Dirasat, Administrative Sciences, Volume **36**, No. **1**, 2009

Activity Based Costing (ABC)
A Proposed Costing Model for Phosphate Industry
Jordan Phosphate Mines Company as a Case Study

Khalid A. Abdullah and Marwan Irshaidat *

ABSTRACT

This research paper aimed at proposing a costing model to replace the current cost accounting system at Jordan Phosphate Mines Company (JPMC) in light of the encouraging benefits of Activity Based Costing (ABC). More accurate cost information results are obtained from ABC than from the traditional cost accounting systems, because ABC logic relies on the relationship of 'cause and effect' when allocating indirect costs rather than on only volume-based allocation. Previous results of some ABC studies showed that its implementation usually led to reduction in costs and improved efficiency in production by decreasing non value added activities. Traditional cost accounting systems have been under constant criticism due to the distortions in costing coming from the inability to accurately and fairly allocate indirect costs. Advantages of this modern costing system encouraged the researcher to propose a model that is based on Underlying theory.

The proposed ABC model is made up of several sub models, were linked together using Microsoft Excel, which the researcher saw as the appropriate customized tool to handle the unique requirements at JPMC and which could manage the huge amounts of data. As a result of the research, the researcher reached the conclusion that JPMC is able to implement ABC to replace the current cost accounting system. Even if implementation is not planned for in the near future, the management of JPMC ought to keep the idea alive due to the numerous strategic benefits that ABC may provide.

Keywords: Activities Based Costing (ABC), Jordan Phosphate Mines Company (JPMC), Primary Activity; Secondary Activity, Cost Driver, Activity Based Manangement (A.B.M); Expense-Activity Dependence; Cost Pool; Activiy Dictionary; Excel; Model; Submodel.

1. INTRODUCTION

Different types of companies use different types of cost systems. An effective cost system must have all of the following three characteristics:(1) Decision focus that meets the needs of management as the decision makers, (2) different costs for different purposes, where the chosen system can provide different cost information for different purposes and for different reports to internal and external parties, (3) and finally, the cost-benefit test, where benefits from the cost system must exceed its costs.

Mining firms like other industrial firms use costing reports to achieve various objectives of which inventory evaluation and product pricing are main goals. These reports are the product of implementing costing systems, which provide the main source of information that assists the process of decision making. The assignment of indirect manufacturing cost represented the major problem in cost accounting even when it only represented minor part of total cost.

The costing system at JPMC relies on traditional bases for assigning indirect manufacturing costs that represent one third of all cost. Traditional cost systems use volume-driven allocation bases, to assign organizational expenses to individual products and customers. The current system does not help in gaining many of the benefits of ABC that is greatly needed by management to face the modern industrial environmental challenges.

* The Arab Academy for Banking and Financial Sciences, Jordan. Received on 7/3/2007 and Accepted for Publication on 5/2/2008.

 © 2009 DAR Publishers/University of Jordan. All Rights Reserved.

1.1 Importance of the Research

The importance of this research stems from the intention of the researcher to propose a costing system model based on ABC in the mining industry to replace the existing costing system. Implementing ABC will support management in making better decisions, increase firms production efficiency.

ABC helps to evaluate the profitability of different product lines that characterize the nature of the phosphate industry and to eliminate the non-value added activities. ABC is the main introductory step to Activity Based Management (ABM) through which a value-added cost as well as a non-value added cost can be determined

1.2 Research Objectives

The main objective of the research is to propose ABC system instead of the existing cost accounting system applied by JPMC to manage production more effectively, test the effect of developed cost accounting system on production management, eliminating non-value-added activities. Generally, avoiding the deficiencies of traditional costing can be cited to be the key objective for this research.

1.3 Statement of the Problem

The researcher specifically aims at answering the following questions which represent the problem of the research: Can the proposed costing system of Activity Based Costing solve the existing costing problems of JPMC and consequently overcome the shortcomings of the existing traditional costing system?

1.4 Research Assumptions

Traditional cost systems are inexpensive to operate, but they lead to large distortions in reporting the cost of activities, processes, products, services and customers. Thus, with this in mind, this research is based on the assumption that the researcher, due to the limitations of the existing costing system applied at JPMC, will propose an alternative costing model based on literature written about ABC adopted by many firms worldwide. As such, the proposed costing model is based on the assumption that Activity Based Costing system has the ability to overcome the shortcomings of the existing traditional costing system cited above.

1.5 Research Methodology

Part two of this research will present the concepts and terminologies associated with ABC and to discuss how ABC underlying theory is used to produce more accurate product costs than those obtained from the traditional cost systems. The profile of JPMC, reserves and production is introduced; the design of the proposed ABC model then is presented to be followed by conclusions and recommendations.

1.6 Limitations

Identifying the degree of success with ABC will be a very difficult task since the method of analysis will involve gathering a huge amount of data. ABC procedures necessitate an extensive training of the employees. Besides, employees' resistance to change is a pitfall that should be tackled; it also needs a large team consisting of technical, accounting and managerial staff. ABC systems are implemented with the objective of obtaining more accurate product and process costing information. Therefore, development of an ABC system requires extensive data collection and analysis that is often estimated. Cost drivers that have been left out of the ABC model can cause a large difference.

In case study research, it is important to give considerable care and attention to the collection and evaluation of evidence. Case study research, is remarkably hard, due to the difficulty of drawing boundaries around the subject matter of the case, as well as, to the ethics of the researcher's relationship with the subjects, which require access to organizations and to confidential information that may ,if declared hurts JPMC self interest. ABC will never be a cure for inefficiency or incompetence. ABC can only help good managers to 'manage better'. It is unlikely to transform an ordinary manager into a great manager by itself. It is up to management to optimize the use of its resources and achieve planned objectives.

2. LITERATURE REVIEW

2.1 Introduction

Activity Based Costing (ABC) is a costing approach that assigns costs to products or services based on their consumption of resources caused by activities (Blocher et al., 1999, p.95). As a costing technique (ABC) was developed to overcome the deficiencies of traditional product costing systems, which may under certain conditions, such as high volume and product diversity, calculate inaccurate product costs. Using direct labor

hours or cost or even machine hours as the only cost driver seldom meets the cause and effect criterion desired in cost allocation. (Maher et al., 2001, p.130-131). The ABC paradigm is based on the principle that it is not the products that a company produces that generate costs, but rather the activities that are performed in planning, procuring and producing the products. It is the resources that are necessary to support the activities performed during the course of business that result in costs being incurred. Products 'consume' activities and activities 'consume' costs. Product costs should therefore be calculated by determining the extent to which each product makes use of the activities being performed. The resources of the business are first matched with the activities that are being performed, and then the product costs are calculated by driving the activity costs down to products based on how each product consumes the activities. (Hansen and Mowen, 2003, p.122-123). Activity Based Costing (ABC) has been popular since the mid 1980s. It was first developed by Robin Cooper and Robert Kaplan, as another costing method in light of the limitations that existed in traditional costing systems, especially in the area of overhead (Johnson and Kaplan, 1987, p.129-130). The new costing method was developed and has been advocated as a means of overcoming the systematic distortions of traditional cost accounting .Traditional costing systems over-cost large-size, high-volume products and under cost small-size, low-volume products when product diversity exists within the same operation. It reports what money is spent on and by whom, but fails to report the cost of activities and processes (Cooper,1988, p.45-54). Traditional methods of absorption can thus be considered inappropriate for current production methods, resulting in distorted product costs, thereby leading to incorrect calculations of selling prices and incorrect decisions(Storey,1995, p.71).

2.2 Activity Based Costing (ABC)

2.2.1 Concepts of ABC

The concept of Activity Based Costing (ABC) has evolved as an alternative approach for obtaining more accurate cost information. It is used as a mechanism for portraying an organization as a series of activities designed to satisfy customer needs and identifies the various activities performed in a firm. ABC is one of the best tools for refining a cost system. It refines a costing system by identifying individual activities as the fundamental cost object (Horngren et al., 2000, p.144-145). ABC came about due to the special circumstances after the spread of advanced manufacturing technology, which led to diversity in production and made cost allocation and cause/effect more difficult to calculate (Garrison and Noreen,2003, p.317-319).

As a technical theory, it provides more accurate information to managers about the cost and profitability of their business processes, products, services and customer. The provision of more accurate information was intended to help managers make better decisions about the use and deployment of their organization's resources (Wilson, 1997, p.272-293). ABC is a costing methodology used to trace overhead costs directly to cost objects, and help managers to make the right decisions regarding product mix and competitive strategies (Cooper and Kaplan, 2001, p.42-44). As such it is a cost accounting system that is used to more accurately determine the full costs of services and products, and allows for cost analysis of service departments and activity centers. (Trussel and Bitner, 1996, p.59).

ABC first assigns resource costs to the activities performed by the organization. Then activity costs are assigned to the cost objects that benefit from or created the demand for the activities (Kaplan and Atkinson, 1998, p.77). Thus, it is a two-stage process, which emphasizes direct tracing and driver tracing, Therefore, identifying activities must be the first step in designing an ABC system (Hansen and Mowen, 2003, p.125-128). As a costing approach, ABC assigns costs to products based on their consumption of the resources caused by activities. Resources are assigned to activities, then activities are assigned to cost objects based on their use. (Blocher et al., 1999, p.95-99).

There are two purposes for ABC. The first purpose is to prevent cost distortion. Cost distortion occurs because traditional costing combines all indirect costs into a single or few cost pools. The second purpose is to minimize waste or non-value-adding activities by providing a process view. This objective can be achieved by activity analysis with multiple cost pools (activities) and cost drivers. Activity analysis provides a much better framework for understanding how and why costs are incurred (Brimson, 1991, p.68-73).

The main idea behind ABC is to classify indirect (overhead) costs and to allocate them to customer required products or services, based on the activities

needed to produce these products. (Raz and Elnathan, 1999, p.61-66). The development of ABC has involved its application to a variety of manufacturing, wholesale, retail and service sector organizations. Moreover, its use has extended beyond purely product costing to a varied range of cost management applications (Wilson, 1997, p.272-293).

ABC is a costing method that is designed to provide managers with cost information for strategic and other decisions that potentially affect capacity and therefore "fixed cost"(Garrison and Noreen, 2003, p.316). ABC is not a separate accounting system. It merely draws data from the same accounting database used to prepare the financial statements for external users. (Baxendale, 2001, p.63-68).

2.2.2 Identifying Activities

Kaplan and Atiknson defined activity as a unit of work or task with a specific goal and classified them into four broad classes of activities: Input activities, processing activities, output activities and administrative activities that support the first three main activities. An activity is any discrete task that an organization undertakes to make or deliver a product or service (Ittner,1999, p.492-493). The process of combining activities into functions is referred to as aggregation. Aggregating activities common to a function provides a basis for directing management attention to high-cost areas that might otherwise be obscured in numerous individual activities. The process of breaking down an activity into tasks is referred to as decomposition. Tasks, being the work elements of activities, are at the appropriate level for introducing change. Performance improvements are best achieved by decomposing activities into tasks and then restructuring the tasks (Brimson, 1991, p.47-49).

ABC systems in manufacturing organizations typically recognize five levels of activities: unit-level activities, batch-level activities, product-level activities, facility level (organization-sustaining) activities, customer-level activitie (Cooper, 1990, p.4-14). Unit level which occur each time a unit of product is made; batch level, which are related to the production of groups of units ; the product level, which supports a specific product or product line made by a company; and the facility level, which are performed to benefit the production process as a whole and therefore are not related to any specific product, batch or unit of production (Edmonds et al., 2000, p.243-247). A fifth activity is the customer-level activities related to specific customers and includes activities that are not tied to any specific product (Garrison and Noreen, 2003, p.323-324).

Activities are classified as repetitive or non-repetitive. A repetitive activity is what the organization does on a continual basis, while a non-repetitive activity is a one-time activity and is managed within a project management system. Activities are either primary or secondary. A primary activity contributes directly to the mission of a department or organizational unit, while a secondary activity supports an organization's primary activities. Secondary activities are general activities carried out in support of the whole or part of an organizational unit's primary activities. An activity is either required or discretionary. A discretionary activity is optional.(Brimson, 1991, p.54-56).

Cost Drivers

The linkage between activities and cost objects is done by activity cost drivers. A 'cost driver' is a factor that causes, or "drives" an activity's costs (Maher et al., 2001, p.131). Another brief definition of a cost driver is any factor having a cause-and-effect relationship with a cost object (Edmond et al., 2000, p.194). The two kinds of cost drivers are resource drivers and activity drivers. A resource driver is a measure of the quantity of resources consumed by an activity. An activity driver is a measure of frequency and intensity of demands placed on activities by cost object (Blocher et al., 1999, p.95). In implementing an ABC system the selection of cost drivers is a major issue since accuracy must be traded off against the complexity of the ABC system. On the one hand, a high accuracy in allocating overhead costs often requires a high number of cost drivers. A small number of cost drivers are desirable to achieve acceptable information cost and to make the ABC-system easier for management to understand (Homburg, 2001, p.23).

Grouping all similar cost drivers into cost pools is also needed. All of the cost associated with a particular cost driver would be grouped into cost pools. These cost pools would be subsequently applied to the product line(s) using cost driver rates based upon the number of transactions for the cost driver (Russel,199, p.38-39). An activity cost pool is a grouping of overhead cost assigned to an activity identified in an ABC system. A homogeneous cost pool is a grouping of overhead cost in which each cost component is consumed in roughly the

same proportion by each product line (Spedding and Sun, 1999, p.289-301).

2.2.4 Motivations for Implementing Activity Based Costing

The motivation to implement ABC comes from the need to first of all understanding cost management in all its aspects. ABC is recognized as a beneficial and powerful cost analysis tool, capable to identify the causes and effects of costs related to cost objects. By identifying the costs of all activities, a company can attempt to eliminate, or at least minimize the costs related to those activities that do not add value to the product (Kreuze and Gale, 2001, p.39-41). Given that cost information generated by ABC is indeed different, management will use it for significant decisions. Managers must regard ABC information as superior (Gordon and Silverster, 1999, p.230-248). Cost leadership is a business strategy for achieving competitive advantage. ABC is critical to this strategy because it identifies key activities, drivers and ways to improve processes to reduce cost. ABC helps managers to understand the relationship between the firm's strategy and the activities and resources needed to put the strategy into place (Blocher et al., 1999, p.102-107). ABC reduces distortions caused by traditional cost allocations, provide a clear view of how the mix of a firm's diverse products, services and activities contributes to the bottom line in the long run (Russell, 1997, p.38-40).

2.2.5 Design of an Activity Based Costing System

Designing an ABC system basically consists of four steps: identify activity centers, assign resource costs to activity centers; identify outputs or cost objects and link activity costs to cost objects using cost drivers.(Maher et al 2001, pp.132-134). ABC system designers can choose from three different types of activity cost drivers: First, Transaction drivers - are the least expensive type of cost driver but could be the least accurate and are simple counts of the number of times an activity occurs. Duration drivers are measures of the amount of time required to perform an activity. In general, are more accurate measures of the consumption of resources than transaction drivers, but they take more effort to record. For this reason, transaction drivers are often used in practice (Garrison and Noreen, 2003, p.324).

There are two stages in the ABC model. In the first stage, costs are assigned to cost pools within an activity center, based on a cost driver. In the second stage, costs are allocated from the cost pools to a product based on the product's consumption of the activities (Campbell et al., 2001, p.106-107). The implementation process of ABC requires accountants to follow some major steps. First, to identify the activities that consume resources and assign costs to those activities. Then identify the cost drivers associated with each activity and compute a cost rate per cost driver unit. Finally, to assign costs to products by multiplying the cost driver rate times the volume of cost drivers consumed by the product (Maher et al., 2001, p.131-134).

3. JPMC PROFILE

3.1 Production

Phosphate bearing deposits were first discovered in Jordan in 1908 in the Al-Rusaifa region during the construction of the Al-Hijazi railroad, By 1962, JPMC commenced operations at Al-Hassa mine and in 1979 the company expanded operations to include the Al-Abiad mine. In 1988 JPMC began mining Eshidiya, which is the newest and largest mine. JPMC holds the only Jordanian license, allowing it to enjoy a monopoly in mining phosphate within the Kingdom for an unlimited period of time.

3.1.1 Eshidiya Mine

Eshidiya mines, which covers an area of approximately 258 km^2, is located in the south of Jordan, approximately 125 km north-east of the port at Aqaba. Phosphate deposits were discovered in the Eshidiya region in 1975 and, following Government exploration and feasibility studies, JPMC took over implementation of the mining project in 1987. Phosphate rock production commenced at Eshidiya in 1988. In 1999 a new deposit with 62 million mt proven reserves of a high grade was discovered in the Upper Horizon area at Eshidiya. The phosphate bearing deposits occur in five layers at Eshidiya (layers A1, A2 and A3 throughout the mine, including two layers in the Upper Horizon area S1 and S2).

3.1.2 Hassa and Abiad Mines

Al-Hassa and Al-Abiad mines are located approximately 20 km apart, some 130 km south of Amman. Each of the mines has a railway terminal linking it to the port at Aqaba.. The mines at Al-Hassa and Al-Abiad, each covering an area of approximately 25 square km, were, until the development of Eshidiya in 1988, the main mining and production sites of JPMC.

3.1.3 Al-Ruseifa

The mine at Al-Rusaifa commenced production in 1935. However, due to depletion of economically exploitable reserves, this mine has been dormant since 1985.

3.1.4 Fertilizer Complex: Plants and Products

Aqaba fertilizer complex consist of several separate plants: sulfuric acid, Phosphoric Acid, Diammonium Phosphate (DAP), Aluminum Fluoride and utilities. The following are the products manufactured from the plants at the Fertilizer complex:

Sulfuric Acid; Phosphoric Acid; Diammonium Phosphate; Aluminum Flouride.

3.1.5 Phosphate Production Processes

The following processes are to be considered in phosphate production: Stripping Operation: Stripping of phosphate rock is carried out by mechanized open cast stripping techniques using electric walking draglines with various bucket capacities.

Mining Operations: Mining operations begin after removing the waste above the phosphate layers. The uncovered phosphate rock is then loosened and then loaded into dump trucks for hauling to crushing and screening plants at the mine sites.

Crushing and Screening Processes: The phosphate rock requires either screening or both crushing and screening depending on grain size and hardness of the phosphate rock.

Beneficiation: Beneficiation means upgrading the screened phosphate using water. There are two types of beneficiation: Washing and flotation which is the process of seperating coarse and fine streams of Silica.

Drying Process: Drying process is performed using rotary dryers to turn over phosphate particles and exposes it to get rid of the water content.

Dedusting: This stage is required only for the screened product to get rid of the soft particles of the phosphate product (Dusts) as per the environmental requirements.

Transportation and Storage: After all processing operations the final product must be transported either to Aqaba or to fertilizer complex or to Joint ventures.

4. THE PROPOSED ABC MODEL

4.1 Methodology

The focus of designing the proposed ABC Model is identifying Eshidiya mine activities and their classifications into either primary and secondary activities. The first step taken was identifying activities. The second step of the designing process consisted in selecting activity cost drivers. The proposed ABC model will focus on Eshidiya, because this mine involves all the process stages in the phosphate industry and it has new production lines, layers, equipments and facilities. The proposed ABC Model will be designed as sub models for stripping and mining, crushing and screening, internal transportation, flotation and beneficiation, drying, de-dusting and handling and transportation. Each one of these stages represents a major case requiring a model in order to clearly show the production and cost flows. After that the sub models must be combined into a comprehensive model, which represents the complete proposed ABC Model.

By implementing the proposed ABC Model, JPMC departments that have traditionally served as cost centers, will be replaced with activities. The indirect costs assigned to each activity comprise an activity cost pool. After assigning indirect costs to activity cost pool in stage one, cost drivers are identified that are appropriate for each cost pool. Then in stage two, the indirect costs are allocated from each activity cost pool to each product line in proportion to the amount of cost driver consumed by the product line (Romney and Steinbart, 2000, p.535-538).The design of an ABC system involves two cost assignment stages: The first stage relates to activity analysis when resource costs are traced to activities through resource drivers; the second stage relates to identifying cost pools and cost drivers in order to distribute activity costs to the cost objects (Cokins, 1993, p.195).

4.2. Activity Analysis

The activity analysis stage starts with the identification of activities Performed; resources and their costs. The next step is mapping of resource costs to activities in which classifying them into primary and secondary based on an underlying activity dictionary is exteremely important. An important step in this phase is to draw up a detailed list of cost elements. The main JPMC cost elements that go into all JPMC cost objects, are labor, equipment costs, material costs and overhead costs. JPMC cost elements are classified to sub-elements into 19 major groups and each group is made up of many sub cost elements. (Table 1 Appendix).

Primary Activities: Based on this survey, the researcher was able to prepare an activity dictionary for primary and secondary activities. Tables (2,3,4/ Appendix) are the main functions performed in the production department and their final total cost will be distributed to the products based on suitable cost drivers. Table (2) shows the primary production activities.

Secondary Activity: A secondary activity is one that is consumed by primary and other secondary activities. Secondary activities are not production activities but are activities that concern more than one production or support activity. Secondary activities are sustaining activities carried out in support of the Eshidiya Mine primary activities. The cost of secondary activities will be distributed in the final stage to production lines. The secondary activity cost distribution to other activities depends on the activity consumption based on the cost driver rate. The secondary activities include support activities and general activities, as in tables (3) and (4)/Appendix.

Table (4) consists of the 13 general activities. General activities serve production operations but they cannot be counted as separate units; Unlike support activities, which can be counted and distributed to primary and other support activities, general activities cost drivers differ from the production and support cost drivers in that they rely on statistical figures concerning human resources rather than on actual consumption figures. The 'G', in table (4), stands for general activity.

4.3 Calculating Activity Costs

The activities that contribute to each expense are identified and the Expense-Activity-Dependence (EAD) matrix is created. The expense categories are listed in the rows of the EAD matrix whereas the activities identified are listed in the columns. If the activity (j) contributes to the expense category (e) a check-mark is placed in the cell (j,e). Each cell that contains a check-mark is then replaced by a proportion of the expense based on an expense resource driver. To obtain the JD values of each activity the following equation is applied.

$$TCA(i) = \sum_{e=1}^{n} EAD(i,e) + A(i)$$

where :

TCA (j) = Total cost of activity j

n = number of expense categories

e = JD value of expense category e

EAD (j, e) = Entry j, e of Expense-Activity- Dependence matrix

A (j) =Total indirect cost of activity j

In this research, JPMC's main cost objects will only refer to finished grades of phosphate from the Eshidiya mine. These products are listed in (Table (5/Appendix). 'A1'in this table stands for raw phosphate rock found at the first layer. Subsequently, A2 and A3 are the same found at the second and third layers. These come from the main Eshidiya mines1and 2.'S2'stands for raw phosphate rock from the Upper Horizon mine, which is a mine located separately from the main Eshidiya mines 1 and 2.

4.3.1 Calculating the Cost Driver Rate for Each Activity

The cost driver rate for each activity cost pool is calculated by dividing the total annual cost of each cost pool by the total annual quantity of the activity measure associated with each cost pool. This is stated more precisely in equation form:

Rj = ACj / AQj where :

Rj = the cost driver rate for activity j.

ACj = costs of activity j

AQj = quantity of activity

j = the number of the activity

4.3.2 Calculating the Total Cost of Each Product

Total cost of each product is equal total direct cost plus total indirect cost. Total indirect cost is determined by multiplying the activity cost driver rates by the activity quantities associated with each product as follows:

$$Ci = Di + \sum_{i=1,\, j=1}^{m,n} Rj \times Aji$$

where :

Ci = Total cost of product *Di* = Direct cost of product i

Rj = Activity cost driver rate for activity j

Aji = Quantity of activity j consumed by product i.

j = Number activity. *i* = Number of product

4.3.3 Calculating the Product's Unit Costs

Calculating each product's unit costs is performed by dividing the total costs for each product i by the number of units of product i produced. The final costs assigned to a product are called a cost object. Cost drivers are used to assign the costs of activities to products.

4.4 The Use of EXCEL to Build the Proposed ABC Model

The model has been developed using a standard

software spreadsheet package. The model uses Excel worksheets, which were designed to provide fully automated self-calculation. The ABC costing models include Excel worksheets with accounts, account costs, activities, cost drivers, cost pools and driver quantities. The bottom line in developing an ABC model is to identify the activities that will be present in the production process of a product and afterwards assign reliable cost drivers and associated consumption intensities to the activities. After identifying the hierarchy of JPMC resources, activities, cost drivers and cost objects, the researcher used Excel to build the proposed ABC model due to its straightforwardness and inexpensive cost.

The Input worksheet contains all the input data which is required to perform the necessary calculations and carry out further analysis of the results. The output worksheets contain the output results from the calculations and links built into the model. For each sub-model there exists an output sheet. In the proposed ABC Model, all accounting entries must be prepared based on the activities symbols in the activities tables and drivers as in tables (2, 3 and 4) in order for users to input activity financial data. Technical reports must be changed to show activities quantity details, where each activity in the input worksheet has a column to input activity cost elements and a column to input distributed cost driver quantities, in order to obtain the JD values of each activity and the activity cost rate applied for each activity. A model is built by entering all data and relationships into a software model to calculate cost driver rates, cost of activities, processes, products, services and other factors.

Cost elements table (1) and special calculation equations and links were entered into Excel workbooks to start the calculation of activity costs. The equations that the researcher used to calculate activity costs is consisted of activity consumption amount of resources and activity consumption amounts from other activities. These amounts in turn, are distributed to other activities based on its cost driver. Calculating the costs of the final product grades, as in table (5), is calculated separately per each grade in each process stage, on separate Excel worksheets, in order to calculate the cumulative cost for each final product in an automated fashion. This section undertakes creating the proposed ABC Sub Models. This is the most important step in the design of an ABC information system. Each sub-model has a set of resources, resource drivers, activities, activity cost drivers, cost pools and cost objects. The proposed ABC Model for the mining industry will be constructed for the Eshidiya mine. The sub models that embody the whole study methodology of the research consist of support, general and production models, as follows:

4.4.1 Support Activities Sub-Model

Support activities costs are allocated to the support, general and production activities, based on the consumption ratio. table (6/Appendix) shows the allocation process and calculation, for the maintenance, mining equipment, general and site administration activities. The ‘S’ represents the support activities as in table (3) and the ‘x’ represents the activities consumption amount of resources. The ‘y’ represents the consumption amount from other general and support activities. The ‘XY’ represents the support activities total cost.

4.4.2. General Activities Sub-Model

The cost of general activities includes the sum of the cost element used plus its portion of indirect cost from support activities. General activities have the same idea as in the support models, which demonstrate how support activities consume cost elements and how they are distributed to production activities in the final stage. The ‘x’ in table (7/Appendix) represents the activities consumption amount of resources. The ‘y’ represents the consumption amount from other general and support activities. The ‘XY’ represents the general activity total cost.

4.4.3 Production Activities Sub-Model

There are 9 Production Activities sub-models, namely: Stripping, Stripping Transportation, Mining, Mining Transportation, Crushing and Screening, Internal transport, Beneficiation and Flotation, Dryer and Deduster and finally Shipping.

4.4.3.1 Stripping Sub-Models

Table (8/Appendix) portray how stripping activities consume resources. The dragline-stripping symbol ‘P1-1’ relates to stripping area 1. There are 4 draglines and consequently 4 stripping areas. The ‘x’ represents the activities consumption amount of resources .The ‘y’ represents the consumption amount from support and general activities. The ‘XY’ represent the total cost for each dragline stripping activities which will be divided by each activity quantity to determine stripping (Bench

Cubic Meter) BCM cost .Table 9/Appendix shows conventional equipment stripping and its direct and indirect cost items. symbol ‘P2-1’ relates to conventional equipment stripping in area 5, whereas symbols ‘P3-1 to P3-10’ represent interwaste stripping of areas 1 to 5. The ‘y’ represents the consumption amount from support and general activities. The ‘XY’ represents the activity total cost for each conventional equipment stripping activity, which will be divided by activity quantities to determine conventional equipment stripping BCM cost.

In each area, the total cost of stripping is calculated as in the following equations. The symbol ‘P1’ relates to a stripping area while ‘P3’ relates an interwaste level. So, P1-1 is a primary stripping dragline activity in area 1 (Table 8) and P3-1 and 2 is interwaste in levels 1 and 2 (Table 9). This applies to all the calculations.

Total cost stripping area 1= cost of activity P1-1 + cost of activity P3-1 + cost of activity P3-2(1)

Table (10/Appendix) shows contractor stripping activities, where symbol ‘P4-1 and P4-2’’ relate to Contractor stripping in areas 6 and 7, the ‘x’ represents the contractor stripping activity costs or the contractor invoice amount for stripping quantity in areas 6 and 7, and the 'y' represents the consumption amount from mining administration activity. The ‘XY’ represents total cost for each activity contractor stripping which will be divided by each activity quantity to determine the contractor stripping BCM cost.

4.4.3.2 Stripping (Overburden and Interwaste) Transportation Sub-Model

Table (11/Appendix) shows transportation of stripping overburden and interwaste activities cost calculation, where symbol ‘P5-1’ relates to transportation of overburden area 5, whereas ‘P5-2 to P5-6’’ relate to transportation of interwaste for areas 1 to 5; the ‘y’ represents the consumption amount from support and general activities based on the activity cost driver quantity and cost driver ratio; the ‘YY’ represents total cost for each stripping transportation activity, which will be divided by activity quantities to determine stripping transportation BCM cost.The following calculations is performed. Where ‘P5’ stands for stripping transportation activities:

Total cost of transported stripping area 2 = Total cost of stripping area 2 + cost of activity P5-3(2)

4.4.3.3 Mining Sub-Model

Table (12/Appendix) shows how mining activities consume resources, where symbols ‘P6-1 to P6-15’ relate to mining of A1, A2 and A3 in areas from 1 to 5; the ‘y’ represents the consumption amount from support and general activities; the ‘XY’ represents the total cost for each mining activity, which will be divided by each activity quantity to determine JPMC mining BCM cost.

The following equation represents how the proposed ABC Model calculates the mining costs of JPMC mined products:

Cost of JPMC mined product of predetermined area =current cost of layer mining + Total cost of transported stripping of the area x (quantity of the mined product in the predetermined area / total quantities of mined products of the predetermined area).

Table (13/Appendix) concerns contractor mining. The symbols ‘P7-1 to P7-4’ relate to contractor mining of A1, A2, A3, S1 and S2 in areas 6 and 7.

The ‘x’ in (Table 13) represents the contractor mining activity costs or the contractor invoice amount for mining quantity in areas 6 and 7. The ‘XY’ represents total cost for each activity contractor mining, which will be divided by each activity quantity to determine the contractor mining BCM cost.

The cost of mined quantity of grades in areas 6 and 7 are calculated based on the following equations where ‘P7’ stands for contractor mining activities:

Cost of mined A1 area 6 = cost of activity P7-1 + Total cost of transported stripping of area 6 x (quantities of A1 area 6/ total mined quantities of area 6)(3).

4.4.3.5 Mining Transportation Sub-Model

Table (14/Appendix) concerns transportation symbols ‘P8-1 to P8-15’ that relate to transportation of (Run of Ore Mine) ROM A1, A2 and A3 to areas 1 to 5. The ‘y’ represents the consumption amount from support and general activities based on the activity cost driver quantity and cost driver ratio. Whereas the ‘YY’ represents the total cost for each mining transportation activity, which will be divided by each activity quantity to determine JPMC transportation mining BCM cost.

When determining the mining transportation activities cost, the cost of transported (Run of Ore Mine) ROM for each grade is calculated as in the follows:

Cost of transported ROM A1quantity from area 1 = cost of activity P8- + Cost of mined A1 area1(4)

The table (15) concerns contractor transportation; Symbols ‘P9-1 to P9-5’relate to contractor transportation of ROM A1, A2, A3, S1 and S2 to areas 6 and 7. The ‘x’

in table (15) represents the contractor transportation activities costs or the contractor invoice amount for transported quantity in areas 5, 6 and 7.

The 'XY' represents total cost for each activity contractor's transportation, which will be divided by each activity quantity to determine the contractor transportation BCM cost. After determining the contractor transportation activities cost, the cost of transported each (Run of Ore Mine) ROM in areas 6 and 7 is calculated as follows:

Cost of transported ROM A1 area 6 = cost of activity P9-1 + Cost of mined A1 area 6(5)

4.4.3.6 Crushing and Screening Sub-Model

Table (16/Appendix) concerns crushing and screening processes. The symbols 'P10-1 and P10-2' relate to crushers 1 and 2, whereas the symbols 'P11-1 and P11-2' relate to screens 1 and 2. The 'x' represents the activities consumption amount of resources. The 'y' represents the consumption amount from general and support activities based on the activity cost driver quantity and cost driver ratio. The 'XY' represents the current total cost for each crusher.

The relationship between previous models and crusher model is shown in the following equations:

Total Cost of feed to crusher 1 =

Cost of transported A1 by JPMC x (quantity of A1 delivered to crusher 1/total quantities of A1 delivered to crushers) + Cost of transported A3 by JPMC (quantity of A3 delivered to crusher 1/total quantities of A3 delivered to crushers)(6)

Consequently the crusher or screener accumulated cost is calculated as in the following equation:

Total Cost of crusher 1 production = cost of activity P10-1 + Cost of feed to crusher 1

Depending on the above equations, the cost of JPMC crushed products are calculated as in the following:

Cost of crushed A1 =

Total Cost of crusher 1 x (screened quantities of A1 of crusher 1/total screened quantities of crusher 1) + total Cost of crusher 2 x (screened quantities of A1 of crusher 2 /total screened quantities of crusher 2)(7)

Calculated total cost for crushers are as in the following equations:

Total Cost of contractor crusher No =Cost of activity P13-1 + Cost of feed to contractor crusher 1

Total Cost of contractor crusher No2 =Cost of activity P13-2+ Cost of feed to contractor crusher 2

4.4.3.7 Internal Transport Sub-Model

The table (18/Appendix) shows how internal transport activities consume resources. The symbols 'P12-1 to P12-2' relate to Internal Transport for lines 1 and 2. The 'x' represents the activities consumption amount of resources. The 'y' (represents the consumption amount from other general and support activities based on the activity cost driver quantity and cost driver ratio. The 'XY' represents the total current cost for each conveyor belt.

Total Cost of internal transport belt conveyor line 1 = cost of activity P12-1 + Cost of crushed A1 JPMC.

Total Cost of internal transport belt conveyor line 2 = cost of activity P12-2 + Cost of crushed A3 JPMC.

Table (19) concerns Contractor Internal Transport. The symbols 'P14-1 and P14-2' relate to Internal Transport by Contractor 1 and 2. The equations that will be used to determine the cost of transported screened phosphate for contractors and for each transported grade as follows:

Total Cost of transported screened phosphate of contractor No 1 = Cost of activity P14-1 + Cost of contractor crusher No 1(8)

4.4.3.8 Beneficiation and Flotation Sub-Model

Table (20/ Appendix) concerns washing and flotation. The symbols 'P15-1 and P15-2' relate to washing lines 1 and 2, whereas symbol 'P16-1' relates to flotation line No 1. The 'x' represents the activities consumption amount of resources. The 'y' represents the consumption amount from other general and support activities. The 'XY' represents the total current cost for each washing and flotation lines which will be distributed to grades. The following equations represent main equations in washing and flotation sub-model:

Total Cost of feed to beneficiation line No 1 =

Cost of internal transport belt conveyor line 2 x (quantity of A3 feed to beneficiation line No 1 / total transported quantities by belt conveyor line No 2) + Cost of transported screened contractors S2 x (quantity of S2 feed to beneficiation line No 1 / total transported quantities of contractors S2) + Cost of transported screened contractors A3 x (quantity of A3 feed to beneficiation line No 1/total transported quantities of contractors A3)(9)

4.4.3.9 Dryers and Dedusters Sub-Model

Table (21/Appendix) shows how drying and de-

dusting activities consume resources. The symbols 'P17-1,p17-2 and P17-3' relate to dryers 1, 2 and 3. While the symbol P18-1 relates to the deduster process. The 'x' represents the activities consumption amount of resources. The 'y' represents the consumption amount from other general and support activities. The 'XY' represents the total current cost for each washing and flotation lines which will be distributed to grades. After identifying the current cost of beneficiation and flotation lines, washed and floated quantities feed to dryers and quantities feed to deduster, a proposed dryer and deduster model for calculating cost of feed to dryers and accumulated cost of dry production is as follows :

Total Cost of feed to dryer 1 = Cost of beneficiation line No 1 x (quantity of washed A1 feed to dryer 1 / total quantity washed quantity of A1)[10].

4.4.3.10 Shipping Sub-Model

Table (22/Appendix) concerns shipping activities. The symbols 'p19-1 and p19-2' relate to the storing yard.

The 'x' represents the activities consumption amount of resources. The 'y' in represents the consumption amount from other general and support activities .The 'XY' in represents the current external transport total cost which will be distributed to final products .

4.5 Cost of Final Products

The previous equations in the proposed ABC model calculation worksheets demonstrated how to calculate the cost of each activity and distributed this cost to the final product. Based on these equations the cost of each product stated in table (5) is as follows:

The cost of A1S2 (62-67%) washed (to Aqaba)

Cost of A1S2 (to Aqaba) = Cost of dryer No 2 + cost of activity P19-1 x (quantity of A1S2 transported to Aqaba / total quantity transported to Aqaba).

The cost of A1S2 (65-67%) crushed

Cost of A1S2 (65-67%) crushed = Cost of transported screened contractors A1 x (quantity of A1 to be mixed as A1S2 (65-67%) / total produced quantity of A1) + Cost of transported screened contractors S2 x (quantity of S2 to be mixed as A1S2 (65-67%) / total produced quantity of S2) + cost of activity P19-1 x (quantity of A1S2 (65-67%) transported to Aqaba / total quantity transported to Aqaba).

The cost of A2 (68-70%) crushed

Cost of A2 (68-70%) crushed = Cost of internal transport belt conveyor line 3 x (quantity of A2 (68-70%) transported / total produced quantity of A2) + cost of activity P19-1 x (quantity of A2 (68-70%) transported to Aqaba / total quantity transported to Aqaba).

The cost of A2 (70-72%) crushed

Cost of A2 (70-72%) crushed = Cost of internal transport belt conveyor line 33 x (quantity of A2 (70-72%) transported / total produced quantity of A2) + cost of activity P19-1 x (quantity of A2 (70-72%) transported to Aqaba / total quantity transported to Aqaba).

The cost of A2 (73-75%) dedusted

Cost of A2 (73-75%) dedusted = Cost of deduster + cost of activity M21-1 x (quantity of A2 (73-75%) transported to Aqaba / total quantity transported to Aqaba).

The cost of S2 (75-77%) crushed

Cost of S2 (75-77%) crushed = Cost of transported screened contractors S2 x 3 x (quantity of S2 (75-77%) transported / total produced quantity of S2) + cost of activity P19-1 x (quantity of S2 (75-77%) transported to Aqaba / total quantity transported to Aqaba)

The cost of A3 floated

Cost of A3 floated = Cost of dryer 3 + cost of activity P19-1 x (quantity of A3 transported to Aqaba/total quantity transported to Aqaba)

The cost A3S2 washed (to Aqaba)

Cost A3S2 washed (to Aqaba) = Cost of dryer No 1 + cost of activity P19-1 x (quantity of A3S2 transported to Aqaba / total quantity transported to Aqaba)

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The researcher came up with the following conclusions:

(1)The traditional cost accounting system currently applied at JPMC is made up of traditional production cost measures. Phosphate mining is a complex process due to the intermingling of the many activities making it difficult to determine the suitable cost center and cost driver.

(2)ABC is based on a cost accounting philosophy that links cost elements to production activities. One useful method of ensuring consistent definitions of activities is to use an activity dictionary to determine typical activities in a department. The process of preparing the activity dictionary for the proposed ABC model, called for identifying the primary and secondary Eshidiya mine activities, determining the drivers for these activities,

aggregating activities into homogenous cost pools and selecting activity measures to represent each pool categories of activities and consumption expenses.

(3)In the proposed ABC model, costs are allocated according to the 'cause and effect' relationship between activities (the actual process) and the cost objects, which is captured by using cost drivers related to the actual process. Identifying and measuring cost drivers are the hardest part of designing a proposed ABC model.

(4)The proposed ABC model allows JPMC to gain an understanding of its cost structure from a process perspective and to find the real value of its product often in the form of inventory. It also can help management understand its manufacturing processes, overhead consumption and manufacturing efficiency.

(5)The proposed ABC model can be used to better manage activities and help in Activity-Based Management. Activity-based management is a system built on an integrated approach that focuses management's attention on activities with the objective of improving customer value and the resulting profit. Activity-based management has the objective of increasing customer value by managing activities.

(6)ABC provides a wealth of data and information that can be used in a variety of analyses. ABC data can be used to provide feed-forward data that can be used for target costing.

5.2 Recommendations

With conclusions cited above the researcher recommends the following :

(1) Maintaining the current cost accounting system while gradually implementing ABC in JPMC's numerous departments and plants. This parallel work will avoid disrupting the flow of cost information, until ABC can fully replace the old system.

(2) Due to the complexity of the model, and the numerous details incorporated in it. There is an urgent need for the implementation of the Enterprise Resource Planning (ERP) as one of the requirements or prerequisites to the successful implementation of ABC. ERP attempts to integrate all departments and functions across a company into a single computer system that can serve all departments' particular needs.

(3) Even though numerous data in building the model was used, JPMC needs to take into account that additional new data maybe required in the future and should be added or amended to suit the model. This will require different quantities and types of information than that which is currently used in JPMC as input data. New data collection techniques and analysis need to be planned for. Rearrangement of data may also be required.

(4)The initial complexity of ABC requires proper training in ABC procedures. Training is needed until employees gain the necessary experience in the ABC process. All participants should be trained in the Excel computer model, which will help ensure that participants use uniform data collection techniques.

(5)The proposed ABC model is done in Excel due to the lack of time and availability of specialized programmers, but the researcher recommends choosing a modern programming language in the future, such as Oracle. Most of the ready-made ABC programs are written in Oracle.

NOTES

(1) This equation should be repeated for areas 2,3,4,5. However, for all subsequent equations, only, the first equation related for each sub model will be mentioned.
(2) The same equation will be applied for areas 3,4,5,6,7.
(3) Same equation for area 7 for layers 2 and 3, S1and S2.
(4) Same equation for layers 2,3 and areas 2,3,4,5.
(5) Same equation for areas 6,3 and layers 2,3
(6) Same equation is applied for crushers 2
(7) Same equation is applied for areas 2,3
(8) Same equation is applied for crusher 2 and for layers 1,2,3 and S1, S2 respectively.
(9) Same equation is applied to beneficiation line 2 and layers 1,2,3 and S1,S2.
(10) Same equation is applied for dryers 2,3 and feed quantities of A2, A3S2.

Table 1. Cost Elements

Code	Expenses
E1 – E19	Water, Electrical Power , Fuel Oil, Gases, Lubricants, Explosives, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries, Wages And Other, Bonuses and Overtime, Rental Charges, Vehicles and Equipment Rented, Maintenance and Repairs, Other Common Materials and Expenses, Contractors, Depreciation and Amortization Exp, Chemical Materials .

(E) Stands for cost element

Table 2. Primary Activities

Code	Primary Activity	Activity Driver	Activity Classification
P4	Contractor Stripping	Stripping Quantity	Unit-related
P5	JPMC Waste Transportation	Transported Quantity	Unit-related
P6	JPMC Mining	JPMC mining quantity	Unit-related
P7	Contractor Mining	Mining Quantity	Unit-related
P8	JPMC Phosphate Transportation	Transported Quantity	Unit-related
P9	Contractor Transportation	Transported Quantity	Unit-related
P10	JPMC Crushers	JPMC Crushers Quantity	Unit-related
P11	JPMC Screens	JPMC Screens Quantity	Unit-related
P12	JPMC Internal Transport	Internal Transport Quantity	Unit-related
P13	Contractor Crushers	Crushers Quantity	Unit-related
P14	Contractor Internal Transport	Transported Quantity	Unit-related
P15	Washing	Washed Quantity	Unit-related
P16	Flotation	Floated Quantity	Unit-related

(P) Stands for primary activity

Table 3. Support Activities

Code	Support Activity	Activity Driver	Activity Classification
S1	Maintenance Administration	Number of work orders	Product-sustaining
S2	Plant Mechanical Workshop	Number of working hours	Facility-sustaining
S3	Plant Electrical Workshop	Number of working hours	Facility-sustaining
S47	Surveying	Square kilometers of area	Batch-related
S48	Safety	Number of inspections	Facility-sustaining
S49	Training	Training hours	Facility-sustaining
S50	Cranes	Working hours	Facility-sustaining
S51	Power Supply	K.W.H Consumed	Facility-sustaining
S52	Water Supply	Cubic meters consumed	Facility-sustaining

Note: Due to the constraints of limited number of pages and as a result of large number of the support activities, the researcher will not declare all of them. This treatment will be done when needed.

Table 4. General Activities

Code	Support Activity	Activity Cost Driver	Activity Classification
G1	Mine Overhead	Production Quantities	Facility
G2	Strategic Planning	Working hours	Facility
G3	Human resources	Number of employees	Facility -sustaining
G4	General Accounting	Number of financial transactions	Facility-sustaining
G5	Cost Accounting	Number of production reports	Facility-sustaining
G6	Building Maintenance	Maintenance Hours	Facility-sustaining
G7	Information Technology	Computer Crew Working hour	Facility-sustaining
G8	Guarding	Production Quantities	Facility-sustaining
G9	Town Site Services	Number of employees in each production stage	Facility-sustaining
G10	Telecommunication	Number of external calls	Facility-sustaining
G11	Exploration Surveying	Production Quantities	Product-sustaining
G12	Agricultural Services	Production Quantities	Facility-sustaining
G13	General Services	Number of work order	Facility-sustaining

Table 5. Cost Objects

Type	1	2	3	4	5	6	7	8
Grade	A2 (68-70%)	S2 (75-77%)	A2 (70-72%)	A1S2 (65-67%)	A1S2 (62-67%) washed	A2 (73-75%) dedusted	A3 (73-75%) floated	A3S2 (73-75%) washed

Table 6.1. Maintenance Activities

Direct Cost

Code	**Cost Element**	**S2 – S17**
E2 – E 18	Electrical Power , Gases , Lubricants , Spare Parts , Consumables and Supplies , Building Materials , Salaries … etc	X X X

Indirect Cost

Code	**Support Activity**	**S2 – S17**
S1 – S52	Maintenance Admin. , Plant Mechanical Workshop , Plant Electrical Workshop , Plant Instruments Workshop , Fabrication Workshop … etc.	YYY
Total Cost		**XY XY XY**

Table 6.2. Mining Equipment

Direct Cost

Code	**Cost Element**	**S18 – S26**
E4 – E 18	Gases , Lubricants , Spare Parts , Consumables and Supplies, Salaries, Wages and Other ,Bonuses and Overtime, Maintenance and Repairs … etc.	X X X

Indirect Cost

Code	**Support Activity**	**S18 – S26**
S4 – S52	Plant Instruments Workshop , Heavy Vehicles Workshop, Fabrication Workshop , Lathing Workshop, Instrument Maintenance …etc.	YYY
Total Cost		**XY XY XY**

Table 6.3. General Support Activities

Direct Cost

Code	**Cost Element**	**S35 – S52**
E1 – E 18	Water, Electrical Power, Gases , Lubricants , Spare Parts , Consumables and Supplies, Building Materials, Salaries, Wages and Other … etc.	X X X

Indirect Cost

Code	**Support Activity**	**S35 – S52**
S9 – S52	Automobile Workshop, Carpentry Workshop, General Electrical Main., Equipment Inspection , Warehouse , Purchases and Supply … etc.	YYY
Total Cost		XY XY XY

Table 6.4. Site Administration

Direct Cost

Code	**Cost Element**	**S35 – S52**
E1 – E 18	Water, Electrical Power, Gases, Consumables and Supplies, Building Materials, Salaries… etc.	X X X

Indirect Cost

Code	**Support Activity**	**S1 – S56**
S41 – S52	Warehouse , Purchases and Supply, Medical Services, Transport, Safety, Training ,Computer Maintenance, Power Supply and Water Supply.	YYY
Total Cost		XY XY XY

Table 7. General Activities Sub-Model

Direct Cost

Code	**Cost Element**	**G1-G13**
E1 – E 18	Water, Electrical Power, Gases, Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries… etc.	X X X

Indirect Cost

Code	**Support Activity**	**G1 – G13**
S2– S52	Plant Mechanical Workshop , Plant Electrical Workshop ,Heavy Vehicles Workshop, Carpentry Workshop, General Electrical Maintenance ,Instrument Maintenance … etc.	YYY
Total Cost		XY XY XY

Table 8. Dragline Stripping

Direct Cost

Code	Cost Element	P1-1/ P1-4	Total JPMC
E2 – E 18	Electrical Power, Lubricants, Explosives, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials…etc.	X X	X X

Indirect Cost

Code	Cost Element	P1-1/ P1-4	Total JPMC
S5– S52 G1-G13	Dragline Mechanical Workshop, Dragline Electrical Workshop, Dragline Instruments, Fabrication Workshop, Lathing Workshop …etc.	YY	XY
Total Cost		XY XY	XY

Table 9. Conventional Equipment Stripping

Direct Cost

Code	Cost Element	P2-1/ P3-10	Total JPMC
E6	Explosives	X X	X X

Indirect Cost

Code	Cost Element	P2-1/ P3-10	Total JPMC
S27– S47 G1-G13	Shovels, Bulldozers, Graders, Electrical Drills, Hydraulic Drills, Blasting, Mining Administration, Surveying, Mine Overhead… etc.	YY	XY
Total Cost		**XY XY**	**XY**

Table 10. Contractor Stripping

Direct Cost

Code	Cost Element	P4-1/ P4-2	Total Contractor
E17	Contractors	**X X**	**X X**

Indirect cost

Code	Support Activity	P4-1/ P4-2	Total Contractor
S36	Mining Administration	YY	YY
Total Cost		**XY XY**	**XYXY**

Table 11. Stripping Transportation

Indirect Cost

Code	Support Activity	P5-1/ P5-6	Total
S27– S47 G1-G13	Trucks<50T, Bulldozers, Graders, Mining Administration, Mine Overhead Strategic Planning, Human resources management… etc.	YY	YY
Total Cost		YY	YY

Table 12. Stripping Transportation

Direct Cost

Code	Cost Element	P6-1/P6-15	Total JPMC
E6	Explosives	**X XX**	**X XX**

Indirect Cost

Code	Support Activity	P6-1/P6-15	Total JPMC
S27– S47 G1-G13	Shovels, Bulldozers, Graders, Electrical Drills, Hydraulic Drills, Blasting, Mining Administration, Quality Control, Laboratories, Surveying… etc.	YYY	Y
Total Cost		**XY XY XY**	

Table 13. Contractor Mining

Direct cost

Code	Cost Element	P7-1/ P7-5	Total Contractor
E17	Contractors	**X**	**X**

Indirect cost

Code	Support Activity	P7-1/ P7-5	Total Contractor
S36	Mining Administration	**Y**	**X**
Total Cost		**XY**	**XY XY**

Table 14. Mining Transportation

Indirect cost

Code	Support Activity	P8-1/ P8-15	Total
S28– S36 G1-G13	Trucks<50T, Bulldozers, Graders, Mining Administration, Mine Overhead, Strategic Planning, Human resources management, General Accounting… etc.	YY	YY
Total Cost		YY	YY

Table 15. Contractor Transportation

Direct cost

Code	Cost Element	P9-1/ P9-5	Total Contractor
E17	Contractors	**X**	**X**

Indirect cost

Code	Support Activity	P9-1/ P9-5	Total Contractor
S36	Mining Administration	**Y**	**X**
Total Cost		**XY**	**XYXY**

Table 16. Crushing and Screening

Direct cost

Code	Cost Element	P10-1/ P11-2	Total JPMC
E2 – E18	Electrical Power , Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries… etc .	XX	XX

Indirect cost

Code	Support Activity	P10-1/ P11-2	Total JPMC
S2 – S37 G1 – G13	Plant Mechanical Workshop, Plant Electrical Workshop, Plant Instruments Workshop, Rubber Workshop, Fabrication Workshop, Lathing Workshop… etc.	XX	YY
Total Cost		**XY XY**	**XY XY**

Table 17. Contractor Crushers

Direct cost from

No	Statement	P13-1/ P13-2	Total Contractor
E17	Contractors	X	X

Indirect cost from

S37	Crushers Administration	y	Y
Total Cost		**XY**	**XY XY**

Table 18. Internal Transport (Belt Conveyors)

Direct cost

Code	Cost Element	P12-1/ P12-2	Total
E2 – E18	Electrical Power, Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries… etc	XX	XX

Indirect cost

Code	Support Activity	P12-1/ P12-2	Total
S2 – S37 G1 – G13	Plant Mechanical Workshop, Plant Electrical Workshop, Plant Instruments Workshop, Rubber Workshop, Fabrication Workshop, Lathing Workshop, General Mechanical Maintenance … etc	YYY	YY
Total Cost		**XY XY**	

Table 19. Contractor Internal Transport

Direct cost from

Code	Cost Element	P14-1/ P14-2	Total Contractor
E17	Contractors	**XX**	**X**

Indirect cost from

Code	Support Activity	P14-1/ P14-2	Total Contractor
S37	Crushers Administration	**YY**	**Y**
Total Cost		**XY XY**	**XY XY**

Table 20. Washing, Flotation

Direct cost

Code	Cost Element	P15-1/ P16-1	Total
E1– E19	Water, Electrical Power , Gases, Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries … etc.	**XX**	**XX**

Indirect Cost

Code	Support Activity	P15-1/ P16-1	Total
S2– S38 G1-G13	Plant Mechanical Workshop, Plant Electrical Workshop, Plant Instruments Workshop, Rubber Workshop, Fabrication Workshop … etc.	**YY**	**YY**
Total Cost		**XY XY**	**XY XY**

Table 21. Dryer and De-Duster

Direct cost

Code	Cost Element	P17-1/ P18-1	Total
E1– E18	Water, Electrical Power , Fuel Oil, Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries… etc.	**XX**	**XX**

Indirect Cost

Code	Support Activity	P15-1/ P16-1	Total
S2– S50 G1-G13	Plant Mechanical Workshop, Plant Electrical Workshop, Plant Instruments Workshop, Rubber Workshop, Fabrication Workshop, Lathing Workshop, General Mechanical Maintenance… etc.	**YY**	**YY**
Total Cost		**XY XY**	**XY XY**

Table 22. Shipping

Direct cost

Code	Cost Element	P19-1/ P19-2	Total
E1– E18	Water, Electrical Power, Lubricants, Spare Parts, Consumables and Supplies, Structural Steel, Building Materials, Salaries… etc	XX	XX

Indirect Cost

Code	Support Activity	P15-1/ P16-1	Total
S2– S50 G1-G13	Plant Mechanical Workshop, Plant Electrical Workshop, Plant Instruments Workshop, Rubber Workshop, Fabrication Workshop, Lathing Workshop, General Mechanical Maintenance … etc.	YY	YY
Total Cost		XY XY	XY XY

REFERENCES

Baxendale, Sidney; *ABC for the small business*; 2001.

Blocher, C. Lin. 1999. *Cost Management – A strategic emphasis*, Irwin McGraw Hill, 95-107.

Brimson, J. 1991. *Activity Accounting; An Activity Based Costing Approach*, New York: John Wiley and Sons.

Campbell, R. Brewer, P. Mills, T. 2001. *Designing an Information System Using Activity Based Costing and the Theory of Constraints.* Readings in Management Accounting, Third edition. S. Mark Young - University of Southern California, Prentice Hall.

Cokins, G. 1993. *An ABC Manager's Primer: Straight Talk on Activity-Based Costing*, 1st ed. McGraw-Hill.

Cooper, R. and Kaplan, R. 2001. *How Cost Accounting Distorts Product Costs.* Readings in Management Accounting; 3d ed. S. Mark Young - University of Southern California, Prentice Hall.

Cooper, R. 1988. "The Rise Of Activity-Based Costing- part one" what is an Activity Based Costing System" *Journal of Cost Management*, Summer

Cooper, R. 1990. "Cost Classification in Unit-Based Management Cost Systems", Journal of Cost Management.

Edmonds, T. Edmonds, C. Tsay, B. 2000. *Fundamental Managerial Accounting Concepts*, 1st ed. Irwin McGraw-Hill.

Garrison, R. Noreen, E. 2003. *Managerial Accounting*, Tenth edition; McGraw-Hill Irwin.

Hansen, D. Mowen, M. 2003. *Management Accounting*; Sixth edition, South-Western.

Homburg, C. 2001. *A Note on Optimal Cost Driver Selection in ABC*, Management Accounting Research, published for CIMA.

Horngren, C., Foster, G. and Datar, S. 2000. "Cost Accounting: Managerial Emphasis; Prentic- Hall International Inc, Twelfth edition.

Horngren, C., Foster, G. and Datar, S. 1997. "Cost Accounting: Managerial Emphasis; Prentice-Hall International Inc, Ninth edition.

Ittner, C. 1999. "ABC Concepts for Quality Improvement" *European Management Journal*, Volume 17.

Johnson, T., Kaplan, R. 1987. *Relevance Lost: The Rise and Fall of Management Accounting*, Harvard Business School Press, Boston.

Kaplan, R. Atkinson, A. 1998. *Advanced Management Accounting*, Third edition, Prentice- Hall International.

Kreuze, J., Newell, G. 2001. *ABC and Life-Cycle Costing for Environmental Expenditures, the Combination Gives Companies a More Accurate Snapshot*, Readings In Management Accounting, 3rd, University of Southern California, Prentice Hall.

Maher, M., Stickney, C., Weil, R. 201. .*Managerial Accounting - An Introduction to Concepts, Methods and Uses*, Seventh edition, South-Western.

Miller, J., Vollman, T. 1985. *The Hidden Factory*, Harvard Business Review.

Raz, T., Elnathan, D. 1999. *Activity Based Costing for Projects*, International Journal of Project Management, Vol.17.

Romney, M. and Steinbart, P. 2000. *Accounting Information System*, 8ed Prentice-Hall International.

Russell, D. 1997. *An introduction to ABC.*

Spedding,T.A., Sun, G. 1999. "Application Of Discrete Event Simulation to The Activity Based Costing of Manufacturing Systems", *International Journal of Production Economics*".

Storey, R. 1995. *Introduction to Cost and Management Accounting*, MacMillan Business Press.

Trussel, J. Bitner, L. 1996. *As Easy as ABC; Re-engineering*

the Cost Accounting System.

Wilson, R. 1997. *Planning: Activity Based Information*. The International Library of Management, Vol. 1.

Zimmerman, J. 2003. *Accounting for Decision Making and Control*, McGraw-Hill Higher Education.

نظام محاسبة تكاليف الأنشطة
Activity Based Costing (ABC)
نموذج مقترح لصناعة الفوسفات
شركة مناجم الفوسفات الأردنية "حالة دراسية

خالد أمين ومروان ارشيدات*

ملخـص

هدفت هذه الدراسة إلى اقتراح نظام محاسبة تكاليف مبني على الأنشطة Activity Based Costing (ABC) بديلاً لنظام محاسبة التكاليف الحالي في شركة مناجم الفوسفات وذلك بعد التعرف إلى العديد من منافع تطبيق هذا النظام، إذ إن منطق علاقة السبب والنتيجة في تخصيص التكاليف الصناعية غير المباشرة يؤدي إلى نتائج صحيحة وأكثر دقة مقارنة بنتائج النظام الحالي الذي يعتمد في تخصيص التكاليف الصناعية غير المباشرة على أسس تقديرية ترتبط بالحجم. إن من أهم ركائز الأنظمة الإدارية الحديثة عند اختيار نظام محاسبة التكاليف هي أن يكون هذا النظام قادراً على توفير المعلومات الصحيحة التي تساعد الإدارة على مواجهة تحديات البيئة الصناعية الحديثة.فقد ارتأى الباحث إمكانية مواجهة تلك التحديات بتبني فكرة تطبيق نظام محاسبة التكاليف بالأنشطة خاصة وأن نتائج الدراسات السابقة قد بينت أن تطبيق هذا النظام يؤدي إلى التوصل إلى تكاليف صحيحة ودقيقة للمنتجات، كما يؤدي إلى تخفيض التكاليف من خلال التخلص من الأنشطة التي لا تضيف قيمة للمنتجات.

إن منهج الباحث في هذه الدراسة تمثل بعرض موجز لأدبيات نظام تكاليف محاسبة التكاليف بالانشطة (Activity Based Costing) لتعريف القارئ بالإطار النظري لهذا النظام ، حيث عرض بالتفصيل مقومات هذا النظام وإطاره النظري والمزايا التي يوفرها . وقد أوصى الباحث بأهمية قيام إدارة شركة الفوسفات بتوفير المتطلبات اللازمة لتطبيق هذا النظام واعتبار ذلك هدفاً تسعى اليه بما له من مزايا عديدة تناولتها الدراسة.

الكلمات الدالة: شركة مناجم الفوسفات، محاسبة تكاليف الأنشطة، الأنشطة الرئيسية، الأنشطة الثانوية، التكاليف الصناعية غير المباشرة، محرك الكلف، مجمع الكلف، نموذج الكلف، إكسل.

* الأكاديمية العربية للدراسات المالية والمصرفية، الأردن. تاريخ استلام البحث 2007/3/7، وتاريخ قبوله 2008/2/5.