibits two important issues related to resource usage:

- Activities which consume resources are not always performed in proportion to the total volume of units produced.
- ABC systems calculate the costs of resources used to undertake activities in order to produce different outputs, during longer periods of time.

ABC reveals the fact that resource usage varies with the demands for the activities to be used for production. The information about the unused resource capacity offers different possible ways of action to the management [7]:

- Management may choose to use the available resource capacity in order to obtain a higher volume of business;
- Or, may choose to reduce the spending on resources, by eliminating the unused capacity;
- Or, may take no action at all, in which case, resource costs remain fixed, irrespective of the unused capacity.

3.4 How to Design an ABC Model

The design of an ABC system involves two assignment stages [5]:

- The first stage relates to activity analysis when resource costs are traced to activities through resource drivers;
- The second stage refers to distributing activity costs to the cost objects which use the activities, through activity cost drivers.

3.4.1. Activity Analysis

The activity-based costing system focuses on the activities performed in organization to satisfy customers' requirements. The activity analysis stage starts with the identification of resources and their costs, and the next practical step is the activities identification. The final step of the activity analysis stage is mapping of resource costs to activities, taking into consideration the business resources consumed by each activity performed.

3.4.1.1. Identifying the Resources

The business resources can be people, machines, computers, equipment, technology, and supplies are accumulated in the general ledger through payroll, journal entries, accounts payable, and other business systems within the company.

An important step in this phase is to draw up a detailed list of cost elements that can be obtained from the general ledger or from the detailed income statement used in company's cost accounting. Each resource cost or cost element in the list should have a resource driver according to which it will be traced to activities.

3.4.1.2. Defining the activities

The most frequent way the cost system designers use to identify activities is interviewing the heads of departments about the main activities which take place in their departments and about their subordinates' responsibilities, time and effort spent to fulfill their tasks.

When the ABC model is designed, activities are custom defined, but after some practice, custom-defined systems can be supported by standard activity definitions dictionary. Besides interviews, the ABC designers collect the data needed to link resource costs to activities performed through tools such as [10]:

- Labor reporting systems and work order systems;
- Employee surveys in which the employees who do not work in production fill in a survey form in which the activity is listed and they estimate the percentage of time they spend on any activity on the list;
- Observation;
- Time keeping systems;

After drawing up the activities list, the activities can be classified according to value added they give to the service or customers. The most seldom methods of classification is:

- Activities which contribute to value added;
- Activities which do not contribute to value added.
- Generally, companies define the most important activities in the value adding from customers' Viewpoint, by answering the following questions: "Would a customer pay for this activity, if there are other choices?", or "If an activity were not performed any more, would the customer realize the difference?"

3.4.1.3. Calculating activity costs

The resource costs are consumed in different ways by activities, therefore an important step in activity analysis is to determine the activity costs. The activity costs are determined by using resource cost drivers to distribute factory production and non-production overheads, the most common sources for overheads data are the following [12]:

- Data from the company's accounting system;
- The detailed income statements;
- Data of employee wages and salaries;
- Fixed assets book-keeping.

In ABC literature, it is suggested that it is better to divide activities into activities performed by machines and activities undertaken by people in order to achieve a simpler distribution of overhead resource costs to activities [26]. Machine performed activities may include a range of technology related resource costs, such as:

- Utility and energy costs;
- Maintenance and repair costs of engineers;
- Specialized, indirect support costs;
- Depreciation costs.

Generally, machines performed activities type of activity is considered to be a unit-volume level activity.

Activities performed by employees are batch-related activities. The costs of this kind of activities are insensitive to unit-volume outputs and are spread only to certain cost objects.

It is highly likely that the resource drivers identification be problematic, in which case, the system designers have to ask questions to department managers that might allow an evaluation of the reasons of committing resources to an activity [11]:

a) Why do you need more than one person on this activity?
b) Under what circumstances would more staff be required on this activity?
c) Under what circumstances could staffing be reduced on this activity?
d) Why is overtime worked on this activity?
e) Why does idle time occur on this activity?

At the end of the activity costs step, it is very important to verify if the sum of resource costs equals the sum of activity costs. If not, it means that there is an insufficient number of resource drivers identified. With the distribution of resource costs to activity costs, the first stage of designing an ABC model comes to an end. From this point on, the focus of system

designers falls on the second stage of the design, which is recasting activity costs to cost objects, such as products, customers or services.

3.4.2. Activity Cost Drivers

The second stage of the costing process consists in selecting activity cost drivers that link the cost objects to the performed activities consumed by individual cost objects. The purpose of this stage is to trace activity costs to cost objects and the way to reach the goal is to choose the appropriate activity cost drivers. Activity cost drivers is quantitative measures which reflect to what proportion an activity is used by products, services, customers or other objects.

Activity costing systems use not only the traditional unit-level drivers, but also batch, product-costing, and customer-sustaining activity cost drivers. For each activity identified in the first stage of the model, the designer selects a unique activity cost driver [19]. In addition, the designer must find the source of information upon the quantity of activity cost driver for each cost object. Nowadays, such information can be collected at a lower cost from the integrated information systems across the enterprise.

3.4.2.1. Categories of cost drivers

ABC systems designers must pay great consideration when selecting the activity cost drivers to reflect the extent to which cost objects consume activities. Kaplan and Cooper identified three categories of cost drivers which can be chosen in an ABC model [9]:

1. Transaction driver. These are the least expensive category of cost drivers because they reflect how many times an activity has been performed and are used when the activities are consumed in the same extent by cost objects.

2. Duration drivers. The use of transaction drivers causes a distortion into reported cost objects when the amount of activities required for different cost objects differ significantly from one cost object to another. In this case, duration drivers are the right choice, but more

expensive to implement, since the model needs to track the period of time during which each activity is performed.

3. Intensity drivers. These directly charge the resources used each time an activity is undertaken. These are the most accurate cost drivers, but at the same time, the most expensive. A model that uses an intensity driver has to be implemented a job order system to record all the resources used by an activity performed.

Kaplan proposes a weighted index approach which the ABC designers can use to stimulate an intensity driver. The approach consists in asking employees to evaluate the difficulty of performing the tasks for a product, a service or another cost object.

3.4.2.2. Activity drivers' selection

The factors to be considered at this stage of ABC model design consists of two classes:

a. Factors that help in choosing the number of cost drivers required by the ABC system;
b. Factors that help selecting the appropriate cost drivers [15].

The first class contains four types of factors that determine the multiple uses of cost drivers:

c. Level of desired accuracy in cost information. The higher the level of accuracy, the more cost drivers need to be selected.
d. Product diversity. Activities are consumed in different proportions by cost objects, so the higher the degree of diversity, and the more cost drivers selected.
e. The relative cost of the activities aggregated. The number of the cost drivers required increases proportionally with the number of activities that represent an important percentage of the total pooled costs.
f. Volume diversity. When products are produced in different batches, the multiple uses of cost drivers are required.

The second class includes three factors, such as:

- Expense of measurement. The selection of the cost driver depends on the cost associated with the cost driver. For the cost drivers for which data is more readily available, the cost of measurement decreases. The transaction drivers are the cost drivers with the lowest cost, because information related to the transaction is generated every time when an activity is performed.
- Correlation. The cost drivers which accurately capture the consumption of activities by cost object will be used in the ABC model.
- Behavioral effects. The cost drivers selected in ABC system have impact on the behavior of employees to the extent the individuals perceive the cost driver selected as a way to measure their performance. If the behavioral effect is not harmful for company, than the cost driver will be selected.

Once identified the cost drivers and the appropriate number of cost drivers for each activity, the final step in the activity cost driver stage is to find out the cost of the product, customer or service by summing up the costs of all the activities performed in order to obtain the respective cost object [2].

3.4.3. Designing an Optimal ABC Model

An optimal cost system means and introduced the concept of the optimal cost system that minimizes the sum of the cost measurement. Those costs associated with the measurements required by the cost system and the cost of errors (those costs associated with making poor decisions based on inaccurate product costs).

A properly constructed activity-based-costing system is a relatively simple system that contains 30-50 activities and uses good estimates and many transaction drivers, with few intensity drivers. Such a system will have accuracy in activity and process costs from 5% to 10% [17].

Conversely, trying to build an ABC system with more than 1,000 activities and intensity or direct charging cost drivers to each activity undertaken for each product, service, and customer would lead to a far more expensive costing system. The construction of such a model is not desired due to the fact that the cost of operating such a system would be higher than the benefit of having better decisions as a consequence of slightly more accurate cost information. This can be achieved by focusing on a driver that requires less effort to be used instead of others that although reflect better the causal relationship between drivers and activities or cost objects that are more expensive.

The purpose of a proper ABC model is not to have the most accurate cost system. The design of an ABC model is judged on the cost/benefit basis. This means that the cost of doing a very detailed and accurate cost tracing should not exceed the benefits of doing that detailed cost tracing. Therefore, an optimal ABC model should aim at balancing the cost of errors made from inaccurate estimates with the cost of measurement

There are various approaches to designing and implementing an ABC system. The company size and desired outcome have to be taken into consideration before adopting an ABC system. A basic approach is to use ABC in conjunction with a company's accounting system. It is possible that the traditional systems are still used, in which case the ABC model represents a shadow system to be used when specific information is needed, without disrupting the current information and financial system. This situation happens in small firms' case or large firms' case, as a first step towards full ABC integration.

At the other end of spectrum, ABC is implemented instead of traditional accounting systems. This action implies important changes within organization, but the advantage is that ABC will be the only costing system used in daily decision making.

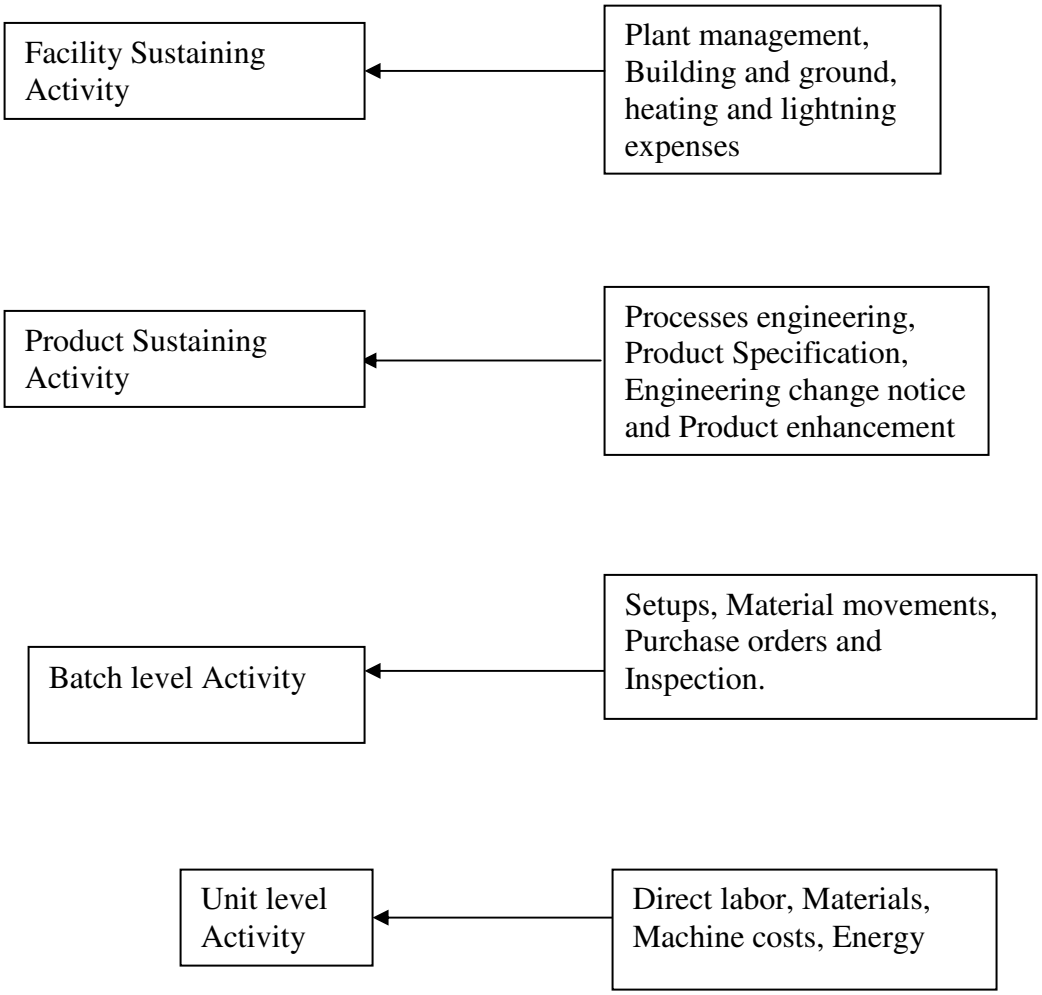
3.4.4. Activity Hierarchy

When separating activities, a hierarchy occurs and activities are classified into four types [16]:

- Facility-sustaining activities: - are those activities that help to run the production system as a whole.
- Product-sustaining activities: - are those activities that are only performed during production.
- Batch-level activities: are undertaken every time when a batch is produced;
- Unit-level activities: are performed for each unit of product. (See figure below).

As one can notice from the figure -, the direct labor, materials, machine costs and energy are classified as unit-level costs, whereas the setups and purchase orders activities belong to the batch-level class. Maintaining engineering change notices or process-engineering is product-sustaining activities. Plant management, buildings and grounds maintenance, heating and lighting are activities that sustain the factory.

Fig. - 3.2. The Hierarchy of factory operating Expenses



There is another way to classify activities in activity costing system: namely process1, Process-support and customer related activities. The costs of facility sustaining activities cannot be directly traced to products. But there are two options related to these costs:

- Either the factory level costs are left aside, in recognition of the fact that there is no proper cost driver which can be found to trace the costs of products.
- Or, the costs can be allocated to products through a more or less arbitrary allocation system.

The activity hierarchy offers the managers the opportunity to think in a more structured way about the relationship between activities and the resources they consume. This means that resources consumed by batch and product-sustaining activities do not vary at unit level, and cannot be controlled at the unit level. Batch and product level costs can be controlled only as the result of making changes in the batch and product level activities.

3.5 Theoretical Framework in applying ABC

This framework consists of the cost view and the process view. The cost view can be seen as the phase of building the ABC-model. The cost view includes the basic steps of the ABC-process and the main focus is in the costs. The resources and their costs are clarified first. Then the costs are allocated with cost drivers to the activities, found out with the help of activity analysis. Finally, the costs are allocated to cost objects. The main purpose of this process is to find out the costs of the activities and the cost objects. The information provided by the cost view is used in strategic and tactical analyses, one of these analyses being the evaluation of customer profitability [25].

The second view in framework is the process view. While the cost view can be seen as the phase of building the model, the process view can be seen as the phase of using the model built in the first phase. The steps of this view consist of finding out the cost drivers of the activities and using the information for performance measurement. The relation of these two views is presented in figure 3.3.

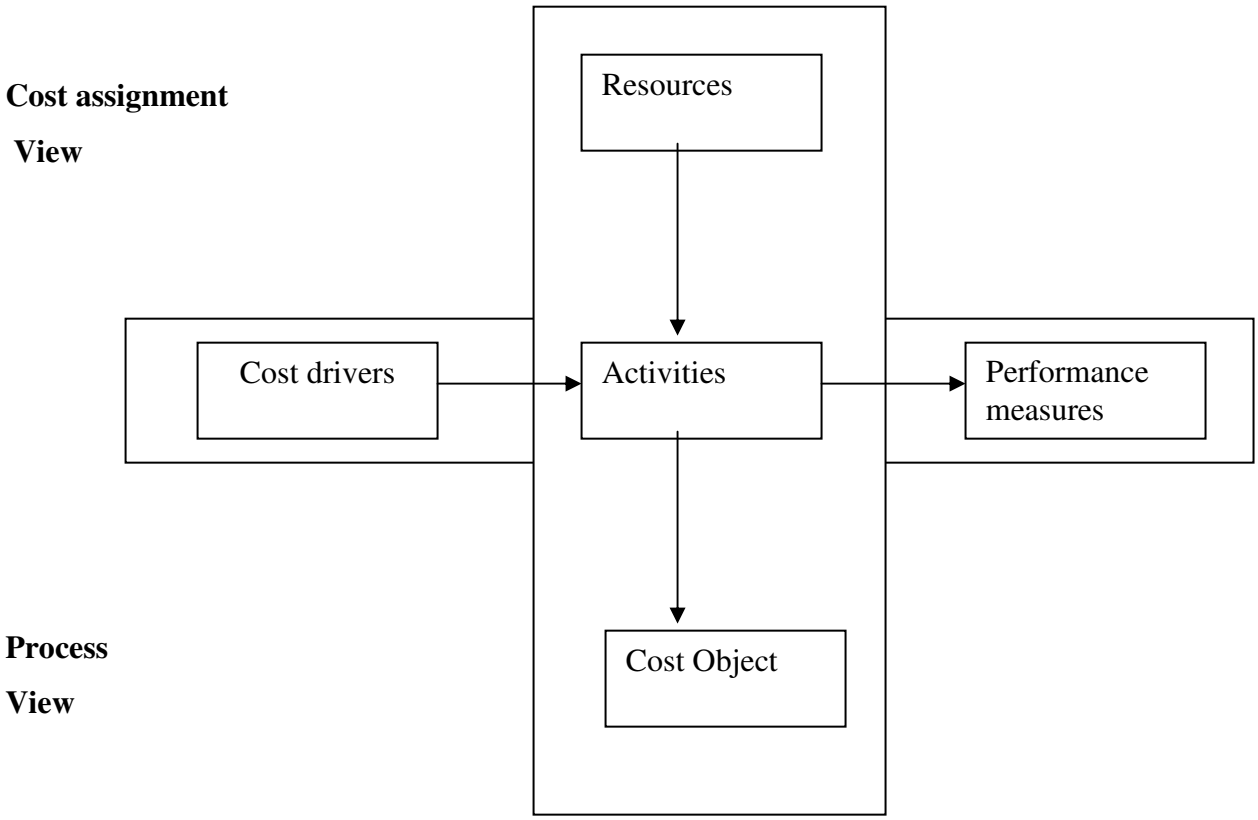


Fig.-3.3. The two-dimensional ABC model

3.6 ABC Application for Non-Production Costs

The trend in non-manufacturing costs within companies such as the selling, general and administrative overheads have higher and higher percentages of the manufacturing costs. Having in view this growing importance of non production overheads, companies have to monitor closely these expenses [20].

The ABC techniques applied for manufacturing overheads should be valid when allocating administration and selling overheads. At this case, ABC can assist in two ways:

- By using appropriate measures for determining the costs of the activities that administration and selling functions carry out;

- After measuring the costs of the activities which consume administrative and selling overheads, ABC can be used to apply these activity costs to different departments.

Procedure to be followed when using ABC in order to trace non-production overheads is the following:

a) The selling and administration overheads are distributed between the administrative and selling functions identified within organization.
b) Then, the ABC designers should identify the activities performed for the company's selling, marketing, shipping, warehousing, and general office functions.
c) The costs distributed between functions are re-assigned to customer or product related activities.
d) Then, the bases for distributing the costs of functions are established. By defining the appropriate cost drivers, accurate product costs or customer costs can be applied to the product or customer involved. For selling, the cost driver might be gross sales or orders received or number of sales calls. Advertising is a promotional activity that can use the units of product sold as a cost driver. In some cases, for the warehousing activity, the cost driver selected is the weight of product sold, and for the shipping activity the cost driver used is the number of units sold, because there is the assumption that the units shipped are equal to the units sold. For the activities of credit checking and general office, the cost driver proposed is the number of customer orders or number of invoice lines.
e) The next step is the calculation of unit costs for each activity.
f) Finally, the activities costs can be allocated to products or customers or divisions on the basis of cause and effect relation.

3.7 Recent Advances in Activity-Based Costing

The greater use of information technologies, mass customization, and globalization has created a competitive environment in which a low-cost structure often becomes critical for success. This environment has created a greater need for accurate cost measurement and management techniques [31].

Many factors have changed corporate cost structures and this has increased the need for more advanced costing systems. Higher overhead and higher indirect costs are forcing changes in organizational cost structures. Industries such as telecommunications and utilities have undergone deregulation and restructuring. Consumers demand more choice and better service. High product complexity, greater product and service offerings, more channel types and the Proliferations of new technologies cause the rise in overhead. At present, many companies calculate overhead as a percentage of labor. The proportion of product costs attributed to direct labor cost decreases as the use of advanced technology increases and as production moves to low-wage countries. Calculating overhead as a percentage of labor at a time when direct labor ratios are shrinking increases costing errors.

This new environment has created a need for tools that better measure how activities consume resources. A popular and effective cost measurement tool is Activity-Based Costing (ABC). ABC measures costs more accurately. Activity-Based Management (ABM) builds upon ABC and focuses on the managing the activities that increase profit and customer value. ABC and ABM are effective for they can view costs from a financial, operational and strategic perspective. ABC can identify and quantify resources, assign resources to activities, and assign activity costs to customers or products. ABC can also be used to monitor existing operations, for example by benchmarking, or to investigate the impact of future business decisions on costs. ABC can provide information to support specific management decisions such as outsourcing, budgeting, reengineering and determining customer profitability.

ABC and ABM are popular because traditional costing systems often fail to determine true product costs, customer profitability, and capital investment profitability [21]. When compared to absorption costing and marginal costing, ABC has several advantages. ABC measures the support resources consumed by products and revenue centers more accurately than absorption costing. Unlike with marginal costing, ABC acknowledges the consumption of resources whose costs are fixed in the short term, but which may vary in the long term

[22]. ABC costs that are based on normal costs are a good proxy for long-term incremental costs and ABC costs can be used for quantitative policy decisions.

Once implemented ABC systems can improve programs such as total quality management (TQM), change management, cycle time compression, core competency, business process reengineering (BPR), product rationalization, target costing, customer & channel costing. To be effective, new management tools must incorporate all functional areas of an organization. This holds true with any corporate wide initiative and partly explain the great demand for Enterprise Resources Planning (ERP). ERP systems allow ABC, operational controls and financial reporting systems to be integrated. Operational systems and ABC systems have different purposes and integrating them may create a system that drives decision-making in the wrong direction. A well designed integrated system helps decision making and identifies both unused capacity and potential capacity constraints. The use of integrated systems for real-time operation control may cause strategic decisions to go in the wrong direction [23].

Target Costing

Target costing is a strategic management tool that reduces the overall cost of a product throughout its life cycle. Target costing provides an effective method for generating plans and managing resources. Target costs are derived by subtracting desired profits from the highest price customers will pay. ABC can be used to help determine target costs and to improve pricing methods. Target costing can be used for profit enhancement. ABC assists manufacturers in setting prices, and in determining life cycle costs. Quality Functional Deployment (QFD) is one target costing technique [20].

Benchmarking

Benchmarking involves comparing a company's performance against that of competitors, industry standards and historical performance. Through benchmarking companies attempt to find "best practices", or the best way of perform activities that are essential to remain competitive. ABC helps provide data that makes benchmarking more accurate [24].

Recent trends in the application and adoption of ABC include the following points:

- Integration of ABC with ERP
- Integration of ABC with analytical applications such as THEORY OF CONSTRAINTS, target costing, and life cycle costing.
- Expansion of ABC practices throughout the organization into areas such as sales and marketing
- A focus on easier implementation
- Centralization of ABC data warehousing and data analysis
- Integration of ABC with decision support systems
- ABC support of mass customization.
- Measurement of product and customer profitability

3.8 ABC Compatibility with Other Applications

3.8.1. General

3.8.1.1. Non-Financial Performance Measures

Activity-based management couples non-financial information with the cost information obtained from activity-based costing. Cost-based performance measures can be established for specific areas within an organization that traditional financial performance measures cannot reach.

Activity-based costing generates non-financial information as a by-product. ABC resource and activity drivers reflect the time and resources consumed in performing specific activities. Underutilized capacity and resources become visible and these can be deployed to support other organizational activities. Non-financial information takes a horizontal or process view of activity performance while ABC takes a vertical cost assignment approach.

3.8.1.2. Strategic Costing

Strategic costing extends new product cost analysis over the full life cycle of a product and over all activities associated with that product's production. Strategic design cost analysis is based on product life cycle, the fact that design quality affects overhead costs, and cost targeting.

3.8.2. Marketing

3.8.2.1. Customer Profitability Analysis

Customer profitability analysis determines how individual customers or customer groupings contribute to profitability. Not all sales contribute to profitability in equal proportions since different customers consume different resource quantities. Traditional cost accounting approaches have assumed that customer driven costs are both insignificant and fixed, and have allocated these costs using sales or other volume-based drivers. In many instances customer driven activities are very significant, for example, when distribution costs exceed manufacturing costs.

3.8.2.2. Price-Led Costing

Price-led costing uses the lowest price customers are willing to pay to determine an allowable cost structure. The use of this approach begins in a product's design stage. To implement price led costing companies need to know all the supply chain costs.

3.8.2.3. Product Line Costing

Product Line Costing (PLC) is useful when adding additional product lines, which require additional indirect labor and additional overhead. Initial low production volumes for new products can cause costs to rise for all products. New and old machines are often grouped in similar cost pools in order to encourage the use of new machines. New machines have

higher operating expenses than the old machines and managers often prefer to produce their products on the cheaper machines.

3.8.3. Purchasing

3.8.3. 1. Total Cost of Ownership (TCO)

Total Cost of Ownership provides a methodology for costing the upstream portion of the supply chain. The approach recognizes that the item's purchase price represents only a portion of the total cost of acquiring an item. Vendor performance also affects the costs of ordering, receiving, and inspecting orders. Many firms bury these costs in overhead expenses. TCO attempts to identify the total acquisition price by including the costs of purchasing, holding, poor quality, and delivery failure. Product returns, nonconformance, and incomplete and late shipments can be incorporated when evaluating alternate vendors. By incorporating these factors into TCO analysis the suppliers that offer the best value can be identified.

3.8.3. 2. Life Cycle Costing (LCC)

Life cycle costing optimizes the value of money during the ownership of physical assets by considering all the cost factors that affect an asset during its operational life. LCC is a procurement method that includes product development and ownership costs, and recognizes that purchase price may be less significant than subsequent ownership costs. The use of ABC in combination with product life cycle costing eliminates many of the shortcomings that are encountered when using traditional costing systems in combination with product life cycle costing. The use of ABC and product life cycle costing allows the entire product life cycle to be examined. Life cycle costing optimizes the cost tradeoffs during the operational life of an asset and ABCM can be useful when planning cost management for new products.

3.8.3. 3. Capacity Analysis

Capacity models determine the capacity of each resource and assign resource costs to activities based on actual consumption. These models can determine how changes in activity volumes or performance will affect resource consumption. The ability to measure cost resource usage is an important feature of activity-based costing. Unused capacity provides a critical link between the cost of resources used, as measured by an ABC model, and the costs of resources available, as reported in financial statements.

3.8.4. Manufacturing

3.8.4.1. Process Based Costing

Process-based costing is designed to assist companies with process improvement, cost control and strategic decision implementation. Process based costing provided many of characteristics that ABC cost management systems lacked—specifically, customer focus, process orientation, and an understanding of cost behavior patterns. Process based costing provides a framework that incorporates ABC [13].

3.8.4.2. Cost of Quality

Cost of Quality attempts to determine the most cost-effective level of quality. As more money is spent on quality, a point is reached where the expenditures exceed the returns. Cost of Quality appraisals include all the resources expended for appraisal, costs, prevention costs, and both internal and external costs of activities and cost objects, not just scrap, unfavorable yields and rework.

3.8.4.3. Capacity Costs

Capacity costs have been identified using ABC, and ABC has been used to optimize production resources, manage capacity and to better define the relationship between production and production costs.

ABC has been used in combination with other business applications, and its capabilities have been extended beyond traditional costing functions. ABC has been used in logistics, JIT, life cycle costing, activity based variance analysis, flexible budgeting, multi-contribution activity based income statements, benchmarking, channel profitability, total cost of ownership, process based costing [27].

3.9 Conclusions

The main issues which have to be retained from this chapter are:

1. The design of an activity-based costing model involves a two cost assignment stages and the focus of the ABC model is the activities performed within organization in order to satisfy customer's requirements.

2. The selection of cost drivers has to be judged on the cost/benefit base.

3. The purpose of an ABC model is not to be the most accurate cost system, but a costing system that reflects slightly more accurate information than the traditional systems.

4. The computation of customer-driven costs is difficult, because companies do not have the required source records to trace the customers' consumption of resources

5. The administrative and selling overheads are allocated to cost objects according to the same procedure as the manufacturing overheads.

6. The recent trends of ABC implementation with different management systems like ERP etc.

CHAPTER FOUR

4. PROBLEM FORMULATION

4.1 Methodology

The study was carried out as an experimental case study. The intention was to find out how the activity-based costing works for process industries especially on a paint factory, The purpose was also to find out what benefits and problems are linked to the implementation process.

The Primary steps in designing the system models are:

a) ***Identifying activities***- Defining and describing activities based on the system

b) ***Reconstructing the general ledger***- the source information for any costing system is general ledger maintained in the accounts department. Reconstruction of the ledger eliminates unnecessary details, builds group cost data and puts the accounts on an economic basis.

c) ***Creation of activity groups or centers***: - Activity centers provide structure to the activities within the company. They also facilitate periodic reporting of activities.

d) ***Defining resource drivers***- Resources are consumed by work going on in the company. Resource drivers measure this consumption, and help to accurately assign the cost of resources.

e) ***Selecting activity drivers***- Activity drivers determine the accuracy with which products, customers and jobs are costed. Activity drivers are to be carefully selected to achieve acceptable accuracy at reasonable cost. The overall methodology therefore is to:

Stage I Group Expenditures by functions

Stage II Trace functions to activities

Stage III Trace activities to Products

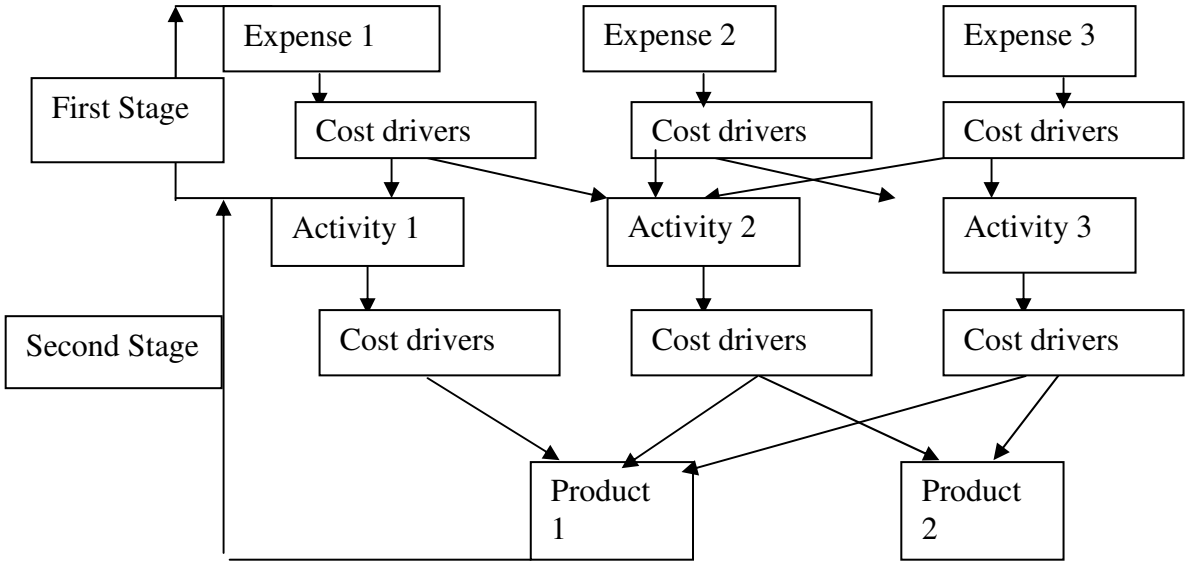


Fig.-4.1. Relationship of expense categories, activities, and products

4.2 Overview on the structure of Zemilli Paint factory

The factory works in to two-shift base and numerous enterprise operations are performed in a year. The structure comprises one General Manager along with one production manager, it has three main departments namely, General administration and finance, Sales and Distribution and Production Departments. The backbone of the enterprise is the production department where as the others are the supporting unit of the factory. The factory operations are the main focus of the study.

One of the strategic objectives of the enterprise is to sustain in the present competitive environment. So the study gave emphasis to the main operation of the production process of the factory namely, Pre-mixing and Grinding, Letdown, Tinting and Packing and filling along with the contribution of the supporting activities of the enterprise. Activity-based costing was seen as a good tool to find out the real costs. With the help of the ABC cost information the possible production costs tried to be calculated.

Zemilli paint factory is structured into three departments. Lead by one General Manager, with a subordinate division leaders and tow Supervisors for Sales & Distribution, and Finance department respectively. A Production Manager who is responsible to govern the production process of the factory. In addition, every stage of paint processes are overseen by workstation and line supervisors.

A. General Finance & Administrative Department

In this section, main supporting activities to be undertaken are:

- Purchasing which encompasses selection of vendors with reference to cost, quality and service. It also monitors the arrival of raw material to the factory, maintains inventory levels of these materials.
- Finance which encompasses maintaining of the integrity of all financial data. It also tracks the expenditure of the different operations sections of the factory and ensures that spending is within the regulation of the factor.
- Scheduling: Master production scheduling is prepared in response to the market demand based on the information from the selling and Distributions Department. Where as Detail scheduling is undertaken by each respected section of the departments. Along with the above activities, Material control, shipping and human resource development activities are the duties of this department.

B. Sales & Distributions department

In this section, the marketing and distribution activities are undertaken. The department manager leads the section and it encompasses sales and distribution of the factory products using the different outlets of the company.

C. Production Department

This section is divided into the different functional units: Pre-mixing and Grinding, *Letdowning*, *Tinting*, *Laboratory & Testing, Labeling, Filling & Packing*. The department is

responsible for improving production processes, design of formulation of paints and ascertaining of specification of raw materials and products of the factory.

4.3 Process description of the first phase of the ABC-process

The study started by collecting periodic cost data of the factory followed by a through activity analysis of the above main operation along with contribution of supporting departments.

The process began with activity analysis. The chain of activities was clarified with interviews. The employees were asked about governing incidence on the process and the time each activity took. It was quite clear from the beginning that time would be the main driver, and the interviews confirmed this hypothesis. The outcome of the activity analysis was a very streamlined process that had no remarkable limitation.

The process mapping was the basis for an activity-based costing model mainly focused on the production activities of the factory. Most of the costs were staff expenses (other than direct material cost) that logically were time-driven. The main driver was the time spent in the different stages of the factory, but it was only used for staff expenses and other cost items that were clearly time-driven. At this stage other costs were handled rather roughly and a great part of the costs were divided evenly for each activity, which naturally bent the cost information.

However, compared to the costing system in use, the ABC result enforces to pay another alternative closer analysis. At this point, there was some dissatisfaction concerning the accuracy of the ABC costs. This dissatisfaction created due to some reservation of supplying reliable cost and product formulation information. The following scheme clarifies the objectives and outcomes of the study, as well as the tools applied.

Summarized overall process:

1. The starting point for the costing system is the annual budget for each resources, and thereafter traced to the activities in each activity cost center based on planned or performed activities and resources drivers which link resources consumption to activities in the corresponding period. Initially the activity groups in line with the functional analysis reported were selected.
2. Activity rates/drivers are established for each activity group.
3. Utilization rates are computed for the corresponding period for variable cost elements such as power, machine utilization etc.

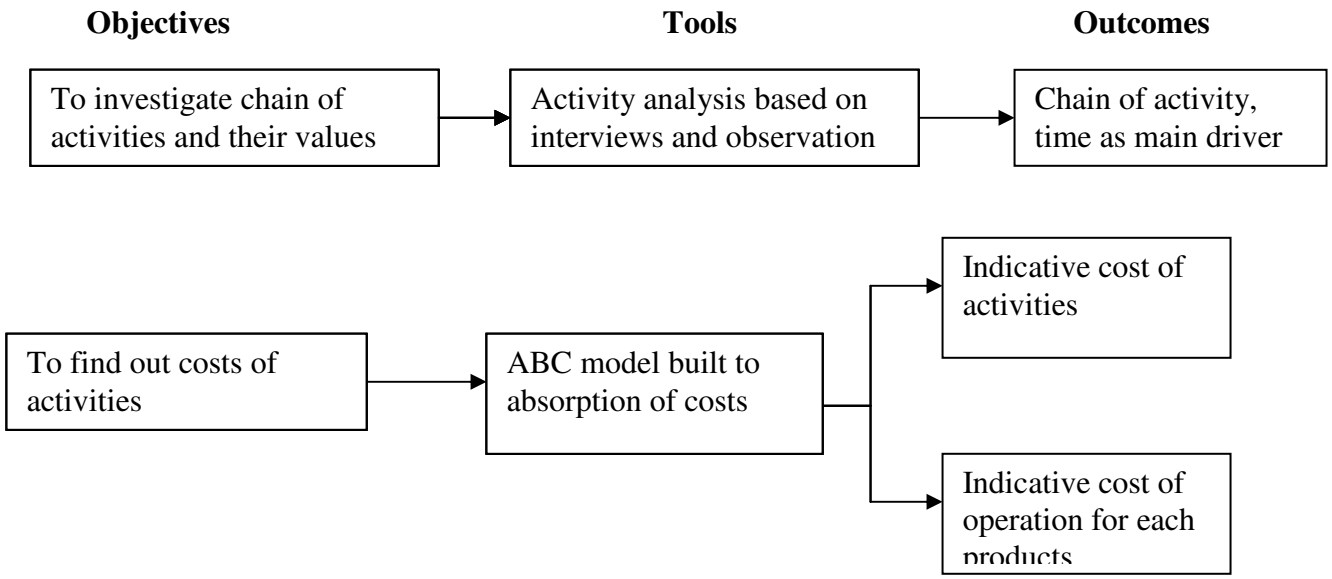


Fig. - 4.2. Process flow of costing system development

In the study due attention was give to the main process operation and other activities are apportioned to the bases of their contribution regarding to these process operation. These cost items were taken under more precise examination. It is found out that many of these cost items were time-related, and also other drivers were taken into account, such as floor area. The future target of the study is to establish a frame work for the managerial intervention based on the activity based costing model outlined. The basic frame work is shown on the figure below.

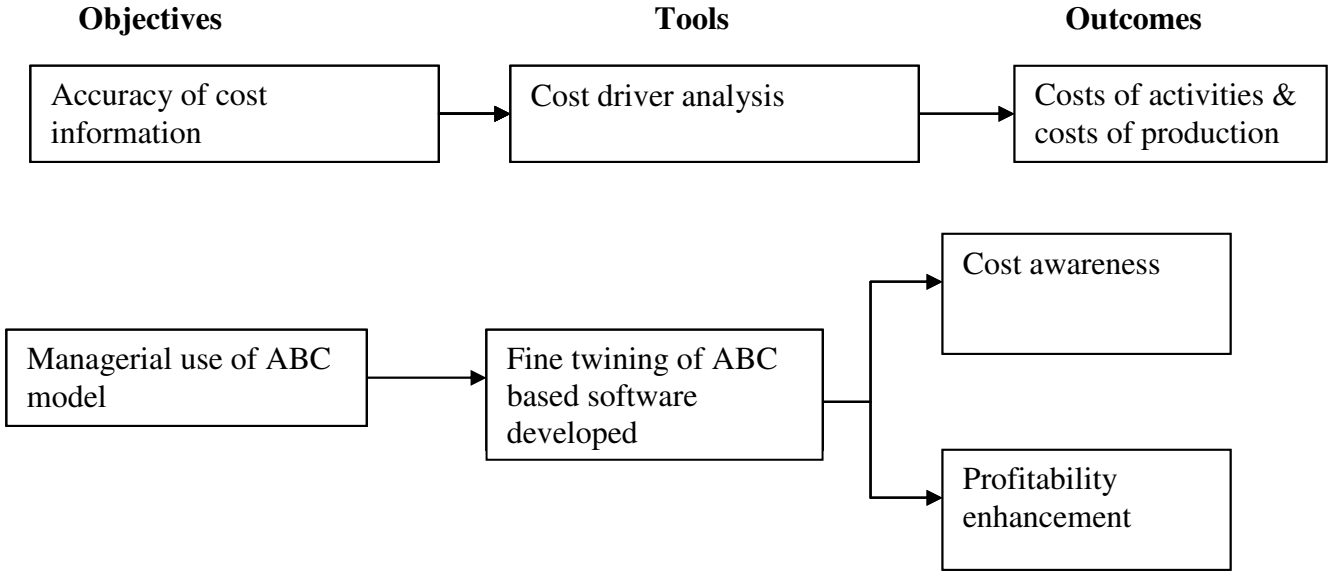


Fig. - 4.3. Frame work for managerial intervention

4.4 The ABC - model for the factory

The ABC-model of the `factory was built on the structure of the company. The capacity of the program was just about enough for the model. MS visual basic program with MS Access database was chosen because it is necessary to adopt and to make changes in the model.

The structure of the model follows the following pattern: first there is basic information about the number of employees, which is used to find out the temporal capacity of the factory. This information is used as a cost driver in the model. The costs of the unit have to

be entered manually for a specific year. Cost driver information was based on the analysis of each specific operation related to every product type to develop a standard time factor for determination of a unit based cost driver as shown in table 4 - 10 in the appendix F. Finally, the costs of the activities and operations are introduced. Figure 4.2 presents the basic structure of the ABC-model.

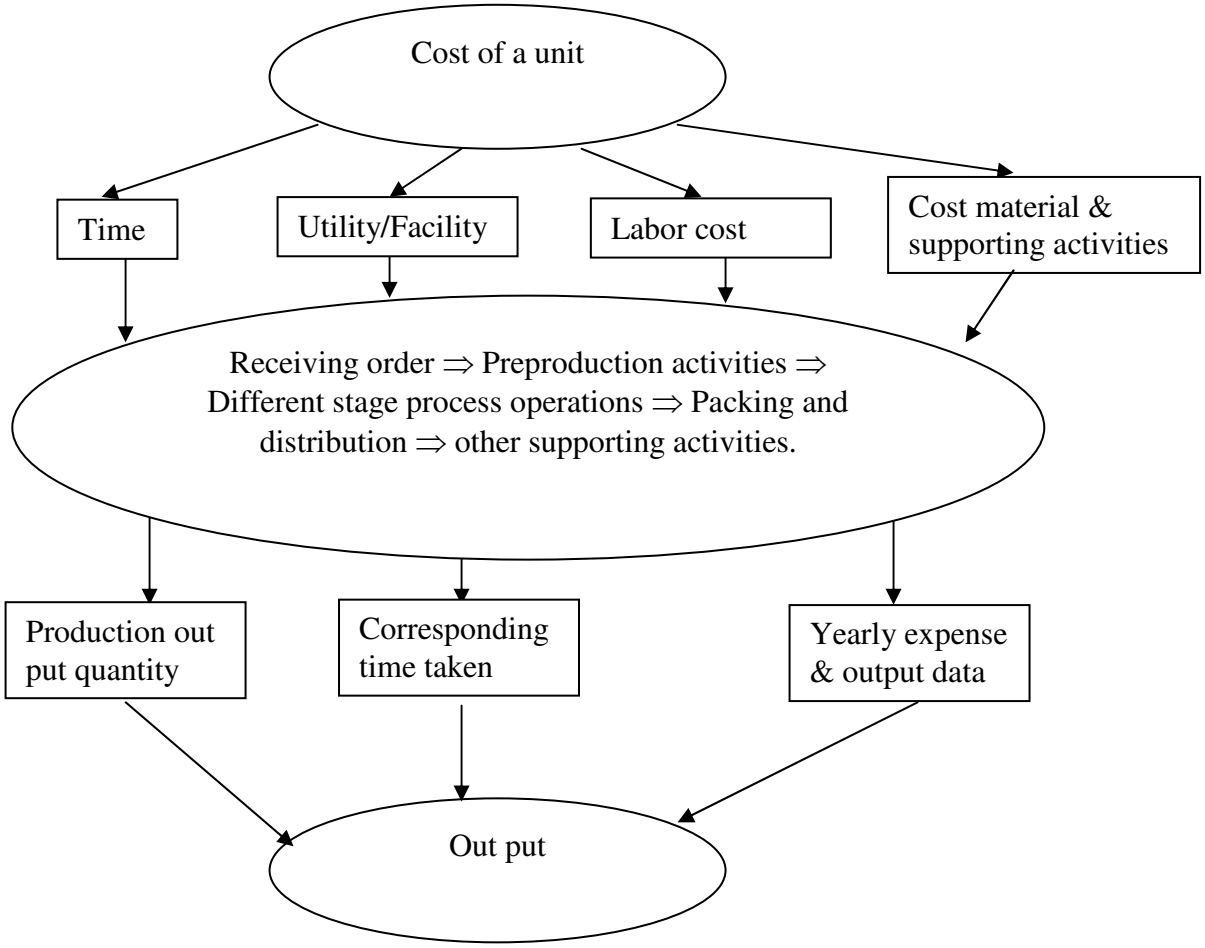


Fig. - 4.4 .*The basic structure of the ABC-model*

As shown in figure above, there are main activities in the model. The first main activities present the path that the order follows when it comes to production. Additionally, there are other activities, which consist of breaks, meetings etc. These other activities are those that do not belong to the main process but are necessary for the unit to function. Finally there is the unused capacity -activity, which reflects the underutilization of the unit's resources. The support activities are cleaning, equipment maintenance and auxiliary equipment

maintenance. The costs of these support activities are divided to the main activities with suitable cost drivers on the basses of relevant expense.

4.5 Elements of cost

There are typically three major cost elements:-Direct Materials, Direct Labor and Production/Manufacturing overhead Cost. Production/ Manufacturing overhead cost are all costs related to the manufacturing operations, except for direct material and direct labor, are called production/factory/manufacturing overhead. Examples of such costs include, factory rent, factory rates, factory heating and lighting, depreciation of plant and equipment, insurance of the factory, and store costs.

The cost elements of the factory are categorized as materials cost, direct Labor cost, Electric Power cost, Machinery Depreciations cost and manufacturing overhead cost.

4.5.1. Direct Materials

These are actually the prime inputs that are responsible for the major portion of product cost, i.e. the major cost of the product goes in favor of direct materials. Raw material costs can be traced to each individual product via material recipe.

4.5.2. Direct Labor cost

The costs of production labor that can be directly and conveniently traced to a unit of product can be called direct labor (e.g. workers on production line). While labor costs that are not directly traceable, or those extremely small in monetary value, are typically called indirect labor (e.g. store keepers, foremen, or secretaries).

The direct labor costs of the cost center unit will be charged under normal routine of payroll sheet summation for a specific period by apportioning.

4.5.3. Electric Power Cost

The total power cost recorded in the financial ledger for a given accounting period will have to be distributed into machines installed in each of the processing segments on the basis of KWH intake. The KWH consumption of machines in each cost center is prepared and shown below in Table 4-1. The power cost distributed in such a manner will be allocated to their respective units. The power consumption doesn't use kilowatt hour rating for apportioning the cost since the company is working under low capacitor factor which leads it operate under a dominant power factor penalty.

Table 4.1 Power Consumption in KWH

Sr.No.	*Process stage*	*KWH*	*Electric Power Distribution Factor*
1.	Pre-Mixing & Grinding	55.98	0.365
2.	Letdown	55.98	0.365
3.	Tinting	33.57	0.219
4.	Filling & Packing	0.86	0.006
5.	Laboratory & testing	3.45	0.023
6.	Finance & Administration	3.26	0.021
Total		**153.04**	1

4.5.4. Machinery Depreciations

The value of depreciation costs computed with the development of a list for machineries classified to selected cost center operation, such that depreciation charges of each cost center is readily available in accordance.

The depreciation charge of each cost center unit therefore can be computed from financial ledger record on cost center basis. These values are shown on the table below.

Table 4.2 Machinery depreciation expense

Sr.No.	*Cost center*	*Machinery value*	*Depreciation rate%*	*Depreciation expense*	*Depreciation Distribution*
1.	Pre-mixing& Grinding	1,157,138	20	231,427.6	0.4183
2.	Letdown	513,990.78	20	102,798.16	0.1858
3.	Tinting	158,834.8	20	31,766.96	0.0574
4.	Filling & Packing	102,267.82	20	20,453.56	0.0367
5.	Laboratory & Testing	102,700	20	20,540	0.0371
6.	Administration Motor vehicles	672,500	20	134,500	0.2431
7.	Office furniture	89,243	20	11,848.67	0.0214
Total				553,335	

4.5.5. Overhead Costs

Costs whose purpose and types are varied and many. They originate from different dimension under and independent operation. However, in an indirect way they have the role and the privilege to form part of the product cost. Since, such costs have to be apportioned to the processing units which are in charge and in touch with products, through a rational method of fair share cost distribution mechanism. To address this issue, cost apportionment factors are developed, for different overhead costs using appropriate standard factors, the proposed approach for this case is shown in table 18 of the appendix.

The apportioned overhead costs computed will be allocated to respective product processing cost center. Overhead components are Factory overhead (Factory building and Factory administration and Sales) and Operation and Sales expense (Factory Management, Management Building and Sales promotion expenses and Salary).

4.6 Implementation outline

There are currently more than 100 employees working for Zemilli paint factory. It operates two shifts per day. The majority of workers (70%) are employed during the first shift. Direct laborers are broken down into skilled and unskilled workers, whose hourly rates are to be considered for the case.

Activity-based costing (ABC) has helped many manufacturing and services organizations improve their competitiveness by enabling them to make better decisions based on an improved understanding of their product cost behavior. The main assertion behind ABC is to classify overhead or indirect costs and to allocate them to end products or services based upon the activities required to produce these products [21].

ABC takes a two-stage approach to allocating overhead costs to products based on multiple cost drivers at various levels of activity. In the first stage, overhead costs are assigned to cost pools within an activity center based upon activity-driven cost drivers shown in tables: 4.3 & 4.4. There is no equivalent step in traditional costing accounting (TCA).

Table 4.3 Production Services Cost & Factory Cost centers Distribution Standard

Sr.No.	*Cost center*	*No. of workers*	*Dist.Factor*
1	Pre-mixing & Grinding	5	0.25
2	Letdown	2	0.1
3	Tinting	1	0.05
4	Labeling	3	0.15
5	Filling & Packing	5	0.25
6	Laboratory & Testing	4	0.2
Total		20	1

Table 4.4 Administrative, Selling & Distribution Cost Distribution Standard

Sr.No.	*Cost center*	*No. of workers*	*Dist.Factor*
1	Pre-mixing & Grinding	10	0.112
2	Letdown	4	0.045
3	Tinting	2	0.023
4	Labeling	8	0.0899
5	Filling & Packing	10	0.112
6	Laboratory & Testing	8	0.0899
7	Administration	30	0.337
8	Sales & Distribution	19	0.214
Total		89	1

In the second stage, overhead costs are allocated from the cost pools to the products based on the product's consumption of indirect activities. This stage is similar to traditional costing

accounting (TCA) except that the traditional approach uses a single volume based cost driver to allocate overhead costs to products without consideration for non-volume-related characteristics. Experts believe that ABC can provide more accurate product costing information than TCA when products are diverse in size, complexity, material requirements, and/or setup procedures. A costing system should provide users with relevant and accurate information that will assist them in making decisions such as product pricing, customer and product profitability analysis, and process improvement. This case study details an ABC system that is developed for a paint factory.

Processing

The operation of factory is relatively simple, and the magnitude of value added as part of the product cost is quite insignificant. However, to facilitate the cost accumulation scheme and at the same time simplify the control mechanism a cost center classification is recognized. The selected cost centers are mainly accounting devices for accumulating items of costs that have common activity characteristics and output. Since a product or part of it passes through these centers cost of operating, the unit can be separated and accumulated independently for each unit or production runs.

Processing Time Intensity Factors

The process operation of the factory had been taken to a consideration of time and motion study on the operating time requirements of each of the factory's paints color varieties. Review and analysis of this study indicates that products passing through these operating units may be categorized into product groups in accordance with their processing time requirements. This in effect will enable job, simplification and error elimination in the product costing effort. Accordingly, categorical time intensity product grouping factor is prepared for each cost center and depicted in table 4.5 - 4.9.

The application of these time related factors into products that had been processed in each of the processing unit in a given cost period will enable conversion of products in to time normalized units.

Table 4.5 Pre-Mixing & Grinding Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Weighting*	*Pre-mixing*	*Grinding*	*Total time*	*Time factor*
Super white	900	8	5	30	45	0.141
Enamel white	900	10	5	60	75	0.234
Quartz paint	900	5	5		10	0.031
Alkyd varnish	900	30	10	-	40	0.125
Anti rust red	900	10	5	30	45	0.141
Antirust gray	900	10	5	30	45	0.141
Wubet	900	15	15	30	60	0.188
Total					**320**	**1**

Table 4.6 Letdown Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Total time*	*Time factor*
Super Paint	900	10	0.111
Enamel Paint	900	20	0.222
Quartz paint	900	15	0.167
Alkyd varnish	900	-	-
Anti rust red	900	15	0.167
Anti rust gray	900	15	0.167
Wubet	900	15	0.167
Total		**90**	**1**

Table 4.7 Tinting Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Total time*	*Time factor*
Super paint	900	10	0.091
Enamel paint	900	10	0.091
Quartz paint	900	15	0.136
Alkyd varnish	900	-	
Anti rust red	900	-	
Anti rust gray	900	10	0.091
Super 116, 111, 125	900	-	
Enamel 424, 423, 427, 403	900	-	
Enamel black	900	-	
Black board	900	-	
Super 142,141,162(121,223,190,230,123,122,201,228,110)	900	30	0.273
Wubet	900	20	0.182
Enamel 404,409,405	900	25	0.227
Total		**110**	**1**

Table 4.8 Labeling Batch Processing Time (in minute)

Sr.No.	*Product*	*Unit*	*Qty*	*Total time*	*Time factor*
1	Super Paints	Plastic	270	30	0.13
2	Enamel paints	Gallon	250	20	0.087
3	Enamel paints	lit	1050	60	0.261
4	Anti rust red	Gallon	150	15	0.065
5	Anti rust gray	lit	600	45	0.196
6	Quartz paint	Pail(30kg)	10	-	-
7	Poly Varnish	Lit.	900	30	0.13
8	Wubet	Plastic	1000	30	0.13
Total				**230**	**1**

Table 4.9 Filling & Packing Stage Batch Processing Time (in minute)

Product	*Unit*	*Qty.*	*Total time*	*Time factor*
Super Paints	Plastic	270	30	0.107
Enamel paints	Gallon	250	30	0.107
Enamel paints	lit	1050	60	0.214
Anti rust red	Gallon	150	15	0.054
Anti rust gray	lit	150	15	0.094
Quartz paint	Pail(30kg)	10	10	0.036
Wubet	Plastic	900	60	0.214
Poly varnish	lit	1000	60	0.214
Total			**280**	**1**

Table 4.10 Laboratory & testing Batch Processing Time (in minute)

Sr.No.	*Product*	*Total time*	*Time factor*
1	Super Paints	15	0.319
2	Enamel paints	12	0.255
3	Quartz paint	5	0.106
4	Wubet	10	0.213
5	Poly varnish	5	0.106
Total		**47**	**1**

Time Normalized Factor Recommended

As stated previously, the cost centers identified for the factory in this study is with regard to either the operating condition or the cost and performance control point of management.

Finally, the central issue of this study dissolves to a recommendation of rational that reduces processing time variation of each product quality in each identified cost center that helps us to have distinct cost drivers regarding corresponding cost object.

The application and use of the time factor has been explained under different sections, successful development or formulation of a technical norm that could express processing time variation of products in different cost centers, sharing identical operation facility but at different intensity, will enable to solve the problem of product processing time heterogeneity by providing corresponding cost drivers.

4.7 Designing ABC for Zemilli paint factory

The ABC system for Zemilli paint factory was developed using a five step process:

a) Identification of overhead cost categories,

b) Identification of cost pools and drivers,

c) Assignment of overhead costs to cost pools,

d) Product data collection and

e) Final ABC analysis. The development process and results of each of these five steps are described in this section

4.7.1. Identification of Overhead Cost Categories

Identifying the overhead cost categories is the first and one of the most important steps in developing an ABC system. Expenses vary from department to department as most departments perform distinct job functions with various consumptions of indirect resources. It is vital to investigate each department separately and identify what indirect resources are consumed and by how much. Most of the indirect resources at Zemilli paint factory are consumed by supplying power to machines, machine maintenance, wages paid to indirect laborers, computer, and marketing. Additional overhead costs include rent for facilities and vehicles, transportation costs including the transport of raw material purchases to the warehouses, customer service, and data management. Table in the annex contains the major indirect expense categories and amounts for the factory. Table 4.11 indicates that the total overhead cost incurred by factory last year was **84,638.72**Birr.

The miscellaneous category includes indirect costs that are difficult to map to particular activities. These costs will be mapped to the activities using educated guesses based on opinion and experience of factory employees.

Table 4.11 Workmen Insurance Cost Distribution Standard

Sr.No.	*Department*	*Monthly Salary*	*Time factor*
1	Pre-mixing & Grinding	2,800	0.013
2	Letdown	1,600	0.018
3	Tinting	800	0.009
4	Labeling	1,000	0.011
5	Filling & Packing	1,200	0.006
6	Laboratory & Testing	3,800	0.013
7	General & Administration	42,085.94	0.465
8	Selling & Distribution	32,244.37	0.411
Total		**84,638.72**	1

4.7.2. Identification of Cost Pools and Drivers

In practice, one can identify a large number of activities performed to produce end products. For example, a setup mixing machine process can be decomposed into numerous micro-activities. A detailed process description is rarely practical in the development of an ABC system. If too many activities are defined, the cost of measurement for the ABC system grows disproportionately high. Activities should be aggregated into cost pools based on similar cost driver behavior. Table 1 in the appendix shows the major cost pools that were identified as primary indirect activities for paint factory. These cost pools were developed from examination of overhead-related data, cost driver analysis, and employee interviews and leads to underline on the activities of the paint processes. The costing system developed is arranged in such a way that the operating floor areas are identified into cost centers. According to the factories management controlling system, the required cost centers are grouped as follows:

- Pre-mixing and Grinding
- Letdowning
- Tinting
- Laboratory and Testing
- Filling & Packing (includes labeling)

Two factors drive the cost of measurement associated with the number of cost pools in an ABC system. The first one is that the system designer must specify the resource consumed

by each activity and how many times the same activity is used for the same output. If the number of outputs is high, identifying numerous activities can lead to a huge data collection task. Second, as the number of cost pools gets larger, the activity-output relationships become more difficult and costly to measure. In order to reduce complexity, key activities that are most important and highly related to indirect resource consumption should be identified.

Machines are the primary equipment used in the production process of the factory. Maintaining data records for all products, designs (formulation), and customers is an important activity and was found to be driven by the number or amount of products administered. Material handling involves the movement of parts throughout the production processes. Zemilli produces multiple products that vary in formulation and volume; but, changeovers occur as machines are set up between productions runs are not highly pronounced one. The number of production runs drives scheduling and production preparation as the number of production runs and associated scheduling and preparation activities increase due to increases in customer orders. Receiving raw materials and outsourced parts is an important activity that must be considered, as it consumes a lot of indirect labor. This activity also requires vehicles to transport the material and administrative assistance in scheduling and preparation receipts, contacting suppliers, and managing warehouses. Final products must be shipped on time to customers in order to avoid penalties and reduce inventory costs. Zemilli customer contact is performed by the sales & Distribution department by using different outlets of the factory located in various regions of the country, and therefore product shipping costs depend on the distance traveled.

4.7.3. Assignment of Overhead Costs to Cost Pools

When it is extremely difficult or impossible to estimate the resources consumed by the activity cost pools, the design must be resorted to arbitrary allocations. The use of arbitrary allocation should be minimized, as it does not provide understanding of the economic behavior of overhead activities.

Since machines consume most of the electricity, and other electricity consumption such as lighting is assumed to be negligible in comparison, all the energy expenses are assumed to consume by the machines cost pool. In addition, the machines cost pool is consuming all of the depreciation and maintenance expenses and a large amount of other miscellaneous resources. The major percentages of the transportation costs are assigned to raw material receiving & handling, while the remaining are consumed in product shipping. Since the in coming raw material passes through most of the production processes the expense allocation is made on equivalent bases. Percentage of facility and vehicle rent is used in material receiving & handling & in shipping finished goods to customer destinations. All business travel and advertising costs are consumed by customer service the sales and distribution section. Indirect labor is consumed across two major cost pools. There are various consumptions of office & utilities resources among the cost pools. Miscellaneous expenses were assigned to cost pools based upon employee approximation and educated guesses.

Expense table below contains the resulting overhead cost of each Zemilli cost pools. Observation of Table indicates that the majority of overhead costs is being incurred by Administration & Rent and Utility cost pools.

Table 4.12 Expense Categories and their respective cost drivers.

Expense Categories	*Annual cost (Birr)*	*Cost drivers*
Administration	1,346,003.67	Time (hours)
Depreciation	18,848.32	Property values use of resources (in Birr)
Rent and Utility	948,987.59	Square meters
Office Expenses	79,874.46	Level of use of office resources (%)
Business insurance and legal expenses	214,094.73	Cost of resource used by the activity (in Birr)
Promotional expense	366,761.33	Level of benefit (%)
Production Shipment	109,352.19	Weight(Kg)
Miscellaneous	132,519.64	None

4.7.4. Product Data Collection

Even though, the activity analysis was made for all product type, the factory supplies compositions of seven paint types. Therefore, Among Zemilli paint factory out put seven product types are taken for the study. This can be classified according to their formulation compositions. Production volume, direct costs, and cost driver levels for each product type were collected and are provided in the tables of Annex.

4.8 Procedures

4.8.1. Account Classifications:

a) The costing system has been designed with actual amounts as of the 1997 Eth.C accounts. All computations are therefore relatively current for the last audited period. However it is recommended that the items of expenditure have to be reviewed and updated prior to its operation commencing for the coming fiscal year.
b) All accounts have been given natural description which could enables classification to accounting system for generation of itemized expenditure under groups suitable for cost elements mentioned previously. These classifications are Materials, Personnel, Consumables, Depreciation, Administration, Selling & Distribution etc.
c) All the expenditures under the above groups have been traced to activities or drivers.

4.8.2. Raw materials input variation is contained through the routine use of recipe, rates for materials consumed are supposed to include invoice costs, freight, insurance, bank charges, transportation, procurement activity costs and storage activity costs.

4.8.3. Activity Cost Analysis: The various components of the activity cost analysis have been computed as under:-

a) The paint variety needs different processing time duration in different cost centers. As a result a result, processing time related equivalent factors are developed for the cost centers pointed out previously shown in the annex tables of no. 4 up to 9.

b) Personnel cost analysis: Salaries and related personnel expenditures have been charged to activity groups in proportion to the number of employee in the cost centers pointed previously in the table 4.4.
c) Power consumption rate: the rate per unit of power consumption has been computed to incorporate the yearly charge of the company in accordance to the reserved power capacity of each cost center in the table 4.1.
d) Depreciation: -Depreciation of all assets and machineries has been computed at rates provided by the factory ledger (depreciation regulation) shown in the table 4. 2. Plant equipment and fixtures depreciation costs have been charged to the activity group on the basis of location or utilization.
e) Asset related expenditures such as property insurance, land and building taxes etc. are computed and apportioned to the cost center based on proportion of property value categorized to each cost center.
f) Depreciation of material handling equipments and some working equipments common to the selected cost centers are allocated to the cost centers based on the proportion of depreciation outlay of each cost center as indicated in appendix F of table 16.
g) House rent, Legal expense, production service costs are those activity cost pools are supporting activity cost pools which are apportioned to each cost center on the bases of appropriate activity rates such as Area, Property and Production overheads respectively. In addition these activity cost pools are also necessary for the management in budgetary control and management review of these activity groups.

4.9 ABC Analysis

The overhead rate for each cost pool was computed by dividing the total overhead cost of each cost pool (from Table 4.11) by its associated total cost driver level. The cost driver level for each cost pool is computed from the sum of the individual products' cost driver levels as given in the total column of Table 18 of appendix. This data was collected from departmental records and employee interviews.

The next step is to calculate the unit overhead cost of each product. For each product type, multiplying each ABC overhead rate by its cost driver value and then dividing it by the product's production volume that is equivalent to number of production runs. Table 19 - 24 provides the ABC overhead costs for each product by cost pool, which were then totaled to provide the ABC overhead costs for each of the seven products. The last step in the ABC analysis is to compute the total product costs by summing the direct labor cost, direct material cost, and overhead cost of each product.

4.10 Product cost calculation

As it has been discussed before, two basic information are required for calculation of product cost using the principle of ABC. These are: -

Activity Cost

Activity Volume

Acquiring these two parameters leads to Cost Driver rate i.e.

Activity Cost ÷ Activity Volume = Cost Drivers rate.

Different Activity Costs are given to the corresponding cost center in the table expense category above. By using these tables, a corresponding calculation of cost pool rate and production cycle time factors are computed in each table that has given us the necessary cost drivers rate. Utilizing the determined cost driver rate with the number of runs of production of a particular product enables us to calculate the different cost parameters.

This can be illustrated as follows: -

Total periodic cost of a particular cost center is equal to X (this is also equivalent to total budgeted cost for that particular cost center). The proportion of cycle time of that particular cost center for a corresponding specific product is given to be Y that is equivalent to total budgeted machine hours proportion of the cost center. Let the total out put of that item in

that corresponding period to be Z (which is equivalent to be estimated out put of that corresponding budgeted period.) Then the unit cost of that particular item for the corresponding specific period is given to be: -

Unit cost of an item for a cost center = X ÷ (Sum of YZ ÷YZ an item) ..... (eq. 1)

Total out put of production volume of an item for a particular period multiplied by a corresponding cycle time proportion of a given cost center gives the number of runs of that particular product for that period. A particular periodic cost divided by a multiple of the sum of all number of runs of the products in that period with the corresponding number of runs of that item which was divided by the total production of that item in that period gives the corresponding unit production cost of a cost center. By using this procedure the different cost elements are calculated for each product types of the factory at hand. The corresponding cost element calculation of product samples are given in table appendix 19 - 24.

Production cost of a cost center unit has been computed by applying time normalizing factor into the total out put volume of the corresponding during a defined period for this case a year, helps to formulate a common denominator for distribution of costs among products that has been processed in the department.

The following total proper accomplishment task enable us to set product costing scheme of a cost center unit.

- Sort and sum up quantities produced from finished goods transfer voucher.
- Assign and charge direct costs for the period.
- Apportion indirect costs or overhead costs using the factors proposed.
- Apply time normalized factor to the production volume already extracted and convert it to a time normalized quantity.
- Then compute a unit cost for each set of production.

Basically, the above enumerated process will end up assigned task of costing products in the cost center unit for a defined time period. A calculated production cost element of each cost

object for a corresponding cost center a table is attached in the annex with a graph to see cost share of the cost object to the particular cost center is also considered.

4.11 Summary of the chapter

The design and accomplishment of ABC model for the case at hand was discussed. The above outline can be summarized with the following tow phase ABC model. That is Phase I is fully costing activities and Phase II fully costing cost objects. The following is a list of the steps of each phase:

4.11.1. Phase I — Activities

1. Identifying all the activities that occur in the factory — this includes support (administrative and financial) as well as production activities.

2. Identifying all the resources consumed in the factory (general ledger birr, people/salaries, depreciation birr, utilities, etc.).

3. Identifying a resource driver (the number of people, duration taken, amount of space, etc.) for each resource, to link resources to the activities which consume them.

4. Fully costing activities with the resource birr they consume via resource drivers.

4.11.2. Phase II — Cost Objects

1. Identifying cost objects, the ultimate purpose of activities — list of products

2. Identifying an activity driver — the number of people — for each fully cost of activity, to link activities to the cost objects that consume them.

3. Fully costing cost objects with the activity birr they consume via activity drivers.

CHAPTER FIVE

5. STRUCTURE AND OBJECTIVE OF THE PROGRAM

5.1 Computer Program for costing system

A program is written in order to solve a problem. A solution to a problem actually consists of two things:

- A way to organize the data
- Sequence of steps to solve the problem

The way data are organized in a computers memory is said to be Data Structure and the sequence of computational steps to solve a problem is said to be an algorithm. Therefore, a program is nothing but data structures plus algorithms [14].

Since the objective of this study is to prepare a working model which enables presentation of ABC system that can underline visual basic programming working model for achievements of different cost data development and cost reporting to valuable decision in puts.

Cost management software products are tools which companies use in order to have more accurate information about their cost management objectives: target costing, customer profitability, and so forth. The basic outline must encompass all necessary company data for analysis, apportioning, updating, and tracing cost data of a cost pool. That is the program has to be organized on the bases of the five basic steps of the ABC procedures. That can assist the company in Data gathering, Activity analyzing, categorizing of Cost pools and corresponding cost drivers, tracking of costs and calculating of the different type of costs.

5.2. Structure of the Program

Given a problem, the first step to solve the problem is obtaining ones own abstract view, or *model*, of the problem. This process of modeling is called *abstraction.*

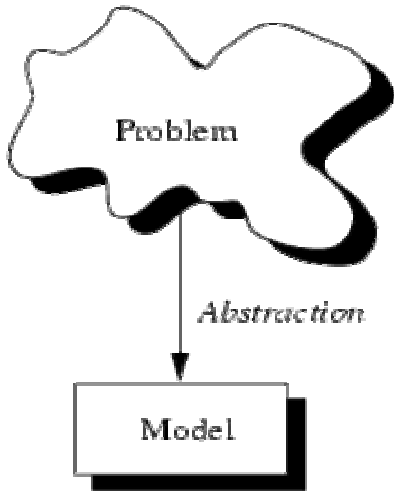


Fig. - 5.1. Data structure model

The model defines an abstract view to the problem. This implies that the model focuses only on problem related stuff and that the programme tries to define the properties of the problem.

These properties include

- *The* data *which are affected and*
- *The* operations *that are involved in the problem.*

With abstraction you create a well-defined entity that can be properly handled. These entities define the *data structure* of the program.

An entity with the properties just described is called an *abstract data type* (ADT).

- Some of the data are paints, activities, packing types, raw materials, recipes and products etc.
- The operations are: -
    a) *Definition of the required data with declared entities of corresponding characteristics.*
    b) *Corresponding stored value data of defined objects and activities.*

Abstract Data Types consists of an abstract data structure and operations. Put in other terms, an ADT is an abstraction of a data structure.

Referring to the above basic principle of data structure, the developed costing system specifically intended for the paint factories. The system architect of the program is described figure 5.2.

Table 5.1 Data base tables' structure

Databases	*Structure*	*Formula*
Raw materials	Material code, Material name, type & properties	
Raw materials cost	Material unit price as of date received	Total Price divided by Total Mass or Volume
Paints	Paint code number, description, type, paint specific properties	
Recipe	Paint code number, Raw material code number & Fraction of recipe corresponding to paint code number	Mass fraction multiplied by unit price,
Products	Product code number, Paint code number & unit of measurement	
Packing types	Packing code number, description, system unit & size	
Packing costs	Date, Packing type & Packing material expense	
Paint Unit process costs	Paint code, Process type, different apportioned costs of a process	
Paint Filling & Packing costs	Paint type, different apportioned unit costs	
Product unpacked cost	Paint type, total cost of processes allocated in the different cost types	
Product packed cost	Paint type, total cost of processes allocated in the different cost types in addition to packing material costs	

This sub-section has the content of the developed program specifically for the paint factories. The program has four entity menus. It is user friendly, below each of these entity menus is discussed in brief.

Databases

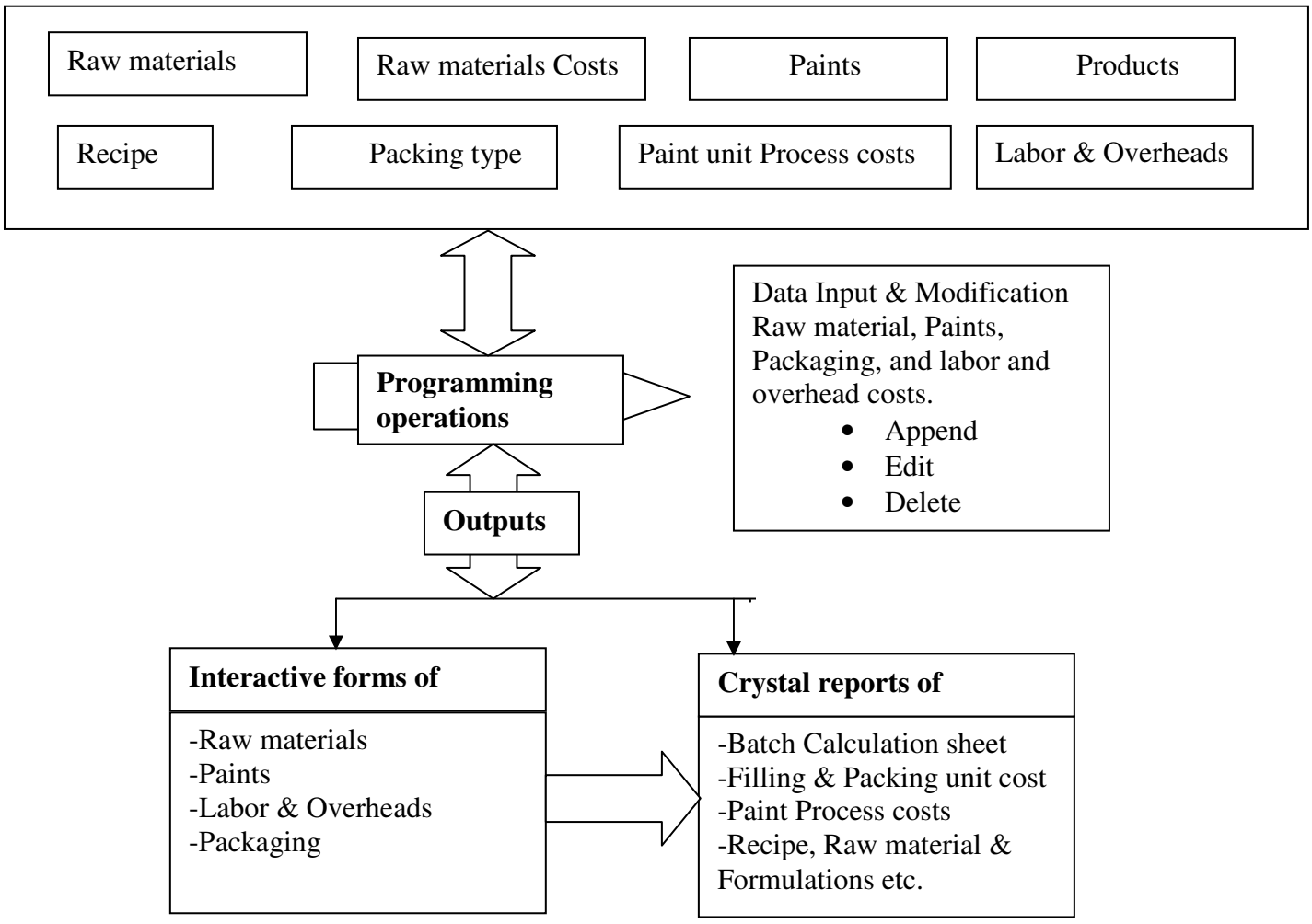


Fig. - 5.2. System Architecture of the Costing system.

The program of this study compresses of an access data base having: -

- Raw material information such as type, cost, unit of measure and their property.
- Package information such as type, cost and unit of measure.
- Paint information such as factory designation of the paint, type and property of the paint.
- Product information such as factory designation of the product, paint type included in that product type and unit of measure of that product.

- Paint unit process costs information regarding different cost elements of a unit cost for a particular paint corresponding to each cost center of the process.
- Product unpacked and products packed costs are also included in the database derived from the product, packing and unit cost information of the database.
- A batch history data also developed which includes product type, product property, product recipe proportion and the different cost element share of that particular production.

The developed database is user friendly and works with visual basic programming interface in appending, deleting and navigating to prepare or simulate cost management information of the factory.

The first entity menu is the standard *File menu*, which is comprised of enabling to accomplish commands like Save, Pack up and Exit.

The second entity *Load menu* which consists of sub-menus which help to feed, retrieve information about Paints, Products, Recipes, Packing types and Raw materials of the factory. These sub menus help to enter necessary information about Paints

- Paint sub menu having characteristics of the paints like: -
    a) Paint Code No. That is a code used in the factory for identification of each paint type.
    b) Description which is a special information regarding the paint given by the factory for some particular purpose.
    c) Type: this is information which gives information that the paint belongs to which category of paint type.
    d) Color: this will give the color of each paints.
    e) Unit gives the measure of quantity of the paint, in addition this page also comprises of the characteristics of the paint like density and viscosity.

- This page can also enables the users to retrieve information about the type and fraction of recipe the paint comprised of and the products which include this paint. The figure below shows the interface of this particular page.

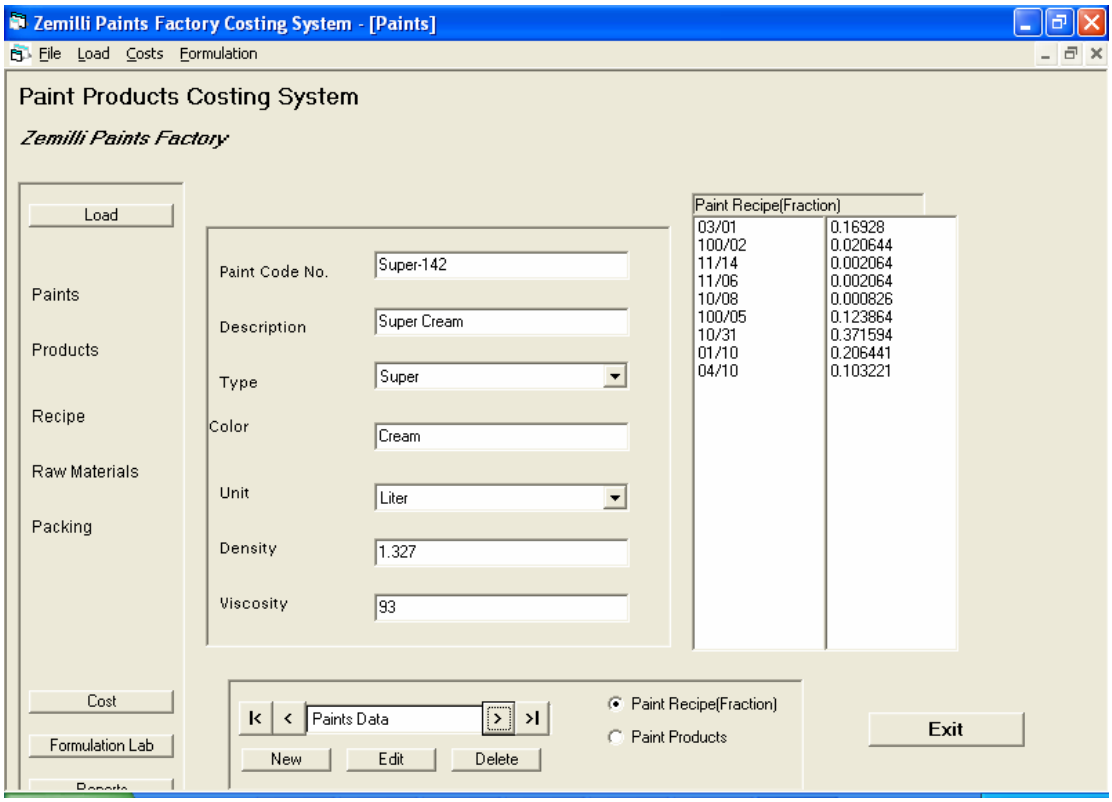


Fig.-5.3. Paint form

- Product sub menu having functions related to the paints like: -
    a) Append and retrieve products information like Product Code No., Paint Code No. Packing Type and relevant description about the products.
    b) It gives basic information about the paint detail and packing detail of that product.

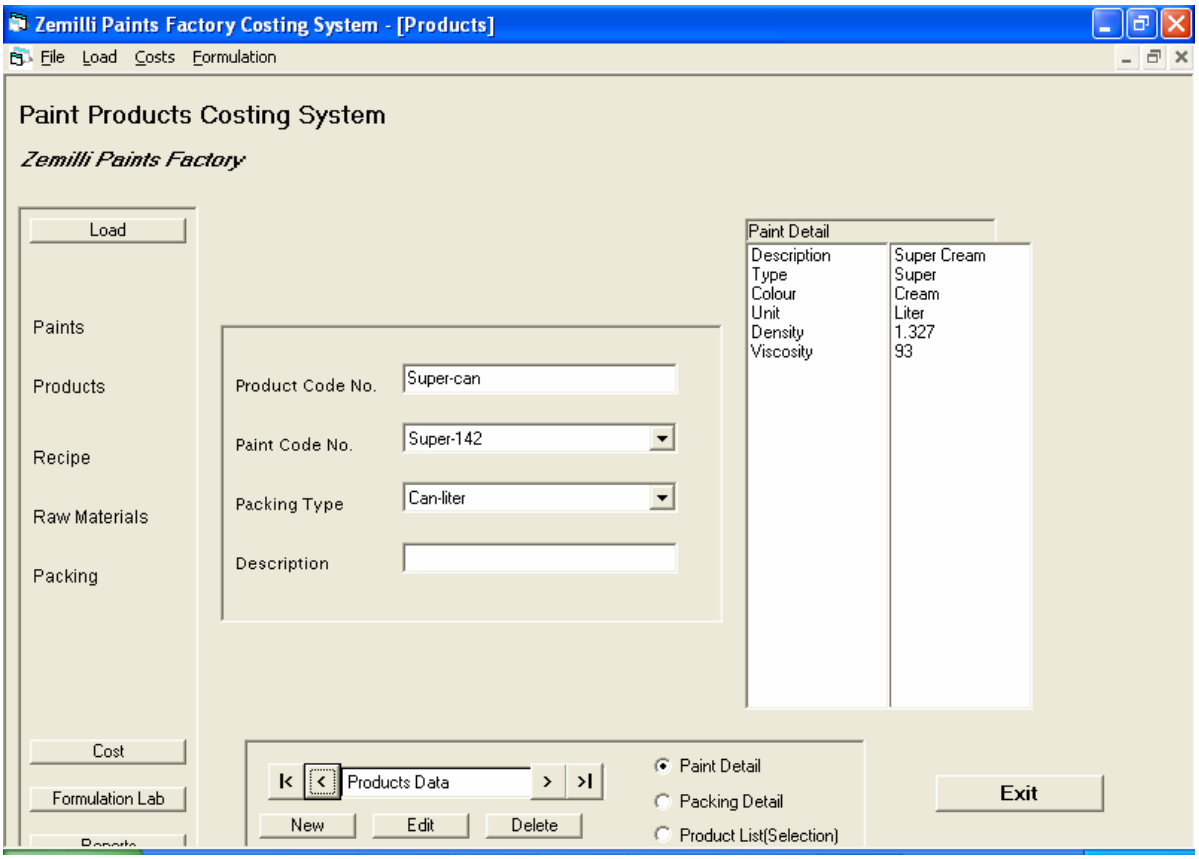


Fig.-5.4. Product form

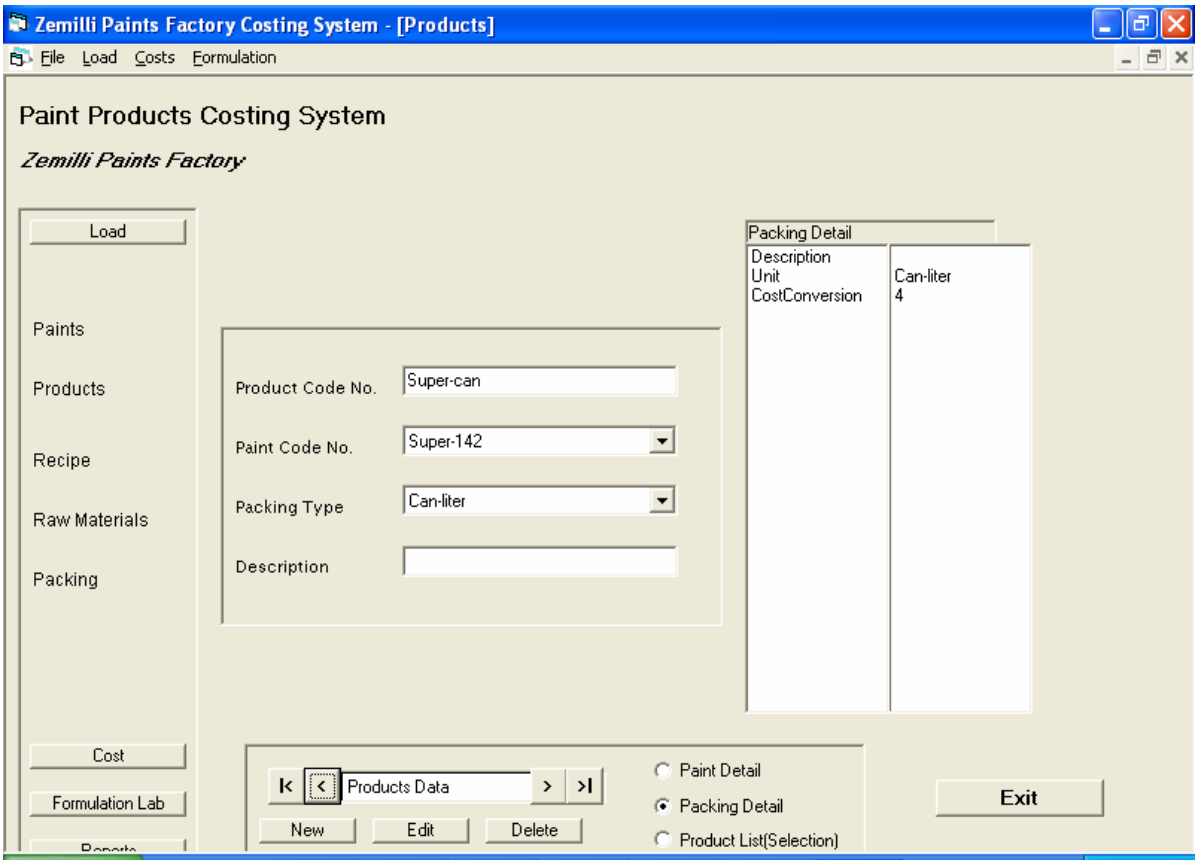


Fig.-5.5. Product form

- Recipe sub menu displays: -
    a) Characteristics of recipes like type, unit of measure, density and solid contents are given.
    b) Information in relation to which type of paint utilizes the recipe and the amount of fraction that the recipe comprised of in a particular paint type also can be retrieved.

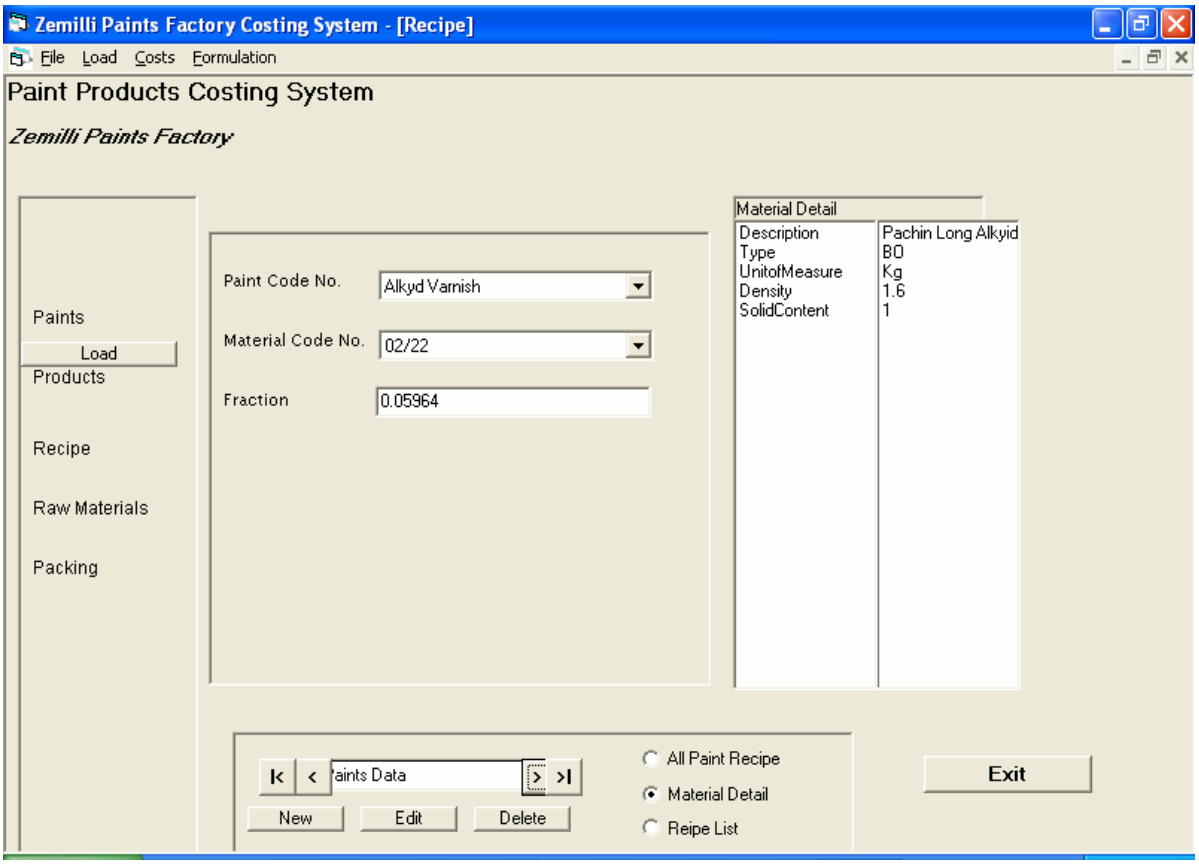


Fig.-5.6. Recipe form

In a similar interface structure, sub-menus of Raw materials and Packing give information on:

- *Raw materials*: - this page enables the user to append and retrieve cost information of the material and the type of paint which uses this raw material.
- *Packing:* - this page enables the user to append and retrieve cost information of the packing type and the products which can be packed with this type of package.

The third entity, *Costs menu*, consists of sub-menus which help to enter, retrieve information about unit process cost, filling & packing cost, packed production cost, batch product cost, packing and Raw material costs. Products,

- Unit process cost sub menu enables to append and retrieve the following information with the similar basic interface structure shown for the others :-
    a) Full information about the paint type.

b) Unit process cost of the paint corresponding to each cost center.

c) Unpacked production cost of the paint at hand and filling and packing cost.

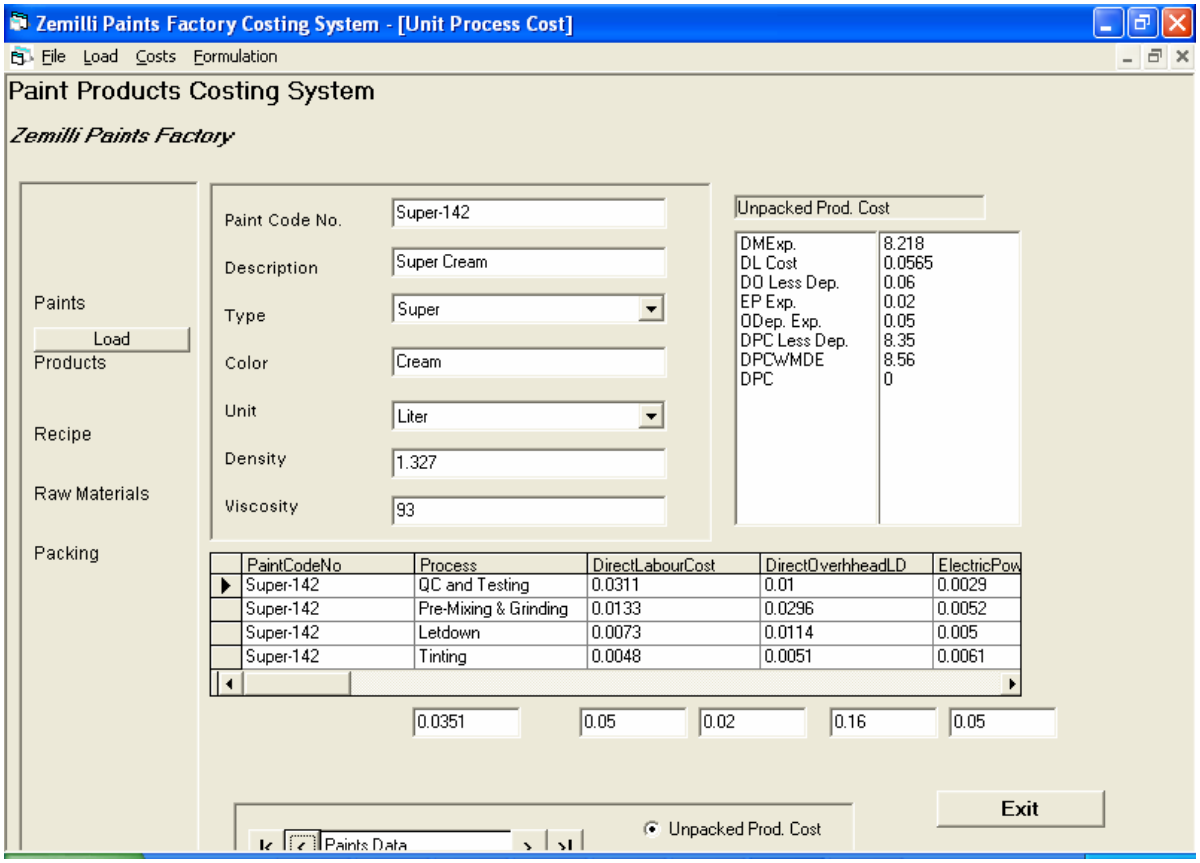


Fig.-5.7. unit process form

- Filling & packing cost gives a cost history of the different packing type and packing relation to the different paint types and product types.
- Packed production menu helps to retrieve information different cost of a product and corresponding packing detail.
- Batch production menu helps us to retrieve different level cost element information of a batch and enables us to calculate different amount batch cost quantities.

Formulation menu.

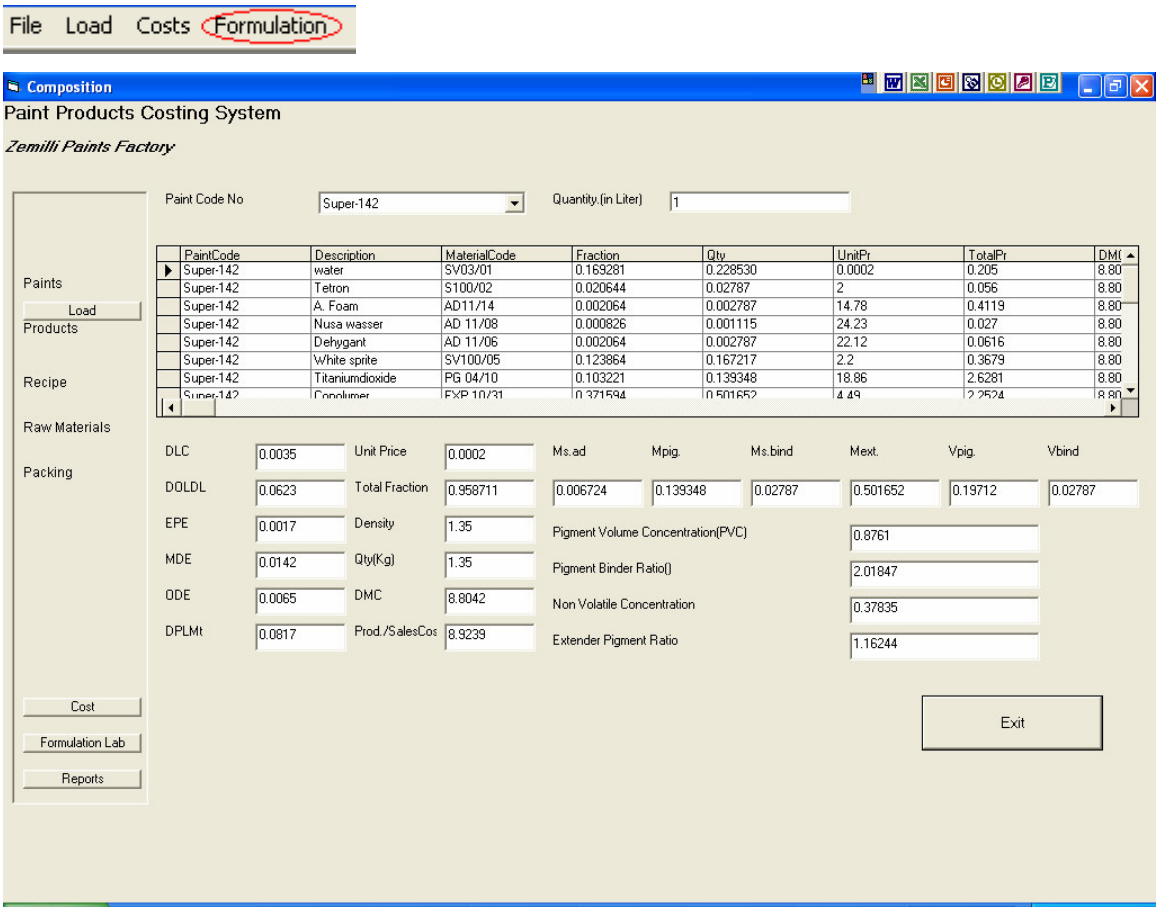


Fig.-5.8. Composition form

This helps to retrieve information of a product about recipe description, fraction quantity and corresponding unit price, different paint characteristics and paint proportion description with the different cost element values.

In addition the Report button in the forms enables the user to go for crystal report preview page of the costing system developed. That enables the user to compile crystal reports of: -

- Paints, Raw materials & Packing costs
- Batch calculation sheet
- Formulations
- Material price

- Paint process unit cost
- Product packed cost
- Recipe report
- Filling & Packing unit costs
- Unpacked products costs

Crystal report preview page form1

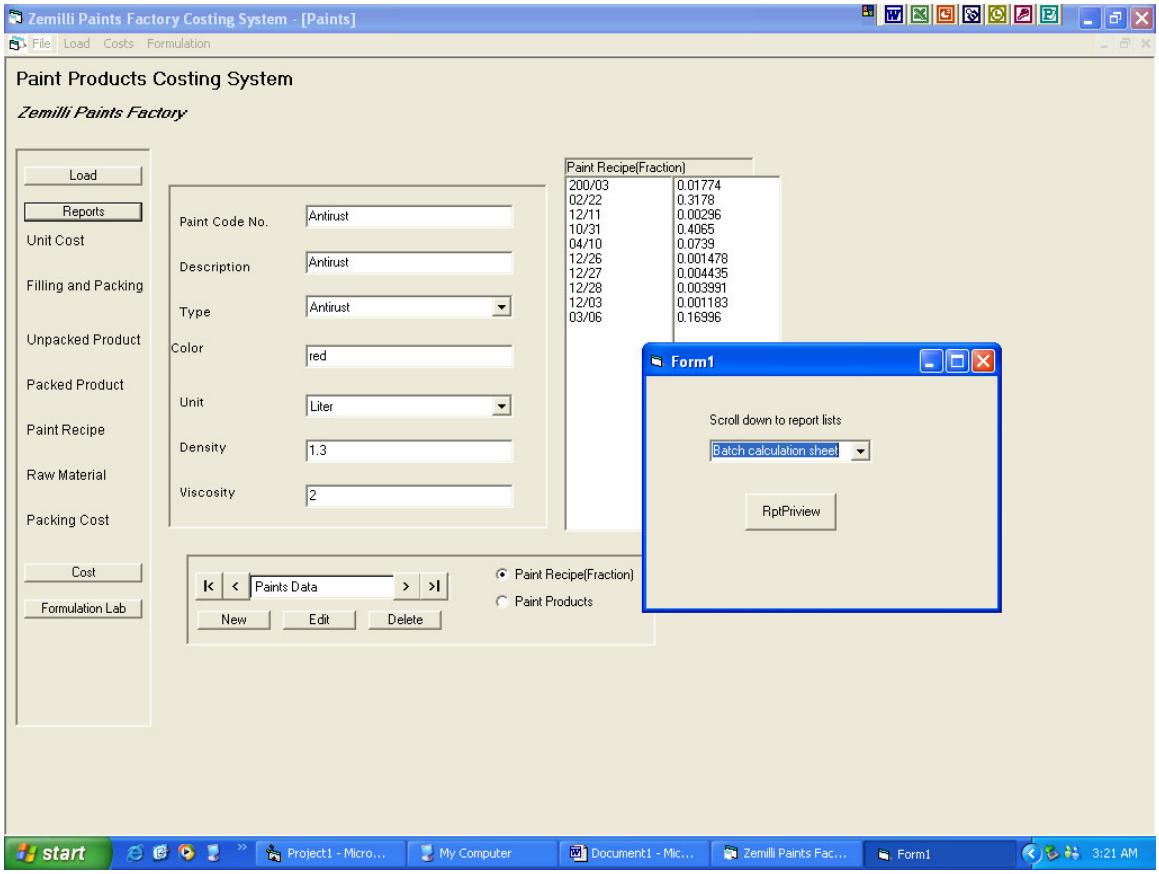


Fig.-5.9. Crystal report preview page form1

For illustration purpose the following crystal reports of Paint process unit cost is shown.

Paint process unit cost

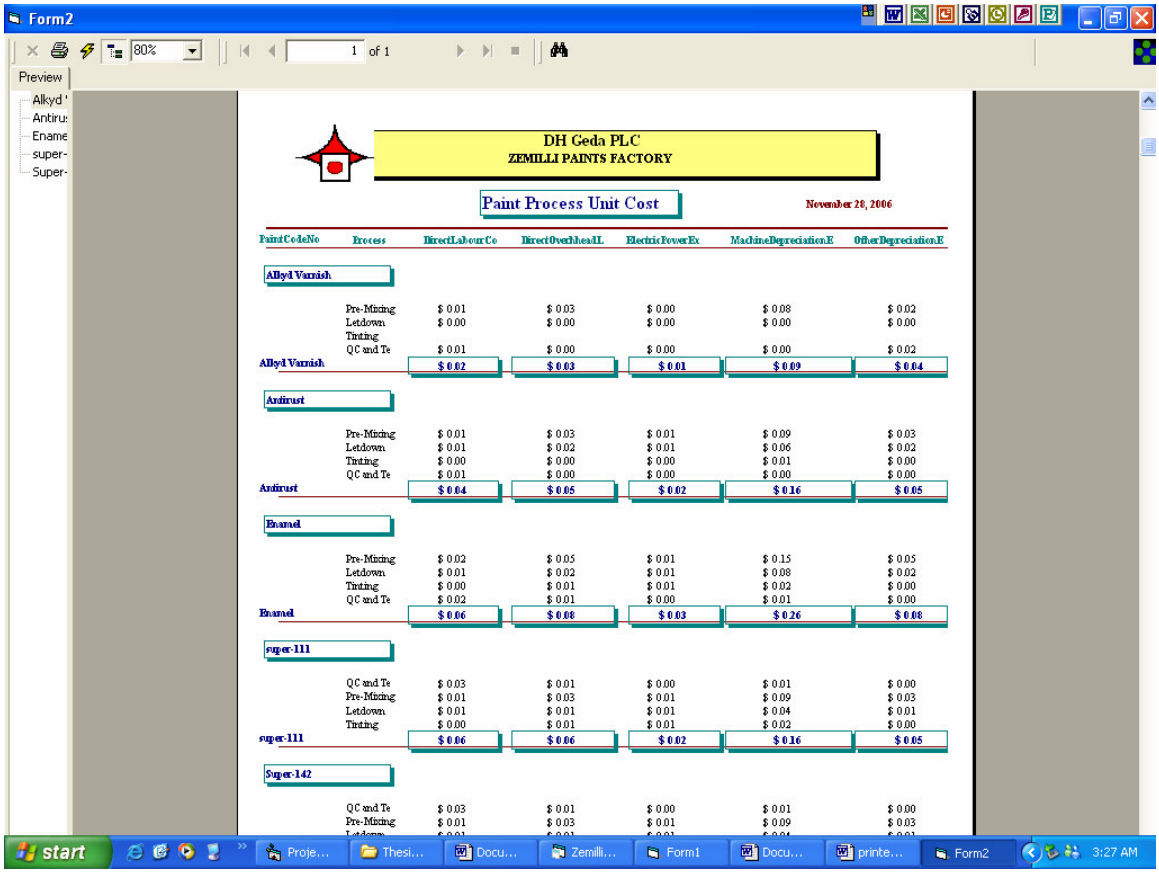


Fig.-5.10. Crystal report of paint process unit cost

CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on the findings in the previous sections, an activity based costing system development would have a crucial benefit for process industries for attaining the extent of value addition in each stage of their processes. This enables them to get a succinct decision on their product mix and business goal achievement.

The costing system of most process industries in Ethiopia needs much improvement and a strong interlink with their operational activities. Such type of interlink will lead them to a sound understanding to the level of value addition of the specific enterprise. As it is seen in chapter four, the development of such a system demands a detail understanding and organization of total information regarding the resource, activities and cost pools which could give a way to develop an active control over every operation of the enterprise.

In order to reach the objective, the thesis has been organized on the basis of developing a concise information system development. The developed system targeted on the different cost levels i.e. from unit level, facility level and batch level costs of the factory. This development of information enables to achieve the general objective of the thesis which was the preparation of an interactive visual basic program on activity based costing principles that can be utilized by the selected application.

As the main objective, this work proposed a model for ABC system implementation which will have a thorough consideration of the workflow of the factory, considering the input and output of the factory.

The model simplifies the whole process by giving an access to secure and up-to-date information of resources activities and cost objects from the developed program that

enables the management to control the activities efficiently. So the intervention of the management will be enhanced which will bring a productivity improvement of the factory. It is accomplished by coordinated basic cost information regarding overhead cost, resources, cost drives and cost object. This enables the factory to have a proactive control of its business activities towards increment of its process value addition that will bring a corresponding better market competitive advantage. The study will help in identifying loss-making products. Thus a necessary decision with regard to continuity of loss making products can be developed in terms of perception and its competitive advantage.

6.2 Recommendations

The following recommendations are proposed for Zemilli paint factory and some of them are equally likely to be implemented for other similar process industries in Ethiopia.

1. An integrated activity based costing system development is a prime importance for the factory that strengthens the management to have detail information for improved and timely decisions. The development of the system should be given emphasis, awareness development to all employee level, improvement target identification and benchmark setting.
2. For the development of such costing system creation of commitment, involvement ownership feeling of all level departments members is a prime target to be worked on as a primary phase.

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3. The product cost on the study shows how the different cost elements can be assigned on the output of the company. This assignment needs corresponding productivity improvement mechanism and process flow improvement targets like customer cost or customer profitability analysis, prioritization of product and profitability.

4. The company should effectively utilize the job order sheet since its design fulfills to develop the necessary background information for activity based costing initiatives and enhancement of cost implication mapping of activities.
5. The company has sister companies governed by common board of directors and also utilizes common distribution channels. Therefore a development of an ABC system for the total organization should be executed by taking consideration of the relationship of these companies.
6. It is a crucial important for a process industries to develop such comprehensive costing system since they are mainly depend on imported raw materials having an impact of cost variation that doesn't allow the factories to sustain in competitive market and to extend their market span out side the country.
7. Activity based costing system development for such industries is likely important to have sufficient information for identification of operational variances causes. This in turn helps to have timely counteracting measurers. Some of the existing variances are material usage, labor rate, efficiency variance etc.
8. It is recommended practice working on activity based costing system with computerization since this enables the enterprise for operational, administrative and strategic improvement.
9. The implementation of ABC in such type of industries will promotes them to lay a strong background for Total Quality management.
10. Finally, further studies can be made on the productivity improvement in Ethiopian processes industries through such type of resource management tool which enables them to improve their value addition productivity.

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Appendix A - The Paint Production Processes

The Paint Production process of the company consists of a series of physical and chemical operations to convert different recipes to commercial type of paints. The recipes are of different types most of them are imported by products of hydrocarbon.

To analyze the process, it is important to subdivide it in to three major phases. The first phase designated by Pre-Mixing and Grinding, is started from raw material weighting preparation, Pre-mixing and Grinding. In this phase a particular paint proportion and size reduction is converted to a relatively homogenous mix of the ingredients.

The second phase Letdowning is process step which converts to a more homogeneous mix of the fluid that has some property need for a particular paint type characteristic, and the third phase Tinting is mixing process which is accomplished until a required characteristics of paint is reached.

The above typical production process of paint production is followed by Labeling, Filling and packing and an every stage control testing of laboratory.

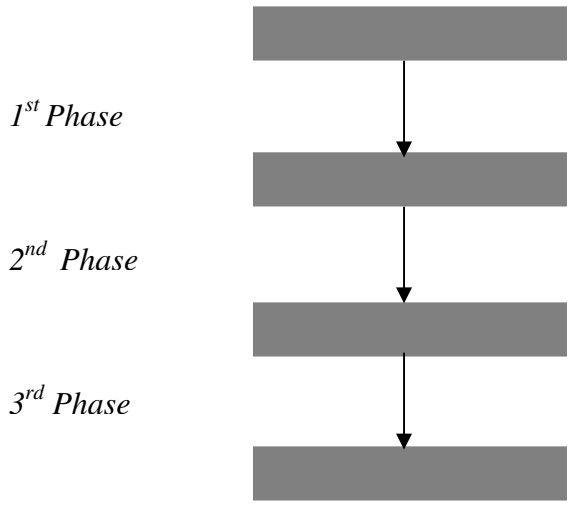


Fig A.1Paint production process flow

Appendix B - The ABC Menu

Categories with related Information Areas:

Activity

- ***Total Cost of Activity*** The total amount of direct and overhead charges associated with or allocated to a single activity
- ***Cost Driver*** A measurable factor that represents the amount of performance

and creates or affects the costs within a single defined activity, i.e. the number of iterations, amount of effort, etc.

- ***Elapsed Time*** The total amount of time, to include the amount of time delay created while awaiting processing, consumed to complete the activity or an iteration of the cost driver.
- ***Cycle Time*** The amount of time to complete one cycle or iteration of the cost driver without including delay or wait times.

Process

- ***Total Cost of the Process*** The total cost of all the activities in a process determined by the amount of the cost driver for each activity in relation to the output of the process
- ***Cost of a Single Iteration*** The total cost of a single incident or cost driver allocation for each of the activities in a process flow which may be equal to the total cost when a single iteration occurs at each activity in the flow.

Output

- ***The Cost of the Output*** The total cost of the activity model allocated by the applied activity drivers to the output of the activity model.

Identification of Change Opportunities

- ***Significant Cost Consumption*** Activities identified which have an evidently

larger consumption of inputs and mechanisms or the value of the output is less than the value of the inputs.

- ***Significant Time Use*** Activities identified which have evidently larger time periods or use of time or large non-value delay periods.

Evaluation of Change Alternatives

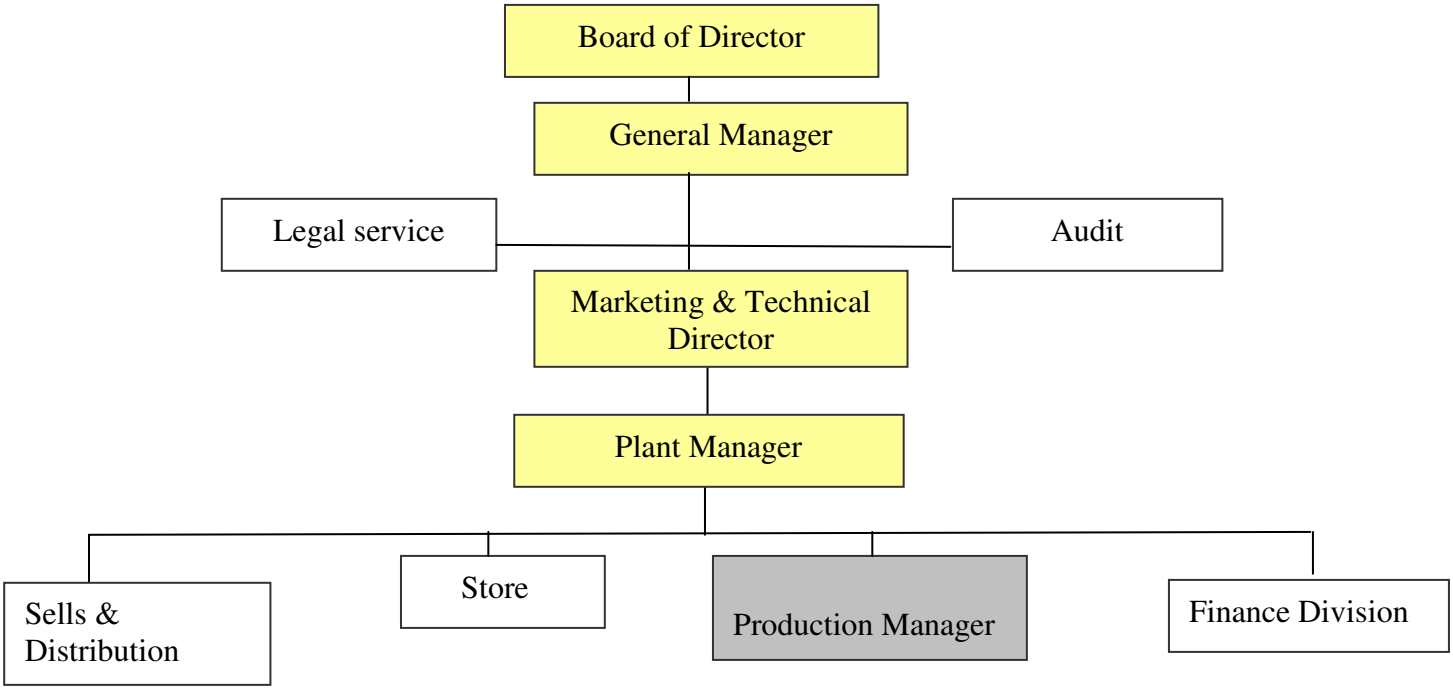
- ***Cost Comparison*** Analysis of the allocated costs from the activity model to two or more alternative process methods.
- ***Time Comparison*** Analysis of the total time or cycle times of two or more alternative process methods.

Appendix C- BALANCE SHEET The FACTORY

AS OF 30 SENE 1997				
			Currency	Ethiopian Birr
	Notes	BIRR	BIRR	1996
ASSETS EMPLOYED				
Fixed Assets	**1,1,2**		3,724,427.19	4,145,110.60
Deferred Expenditure				
CURRENT ASSETS				
Stock & good in transit	**2,2,3**	10,656,490.60		8,887,951.17
Debtors & payments	**4**	13,948,606.17		5,995,110.48
Associated Companies		4,968,726.08		-
Value added tax receivable		316,682.99		510,275.14
Cash & bank balances	**5**	26,043.29		800,249.41
TOTAL CURRENT ASSETS		29,909,549.29		16,193,586.41
CURRENT LIABILITIES				
Creditors & accruals	**6**	2,940,862.89		2,722,943.01
D.H. Trade & Industry		3,781,799.66		
Withhold tax payable		10,112.81		5,272.58
Bank overdraft		5,397,581.38		4,616,761.12
Short term loan	**8**	2,710,127.43		1,384,195.30
Profit tax payable	**9**	230,739.70		294,,100.27
		15,062,223.87		
NET CURRENT ASSETS			14,847,325.26	7,170,313.92
			18,571,752.45	**11,315,424.52**
REPERESENTED BY				
Authorized issued share capital				
500 shares of Birr 1,000.00 each	**10**		15,000,000.00	5,000,000.00
Legal reserve			236,550.24	209,630.61
Retained earnings	**11**		3,335,202.21	2,932,970.06
Shareholders account			-	3,172,823.85
			18,571, 752.45	**11,315,424.52**

Appendix D - Organizational Structure of Zemilli Paint Factory.

- DH-Geda PLC has six factories having common board of director with common marketing and technical directors but having their own Plant managers.



Appendix E- Product Cost Calculation

1. $$Number\ of\ batch\ of\ \text{a}\ product = \frac{\text{Pr}oductionQuantity/Year}{UnitBatchQuantity}$$

2. $$Total\,\text{Pr}oductTimeof\ a\,\text{Pr}oduct/Year = Batch\,\text{Pr}oduct\,\text{Time} \times Numberof\ batchof\ \text{a}\ product$$

3. $$Time\ Intensity\ Factor = \frac{Total\ \text{Pr}oduct\ Time\ of\ \ a\ \text{Pr}oduct\ /\ Year}{Total\ \text{Pr}ouctionTimeofaYear}$$

4. $$Unit\ Cost = \frac{Time\ Intensity\ Factor \times PeriodCost}{Total\ \text{Pr}oductionQuantityofa\ \text{Pr}oduct}$$

Appendix F- List of Tables developed for Product cost computation

Table 1 Main Activities of the factory

Department	*Activity Category*	*Activities*
Selling & Distribution	Customer Management	Contact Customers Prepare Quotes Invoice and Collect Money
Production & Administration	Production Planning and Preparation	Perform Engineering work Plan Production Prepare purchase Specification
Production	Production Management	Receive and Handle Materials Manage Production
General Administration & Finance	Enterprise Management	Manage Business, Store & Ship final products

Table 2 Expense Categories and their respective cost drivers.

Expense Categories	*Annual cost(Birr)*	*Cost drivers*
Administration	1,346,003.67	Time (hours)
Depreciation	18,848.32	Property values use of resources (in Birr.)
Rent and Utility	948,987.59	Square meters
Office Expenses	79,874.46	Level of use of office resources (%)
Business insurance and legal expenses	214,094.73	Cost of resource used by the activity (in Birr.)
Promotional expense	366,761.33	Level of benefit (%)
Production Shipment	109,352.19	Weight (Kg)
Miscellaneous	132,519.64	None

Table 3 Main Activities and their second stage cost drivers.

Activity	*Cost driver*
Customer contact	Number of Customers Contacted
Quote Preparation	Number of quotes
Engineering works	Engineering hours
Material purchasing	Number of purchases
Production Preparation	Number of production runs
Material receiving and handling	Number of receptions
Production management and supervision	Production complexity
Product shipping	Distance
Customer payment administration	Number of payments
General management & administration	Intensity of activities

Table 4 Pre-Mixing & Grinding Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Weighting*	*Pre-mixing*	*Grinding*	*Total time*	*Time factor*
Super white	900	8	5	30	45	0.141
Enamel white	900	10	5	60	75	0.234
Quartz paint	900	5	5		10	0.031
Alkyd varnish	900	30	10	-	40	0.125
Anti rust red	900	10	5	30	45	0.141
Antirust gray	900	10	5	30	45	0.141
Wubet	900	15	15	30	60	0.188
Total					**320**	**1**

Table 5 Letdown Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Total time*	*Time factor*
Super Paint	900	10	0.111
Enamel Paint	900	20	0.222
Quartz paint	900	15	0.167
Alkyd varnish	900	-	-
Anti rust red	900	15	0.167
Anti rust gray	900	15	0.167
Wubet	900	15	0.167

Table 6 Tinting Stage Batch Processing Time (in minute)

Product	*Batch Volume (Liter)*	*Total time*	*Time factory*
Super paint	900	10	0.091
Enamel paint	900	10	0.091
Quartz paint	900	15	0.136
Alkyd varnish	900	-	
Anti rust red	900	-	
Anti rust gray	900	10	0.091
Super 116, 111, 125	900	-	
Enamel 424, 423, 427, 403	900	-	
Enamel black	900	-	
Black board	900	-	
Super 142,141,162(121,223,190,230,123,122,201,228,110)	900	30	0.273
Wubet	900	20	0.182
Enamel 404,409,405	900	25	0.227
Total		**110**	**1**

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Table 7 Labeling Batch Processing Time (in minute)

Sr.No.	*Product*	*Unit*	*Qty*	*Total time*	*Time factor*
1	Super Paints	Plastic	270	30	0.13
2	Enamel paints	Gallon	250	20	0.087
3	Enamel paints	lit	1050	60	0.261
4	Anti rust red	Gallon	150	15	0.065
5	Anti rust gray	lit	600	45	0.196
6	Quartz paint	Pail(30kg)	10	-	-
7	Poly Varnish	Lit.	900	30	0.13
8	Wubet	Plastic	1000	30	0.13
Total				**230**	**1**

Table 8 Power Consumption in KWH

Sr.No.	*Process stage*	*KWH*	
1	Pre-Mixing & Grinding	55.98	0.365
2	Letdown	55.98	0.365
3	Tinting	33.57	0.219
4	Filling & Packing	0.86	0.006
5	Laboratory & testing	3.45	0.023
6	Finance & Administration	3.26	0.021
Total		**153.04**	1

Table 9 Filling & Packing Stage Batch Processing Time (in minute)

Product	*Unit*	*Qty.*	*Total time*	*Time factor*
Super Paints	Plastic	270	30	0.107
Enamel paints	Gallon	250	30	0.107
Enamel paints	lit	1050	60	0.214
Anti rust red	Gallon	150	15	0.054
Anti rust gray	lit	150	15	0.094
Quartz paint	Pail(30kg)	10	10	0.036
Wubet	Plastic	900	60	0.214
Poly varnish	lit	1000	60	0.214
Total			**280**	**1**

Table 10 Laboratory & testing time Batch Processing Time (in minute)

Sr.No.	*Product*	*Total time*	*Time factor*
1	Super Paints	15	0.319
2	Enamel paints	12	0.255
3	Quartz paint	5	0.106
4	Wubet	10	0.213
5	Poly varnish	5	0.106
Total		**47**	**1**

Table 11 Property Insurance Distribution Standards

Sr.No.	*Cost center*	*Machinery value*	*Dis. Factor*
1	Pre-mixing& Grinding	1,157,138	0.568
2	Letdown	513,990.78	0.252
3	Tinting	158,834.8	0.078
4	Filling & Packing	102,267.82	0.050
5	Laboratory & Testing	105,700	0.052
Total		**2,037,931.77**	**1**

Table 12 Production Services Cost & Factory Cost centers Distribution Standard

Sr.No.	*Cost center*	*No. of workers*	*Dist.Factor*
1	Pre-mixing & Grinding	5	0.25
2	Letdown	2	0.1
3	Tinting	1	0.05
4	Labeling	3	0.15
5	Filling & Packing	5	0.25
6	Laboratory & Testing	4	0.2
Total		**20**	**1**

Table 13 Administrative, Selling & Distribution Cost Distribution Standard

Sr.No.	*Cost center*	*No. of workers*	*Dist.Factor*
1	Pre-mixing & Grinding	10	0.112
2	Letdown	4	0.045
3	Tinting	2	0.023
4	Labeling	8	0.0899
5	Filling & Packing	10	0.112
6	Laboratory & Testing	8	0.0899
7	Administration	30	0.337
8	Sales & Distribution	19	0.214
Total		**89**	**1**

Table 14 Building insurance Distribution Standard

Sr.No.	*Department*	*Building Value*	*Dis.Factor*
1	Office Buildings	104,346.6	0.055
2	Factory buildings	1,781,418.6	0.939
3	Container Shop	11,914.3	0.006
Total		**1,897,679.5**	**1**

Table 15 Workmen Insurance Cost Distribution Standard

Sr.No.	*Department*	*Monthly Salary*	*Dis.Factor*
1	Pre-mixing & Grinding	2,800	0.013
2	Letdown	1,600	0.018
3	Tinting	800	0.009
4	Labeling	1,000	0.011
5	Filling & Packing	1,200	0.006
6	Laboratory & Testing	3,800	0.013
7	General & Administration	42,085.94	0.465
8	Selling & Distribution	32,244.37	0.411
Total		**84,638.72**	1

Table 16 Monthly Factory Overhead Cost Summary

Production personels Salary						4512		
	Provident fund contribution					451.2	4963.2	
Stationery & office supplies						3503		
Fork lift operation Salary						1000		
	Provident fund contribution					100		
Material handling & Scale Depreciations						4347.61		166966
Factory Building Depreciation							7423	
Medical Expenses								
Workmen Insurance						1103.21		
Property Insurance						7111.78		
Total								

Table 17 Machinery depreciation expense

Sr.No.	*Cost center*	*Machinery value*	*Depreciation rate%*	*Depreciation expense*	*Dis.Factor*
1	Pre-mixing& Grinding	1,157,138	20	231,427.6	0.4183
2	Letdown	513,990.78	20	102,798.16	0.1858
3	Tinting	158,834.8	20	31,766.96	0.0574
4	Filling & Packing	102,267.82	20	20,453.56	0.0367
5	Laboratory & Testing	102,700	20	20,540	0.0371
6	Administration Motor vehicles	672,500	20	134,500	0.2431
7	Office furniture	89,243	20	11,848.67	0.0214
Total				**553,335**	

Table 18	Overhead Cost Distribution Schedule								
Property Insurance									
Period Cost In Birr									7111
Distribution Standard	0.568		0.252		0.078	0.05	0.052		
Cost Center	Pre-Mixing & Grinding		Letdown		Tinting	Filling & Packing	Laboratory & Testing		
Share of Cost	4039.49104		1792.16856		554.71884	355.589	369.81256		7111
Workmen Insurance									
Period Cost In Birr									1103
Distribution Standard	0.031		0.018		0.009	0.024	0.042	0.876	
Cost Center	Pre-Mixing & Grinding		Letdown		Tinting	Filling & Packing	Laboratory & Testing	Admin.	
Share of Cost	34.19951		19.85778		9.92889	26.47704	46.33482	0 966.412	1103
House(Office) Rent									
Period Cost In Birr									892
Distribution Standard	0.029239766		0.009746589		0.00974659	0.194932	0.06822612	0.688109	
Cost Center	Pre-Mixing & Grinding		Letdown		Tinting	Filling & Packing	Laboratory & Testing	Admin.& others	
Share of cost	2608.187135		869.3957115		869.395712	17387.91	6085.76998	61379.34	892
Legal Expense									
									10259
Period Cost In Birr	0.568		0.252		0.078	0.05	0.052		
Distribution Standard	Pre-Mixing & Grinding		Letdown		Tinting	Filling & Packing	Laboratory & Testing		
Cost Center									
Share of Cost	58274.00544		25853.96016		8002.41624	5129.754	5334.94416		10259

Table 18 continued											
Production & Service cost											
Period Cost In Birr											13913.81
Distribution Standard		0.25		0.1		0.05	0.4	0.2			1
Cost Center		Pre-Mixing		Letdown		Tinting	Filling &	Laboratory & Testing			
		& Grinding					Packing				
Loading & Unloading		3478.453		1391.381		695.6906	5565.525	2782.762			13913.81
Period Cost In Birr											18867
Distribution Standard		0.328		0.328		0.328	0.016	0			1
Cost Center				Letdown		Tinting		Laboratory & Testing			
		Pre-Mixing & Grinding					Filling & Packing			Admin.& others	
		6188.376		6188.376		6188.376	301.872			0	18867
Adminstration & others											
Period Cost In Birr											106508.2
Distribution Standard		0.112		0.045		0.023	0.2019	0.0899			
Cost Center		Pre-Mixing		Letdown		Tinting	Filling &	Laboratory & Testing			
		& Grinding					Packing				
		11928.92		4792.869		2449.688	21504	9575.086			
Term Loan											
Period Cost In Birr		0.568		0.252		0.078	0.05	0.052			901660.3
Distribution Standard		Pre-Mixing		Letdown		Tinting	Filling &	Laboratory & Testing			
Cost Center		& Grinding					Packing				
		512143.1		227218.4		70329.5	45083.02	46886.34			901660.3
Total Apportioned cost		**598694.7**		**268126.4**		**89099.72**	**95354.15**	**71081.05**		**62345.75**	
Other depreciation											
Period Cost In Birr											166965.7
Distribution Standard		0.4183		0.1858		0.0574	0.0367	0.0371		0.2645	0.9998
Cost Center				Letdown		Tinting		Laboratory & Testing			
		Pre-Mixing & Grinding					Filling & Packing			Admin.& others	
		69841.77		31022.24		9583.834	6127.643	6194.429		44162.44	166932.4

Table 19			Pre-mixing & Grinding/1997Etc.							
	Products	Production Quty/Lit.	Total production time of a product/year	Time intensity factor	Direct Labour	Electric power	Depreciation	Factory Overhead	Other Dep.	Total
Period cost					33600	13140	231428	598694.7	69841.77	
	Super	832686	41634.3	0.33073	0.01335	0.00793	0.091918302	0.237789	0.02774	0.378723
	Enamel	547968	45664	0.36274	0.02224	0.03882	0.15319717	0.396315	0.046233	0.656808
	Anti Rust	122777	6138.85	0.04876	0.01335	0.00368	0.091918302	0.237789	0.02774	0.374469
	Alkyd	174272	7745.422222	0.06153	0.01186	0.01621	0.081705158	0.211368	0.024657	0.345806
	Poly varni	49866	2216.266667	0.01761	0.01186	0.00952	0.081705158	0.211368	0.024657	0.339113
	Black	24299	2024.916667	0.01609	0.02224	0.0087	0.15319717	0.396315	0.046233	0.626685
	Glue	104082	8673.5	0.0689	0.02224	0.0087	0.15319717	0.396315	0.046233	0.626685
	wubet	176800	11786.66667	0.09363	0.01779	0.00696	0.122557736	0.317052	0.036986	0.501348
	Primer	356	3.955555556	3.1E-05	0.00297	0.00116	0.020426289	0.052842	0.006164	0.083558

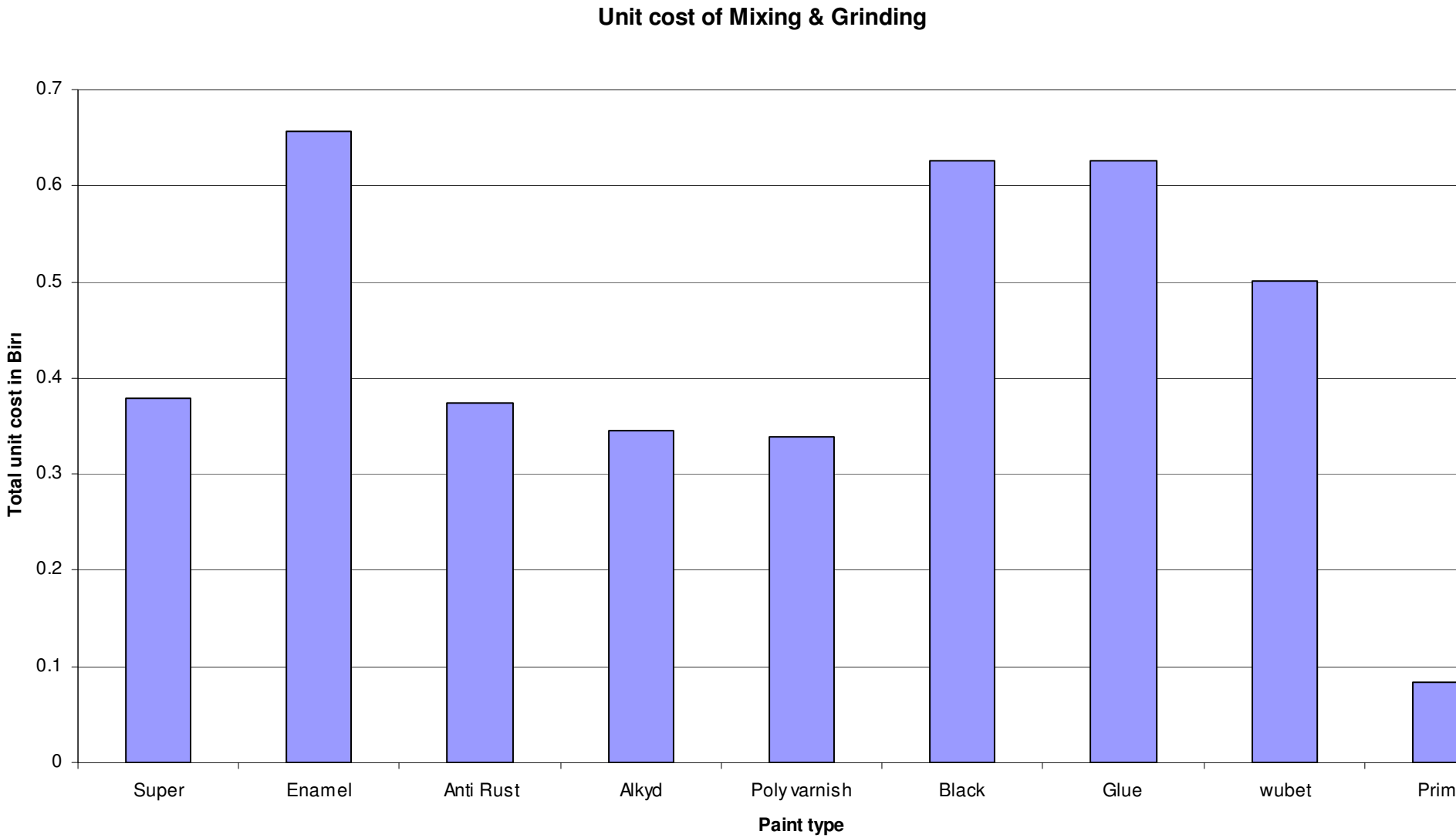

Unit cost of Mixing & Grinding
Total unit cost in Birr
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Super
Enamel
Anti Rust
Alkyd
Poly varnish
Black
Glue
wubet
Prim
Paint type

Table- 20			Letdown cost/1997Etc.						
Products	**Production Quty/Lit.**	**Total production time of a product/year**	**Time intensity factor**	**Direct Labour**	**Electric Power**	**Depreciation**	**Factory Overhead**	**Other Dep.**	**Total**
Period cost				19200	13140	102798	268126.4086	Other Dep.	
Super	832686	9252.066667	0.315976	0.00729	0.00499	0.039008327	0.101744806	0.01177	0.1648
Enamel	547968	12177.06667	0.41587	0.01457	0.00997	0.078016654	0.203489612	0.02354	0.32959
Anti Rust	122777	2046.283333	0.069885	0.01093	0.00748	0.05851249	0.152617209	0.01766	0.2472
Black	24299	539.9777778	0.018441	0.01457	0.00997	0.078016654	0.203489612	0.02354	0.32959
Glue	104082	2312.933333	0.078991	0.01457	0.00997	0.078016654	0.203489612	0.02354	0.32959
wubet	176800	2946.666667	0.100634	0.01093	0.00748	0.05851249	0.152617209	0.01766	0.2472
Primer	356	5.933333333	0.000203	0.01093	0.00748	0.05851249	0.152617209	0.01766	0.2472
Total		**29280.92778**							

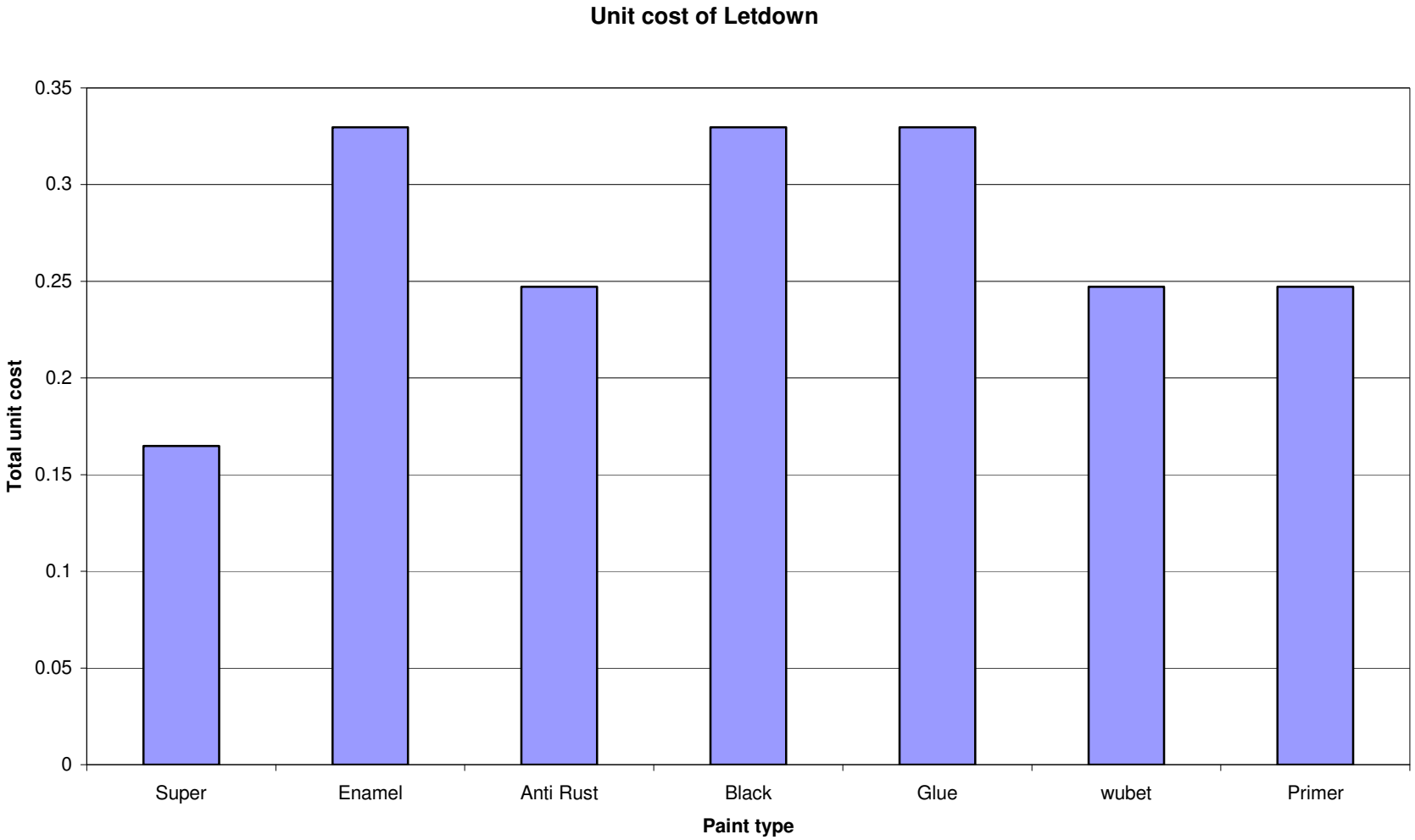

Unit cost of Letdown
Total unit cost
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Super
Enamel
Anti Rust
Black
Glue
wubet
Primer
Paint type

Table- 21				Tinting cost/1997Etc.						
	Products	**Production Quty/Lit.**	**Total production time of a product/year**	**Time intensity factor**	**Direct Labour**	**Electric Power**	**Depreciation**	**Factory Overhead**	**Other Dep.**	**Total**
Period cost					9600	12000	31767	89099.72	9583.83382	
	Super	832686	27756.2	0.65077	0.0075027	0.00938	0.024826754	0.0696338	0.00749002	0.11883
	Enamel	547968	10959.36	0.25695	0.0045016	0.00563	0.014896052	0.0417803	0.00449401	0.0713
	wubet	176800	3928.888889	0.09212	0.0050018	0.00625	0.016551169	0.0464225	0.00499335	0.07922
	Primer	356	7.12	0.00017	0.0045016	0.00563	0.014896052	0.0417803	0.00449401	0.0713
			42651.56889							

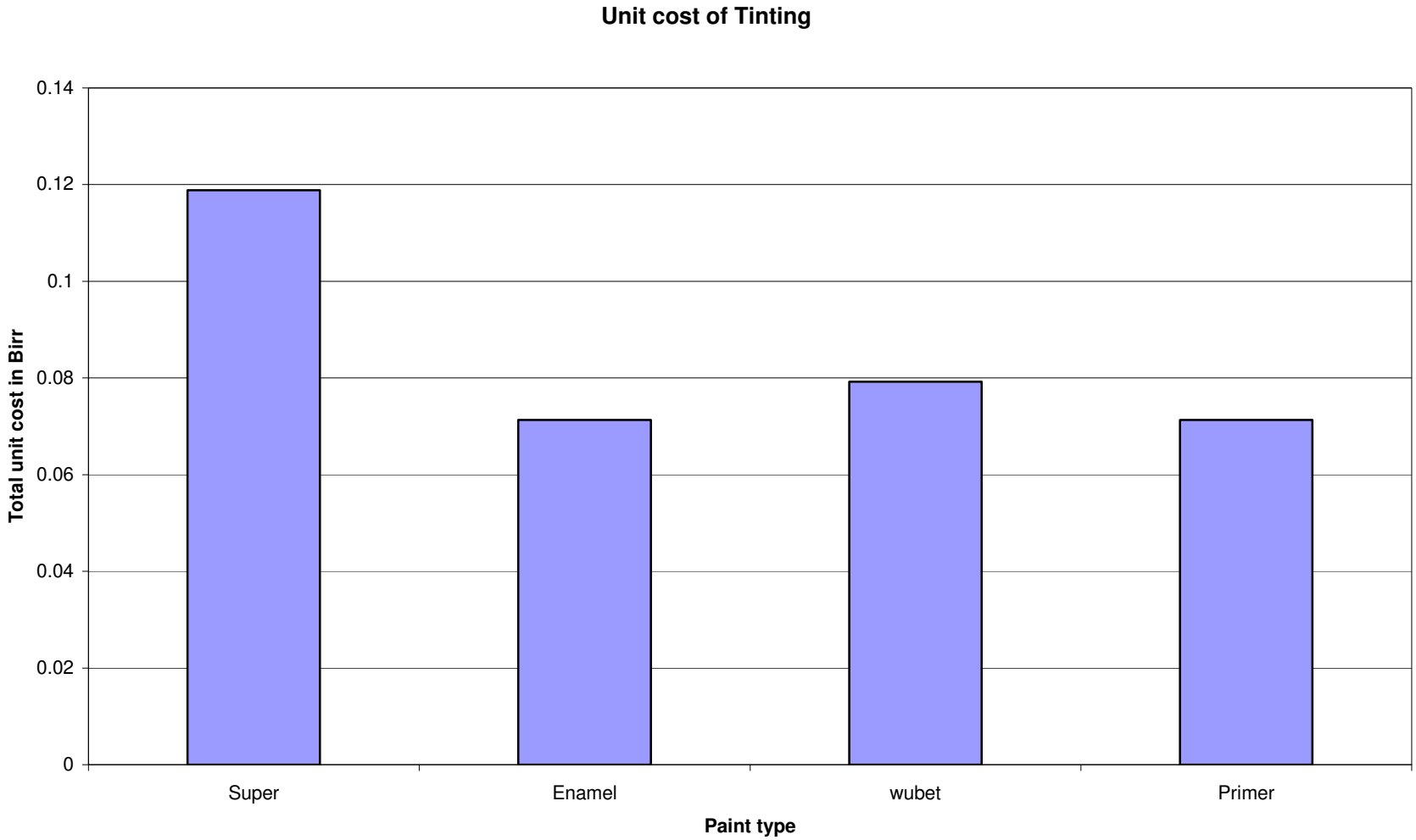

Unit cost of Tinting
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Total unit cost in Birr
Super
Enamel
wubet
Primer
Paint type

Table- 22			Labeling cost/1997Eth.C						
	Products	**Production Quty/Lit.**	**Liter/batch**	**Total time**	**Time intensity factor**	**Direct Labour**	**Electric Power**	**Overhead**	**Total**
Period cost						12000	2160	6296	
	Super	832686	945	26434.476	0.45523	0.00656	0.00118	0.003442	0.01118
	Enamel	547968	2050	13365.073	0.23016	0.00504	0.00091	0.0026445	0.00859
	Anti Rust	122777	1200	4092.5667	0.07048	0.00689	0.00124	0.0036142	0.01174
	Alkyd	174272	1200	4356.8	0.07503	0.00517	0.00093	0.0027106	0.00881
	Poly varni	49866	900	1662.2	0.02863	0.00689	0.00124	0.0036142	0.01174
	Black	24299	900	539.97778	0.0093		0.00083	0.0024094	0.00324
	Print ink	1632					0	0	0
	Quartz	27945	200				0	0	0
	Glue	104082	900	2312.9333	0.03983	0.00459	0.00083	0.0024094	0.00783
	wubet	176800	1000	5304	0.09134	0.0062	0.00112	0.0032527	0.01057
				58068.027					

Table- 23				Filling & Packing cost/1997Eth.C							
	Products	**Production Quty/Lit.**	**Liter/batch**	**Total time**	**Time intensity**	**Direct Labour**	**Electric Power**	**Machine Dep.**	**Factory Overhead**	**Other Dep.**	**Total**
Period cost						14400	216	20454	95354.15	6127.643	
	Super	832686	945	28350	0.040891	0.000707	1.06E-05	0.0010045	0.004683	0.000301	0.006706
	Enamel	547968	2050	112750	0.162628	0.004274	6.41E-05	0.0060704	0.0283	0.001819	0.040526
	Anti Rust	122777	1200	18000	0.025963	0.003045	4.57E-05	0.0043253	0.020164	0.001296	0.028876
	Alkyd	174272			0	0	0	0	0	0	0
	Poly varni	49866	1000	60000	0.086543	0.024991	0.000375	0.035498	0.165487	0.010635	0.236986
	Black	24299	900	412200	0.594548	0.352339	0.005285	0.5004684	2.333125	0.149931	3.341149
	Glue	104082	200	6000	0.008654	0.001197	1.8E-05	0.0017007	0.007929	0.00051	0.011354
	wubet	104082	900	54000	0.077888	0.010776	0.000162	0.0153065	0.071357	0.004586	0.102187
	Primer	356			0	0	0	0	0	0	0
	Quartz	27945	200	2000	0.002885	0.001487	2.23E-05	0.0021115	0.009843	0.000633	0.014096

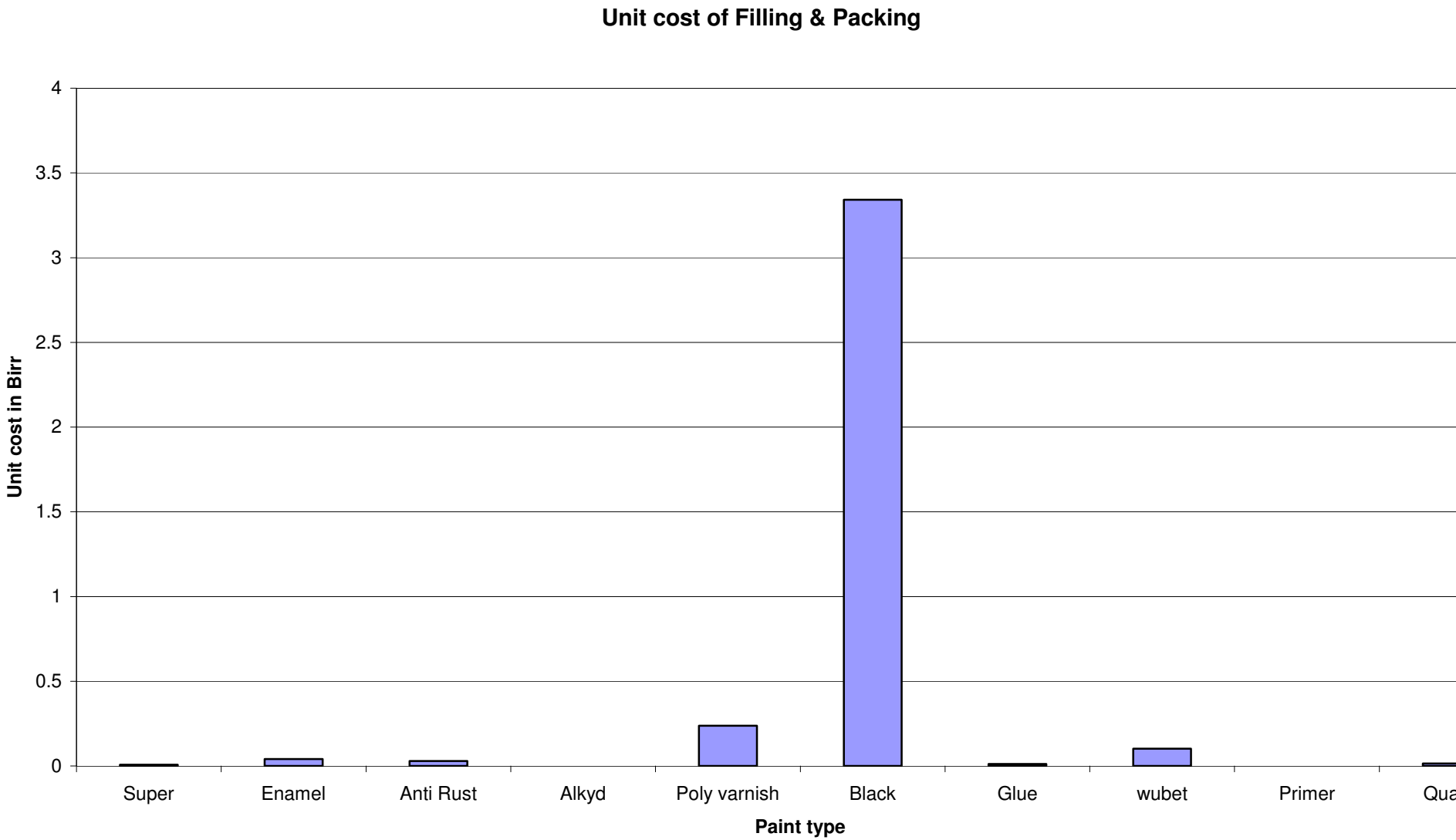

Unit cost of Filling & Packing
Unit cost in Birr
4
3.5
3
2.5
2
1.5
1
0.5
0
Super
Enamel
Anti Rust
Alkyd
Poly varnish
Black
Glue
wubet
Primer
Paint type

Table- 24				Laboratory & Testing						
	Products	Production Quty/Lit.	Total Time	Time intensity	Direct Labour	Electric Power	Depreciation	Factory Overhead	Other dep	Total unit cost
Period cost					45600	4248	20540	71081.05	6194.43	
	Super	832686	13878.1	0.51739	0.02833	0.00264	0.01276247	0.044166	0.00385	0.09175
	Enamel	547968	7306.24	0.27238	0.02267	0.00211	0.01020998	0.035333	0.00308	0.0734
	Anti Rust	122777	682.094	0.02543	0.00944	0.00088	0.00425416	0.014722	0.00128	0.03058
	Alkyd	174272	968.178	0.03609	0.00944	0.00088	0.00425416	0.014722	0.00128	0.03058
	Poly varni	49866	277.033	0.01033	0.00944	0.00088	0.00425416	0.014722	0.00128	0.03058
	Black	24299	323.987	0.01208	0.02267	0.00211	0.01020998	0.035333	0.00308	0.0734
	Glue	104082	1387.76	0.05174	0.02267	0.00211	0.01020998	0.035333	0.00308	0.0734
	wubet	176800	1964.44	0.07324	0.01889	0.00176	0.00850831	0.029444	0.00257	0.06117
	Primer	356	35.6	0.00133	0.17	0.01584	0.07657483	0.264996	0.02309	0.5505
			26823.4							

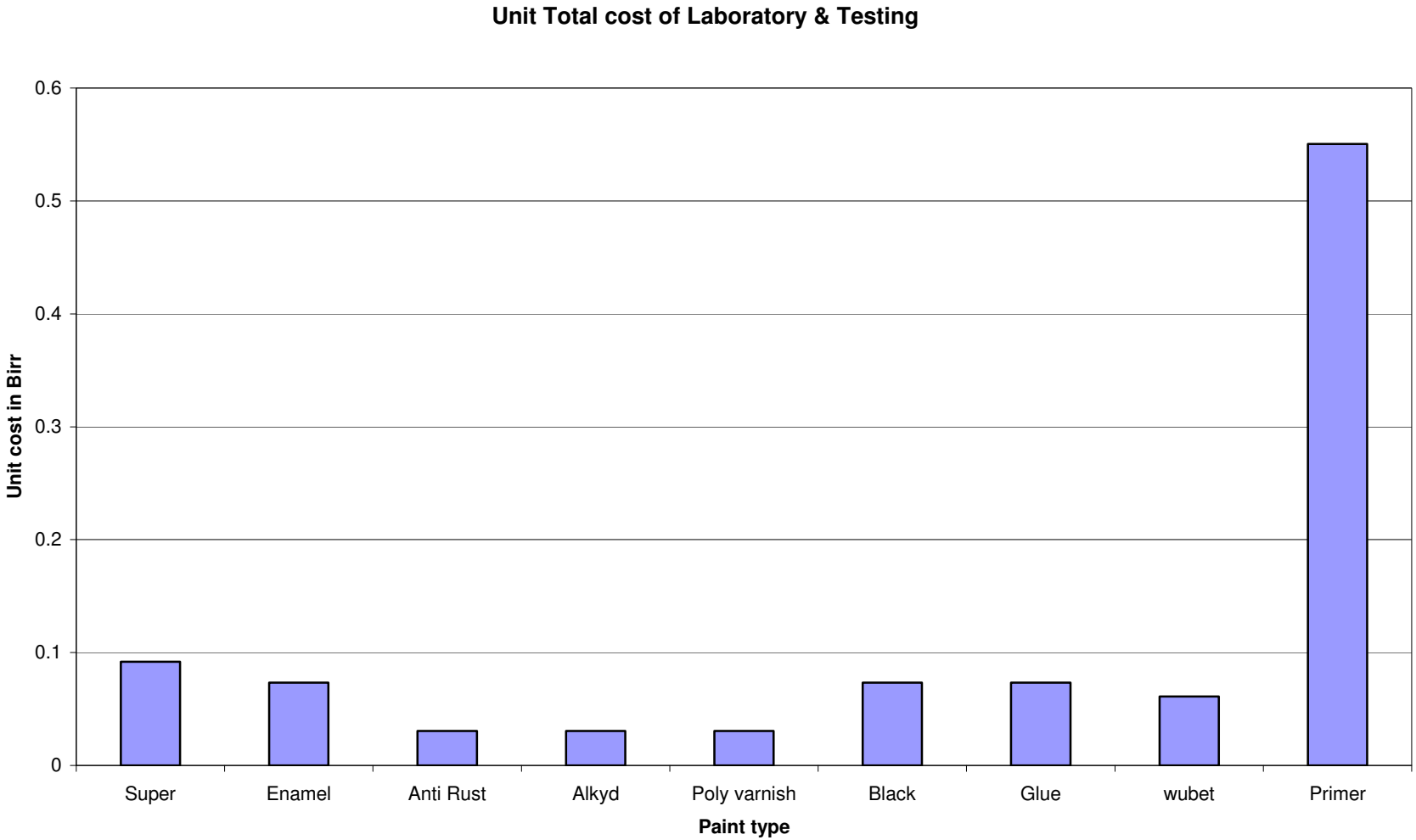
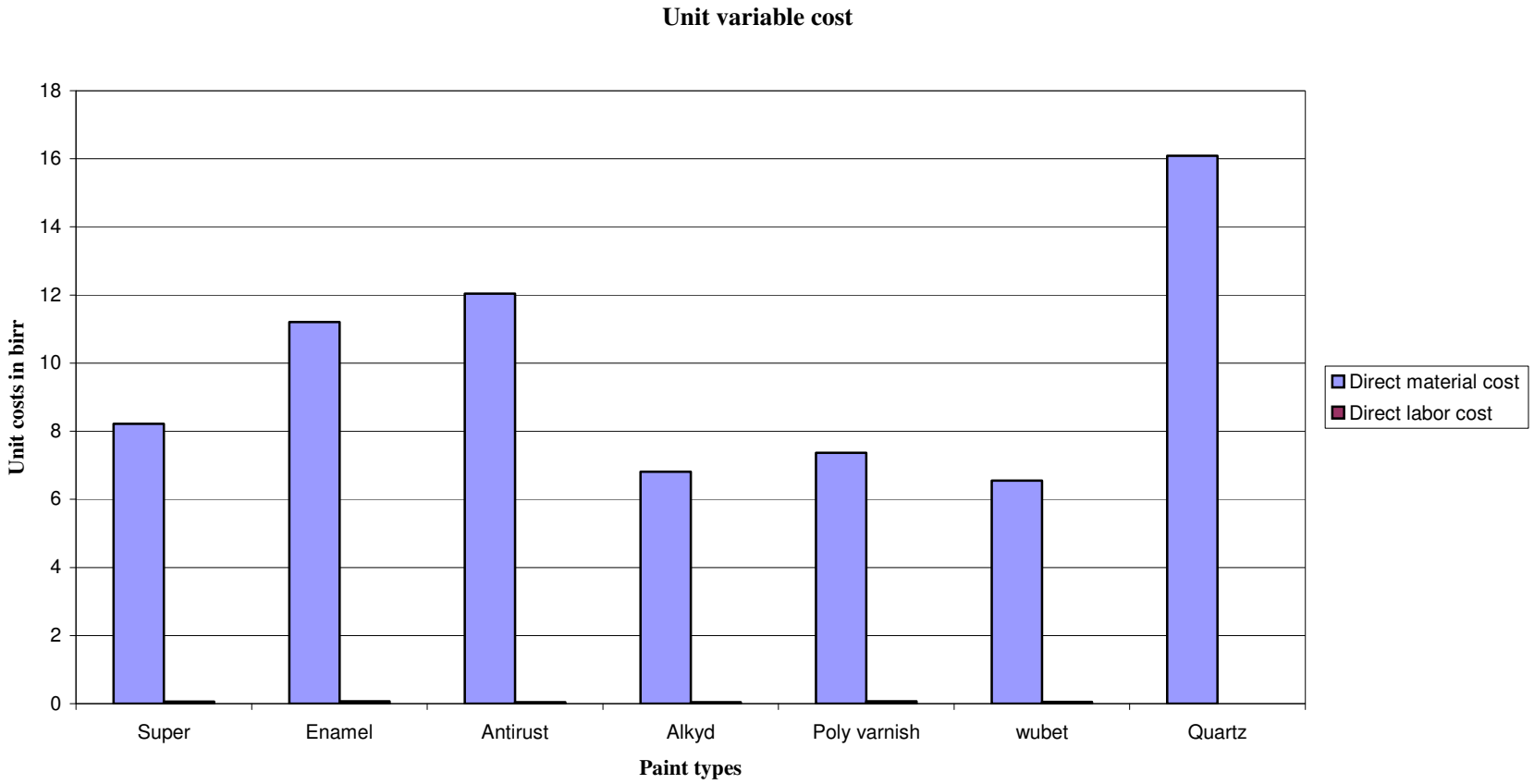

Unit Total cost of Laboratory & Testing
Unit cost in Birr
0.6
0.5
0.4
0.3
0.2
0.1
0
Super
Enamel
Anti Rust
Alkyd
Poly varnish
Black
Glue
wubet
Primer
Paint type

Table- 25			Paint Cost Summary							
	Paint type	Super	Enamel	Antirust	Alkyd	Poly varni	Glue	wubet	Quartz	Primer
S.No.	Description	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.	Birr/Lit.
1	Variable Costs									
	Raw material Cost	8.21837	11.204	12.0365	6.8149	7.3655	N.A	6.54988	16.0909	N.A
	Direct Labour	0.06373	0.0733	0.04365	0.04104	0.06776	0.06163	0.05423	0.00149	0.17747
	Variable cost Total	8.28211	11.2773	12.0802	6.85595	7.43326	0.06163	6.60411	16.0924	0.17747
2	Fixed costs									
	Power Costs	0.00264	0.00211	0.00088	0.00088	0.00088	0.00211	0.00176		0.01584
	Depreciation machin	0.17296	0.26503	0.16262	0.16669	0.20309	0.22362	0.15904	0.00211	0.11515
	Adminstration	0.01548	0.02382	0.014	0.00983	0.04351	0.01444	0.03038	0.00222	0.04063
	Factory overhead	0.46146	0.70786	0.42891	0.2288	0.39158	0.64548	0.62015	0.0036	0.51224
	Total Fixed Costs	0.6571	1.02776	0.60124	0.34569	0.52505	0.75703	0.86531	0.00793	0.71275
	Total Product Costs	8.939212	12.30502	12.68141	7.187072	7.943733	0.822299	7.48478	16.10033	0.901144


Unit variable cost
Unit costs in birr
18
16
14
12
10
8
6
4
2
0
Super
Enamel
Antirust
Alkyd
Poly varnish
wubet
Quartz
Paint types
Direct material cost
Direct labor cost

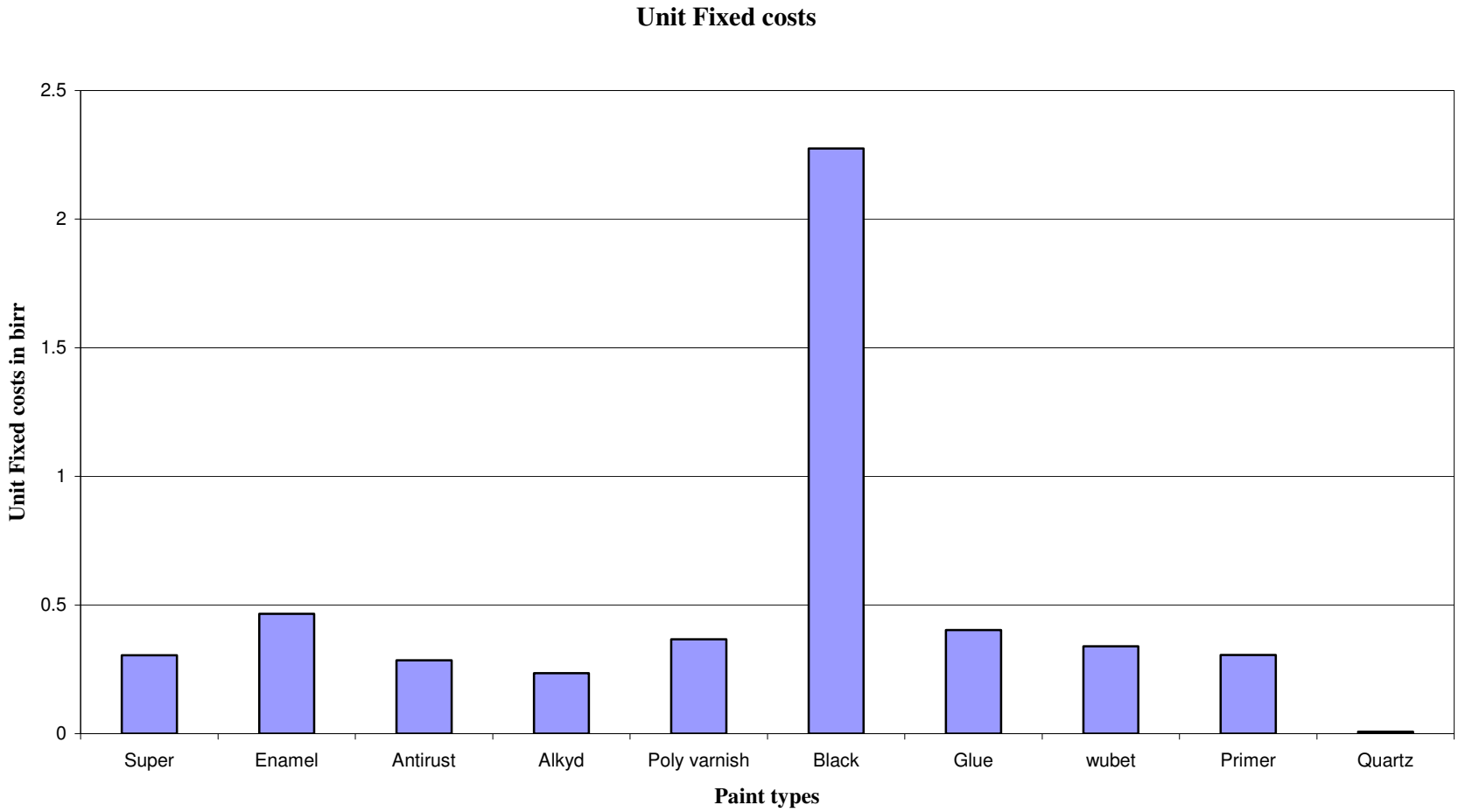

Unit Fixed costs
Unit Fixed costs in birr
2.5
2
1.5
1
0.5
0
Super
Enamel
Antirust
Alkyd
Poly varnish
Black
Glue
wubet
Primer
Quartz
Paint types

Table 26 *Operation area distribution factor*

Cost Center	Operation area(Squ.m)	Factor
Pre-Mixing & Grinding	30	0.02924
Letdown	10	0.00975
Tinting	10	0.00975
Laboratory& Testing	70	0.06823
Lebeling	50	0.04873
Filling & Packing	150	0.1462
Adminstration & Fina	156	0.15205
Store	400	0.38986
Others	150	0.1462
Total	1026	

Table 27 *Packing cost for the different types*

Type	*Unit cost*	*Packing cost Can4lit.*	*Packing cost Can2it.*	*Packing cost Can1it.*	*Packing Cost Excel 3.8*	*Packing cost Glue*
Excel plastic 3.8liter	6.52					
Rigb Plastic 1lit.	1.53					
Can4lit.	6.95	6.59				
Can2lit.	5.85		5.85			
Can 1lit.	3.53			3.53		
Carton 4lit	4.54	1.14				
Carton 2lit.	3.72		0.93			
Carton 1lit.	3.53			1.04		
Sticker Super	0.39				0.39	
Sticker Glue	0.44					0.44
Carton Label	0.12	0.12	0.12	0.1	0.1	0.54
Can Label	0.22					
	Total	**8.43**	**7.12**	**4.67**	**5.13**	**3.45**

Table 28 *Zemilli Paint Factory Plc. Production Report for the year ending, 1997 Eth. Cal*

No.	*Description*	*Qty. /Lit.*
1	Mega Super	832,686
2	Mega Enamel	547,968
3	Mega Anti Rust	122,777
4	Mega Alkyd Varnish	174,272
5	Polyurethane Varnish	49,866
6	Mega Black Board	24,299
7	Mega Glue	104,082
8	Mega Printing Ink	1,632
9	Mega Wubet	176,800
10	Mega Quartz	27,945
11	Mega Primer	356