



Costing, Activity-Based Costing and Time-Driven Activity-Based Costing - A comparative and conceptual study

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Abstract

The pursuit of optimal use of available resources is important to achieve the most considerable amount of returns. Time-driven activity-based costing (TDABC) offers great opportunities to enhance the quality of companies and outcomes while reducing costs. The innovation of Activity Based Costing (ABC) and, especially its newer variant, TDABC can be viewed as rediscovering this basic cost-accounting equation and applying it to all resources acquired and supplied by an organization. TDABC helps organisations to manage the resources efficiently in making and supplying the products to the customers at the lowest possible cost. Thus, when compared to traditional costing and ABC, TDABC helps the organisation in effective utilisation of resources and maximisation of its returns.

Key words: Costing - Activity Based Costing - Time-Driven Activity- Based Costing

Introduction

Cost Accounting

Traditional cost accounting has been the most favourable and common method for a long time. The process of assign manufacturing overhead costs to production units, the conventional method of accounting for costing has two main stages (Helles, 2007):

The first stage: in which the elements of costs (resources) are assigned to cost centres, based on some measures that provide the relationship for the use of those resources.

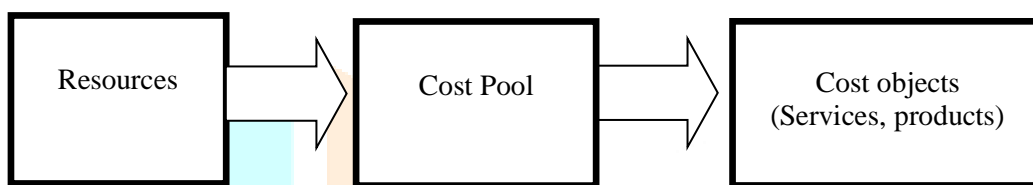
The second stage: cost centres allocated to the final products using some rates or allocation bases related to volume, such as the number of direct working hours consumed or machine hours used. Although the fact that many components of overhead costs are not connected on these bases, the value of these costs is not proportional to the number of units produced, as well as the nature of the elements of overhead costs themselves.

The traditional cost system ignores many important considerations in the company's activities and production operations when calculating the costs of products or services because it focuses on the volume of production and the number of units produced, and this leads to not allocating indirect costs

accurately to services and products. Thus, this affects management decisions, especially pricing decisions for products or services (Shaqfa, 2007).

The traditional cost method for allocating manufacturing overhead costs depends on the cost centres for assigning to final products using some rates related to volume, without taking into account the lack of many elements of manufacturing overhead related to volume. This method leads to inaccurate values for the elements of manufacturing overhead costs that include the cost of the final products. This basis for allocating the manufacturing overhead costs does not take into account resource consumption, which may reduce the effectiveness of the traditional cost method as a key tool for measuring the cost of products (Youssef, 1998).

The concept and method of allocation manufacturing overhead costs on products and services can illustrate in figure 1.



Source: Horngren, 2013

The traditional cost system ignores many important considerations in the enterprise's activities and production operations when calculating the costs of products or services, as it focuses on production volume and the number of units produced. The costs are distributed on the basis that the products and services are the ones that consume the resources. Thus, the traditional allocation bases relate to the product units, which in turn lead to manufacturing overhead costs not allocated accurately to the services and products (Jeyaraj, 2015).

Cost accounting allows the measurement and provides cost information; however, the measurement of cost is more difficult to be determined for the provided services, based on the traditional costing methods which depend on allocating the cost based on non-logical criteria, which will lead to allocate unjustifiable cost to the final product at the end, regardless if these costs are associated directly or indirectly with the product (Hardan & Shatnawi, 2013)

The traditional cost system ignores many important considerations in the company's activities and production processes when calculating the costs of products or services, because it focuses on the volume of production and the number of units produced. This leads to the non-allocation of indirect costs to services and products, and thus this affects the management decisions and especially the pricing decisions for products or services (Baroud, 2007).

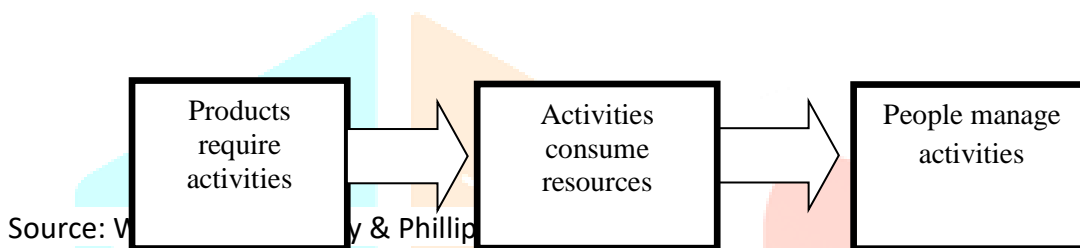
By the 1980s, the standard cost systems designed during the scientific management movement seventy-five years earlier no longer reflected the current economic reality. Companies were now operating with distorted information about the profitability of their orders, products, and customers. For example, while traditional cost systems might show that all customers were profitable, the economic reality was that a minority of customers earned between 150 and 300 percent of profits, and unprofitable customer relationships lost 50 to 200 percent of profits (Bjørnenak & Mitchell, 2002).

Activity-Based Costing (ABC)

The emergence of ABC was the result of criticism of the traditional costing system for allocating manufacturing overhead costs to services or products. The researchers Kaplan and Copper created ABC activities in the 1980s as an alternative for allocating costs for products and services instead of the Traditional Cost Calculation (TCA).

The Consortium for Advanced Manufacturing International defines ABC as an approach that measures the cost of activities, resources, and cost objects. Cost of resources assigned to activities, then activities are assigned to cost objects based on their consumption from those activities. Activity-based costing distinguishes the causal relationships of cost drivers to activities (Raffish, 1991).

ABC is based on a basic idea that activities consume resources, products consume activities, and that is, activities are what causes costs, not products or services (Al-Takriti, 2007). ABC is called a two-stage method for assigning indirect costs, as they are grouped into cost pools and then allocated to services or products based on cost drivers (Hilton, 1994) as shown in figure 2.



The Steps to Implement ABC

To reach the design and the mechanism by which cost accounting based on activities (ABC), the following stages can be traced (Al-Shaarani, 2010):

1- Identify the major activities in companies

Determine and define activities in the company, and specify the resources necessary to perform each activity, and the number of times the activity performed for each service or product. After activities are identified, they are categorized into main activities and sub-activities, or the related activities grouped into groups in the activity cost pools (Al-Sharasani, 2010).

The number of activities depends on the complexity of the operations. The more complex the operations, this leads to an increase in the number of activities that cause costs. The number of activities can expand, which gives greater accuracy in the distribution of indirect costs, but this, in turn, increases the burden and costs of implementation (Abu Nassar, 2008). The number of activities relates to the goal of using Activity-Based Costing accounting (ABC). If the goal is to improve performance, we use many activities, and if the goal is to calculate costs better, we use some activities compared to performance improvement activities (Farhat, 2004).

2- Determining the cost driver

The determination of the appropriate cost driver for each activity cost centre requires an understanding of the cost behaviour. ABC is based on an analysis of cost behaviour based on measures that are the reason behind the occurrence of costs and these measures are drivers or causes of cost. Cost drivers are defined as the factor that causes or drives the costs of the activity, and cost behaviour is an indicator of how a cost will change in total when there is a change in some activity (Al-Tikriti, 2007).

Two conditions must be met in the cost driver, firstly the ease and understanding of the cost driver so that it can apply without hardship or high cost; secondly, the cost driver must be appropriate for control purposes because it influences the cost (Joudeh, 2010).

It should note that there are four factors that consideration of selecting a cost driver for each activity (Attia, 2000):

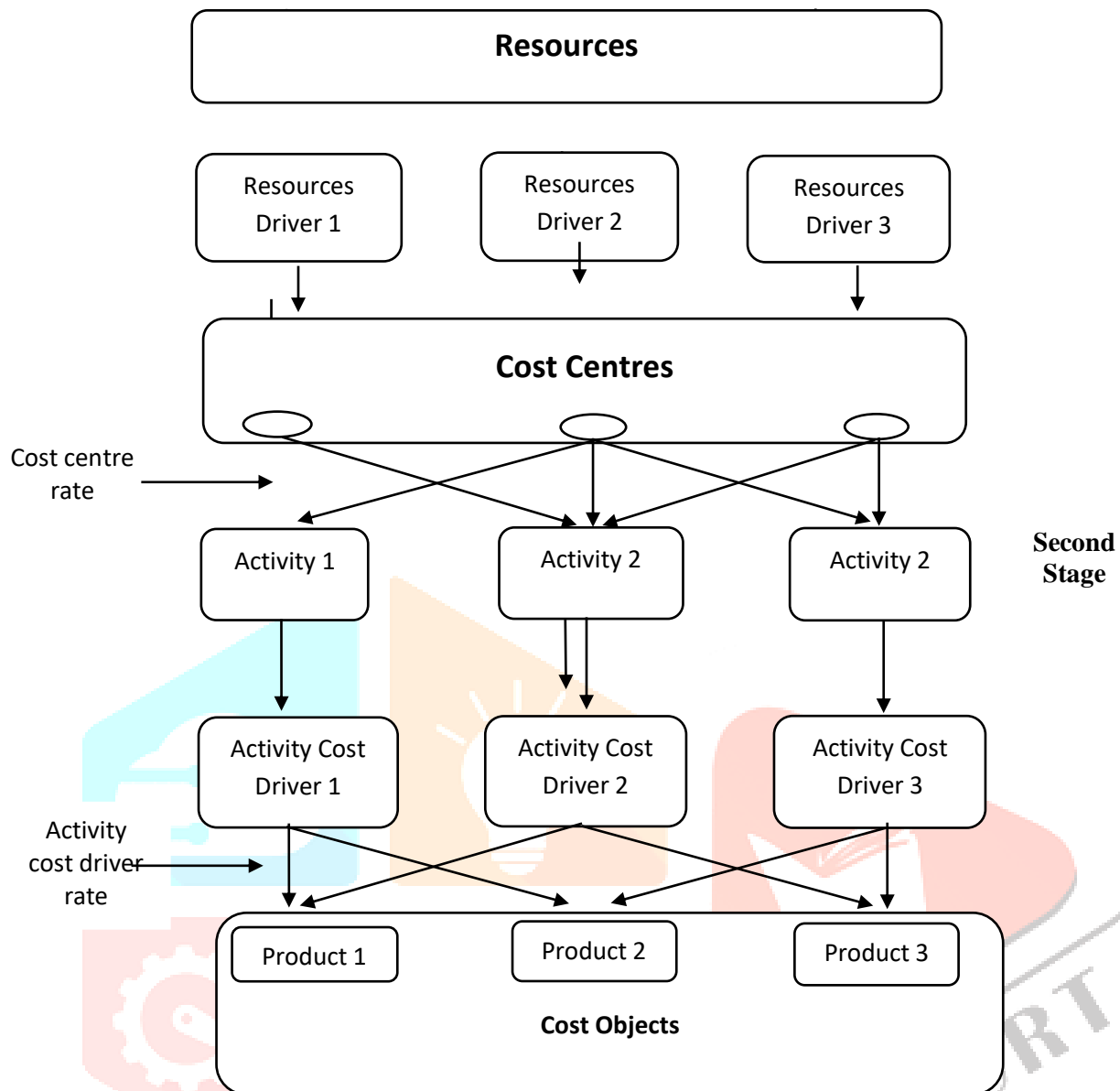
- 1- The degree of accuracy required in the cost data.
- 2- Diversity of production.
- 3- The ratio of the cost of the activity to the total costs.
- 4- Cost to collect cost drives data.

3-Determine activity cost driver

After determining the activity cost centres and the appropriate cost drivers for each cost centre, the direct and indirect costs are collected into cost pools (Al-Shaarani, 2010).

4- Linking activities cost and cost objects:

After determining the activity cost centre, allocate rates are determined based on cost driver. Activities consume resources and thus costs associated with them. On the other hand, products consume activities, which require loading them at the cost of this consumption. Therefore, this step means loading activities costs for products based on the consumption of each product of activities, using an appropriate cost driver (Abbas, 2011).

Figure 3: Allocation of indirect costs illustrated using Activity-Based Costing (ABC)

Source: Dewi, 2012

Resource costs for activities are assigned based on the number of resources these activities use, as activities consume resources, Activities costs are allocated to cost objects (product or service) by activity cost driver rate according to the degree to which they benefit from each activity.

Advantages of Activity-Based Costing

ABC provides a set of advantages as follows (Abu Ghuban, 2013):

1- Activity-Based Costs (ABC) classifies activities according to the value they add; this provides an opportunity for the company's management to study the costs of the activities in-depth and make it able to appropriate analysis and try to exclude activities with high costs that do not add value. As well as study the possibility of improving methods of performing low benefit activities.

2- ABC helps to make better management decisions by carefully determining the costs of products and thus making decisions related to stopping or expanding the production and delivery of a particular product.

3- ABC assists Managers to reduce and rationalizing the resources consumed by improving the level of performance when implementing sales and marketing operations, in addition to raising the efficiency of the performance of business units using modern approaches such as total quality management. Besides, this method contributes to providing financial and non-financial information about business units, which leads to increased profitability and improved performance in the operations and activities of business units.

4- ABC system provides accurate information about the cost of activities. It also provides managers with the reasons for cost creation, which provides them with a clear vision of cost-benefit analysis to analyze decisions, and enables better exploitation of scarce resources.

It can be summarized above that (ABC) represents a modern strategic method. Through ABC, companies can achieve many benefits. By defining and identifying activities that are more related to costs that achieve benefit and addition to the product, and thus excluding or reducing the useless activities that do not add value to the product, this gives management an excellent opportunity to redistribute and allocate resources more precisely. Besides that, its contribution to planning, monitoring, and evaluating the performance of business organizations is significant.

Comparison between the Activity-Based Costing and the Traditional Costing

To distinguish between activity-based costing accounting and conventional cost accounting through the following points (Sheikh & Joudah, 2007) as in Table 1.

Table 1: Difference between activity-based costing and traditional costing

Comparison	Traditional costing (TC)	Activity-Based Costing (ABC)
Information	Provides complete cost information. They are a combination of the various activities in the various departments that the production process for products passes. Therefore, they are difficult to analyze.	Provides detailed information about each activity within any department
Focuses	Focuses on products and considers a cost object.	Focuses on activities and considers a cost object.
Cost Driver	A single rate is used to allocate the indirect costs to the whole organization, and this is determined by dividing the total indirect costs by the basis of the chosen allocation. (direct signal labour or machine hour)	The cost-per-activity driver is used. It is measured by dividing the cost of the specified activity by the driver by the cost of this activity. (different cost drivers)

Cost pool	One pool of indirect costs uses in each department or several groupings of the company.	Many to reflect various activities. Several cost pools use in one department, and each pool specializes in a specific activity or similar activities.
Allocation	First, allocate indirect cost to the department, second to a cost object (product or service).	First, allocate indirect cost to activity cost pool, second to a cost object (product or service).
variables	The fundamentals of allocation include financial variables, such as the cost of direct materials, direct labour, or machine hour.	Often the cost driver is not based on financial variables only, but on other variables such as the number of orders or times, and the amount of production.

Source: Sheikh & Joudah, 2007

The main difference between traditional costing and ABC is that ABC extends the number of indirect cost pools that can be assigned to specific products. Traditional costing takes one pool of corporation total indirect costs to assign to all products (Johnson, 2017).

Disadvantages of Activity-Based Costing

Despite the advantages of ABC in providing accurate information that helps management in making decisions, planning, and controlling costs; there are some criticisms directed to costs based on the activity (Abu Nassar, 2008).

1- High application costs, ABC is more costly in terms of development and maintenance than the traditional costing system, which requires conducting (cost-benefit) analysis before application for the purpose of verifying the feasibility of the application (ABC) (Al-Takriti, 2007). The reason for the high cost of the application is that it requires many data and details, just as activity-based costing needs to use advanced computer equipment (Abu Ghoban, 2013).

2- The difficulty of updating, companies has found it difficult to maintain ABC and update it. The amount of spending on resources change, and new products or services added, and increase in the diversity and complexity of individual requests, thus update process requires a re-estimate through re-interviews and inquiries, which means additional cost and additional time (Kaplan & Anderson, 2004).

3- Lack of consideration of the complexity of operations, activity-based costing failed to deal with multiple activities and with complex operational processes, and its continuation became costly in time and effort, given the diversity and multiplicity of data that must be collected and analyzed about the organization's activities (Helles, 2006).

4- Assigning costs not related to production, ABC encourages allocating costs not related to production such as research and development on products while product costs such as building depreciation are not allocated to products. Hence, most companies use (ABC) for internal analysis and continue using their traditional costing system for external reporting (Al-Tikriti, 2007).

5- Activity-based costing uses one driver for each activity that may create some difficulties in terms of placing multiple drivers for the activity. For example, the costs of registering a patient in a health centre do not depend on the number of patients only but the type of patient as well (known, unknown) (Demeere, 2009).

Activity-based costing since the 1980s was the best solution to the problem of cost allocation that resulted from dependence on traditional methods where ABC is considered the most accurate tool in providing information about the costs of activities, as well as a tool that helps in decision-making. However, criticisms began to appear about the problems of application, operation, and upgrade that have become costly for companies due to the cadres, techniques, and expertise required by them, which have become a burden on companies applying it.

ABC appeared in the 1980s; it came as a result of criticisms of the traditional cost system for allocating indirect costs to services or products. According to Computer-Aided Manufacturing International (CAM-I): Activity-Based Costing is a methodology that measures the cost and achievement of activities, resources, and cost elements. Resources are allocated for activities, and then activities are assigned to cost objects based on their use. Activity-based cost acknowledges the causative relationships of cost drivers of activities (www.cam-i.org).

Activity-based Cost Accounting (ABC) is based on the two-stage method of allocating indirect costs, which are grouped into cost pools and then allocated to final services or products based on cost drivers (Hilton, 2008).

ABC has been difficult for many organizations to implement because of the high costs incurred to interview and survey people for the initial ABC model, the use of subjective and costly-to-validate time allocations, and the difficulty of maintaining and updating the model like (1) processes and resource spending change, (2) new activities are added, and (3) increases occur in the diversity and complexity of individual orders, channels, and customers (Kaplan & Anderson, 2004).

As originally introduced in the 1980s, ABC corrected serious deficiencies in traditional standard-cost systems.' The traditional systems typically used only three cost categories: labour, materials, and overhead. While manufacturing companies could generally trace the labour and materials used by their individual products, their cost systems allocated the indirect and support costs the "overhead" with measures already being recorded, such as direct labour hours and direct labour dollars.

As the direct labour content of products decreased, through automation and industrial engineering-driven efficiencies, the percentage of total costs represented by the somewhat arbitrary allocations of overhead had continually increased during the twentieth century. In addition, many companies had shifted from mass production strategies to those that offered customers more variety, features, and options. The customer-focused strategy attempted to attract, retain, and grow business by offering services such as the following:

- Producing and stocking a greater variety of products
- Supporting more order-entry and order-tracking channels
- Producing and delivering in smaller order sizes
- Delivering directly to customers' end-use locations, often in expedited and narrow time windows
- Providing specialized technical applications support (Jassem, 2019).

Activity-based costing seemingly solved the inaccurate allocation of overhead from standard cost systems by tracing these indirect and support costs first to the activities performed by the organization's shared resources, and then assigning the activity costs down to orders, products, and customers on the basis of the quantity of each organizational activity consumed. Managers used the more accurate ABC and profitability information to make better decisions about process improvements, order acceptance and rejection, pricing, and customer relationships. The decisions led to near-term and sustainable improvements in product and customer profitability (Jassem, 2019).

Despite its attractive value proposition, however, ABC was not universally accepted. Some companies failed to adopt ABC, or abandoned the tool, because of behavioural and organizational resistance that accompanies any new idea, particularly one as seemingly radical as to treat most organizational costs as variable and to acknowledge the possibility of unprofitable customers. But much of the resistance to adopting and sustaining ABC was rational and justified. As our opening example documents, ABC systems were expensive to build, complex to sustain, and difficult to modify. People also questioned the accuracy of cost assignments based on individuals' subjective estimates of the percentages of their time spent on various activities. Apart from the measurement error introduced by employees' best attempts to recall their time allocations, the employees anticipating how the data would be used might bias or distort their responses. As a consequence, operations, sales, and marketing managers argued about the accuracy of the model's estimated costs and profitability rather than addressing how to improve the inefficient processes, transform unprofitable products and customers, and cope with the considerable excess capacity that the model had revealed (Jarvinen & Vaatja, 2018).

Because of the difficulties that conventional ABC software solutions had in scaling to enterprise-wide models, companies (and their consultants) frequently built isolated ABC models for individual facilities, departments, and businesses that could not link with each other, or the companies built separate models for product and customer analysis that did not link. Because of the proliferation of models across units, the companies could not take a holistic view of cost and profitability. Improvements were incremental and local. The benefits from the ABC models could not justify the models' high cost to maintain and run (Jarvinen & Vaatja, 2018).

Time-Driven Activity-Based Costing (TDABC)

TDABC method credited by Kaplan and Anderson researchers who were the first to submit a study on this topic in 2004 (Dewi, 2012). The reason for thinking about the TDABC approach is the result of ABC's failure to deal with multiple activities and complex processes. Its continuation became costly in time and effort, ABC was subject to many criticisms, the most important of which are high cost of application, and the large time used to conduct interviews with officials of business units in obtaining information about activities and the time consumed. In addition to the difficulty of selecting and determining cost drivers when there are a large number of activities, and this needs a great time in preparing a model for ABC and processed it on a computer (Kaplan & Anderson, 2004).

TDABC relies on time drivers to calculate activity-based costing, so those cost elements (material, labour, and expenses) easily identified using time equations (Bruggeman, 2005).

Time-driven activity-based costing is a new alternative cost allocation methodology that addresses most of the problems and shortcomings in ABC (Terungwa, 2012).

Szychta defined TDABC as a new version of ABC as it aims to eliminate the problems of application and use of ABC in companies by changing the method of collecting data about activity times and adjusting the calculation of activity cost. TDABC uses time as its main cost driver. Time is used for allocating resource costs to objects, which makes it exclude a complicated step in ABC, that assigning resource costs to activities before allocating activities to cost objects (Szychta, 2010).

The ability of TDABC accounting to contain the strengths of ABC accounting and overcome most of its weaknesses helped the concept of allocating activity-based costing to return to the forefront. Moreover, the transition from a complicated and costly method to a tool that provides useful and accurate information to management at a less cost (Hon & Chu, 2012).

TDABC is a conceptually simple, strong implementation method. It is mainly based on awareness and knowledge of the amount of effort required to perform any operation and then adding the cost calculated on the activities basis of activities (Max, 2007).

Kaplan & Anderson (2007) explained that time is the primary cost driver so that most resources, such as employees and machines, can be measured by the amount of time available to complete the work. Other resources use other measures such as warehouse storage capacity and data storage capacity in gigabytes. Time uses to allocate resource costs directly to cost objects (products, services) which leads to ignoring the difficult step involved in ABC, which is to assign resource costs to activities before allocating them to cost objects.

TDABC is a variant of ABC. It is based on estimating the cost of production and time capacity, identifying resources, then estimate the practical capacity of available resources by reviewing the activities of companies for a previous period, then estimate the time required to complete the activity. It makes it easier to handle complex operations by using the time function much simpler than in ABC accounting.

Time-Driven Activity-Based Costing (TDABC) offers great opportunities to enhance the performance of companies and outcomes while reducing costs and provides a foundation for value-based payments. Pilot projects conducted by more than two dozen leading organizations demonstrate the power of Time-Driven Activity-Based Costing to improve the organization value. Companies can determine the true cost of enhancing profits in a better way. Combining TDABC data with outcome measurement illuminates the value of service provided and enables Corporate Directors, leaders, and staff to identify opportunities to redesign processes to deliver the same or better outcomes at lower total cost (Kaplan,2014).

Furthermore, the innovation of ABC and, especially its newer variant, TDABC can be viewed as rediscovering this basic cost-accounting equation and applying it to all resources acquired and supplied by the organization. In this way, almost all personnel, equipment, facility, and indirect and support costs can be directly attributed, not allocated to the companies' output of products and services.

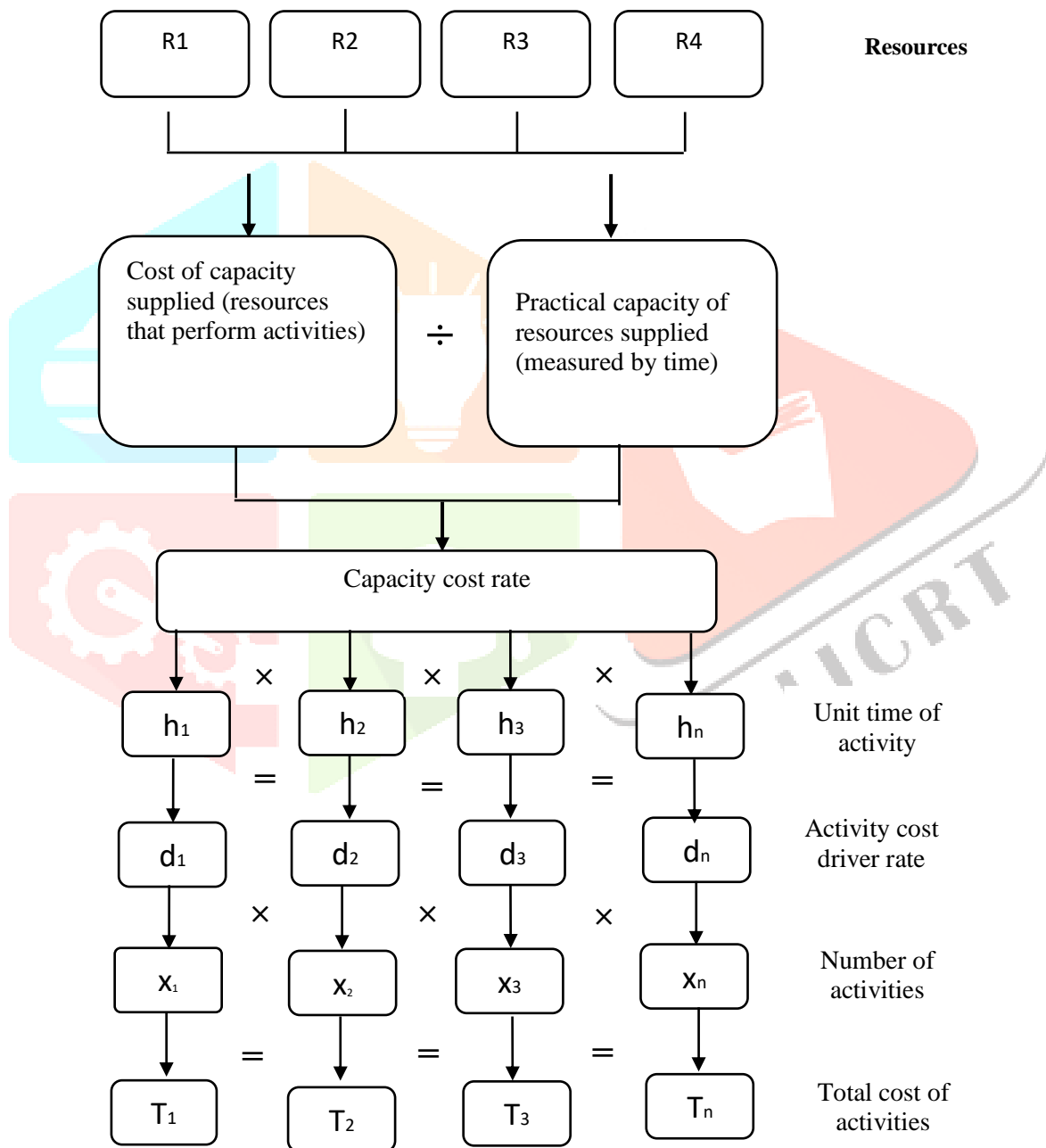
Application of Time-Driven Activity-Based Costing

Kaplan & Anderson (2007) stated that before applying TDABC, two major questions must be considered - how much does resource supply cost per business unit and what is the amount of time wanted to carry out a transaction or activity.

The steps for implementing TDABC are as follows (Bruggemam, 2005):

- 1- Identify the different resource groups that used to carry out the activities.
- 2- Estimate costs for each group of resources.
- 3- Determine the practical time capacity for each group of resource groups (available working hours).
- 4- Calculating the unit cost for each resource group by dividing the total costs of the resource group by the amount of practical capacity (measured by time).
- 5- Determine the time required for each activity event based on time drivers using time equations.
- 6- Calculating the total cost of the measurement subject (object), by multiplying the unit cost by the required time to trace costs to cost objects.

Figure 4: Steps for implementing TDABC



Source: Szychta, 2008

As shown in Figure 1.3, determined the Cost of capacity supplied (resources that perform activities), then determined the practical capacity of resources supplied (measured by time). We will get the Capacity cost rate by dividing the Cost of capacity supplied by the practical capacity of resources supplied. It is obtaining information about the need for each activity from the unit time of activity (h_n) through

observation and direct interviews. The activity cost driver (d_n) is gotten by multiplying the capacity cost rate (h_n) by the unit time of activity. Finally, the total cost of activities (T_n) is calculated by multiplying the activity cost driver by the number of activities carried out.

The practical capacity is the highest level at which the factory can produce over the long term and operate efficiently. Practical capacity often allows for inescapable operating obstruction, such as repair time, waiting time, machine setup time, or scheduled employee time.

The process of calculating TDABC is different compared to ABC. Managers estimate the demand for resources directly instead of allocating resource costs as the first stage on activities and then on cost objects for each set of resources.

Cost of Supplied Resources

The cost of resources supplied to the operating department includes sundry elements. The following are examples of cost pools, which happen in one manufacturing department: Direct labour, e.g. assembly-line workers. Indirect labour, e.g., legal advisor. Equipment and technology, including computing and telecommunication resources, are used by employees and their supervisors. The occupancy is the cost of supplying space for employees, supervisors, and equipment.

Estimate Cost of capacity supplied

The first step in the process of calculating TDABC is by estimating the cost of the supplied capacity unit (Terungwa, 2012), this means identifying all the resources necessary to perform a specific activity. For example, in the Public Relations Department, the following resources identified reception staff, reception staff supervisor, auxiliary resources (computers, communications, and furniture), resources from other departments (IT, human resources) (Al-Shaarani, 2010).

The practical capacity of resources supplied is realized as a percentage of theoretical capacity and is usually estimated between 80% and 85%. If the worker or the machine is limited to his ability to work 40 hours per week, so practical capacity equal 32 hours per week, the remaining 15-20% express unexploited capacity such as at times of attendance, departure, rest, and lost times in machinery downtime due to repair and maintenance. The practical capacity can also be estimated by reviewing the activities performed in a previous period, such as determining the number of customer requests received during the past one or two years, taking into account the absence of excessive delay, poor quality, additional work (repair) or excessive strain of employees (Kaplan and Anderson, 2004).

The determination of the capacity cost rate by dividing the cost of capacity supplied by the practical capacity of resources supplied (by time) is shown below.

Capacity cost rate =	cost of capacity supplied
	The practical capacity of resources supplied

Source: Kaplan & Anderson, 2007

Estimate the unit time of activity

It is an estimate of the time needed to complete the activity. This step represents the important addition provided by TDABC. It is an alternative step for conducting interviews with workers, where is determined the time required to complete the activity by direct observation or through conducting interviews with managers (Kaplan & Anderson, 2004).

This process differs from ABC in terms of questionnaire scope and interviews. In ABC, the questionnaires and interviews conducted by all workers to obtain a distribution of their time on all activities carried out for the update and preparation of monthly cost reports, while TDABC enquired from workers about their role in a specific process within a specific activity after having activities are defined as a first step, the goal of setting standards of time for activities to build time equations that are adopted as a basis for calculating the cost of the activity and preparing monthly reports (Zaidi, 2012).

The time can be confirmed by directly measuring the time taken to perform the activity several times, then can be determined average completion time can be defined (Adioti & Valverde, 2013)

The estimates used in cost accounting TDABC are the responsibility of the administration, and the cost accounting TDABC allows management and its decisions to be accurate because this is what management aspires to.

Time equations

Time equations are one of the steps of TDABC, which is a mathematical function used to express the time when an activity or event was performed using time drivers, according to the following formula (Kaplan & Anderson, 2007):

$$T = \beta_0 + \beta_1 \cdot X_1 + \beta_2 \cdot X_2 + \beta_3 \cdot X_3 + \dots + \beta_i \cdot X_i$$

T: Total time required to perform the activity.

β_0 : Benchmark time to perform the main activity.

β_i : Estimated time to complete the additional activity (i) where (i = 1, ..., n).

X_i : amount of additional activity (i) where (i = 1, ..., n).

TDABC through time equations can accommodate the diversity in time demand for different types of activities. It does not simplify assumptions that all activities carried out with the same amount of time, but it allows the possibility to make estimates of the time to complete different activities based on demand or activity specifications, compared to ABC requiring expansion in the number of activities to accommodate the complexity and increase production processes (Kaplan & Anderson, 2007).

Designing a time equation requires defining the main activity and all differences and variables that characterize the diversity of the activity. In order to estimate the standard time to complete the main activity and the diversity it entails, by adding the time needed to complete the additional activities. Special activities required by complex requests or special requests can add, and the equation can easily modify by adding a new activity time or deleting an activity (Szychta, 2010).

Time equations provide managers with the ability to simulate the future because they control the fundamental factors of demand for practical capacity, changes that occur during the operational process, and product size, it assists managers in analyzing (what-if) in different conditions (Kaplan & Anderson, 2007).

Kaplan & Anderson (2007) showed that time equations achieve a great deal of accuracy, as they are fed with data from various systems such as company resource planning, customer relationship management, and general ledger, which include completed transactions and activities.

The time equation is interpreted as a linear equation, it equals a sum of the times of activities needed to produce a product or service. The time equation is of the form ($y = a+bx$), where y is the dependent variable and x is the independent variable, (a) and (b) are the intercept and slope. Consequently, the time equation can view as a form of a linear Regression equation.

Updating Time-Driven Activity-Based Costing

TDABC can be updated and expanded by adding other activities to accommodate changes in operating conditions and work environment by estimating the time for each new activity without the need to re-meet the workers, and managers can update the cost driver rates, it change is affected by two factors (Martin et al., 2018):

1- The change in the prices of available resources affects the average cost of energy. For example, if workers' recompense increases, a new machine is replaced, or a new device is added, this will lead to a change in the cost of the associated process, and this requires the analyst to adjust the capacity cost rate to contain the changes.

2- High activity efficiency, such as quality and improvement programs and the adoption of new technology that can reduce the time or resources needed to carry out the same activity. When a new database or program is entered into a section, the standard time for the activity associated with computing will be affected. Therefore, the analyst must change the unit time estimates of the new activity.

The modification and updating of TDABC are based on events. When analysts realize that there is a noticeable change in the costs of available resources or a change in the demand for resources needed to carry out the activity, they adjust the rate of cost drivers. As well as when they know that there has been an increase and an important development in the efficiency with which the activity is carried out, they decrease the unit time estimate required to implement the activity to reflect the reduction achieved as a result of the higher production efficiency.

Advantages of Time-Driven Activity-Based Costing

Through the TDABC analysis, it has been found that TDABC has overcome the difficulties of the ABC because TDABC is an easy-to-implement and renewable managerial tool that is in line with developments (Kaplan and Anderson, 2007). The advantages of time-driven activity-based costing TDABC are:

1- Easier and faster usage and provides a vision and clarity to work effectively and make use of the available capacity and integrates with the data of the Enterprise Resource Planning (ERP) system and Customer Relationship Management (CRM) systems, and thus is inexpensive in its application and can continue to apply without stopping (Kaplan & Anderson, 2007).

2- The ease of updating the rates of cost driver rates, given that changes in the cost rates are caused by two factors (Martin et al., 2018):

- Change in prices for available resources, such as a bonus employee.
 - Deviation in the efficiency of activities, such as the use of new technology that allows activities to be performed in less time.
- 3- Finding the cost of unused capacity is through the difference between capacity supplied (both quantity and cost) and capacity used. It allows managers to review the cost of unused capacity and think about procedures to decide how to minimize the costs of supplying unused resources in the future time (Kaplan & Anderson, 2007).
- 4- A good tool for designing a new competition strategy is a tool for determining customer profitability and new market opportunities (Dejnega, 2011).
- 5- Standard data is used as a basis for calculation and thus reduces the amount of data to be provided, especially if the economic conditions in which the company operates are constant, and this makes it a tool that provides accuracy and speed of data at low cost (Gervais, 2010).
- 6- Clarity and transparency in determining the costs of activities and enables companies to understand the relationship between cost and activity (Max, 2007), which means that it is easy to explain the source of high cost, as there are no averages, as time equations show all the drivers.
- 7- Provide companies with knowledge and ability to develop a policy for pricing products or services provided to clients (Max, 2007).
- 8- Designing an effective time equation to accommodate diversity in requests and customer behaviour, and effectively contain the complexities within activity time equations (Bruggeman, 2005).
- 9- Ensures stability in pricing in the short term, and achieves fairness in pricing, as it allows the customer to hold the cost of the capacity utilized only (Al-Shaarani, 2010).
- 10- Unlike the percentages that employees subjectively estimate for a conventional ABC model, the capacity consumption estimates in a time-driven model can be readily observed and validated (Kaplan & Anderson, 2007).

Time-Driven Activity-Based Costing and Activity-Based Costing

The main differences between the two approaches are not only in the method of dealing with the costs of activities where TDABC uses time drivers. Also, the ability to determine unexploited capacity because ABC cannot conclude that capacity in addition to that it takes a lot of time to adjust and update to keep up with the evolving conditions of the company. At the same time, TDABC can contain all operational conditions in a one-time equation (Dejnega, 2011).

The difference in the use of duration drivers in ABC and time drivers in the time-driven activity-based costing is that the use of duration drivers such as ABC comes at the second stage of allocation activities to the cost objects. At the same time, TDABC accounting ignores this and uses time drivers to directly determine the relationship between resources and cost objects (Zaidi, 2012).

The following two tables illustrate the differences between TDABC and ABC.

Table 2 : Differences between ABC and TDABC

Comparison	ABC	TDABC
Allocation cost driver	Transaction drivers. Dealing with the number of occurrences of factors (number of setup machines).	Time drivers. Dealing with the operating time, the time needed for start-up activity.
Drivers number	One driver only used with each activity	unlimited drivers can be used with each activity
Accuracy	ABC doesn't consider all activity specifications which it influences the costing accuracy	TDABC considers activity specifications in allocation time efficiently. So it has sufficient accuracy
System dimensions	Every difference in activities requires implementing the new separated activity.	For each activity used one-time equation, which has all specification and differences of activity
updating	The system has many details, and it takes a long time to update	The system contains fewer details of its ability to contain activity features in one equation, so it is easy to update
unused capacity	ABC does not support capturing and calculating unused capacity	TDABC allows capturing and calculating unused capacity

Source: (Kowsari, 2014)

The important difference in addition to time drivers is the unused capacity, the activity-based costing relied on supplied capacity while time-driven activity-based costing relied on the used capacity, which is what customers must incur. The TDABC put capacity unused at the disposal of management in order to be able from their exploitation, and since TDABC uses only the capacity used, thus the cost of the service or product decreases.

Table 3: Differences in Implementation Steps between ABC and TDABC

Steps	ABC	TDABC
1	Identify all activities to create the product	Identify the different resource groups that used to carry out the activities
2	Assignment of indirect costs to activities using the resource driver	Estimate the total cost for each resource group. Estimate the practical capacity of each resource group
3	Determine the cost driver for each activity	Calculate capacity cost rate by dividing the cost of capacity supplied by Practical capacity of resources supplied
4	Calculate the activity driver rate by dividing total indirect cost in each cost pool by the total cost drivers	Calculate the activity cost driver by multiply Capacity cost rate by unit time of activity
5	Multiply the cost driver rate by the number of cost drivers to assign costs to products	Calculating the total cost by multiplying the unit cost of each resource group by the time per activity

Source: (Kowsari, 2014)

The difference in the implementation mechanism between TDABC and ABC is that TDABC estimates both the total cost of resources and the practical capacity of resources and then builds the time equation and thus allocates resource costs. But it is not the same in the case of ABC.

Conclusion

The above review of literature and the concepts of costing, ABC and TDABC make us understand that ABC is a better solution when compared to traditional costing system and similarly, TDABC is a modern technique and helps the organisation in effective utilisation of resources and maximising returns when compared to ABC.

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