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Abstract: The purpose of this study is to direct interest in using the sound methodology in cost management and to choose a more effective approach to managing costs from a series of alternatives in order to obtain more accurate data on the cost of the product. Competition in the market, Clarifying the role of the time-based product life cycle costing technique in providing integrated information on resources and their costs and for each stage of the product life cycle, which would contribute to managing costs throughout the product life cycle. To achieve this goal, the time-based product life cycle costing technique was applied on data obtained from the laboratory records, the research sample, as well as the field experience.

The research reached several conclusions, the most important of which is that the failure of traditional cost systems to meet the requirements and objectives of management as they are no longer able to provide accurate data that help the administration in making decisions as a result of changes and developments in the business environment, most notably the intense competition, which resulted in the emergence of modern techniques in the field of management Cost that is able to keep pace with these changes and developments. The most important of which is the time-based product life-cycle cost technique.

Keywords: *cost management techniques; activity-based costing; time-based activity costing; time-based product life cycle costing; cost management.*

1. Introduction

The developments in the modern business environment at the present time, which are represented by intense competition, technological progress, market openness, and the short life cycle of the product as a result of the continuous change in the tastes of customers and their need for products that meet their requirements with high quality and low prices (Horngren, et al., 2021, p. 3) has led economic units to think about reconsidering the traditional accounting systems applied to them as a result of the increasing criticism directed at them because of their inability to provide information that reflects the above developments that occur in the business environment because the core of his focus on these systems is the internal environment of these units and the search for technologies (Drury, 2018, p. 889). The modern strategy in the field of cost accounting and management, which meets the needs of the customer as well as assistance in cost management, and perhaps the most important of these techniques, is the cost of the product life cycle time oriented (Ghosh, icai.org.2013, p. 62-63).

The time-based product life-cycle cost technique is based on the principle of optimal utilization of resources by allocating the cost on the basis of each stage of the product life cycle, taking into account the time consumed by each of these stages. This would help in determining the cost of the product including the different stages that represent its life cycle more accurately and in a way that achieves the goal of cost management. Accordingly, the problem that this research deals with is concentrated in an important aspect, which is that most economic units suffer from high production costs and their management due to the non-use of modern accounting techniques. Perhaps the most important in this area is the time-oriented product life cycle cost t technique that can help achieve the goal of cost management by reducing it. Supporting competitive advantage, decision-making, and others.

Depending on the aforementioned problem, the main research hypothesis is verified, which is that the use of time-guided product life-cycle cost t technique contributes to cost management, accurate determination of product cost and provides a more comprehensive approach to managing costs during product life stages, which contributes to improving product value, increasing its quality and reducing its cost. As a result, the competitive advantage of economic units is achieved.

2. Research Methodology

2.1. Research problem

In light of the conditions imposed by the modern business environment, it has become necessary for economic units to think, if they want to stay and continue their work, to adopt modern technologies for cost management as the main factor in facing the severe competition in the market. Accordingly, the research problem is that many economic units do not use modern approaches to cost management that provide appropriate information on product costs to the management and that help them keep pace with developments in the modern business environment, and among those technologies is the "time-based product life-cycle cost" that relies on the time-consuming component. Charging costs to the product, which in turn needs integrated information that covers all costs of activities in the unit and the estimated times of its performance. According to this basis, the research problem will be formulated in the following question: Does the application of the time-based product life-cycle cost technique contribute to cost management in economic units?

2.2. Research objective

The research aims to the following:

- Direct interest in using the sound methodology in cost management and to choose a more effective approach to cost management from a series of alternatives in order to obtain more accurate data on the cost of the product leading to help the management in making appropriate decisions in an environment where the pricing factor is one of the most important factors of competition in the market.
- Clarifying the role of the time-based product life-cycle cost technique in providing integrated information on resources and their costs and for each stage of the product life cycle, which would contribute to cost management throughout the product life cycle.

2.3. The importance of the research

The importance of the research lies in the need of the economic units in general and the research sample in particular, to apply modern techniques in the field of cost and administrative accounting, perhaps the most prominent of which is the time-based product life-cycle cost technique that calculates the product costs for all stages of the product life, starting from the development of the product idea to the stage of disposal and the impact of cost management in all stages of the product life cycle.

2.4. Research hypothesis

The research is based on a basic Hypothec "The use of the time-based product life-cycle costing technique contributes to cost management by contributing to improve the product's value, increasing its quality, reducing its cost and as a result, and achieving the competitive advantage.

2.5. Research limits

- Spatial boundaries: The Al-Noura plant in Karbala was chosen to apply the practical side of the research, due to its high costs and exposure to large losses, in addition to the great importance of the Noura product in the construction industries that contribute to the development and reconstruction of the country.
- Time limits: - The accounting data for the year 2019 was used.

2.6. Research methodology

For the purpose of achieving the research objective in its theoretical and practical sides, the descriptive and analytical approach will be adopted as follows:

- Descriptive approach: This is done through the use of various sources, periodicals and references to clarify the theoretical side of the research and to provide a background of knowledge on some of the administrative techniques adopted in cost management and the time-oriented product life cycle cost technique, as well as the use of the global information network (Internet).
- Analytical approach: In light of this approach, accounting records and cost reports in the laboratory were relied upon, the research sample, coexistence, field visits, and personal interviews conducted by researchers with officials and workers in the laboratory.

3. Literature Review

3.1. Cost management: concept, objectives, and techniques

The rapid developments in the modern business environment, most notably the intense competition, technological advances, shortening of the product life cycle, globalization of markets, and the diversity of customer requirements have made the traditional systems and approaches to cost and administrative accounting unable to provide information that meets the new requirements that should be achieved to succeed in light of these developments because these traditional systems have been successful in certain conditions characterized by stability. Therefore, in light of these developments in the modern business environment, it has become necessary for economic units to think of the purpose of their success and survival in finding modern accounting techniques to manage costs, whether by reducing them, taking appropriate decisions regarding them, and being able to compete. The traditional concept of cost management has become not limited to the goal of reducing costs only but has extended to include increasing revenues, improving productivity, achieving value for the customer, and at the same time improving the competitive position of the economic unit. It must be noted that the application of a particular technique of these technologies depends on the nature of the goal to be achieved by the economic unit.

Horngren et al. (2021) indicated that the term cost management is widely used in the business environment. There is no specific definition for this term, but cost management can be defined as a set of methods and activities that managers practice which are related to planning and control decisions. In the short and long term, which works to increase customer value and reduce the cost of products and services (p. 3).

Drury (2018) mentioned in his definition of cost management that as the business and activities carried out by the economic unit administration with the aim of reducing costs, enhancing customer satisfaction and achieving competitive advantages (p. 889). As for Huang and Zhang (2013), they believed that cost management is the use of cost data to manage projects, including activities and processes, to achieve competitive advantage (p. 10). Datar and Raja (2018) believed that strategic cost management is the work that is accomplished by managers through the use of various resources and in a manner that achieves customer satisfaction and achieves the goals of the economic unit (p. 23).

It is noted from the above definitions that the concept of cost management has not become limited to the goal of cost management by reducing costs only, but also has extended to include increasing revenues, improving productivity, achieving value for the customer, and at the same time improving the competitive position of the economic unit. There are several techniques that were brought up in the literature related to the accounting issue, which are used in achieving the goals of cost management according to its modern concept. It will be dealt with briefly and in focus of the most common of these techniques in terms of application, including:

- **Target cost technique**

Targeted cost t technique is among the most important modern techniques in the field of cost and administrative accounting, which is a response to the developments brought about by the contemporary business environment due to its focus on designing products that meet the requirements and needs of the customer, achieving the competitive advantage of the economic unit in the market, and reducing costs. Ali (2017) indicated that the original idea of the target cost t technique was inspired by a simple American idea called value engineering, which was practiced in some American companies to face the conditions dictated by the Second World War, and the Japanese have borrowed this idea and worked to develop and convert it into An effective approach aims to produce products efficiently, reduce costs, and plan profits, as well as being used as a strategic weapon by Japanese companies to manage their costs (p. 62-63).

Bengu (2010, p. 213-214) and Ghosh, icai.org. (2013, p. 62-63) indicated that Toyota's first use of targeted cost t technique was in Japan by Toyota during 1960 with the aim of reducing the cost of its products .As for the characteristics of the target cost t technique, Ghafeer et al. (2014) explained that this t technique is characterized by characteristics (p. 250), the most prominent of which are the following:

1. It is a technique designed with the understanding that it is directed by the customer to meet their needs and desires during the planning stage of preparing the product design.
2. It is a systematic process aimed at reducing product related costs and along the entire value chain.
3. It works on directing cost objectives and the associated resources and activities to be accomplished starting from the product planning stage and then designing it to the after-sales services stage.
4. It works on managing the profits of economic units through the product development process.

- **Steps to implement the target costing technique**

The process of implementing the target costing technique goes through the following steps (Datar & Rajan, 2018, p. 530).

1. Determining the target price.
2. Determining the target profit.
3. Determining the target cost.

4. Determining the current cost.
5. Determining the target reducing.
6. Achieving the target reduction.

To achieve the targeted cost reduction, Burns et al, (2013) stated that the process of reaching the goal of achieving the targeted reduction in cost requires the use of several different tools or methods, the most important of which are value engineering, benchmarking, and disassembled analysis.

• Continuous improvement technique

Feil et al. (2004) believed that the technique of continuous improvement is closely related to the target cost t technique, and since the target cost technique is designed to help achieve the goal of the product cost determined through the market during the production planning process, the cost of continuous improvement focuses on the process of continuous cost reduction during the production phase (p. 15-16). Japanese companies widely use continuous improvement t technique as a mechanism to reduce and manage costs. Noting that Kaizen is a Japanese term meaning continuous improvement in operations. The difference between target cost and continuous improvement is that the implementation of the target cost is usually done in the product design stage while continuous improvement is applied during the manufacturing phase (Drury, 2018, p. 597).

• Theory of constraints

(Senichev et al. (2006) stated that the theory of constraints helps in identifying difficult situations and trying to get rid of them, that is, the situation in which products or services reach the stage of partial production while they are waiting for the customer's need to be satisfied, and bottlenecks can appear in different stages of the product life cycle, such as production, packaging, processing, and others (p. 34). The theory of constraints works according to steps that begin with identifying bottlenecks or restricted resources, whether internal or external and trying to find appropriate solutions to address them.

Akman and Ozcan (2016) defined the theory of constraints as one of the modern technologies that seek to maximize profit by addressing bottlenecks or constrained resources through an administration capable of identifying restricted resource areas for the purpose of reaching optimal production, and there are specific steps to apply them aiming to remove restrictions and reach optimal production (p. 4).

• Activity Based Costing (ABC)

Researcher Anderson presented a study in 1979 on the activity-based cost technique as indicated by (Cecevic & Antic, 2017, p. 311), in which he demonstrated the importance of having some basic elements when working with this t technique to allocate indirect costs, as well as showing that cost drivers increase with the increase in activity centers and with their different functions. Relying on a single vector as in traditional cost systems, which is one of the reasons for the failure of these systems to face the indirect cost allocation process. Activity-Based Costing (ABC) System aims to link indirect costs to activities first and then to products as a final cost objective second. Al-Sammani (2016) indicated that the core focus of the ABC system is the activities that cause costs, and it is considered as a treatment for the wrong path related to the allocation of indirect costs under modern industrial conditions (p. 23). Tse and Gong (2009) indicated that despite the superiority of the ABC system over traditional accounting systems in terms of appropriate accuracy in calculating costs, assisting in decision-making, and rationalizing resources, it faced many criticisms (2). The most important of which was its disregard for untapped energy, the high cost of its application, and the difficulty of implementing it. Define activities.

Activity based costing is defined as a costing approach that relies on individual activities as primary cost components. The cost of these activities is used as a basis for directing costs to other cost targets such as products or services (Datar & Rajan, 2018, p. 180). As for the steps for implementing ABC (Drury, 2018, p. 263), there are several steps for its implementation as follows:

Defining activities: as the economic unit, the nature of its work, and the mechanism of operations in its various departments are studied, and then the activities related to these operations are identified and analyzed.

Grouping costs in cost pools for each activity: Grouping costs consistently into cost pools.

Selection of cost drivers for each activity: For the purpose of allocating the costs related to each activity center, a cost guide is chosen for each center, and the guidelines in this step are called the activities cost guides.

Allocate the cost of activities to cost targets: After implementing the above-mentioned steps, the cost is then allocated to the cost targets, using the loading rates that are calculated for each of the cost pools.

• Resources Consumption Accounting

Webber and Clinton (2004) defined resource consumption accounting as one of the strategic cost management techniques that combines the advantages of the two most important global systems, namely the German cost management system that focuses on resources and the US cost management system that focuses on activities and in a way that supports decision-making processes (p. 1).

Jinkens and Yallapragada (2010) believed that resource consumption accounting t technique is one of the modern techniques of cost and administrative accounting that works to provide more appropriate and detailed information on activities related to the product and in a way that helps making decisions (p. 122). Demmer, A. et al. (2018) stated that, at present, manufacturing companies must view the consumption of their resources as a cost driver in order to identify efficient and economic processes. Methodologies for checking, evaluating, and comparing process chains are vital to obtaining accurate cost statistics throughout the entire process chain, this investigation enables to reduce process costs, labor and material wages, and indirect industrial costs during operations. The technique of accounting for resource consumption, as indicated by Karaca and Kucuk (2017, p. 354), confirms that the main reason for the occurrence of costs is the resources, where the cost is classified in multiple ways in order to provide detailed information to decision-makers with a focus on the cost of resources that are classified into fixed and proportional costs while allowing by calculating the cost of idle energy in order not to be charged on the products. The application of this t technique requires the availability of two parameters, which are resource energy and costs, and the steps for implementing the t technique are as follows (Okutmus, 2015, p. 51-55; & Ahmad & Moosa, 2011, p. 765-768):

- Defining the various resource pools.
- Determining the costs related to resource pools.
- Defining resource cost drivers.
- Determining the share of production departments from the costs of resource e.
- Complexes on the basis of theoretical capacity.
- Determining the share of production departments from the costs of resource g.
- Complexes on the basis of actual capacity.
- Calculating idle energy costs.

- **Time Driven Activity Based Cost (TDABC)**

This technique is based on the principle of good allocation of costs by linking them to the optimal time that activities take to produce the product or to provide the service at each stage of the product life cycle that has been previously determined as the time driven activity-based cost technique (TDABC). One of the cost management techniques as mentioned by Atkinson et al. (2014, p. 172-173) is developed by Kaplan and Anderson (2004, 2007). This technique provides accurate information about the cost in a wide range of activities which was initially developed for manufacturing processes to overcome the difficulties of the inappropriateness of traditional costing systems for modern environment variables, and even cost management systems that were newly developed such as the ABC cost system and gain special attention to management in that it helps in conducting cost analysis in a simple and accurate way. For the purpose of making the decision, Vande Wallet et al. (2014) said that it is a recent introduction in measuring and allocating costs directly to the cost target, and it is a simple and easy-to-implement system that fits with the limited capabilities of industrial projects and is a method for reducing costs because this method is based on the assumption that the time consumed in the implementation of any activity (p. 3). It is the only measure of the energy of the resources consumed in the implementation of that activity, a basis for reducing its costs, and that the energy of most resources can be measured of time. Kont (2014) defined time driven activity-based costing as one of the techniques that is characterized by speed and ease when applied (p. 4). As its application requires the availability of two parameters, they are the unit time cost of the different group of resources calculated on the basis of the practical energy, and the time of activities to perform the activities of each group from resource groups. As for the steps to implement the TD-ABC t technique (Putteman, 2009, p. 6), there are several steps to apply it, as follows:

- Defining the resource group that performs the activities.
- Determining the costs related to each of the resource groups: represented by the total direct and indirect costs, except for direct materials. These costs represent the costs required to complete the activities for each department.
- Determining the practical energy related to each group of resources: as the practical energy is represented by the working hours required to carry out any of the activities, and it is usually limited between (80% -85%) of the theoretical energy (Kaplan & Anderson 5, 2003).
- Determining the unit cost of time related to each of the resource groups: This is done by dividing the total resource cost by the practical energy.
- Determining the time required to implement each of the activity events: This step is accomplished by formulating a time equation that reflects the performance of each activity associated with each group of resources.
- Calculating the total costs related to each of the resource groups: This is done by multiplying the unit cost of time for each resource group by the time required for the activity to occur.

- **Time Driven Product Life Cycle Costs Technique (TDLCC)**

This technique is the basis of the topic of this research, so the next paragraphs will deal with everything related to this t technique in terms of origin, concept, steps and others.

First: The product lifecycle cost technique has evolved

As mentioned by Wang and KE (2016), the product life cycle cost technique arose from research on cost control of military materials that the US Department of Defense conducted in the early 1960s (p. 2016). At that time, the United States Department of Defense required material suppliers to design and develop supplies provided according to certain specifications and standards that the cost of the product must achieve the lowest amount in the entire life cycle so that they can obtain the necessary military supplies and control the national defense expenditures. It thus brought about a new idea of traditional cost management, and this t technique is based on the idea that product costs are not limited to manufacturing costs only, but rather may precede and continue after this stage.

TPGhosh (2013) mentioned in the definition of the product life cycle cost technique as a structured method that addresses all cost elements throughout the life stages of the product, project, etc., and can be used to produce a product or service expenditure information file during the expected life period (p. 81-88). The results of the LCC analysis can be used to assist management in the decision-making process when there is more than one alternative. They are thus a valuable tool for comparison when the long-term assumptions apply to all options. It is described as a system that tracks the accumulation of actual costs and revenues attributable to the cost objective from its inception to its abandonment. Thus, the profitability of any particular cost target can be determined at the end of its economic life. Life cycle costing differs from the traditional cost accounting system which reports cost target profit on the basis of the accounting period calendar, i.e., monthly, quarterly and annually. Whereas life cycle costing includes tracking the cost and revenue of a product as per product rules over several accounting periods. Costs and revenues can be analyzed by time period, but the focus is on accumulating cost revenue over the life cycle of each product.

Jan Vlachy (2014) stated that the product life cycle cost technique is simply can be clearly described as an analysis of the different types of costs that must be taken into account, ranging from the life span of the product from concept to end of life, and relates to an appropriate unit of product (p. 1). To achieve maximum impact in cost management, such comprehensive economic analysis must be undertaken at a very early stage in the product life cycle, such as its design or even its conception. Advanced techniques, including an accounting information system, are usually required to gain sufficient insight into the various processes and uncertainties contained in the realism of any life cycle model.

Second: Product life cycle stages and costs

The cost of the product life cycle differs in concept and perspective between the producer, the customer and the market.

Understanding the inter-relationship between the three perspectives provides a comprehensive framework for opportunities to manage costs and then reduce them. To effectively manage costs, focus on the three perspectives, each of which has different stages and costs associated with them, as each indicates (Hansen & Mowen, 2007, p. 741-742, & Horengren et al., 2018, p. 540).

From the product perspective or the so-called production viewpoint, which includes the stages of research, development, design, production and other related costs, and from the market viewpoint, which focuses on the behavior of sales revenues and includes the life cycle in multiple stages, starting from the stage of offering the product to the market, the stage of growth and progress in sales, and then the stage of maturity and decline, it includes costs such as marketing, distribution, advertising, promotion, after-sales services, etc. From the consumer's point of view, it is the orientation towards achieving total satisfaction for the current customer and attracting the new customer, which is affected by both the purchase costs (acquisition, installation and use costs) and post-purchase costs such as operation and maintenance. In addition to disposal, the consumer's point of view must be carefully taken into account by the point of view of the product and not ignored due to its importance to the consumer and the company alike. When product design takes into account operating and maintenance costs and makes them as low as possible, and the product has a high selling value upon completion, it affects the prices that the company imposes on its product. These jobs are a factor in competition with it in the market, and on the one hand, it is an attraction factor for the consumer and influences the decision of buying it.

It is evident from the above that the comprehensive product life cycle cost technique includes all costs associated with a specific product or project throughout its life, which are all direct, indirect, and other related costs that have been incurred or estimated that are incurred in research, development, design, investment, operations, maintenance, disposal, and environmental-related costs. Product relationship, warranty costs, and after-sales services focus on tracking and collecting the total costs associated with producing a product or project and allocating and managing costs at each stage of the product's life. Each stage has its own costs, which requires work to manage it with the intention of reducing it and then reducing the cost of the product as a whole. That is, it is not limited to the productive functional, but rather extends to sources and cost drivers wherever they are found.

This view of LCC t technique differs from the traditional perspective of cost management, which was the focus of its attention on the production process and the costs associated with it. They are called *perceived costs* and work to reduce them. They consider the pre-production and post-production costs, which are called *hidden costs*, as period costs borne by the economic unit at the time of its realization.

SAVE International (2007) indicated that adopting the principle of linking costs to each stage of the product life cycle may be more important and valuable if time is taken into consideration as a cost guide in the process of determining the cost for each stage (p. 6). Therefore, we see that the adoption of time as a basic guide in determining the cost for each stage of the product life cycle may be more important in allocating the cost of resources to the cost goal represented by each stage of the product life cycle, which in total represents the cost of the final cost goal that is the product, and then it will be said that the cost of each stage of the life cycle is time-driven, that is, the term time-driven product life-cycle based cost (LVC) t technique appears.

Accordingly, the time-based product life-cycle cost technique is known from the researchers' point of view as one of the modern cost management techniques that focus on the use of time as a primary cost guide in allocating the cost of resources to the cost objectives represented by each stage of the product life cycle, which together represent the final cost of the product. This t technique is characterized by important features that can be explained in the following points:

- It is a time-based technique as a key driver in allocating resource cost to the stages that a product goes through during its life cycle.
- The cost of the product includes the total cost of its life cycle during the stages it passes through.
- The cost of each of the stages that the product goes through is considered as the total cost of the activities that must be accomplished.
- This technique is considered as an approach to controlling the product life cycle cost.
- Helps provide detailed product information for decision makers.

Third: Objectives of time-driven product life-cycle cost technique

Much of the research and literature related to the accounting issue indicates that the attempt to link the cost of each stage of the product life cycle with time is an indication of the time-based product life-cycle cost technique, which can achieve the following goals if applied:

Provides information on the energy used with an indication of the time required to complete each stage (Lourenco, 2013, p. 23)

Provides the different cost information that managers rely on in the field of cost management more effectively because it focuses on the cost at each stage of the product life cycle (ElKelety, 2006, p. 437)

Creates information that helps conducting strategic product life cycle cost analysis to identify opportunities for reduction (Lawson, 1994, p. 33)

Creating information needed by management in making operational and strategic decisions (Sievanen & Tornberg, 2002, p. 3).

Provides information on product life cycle costs and stages in order to improve product value to suit the requirements and needs of customers. (Stelling, et al., 2010, p. 2239)

Fourth: Ingredients and principles of application of the time-driven product life cycle costing technique

Through reviewing the accounting literature related to TDABC t technique and the modern t technique in question, we find that they are similar in terms of ingredients and components through which the necessary steps are determined to apply the t technique. TDABC technique calculates the costs of all activities that contribute to production while TDPLCC t technique calculates the costs of activities that arise at each stage of the product life cycle and then the total costs of the product by adding the costs of those stages. Accordingly, there are important foundations and principles that must be taken into account when applying TDPLCC technique, including:

The application of this technique is based on two main parameters as indicated (Blocher, et al., 2014, p. 153; Yonpae, et al., 2019, p. 9 & Atkinson, et al., 2012, p. 175).

First - Determine the cost rate for each type of indirect costs. It is completed in two steps: -

Determining all resource costs incurred such as machinery, indirect labor, and plant space.

Determining the practical energy of resources, which is measured by processing time such as working hours, warehouse space, and by dividing the resource costs on the resource energy measured by time (the cost per unit of time of the practical energy supplied from the resources)

Second - Determine the time required to perform each activity by estimating the time required for each process or event for a single activity based on the characteristics or causes of the time of the activity (the number of units of time required to perform the activity). It is necessary to determine the power unit cost rate and duration of time to implement the activities performed by each cost component.

The need to adopt a comprehensive information system that provides data and information for this method, as he said by Coners & Von der hardt (2004, p.108-118) and Oleg Dejnega (2011, p. 2) to successfully implement TDABC and use the information generated from the system effectively it is necessary to integrate it with the system. By ERP project resource planning and customer relationship management system (CRM), through the

company's integrated information system, one can know the times needed for activities, resource prices, and other processes that contribute to the implementation of activities.

There are several elements that make up this technique that can be illustrated as follows: -

The cost drivers and their cost drivers are that activity or variable that causes the cost, as seen by Horengren, et al., (2012, p. 345), which is the main factor causing the increase or decrease in the cost according to its use, which is used in measuring the cost or as a basis for better charging. On the activities or final cost targets. In the TDABC approach, the Duration Driver is used in allocating costs and is more accurate than the Transaction Driver, as these directives are related to the number of times the activity is executed (such as the number of times the machines are configured, the number of times of inspection, etc.) when the resources required to implement the activities vary in Every time the activity is performed, the costing based on the transaction vectors is imprecise.

Time drivers which are the variables or characteristics that determine the time required to carry out an activity and take into account multiple directives to determine the time required to perform each activity and then determine the cost of each product, in other words that for each activity there are several processes to complete, and each process needs a time guide of its own. Singuenza-Guzman (2014, p. 10-11) referred to estimating the time required to perform an activity on the basis of standard times instead of actual times because it may be variable due to non-recurring factors. Character or operations maps.

Time equations, which are simplified linear equations, are used to express the time required to complete the disparate activities and the additional times required for them depending on the characteristics of the activity or event using time triggers Antic and Georgijevski (2010, p. 33). Time equations are based on a basic principle that is to convert cost drivers into time equations that express the time required to perform the activity.

Fifth: Steps to implement the Time-Driven Product Life Cycle Cost (TD-PLCC) technique

Sinuenza-Guzman (2014, p. 7); Dejnega (2011, p. 1-9); Antic & Georgijevski (2010, p. 25) and Yonpae, et al. (2019, p. 6) indicate that:

TD-PLCC technique steps can be as follows if time is used as a guideline in its implementation:

- Defining the resource groups associated with the product life cycle: In this step, the resource groups are identified that are associated with the stages that the product undergoes during its life cycle.
- Determining the total cost of resources for each stage of the product life cycle: The cost of resources is represented by direct and indirect costs, as direct costs include wages and salaries of workers while indirect costs include indirect industrial costs excluding direct materials.
- Determining the practical energy of each group! Of the resource groups: The practical energy includes the working hours or the time required to produce the product as 80% of the theoretical energy was adopted as a result of excluding downtime, machine repair and maintenance, or employee guidance, and others that are not related to the actual work of performance. (Szychta, 2010, p. 55)
- Determining the unit time cost for each group of resources! Related to the product operations: This step is accomplished by dividing the total operational costs represented by direct and indirect costs by the practical energy.
- Defining and grouping activities related to the stages of the product life cycle and the time required for each activity: In this step, a time equation is prepared for the activities of each resource group, as for its formula as follows: (Dejnega, 2011, p. 9) and can be expressed in the following mathematical formula:

$$T = \beta o + \beta 1\, X1 + \beta 2\, X2 + \ldots\ldots + \beta n\, X\, n$$

T = Time required to perform any activity or event in a major activity.

βo = Standard time to perform the basic activity.

1β1 = the estimated time for an additional process in a given activity or the time consumed for a unit of time reasoner.

X1 = The number of additional operations in the given activity, the reason for the first time

βn = time vectors of variables (specifications) determine the time required to complete the activity.

Xn = the number of varying activities within the main activity, the number of time triggers that determine the time required to complete the activity

Activity cost can be calculated = time required for activity * cost per unit time of activity

Time required for activity from the time equation for activity.

Unit Time Cost (Activity Vector) = Resource Energy Cost Available / Practical Energy Cost of Available Resources measured in time

- Calculating the total cost of the stages of the product life cycle
- The last step in the application of t technique steps is the calculation of the total cost of the stages that the product goes through during its life cycle after adding the incoming materials and other costs to the operational costs.

Sixth: The role of time-driven product life cycle costing technique in cost management

Potkany et al. (2012, p. 89) indicated that the developments and changes that have occurred in the contemporary business environment have led to the loss of the old cost accounting and administrative systems of their importance because these developments resulted in many changes that forced economic units to search for modern techniques for calculating costs, the most prominent of which is in this regard, the technique of the cost of the product life cycle is based on time units. According to the time used, work contributes to making the determination of the cost of the product life cycle more effective if the cost drivers are calculated on the basis of the utilized energy of the supplied resources in addition to allocating the cost to the cost objectives represented by the stages that the product goes through during its life cycle and on the basis of the time units that have been made. Its consumption by the activities that contributed to the completion of the stages of the product life cycle, and in this way, will be more efficient in its cost management by linking the cost of resources with the energy that is used in the completion of each of the stages that the product goes through.

The time-based product life-cycle cost t technique focuses on tracking and collecting the total costs associated with producing a product or project, allocating and managing costs at each stage of the product's life. Each stage has its own costs, which requires work to manage it with the intention of reducing it and then reducing the cost of the product as a whole, i.e., not limited to productive functionality but extends to sources and cost drivers wherever they are found. This view of LCC t technique differs from the traditional perspective of cost management, which was the focus of its attention on the production process and the costs associated with it, which are called *prospective costs* and working to reduce them, and considering the pre-production and post-production costs, which are called *hidden costs*, as the costs of a period borne by the economic unit at a time. Check it out.

4. Practical side

The Al-Noura plant in Karbala was chosen to apply the theoretical side of the research, and it is one of the factories of the Southern General Cement Company of the Ministry of Industry and Minerals, which was established in 1981 and the plant is located 15 km from the holy city of Karbala on the road to Hajj and began production in 1984, and it is one of the unique laboratories of its type is in Iraq, it produces the Noura material as a basic product, and it is of the three types of live (hard and soft) and the extinguished flower, and there is an occasional product that comes out after the process of crushing the stone called the filler material. The living Noura, of both types, is used as a basic material in construction industries, such as lime bricks and thermostones. As for the extinguished Noura, it enters into the manufacture of dyes, water treatment, and the filler material in the manufacture of cement, poultry fields, etc. The material produced in this laboratory is characterized by high specifications and quality that may exceed what produced by developed countries, and product specifications are being matched with the Iraqi standard specifications 807 conforming to international specifications. The factory contains administrative departments such as administrative affairs, human resources, planning, quality management, legal, commercial, etc., and the industrial management department, including production line, marketing, quality control, maintenance and services. The lab includes the Information Systems Center to organize administrative and financial work and work on training and developing the lab staff to adopt the software developed in business administration. The laboratory did not have the research sample special programs for cost and the possibility of analyzing and evaluating performance, that is, there was no information system that provided support to the administration in making relevant decisions. Costs that support the process of pricing and competition in the market.

4.1. Application of the time-based product life-cycle cost technique in the laboratory research sample

It has been indicated in the theoretical side of the research that every product has a life cycle from the market point of view, from the customer's point of view, and from the producer's point of view (the laboratory). The researchers found that Noura product has a life cycle from the product's point of view through which it can effectively manage costs and achieve a goal. The price competition faces the product due to the lack of protection for the national product. Through the interview with the administration and marketing officials, it appeared that the product has no life cycle from the market point of view because the factory is designed to produce a material to meet the market need of it and is mainly involved in the manufacture of other materials, so the imported light cannot face specifications and quality of the laboratory product, the research sample, according to the certification of the manufacturers who use it. Likewise, Noura product does not have a life cycle from the customer's point of view because that material is not directly dealt with by the customer, meaning there are no products that meet the consumer's desires in the laboratory, the research sample, and accordingly the time-oriented product life cycle cost technique will be applied from the product's point of view that pertains only to the production phase.

The research and development stage the cost data for the research sample laboratory indicate that there are no costs related to research and development.

The design stage: Also, there are no costs associated with this stage in the laboratory data.

The stage of production operations: the rates of energy utilization in the laboratory are calculated at the level of the operations carried out within the responsibility center that represents the production department and the head of the production department is directly responsible for all the implemented activities that lead to production, and the costs of this stage can be calculated by applying the cost steps cycle the life of a time-oriented product that is covered in the theoretical aspect, according to the following steps:

A - Determining the resources at the plant level that pertain to production, administrative and service activities and were as follows:

1. Raw materials, which are only one material, are limestone, symbolized by caco2, which is of high purity.
2. Salaries and wages, where the research sample employs 420 workers between permanent affiliates and work contracts.
3. Fuels and oils, where black oil is used for the process of burning stone in furnaces, in addition to electrical energy, to reach the temperature of the furnace to complete the combustion to 900 - 1200 degrees Celsius.
4. Staff equipment, including protective clothing and various safety measures.
5. Spare tools and maintenance services, including replacement of consumed parts such as ovens, mills, and others
6. The electrical energy that is mainly used in the furnace heating process.
7. Renting machines and equipment such as vehicles for transporting stone from quarries and others.
8. Packaging materials, where the hydrated Noura is packed with plastic or paper bags, and the other types are transported in a foul way in the designated tank cars.
9. Various service materials. Table (1) below shows the costs of these resources for 2019.

Defining the activities contributing to the production processes and they were as follows:

Stone crushing activity, where it is transported from designated stone quarries to the factory and its size is up to 70 cm and is broken in the primary crusher to reach a size of 35 mm and then to a size of 2.5 mm after leaving the secondary crusher and below that size comes out as a byproduct called filler material before entering the furnace 25 workers work in this activity for a period of 6 hours a day, up to 250 days a year.

Burning activity (ovens), the length of the convection oven is 52 m, in which the stone is burned at a very high degree, reaching 900-1200 Celsius, and it requires heating for a period of 24 hours of burning fuel and electric energy, leading to chemical reactions and the loss of about half the weight of the stone entering the furnaces, then the stone is transported to the cooling area, where it is cooled to 60 ° C by dry air, after which the stone is prepared for the subsequent grinding process, and 60 workers work in the burning activity at a rate of 6 hours a day for a period of 300 days a year, and the furnaces work 24 hours a day. Determination of the type of light (both extinguished and live) is done through the burning process and according to the temperature of the oven, which is regulated by the specialized technicians.

The milling activity (mills) employs 40 workers at a rate of 6 working hours per day and 250 days per year, and two work meals per day or three meals as requested. After the stone is milled, the flower is transferred according to its type to the specialized silos.

Packaging activity: Packaging is with plastic bags for the hydrated Noura weighing 20-25 kg per package, or transporting with wheels designated for live Noura, both hard and soft. 25 workers work in this activity, with 6 hours of daily work, over 250 days per year.

The quality inspection activity, which is one of the important activities of the laboratory, the research sample. The quality inspection process is carried out before and after each activity in the production process, and the stone is subjected to laboratory testing from the quarry, before and after crushing, to ensure that it conforms to the standard specifications and after the burning process, the product is subjected to physical and chemical examination in the laboratories equipped with the necessary equipment for this. Note that the checks are going on several times for one day. 30 workers work in this activity for 6 hours a day and 300 days a year.

Marketing activity, which works on marketing the product, making advertisements to show product quality, receiving customer requests, making data on the required quantities and their type, and sending them to the production official; 10 workers work in this activity at a rate of 6 working hours per day and 250 days per year.

Maintenance activity is responsible for the preventive maintenance of parts of the production line, routine maintenance and emergency maintenance of the various sections of the plant, including equipment, buildings, etc.; 60 workers work in this activity at a rate of 6 working hours per day and 300 days per year.

Administrative activity: This activity includes the various laboratory departments such as administrative affairs, quality management, legal and commercial affairs, service and guard work, occupational safety and firefighting work, and others in addition to 170 affiliates work in this activity between workers, technicians and administrators at a rate of six working hours per day and 250 days per year.

B- Determining the practical energy of the activities: The practical energy represents 80-85% of the theoretical energy of the workers in the plant, the research sample of 7 hours per day, with the calculation of the time of departure and rest of the workers, and therefore the actual working hours are 6 hours per day.

H - Determine the total costs of the specific activity and what includes work wages and other costs.

G- Extraction of the cost of one unit of time (activity vector) by dividing the total costs of the activity by the practical energy of the activity measured in time (minutes).
K- Calculating the complete time spent for each activity by multiplying the results of the time equations that represent all the times of events causing the specific activity by the number of times the activity repeats.
L- Calculating the cost on the basis of time vectors by multiplying the unit cost of time from paragraph (x) x the time equation result from paragraph (k).
Post-sales costs: - There are no costs associated with that stage in the laboratory's accounting records.
First - Determining the costs of total resources at the level of the economic unit
Table No. (1) shows the resource costs related to activities contributing to the production operations for the year 2019

Table (1): Resource energy costs that pertain to activities contributing to the production of the product

Cost per Dinar	Resources
530085066	Raw materials and raw materials
5363686557	Salaries and wages
1407070836	Fuels and oils
8000809	Personnel supplies
800748843	Backup tools
63949000	Maintenance Services
382080365	Electricity
12440000	Rental of machinery and equipment
23925088	Packing materials
138831415	Miscellaneous service expenses
124421500	administrative expenses
8855239479	**Total**

From the preparation of researchers based on the accounting records of the laboratory, the research sample for the year 2019

The quantity of production of Noura material for the year 2019 was around (37,000) tons of its live types (soft and hard) and extinguished Noura, therefore, the cost per ton of the product according to the traditional cost system followed in the factory was up to (239331) dinars in order to load all expenses on the product, which leads to the high cost of the product, which negatively affects the pricing process due to the presence of the market competition element. Because the plant does not have a cost accounting information system that helps the administration in analyzing costs and determining the surplus capacity of resources for the purpose of properly exploiting them and identifying opportunities to reduce the possible costs to benefit from them, and the laboratory's failure to apply modern administrative methods for cost management, which led to the laboratory's exposure to the research sample in 2019 to a loss. Up to five billion dinars due to the high costs and the decrease in the selling price, which was 110,000 dinars per ton.

4.2. Cost calculation according to TDPLCC technique

Table No. (2) shows the product costs according to TDPLCC t technique and according to the above-mentioned steps

Table (2): product costs according to TDPLCC t technique

Reduction ratio (7) = 6 ÷ 2	The amount of the reduction (6) = 2 - 5	Costs per ton (5) = 4 x 3	Equivalence of time (4) (min)	Time vector unit cost (3) = 2 ÷ 1	Current activity costs (2) IQ	Practical activity energy min (1)	Activity name
38%	120607200	198660000	1400000	141.9	319267200	2250000	Cracking stone
51%	982527536	958560000	3200000	299.55	1941087536	6480000	The burn
62%	317843520	192984000	1360000	141.9	510827520	3600000	Milling
48%	165549749	177642539	1164640	152.53	343192288	2250000	Packaging
47%	183482240	207638400	1720000	120.72	391120640	3240000	Quality inspection
58%	80932380	57810000	375000	154.16	138742380	900000	Marketing
25%	407725723	1223213400	4860000	251.69	1630939123	6480000	Maintenance
82%	2485719146	564260175	2830500	199.35	3049979321	15300000	Administrative activity
	4744387694	**3580768314**			**8325156008**		

Researchers work based on field observations, interviews with specialists, and cost tables from the Laboratory Accounts Division, research sample for a year

The results of Table (2) show that the amount of cost reduction that has been achieved by adopting the time-based product life cycle costing method in the laboratory, the research sample in order to manage costs, and the approval of these results by the administration to help in decision-making and the possibility of building a database on the cost of the product that supports the information system in the lab is used to analyze costs, evaluates performance for future phases, and assists in making relevant decisions. Table (3) shows the process of calculating the unit cost of the product by applying TDPLCC t technique.

Table (3): unit cost of the product

3/4=5 Cost per ton	Production per Unit (4)	1+2=3 Total Cost	Cost (2) TDPLCC	Raw Material per Dinar(1)
111104	37000	4110853380	3580768314	530085066

Researchers' work based on the results of Table (1, 2). Accordingly, the cost of one ton of the Noura product has become (111104) dinars, which is close to the selling price of the product after it was up to (239331) dinars thanks to the application of TD-PLCC t technique to calculate the cost of the operational operations phase of the stages of the life cycle of the product of the flower in the laboratory. The research sample represents the comprehensive cost for the product, directing the management's attention to the surplus energy in the project's resources to optimize the utilization of it and for the presence of other resources for the plant as idle energy, such as the presence of vacant land areas and the possibility of using them according to the opinion of the production engineer, and the adoption of cost information systems in accordance with modern approaches to cost management such as the time-directed activity method, availability of t technique more comprehensive cost management throughout the product life cycle stages. This supports the research hypothesis that the use of comprehensive cost t technique for the product life cycle based on an accounting information system contributes to cost management and accurate determination of the product cost.

*The equation of time, process energy, college costs and total time for each activity was calculated as shown below:

1 -Cracking activity total activity time = total times of events causing the activity

The estimated time for discharging the stone in the crusher is 2 minutes / ton + crushing time 9 minutes / ton + the time taken for transportation to the warehouse 3 minutes / ton = 14 minutes / ton

Practical activity energy = 25 workers x 6 hours x 60 minutes x 250 days = 2,250,000 minutes / year

Current activity costs = annual employee wages 319,267,200 dinars

The cost of the activity vector (unit of time) = cost ÷ practical energy = 319267200 dinars / 2250000 minutes = 141.9 Sec

Total time spent in the activity = quantity in tons per year x time equation = 100,000 tons x 14 minutes / tons = 1400000 minutes.

The equations of time, practical energy, total costs and total time for the rest of the activities are calculated in the same way and as shown in the research appendices.

5. Conclusions and recommendations

5.1. Conclusions

- The economic unit's possession of integrated information systems is a necessary matter if it wants to remain in the market, to meet the conditions imposed by the current business environment, including the competition element in the market and other variables.
- The use of the comprehensive cost approach for a time-oriented product life cycle and its effect on accurately determining the cost of the product provides a more comprehensive approach to managing costs during the stages of the product life cycle that contributes to reducing costs and determining the capacity of surplus resources.
- Modern management techniques such as the product life cycle cost which is time oriented as an information system that serves the economic unit management in its endeavor to manage costs in a way that helps it in facing competitors. And considering the results obtained from its application as a management database used to make various current and future administrative decisions.
- TDPLCC provides a comprehensive view of product costs and allows management to fully envision the costs and profitability of the product. It is considered a tool for strategic thinking as it gives a long-term perspective and takes into account the details of costs over the life of the product and the management focus on each of those stages to search for opportunities to reduce costs and improve production or operations or elimination of non-value-adding activities.
- The time-guided comprehensive costing technique provides important information to the management and makes it a database for the management accounting information system for the administration to use in the cost analysis and performance evaluation process, the pricing process and acceptance of special requests.

- Using period vectors to directly determine the relationship between resources and cost objectives is an easier and faster way to calculate product costs and determine unused capacity as it relies on project-specific data.
- The practical results of applying TDPLCC t technique in calculating the costs of the operational operations stage of the life cycle of the Noura product indicate that there is idle and unexploited capacity of about 56% of the project's resources that can be optimally exploited by the administration.
- Adopting the time-oriented product life-cycle cost t technique provides an excellent scientific option for industrial projects to develop cost management systems in them, as it provides accurate information about costs as a tool to predict the resource costs required for the expected production in the coming period through a comparison between resource demand and energy cost rates for the period. Current and future.

5.2. Recommendations

- The lack of interest in the laboratory management of the research sample in the role of accounting information systems as the cost system for cost analysis and reporting, and management accounting systems for performance evaluation, despite the existence of a special division of informatics for the financial accounting information system for preparing financial reports.
- The laboratory did not adopt the research sample modern approaches to cost management, such as the time-based product life-cycle cost approach that relies on data provided by information systems such as the project resource planning system (ERP). Providing accurate information about costs can be a feedback to the system.
- The possibility of exploiting the unexploited energy in the plant's resources to improve the actual production capacity. When a field observation of the researchers notice the presence of a waste in the crushed stone through the primary crusher and the conveyor belts to the warehouse, as well as before and after the milling process, the surplus energy of the workers can be exploited in re-wasting and exploiting it is. Therefore, the specialists referred to it.
- Amounts must be allocated for the environmental costs due to their importance to the laboratory and the research sample to treat the fumes resulting from the operational processes and the environmental impact they cause.
- Laying down plans to increase production due to an increase in demand for the product of Al-Noura in the future due to the qualitative characteristics it carries, which will be reflected positively on the products that enter into the manufacture of the material of Al-Noura or exploiting the energy of the idle factory land area by establishing a thermos tone production plant, or a product whose manufacture includes the byproduct material (filter).

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