Universiti Malaysia PAHANG
Engineering • Technology • Creativity

JOURNAL OF MODERN MANUFACTURING SYSTEMS AND TECHNOLOGY

Homepage: http://journal.ump.edu.my/jmmst

COMPARATIVE STUDY: ACTIVITY BASED COSTING AND TIME DRIVEN ACTIVITY BASED COSTING IN ELECTRONIC INDUSTRY

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Articles Info:
Received **1 February 2020**
Received in revised form **24 February 2020**
Accepted **27 March 2020**
Available online **31 March 2020**

Keywords:
Activity based costing; Time driven activity based costing; Electronic industry

ABSTRACT

By the 1980s, Traditional Cost Accounting (TCA) is no longer reflecting the current economic reality due to distorted information about the profitability of their orders, products, and customers. In addition, Activity-based Costing (ABC) is a costing method originally developed to overcome the shortcoming of TCA method in the era of rapidly increasing product complexity and diversification. However, it is not universally accepted because it ignores the potential for unused capacity which will be beneficial for forecasting. The objective of this work is to compare the advantages of ABC and Time-driven Activity-Based Costing (TDABC) by analyzing the features towards costing sustainment. The work begins by collecting data at electric electronic industry located at Pahang and the product selected is a magnetic inductor. ABC focuses on the costs inherent in the activity based products to produce, distribute or support the products concerned. TDABC uses time equation and capacity cost rate (CCR) to measure the unused capacity with respect to the time and cost. This work has successfully compares the methodology between ABC and TDABC in electronic industry. The item such as stages for cost allocation, determination of drivers, action taken for an additional activity, cost consideration for implementation, system building, system update, information given from each method, transparency, overestimation of cost, differentiation of service level, oversimplification of activities and capacity forecast and planning. It concludes that both have their strength according to the industry needs.

INTRODUCTION

Cost accounting is a conscious and balanced procedure for collecting costs and relating such costs to specific products or departments for effective management action. As it establishes budgets, standard costs and actual costs, it is also a set of procedures used in refining raw data into usable information for management decision making, for ascertainment of cost of products and services and its profitability. Management accounting had not changed since the early 20th century and had lost its applicability in delivering decision-making information. Traditional cost accounting is not conceptually prepared to operate efficiency to support a growing business anymore. Increased demand pressure from customers, coupled with increased competition among manufacturers over the past two decades, formed the basis for the development of cost and accounting management.

Many organizations around the world have been promoted numerous and advanced cost and accounting management techniques. In the mid-1980s, ABC has emerged in response to competitive

challenges and in pursuing their overall strategic goals as mention by [1]. However, studies show that ABC adoption in company remains low [2]. Unfortunately, the adopting process of ABC had significant issues. ABC is considered as an obsolete method due to the time-consuming and costly method of measuring operation costs by interviews. The complexity of gathering, preserving, sorting and reporting and upgrading of information were some of the problems occurred [3]. Therefore, a new method called Time-driven Activity-based Costing, known by the initials TDABC. It has developed further from the ABC in a way that time is used as the main cost driver. The ability of TDABC to grasp the needed metrics causes it to be a valuable costing method. As mention by [4], TDABC model is practical and ideal for manufacturing environments and it is capable of handling system variation. Moreover, for companies to remain profitable, the system need to identify waste, recognize efficiency and develop improvement on unused capacity information. The impact of profitability and cost management affects all processes of management and is a crucial element of an overall management system for a business performance.

ABC was widely known as one of the most important innovations costing methodologies. During 1970s and 1980s, under the supports of multiple theoretical and practical research, the concept of ABC was developed in the United States of America. At the same time, the Consortium for Advanced Management-International, an international consulting group also introduced a formative role to study and codify the principles. ABC aims to determine the casual and impact relationships in order to allocate costs objectively. Compared with TCA, ABC is more accurate to determine the actual costs of production and related service of a product. The accurate costing information helps the management to have a better understanding about their economics and make better decision making. In 1989s, the supporters of balanced scorecard - Robert S. Kaplan and Robin Cooper had published some articles of about this concept in Harvard Business Review. From their articles, the problems of traditional cost management had been listed. The problems of traditional cost management are unable to identify the actual production costs of a product and of its' services cost. Therefore, the management usually were using the inaccurate data to do decision making. When there are multiple products, the situation become more worst. Therefore, Robert and Robin characterised ABC as one of the better to solve those problems [5].

To implement ABC, cost drivers been used in order to allocate the actual costs according to the involved activities. Factor that affect the cost of the activity would be the cost drivers. Besides, unit cost would be considered as an output of ABC for measurement. Generally, four simple steps were required to implement ABC. There are identify activities, allocate resource costs to activities, identify outputs and assign activity costs to outputs. For the first step, the organization needs to carry out a detail analysis about the operating processes for each of the working centre. There might consist one or more than one activity involved in each process in order to produce an output. Those activities should be clearly defined and recorded. Next, resource costs of all identified activates need to be allocated. By this step, the organization allowed to trace back the costs for each activity and determine why the cost occurred. The resource costs can be classified into three types. There are direct costs, indirect costs and general/administration costs. Direct costs are the costs that are relatively easy to trace directly to one output. Costs that cannot be assigned to an individual output are the indirect costs. Then, all the output needed to be clearly identified. The outputs are very simple. The outputs can be the products, services or customers. The last step is all the activity costs need to allocate to outputs based on the consumption for activities by using cost drivers. Through the four simple steps of ABC, accurate costs information will be obtained. The management would be making better decision making based on the accurate cost information [5].

ABC had been widely used due to its several advantages. It provided accurate, timely and reliable information to managers in order to make decisions [6], helped to determine the process cost of contemporary production processes [7], provided a more accurate product cost than TCA [8], helped to doing cost estimation during complex processes exist [9], achieved a proper cost estimation tool to set up budget of a complex project [10], allowed to estimate production costs and environmental cost accurately [11], helped to estimates the product/service costs by assigning the cost to the activities involved in the creation process [12], provided actual cost information to support management to do decision making [13], provided detailed and accurate cost information often required in taking various managerial decisions [14], provided detailed information for planning and controlling which lead to reduce unnecessarily costs [15], provided actual cost information that make management easy to provide decision making [16], helped to understand how to allocate resources and funding for activities to each system through appropriate cost drivers [17], helped for effectively computing values of cost drivers as well as making accurate cost estimations [18], helped managers understand how to allocate resources for activities through appropriate cost drivers [19], provided more detailed information on costs accurately calculate the manufacturing cost of our choice [20], helped to calculate an increasingly accurate manufacturing cost amidst the situation in which the share of indirect manufacturing cost increases due to the production technology advancement

[9], helped to identify profitable and non-profitable products and account for resource constraints [21], determined the relative profitability of each market segment [22], helped to provide production plan and achieve the optimal profitable product mix [11] and improved all the company's inefficient activities [23].

In real life, the concept and application of ABC had been proven far beyond the academic discussion. ABC had been widely applied in many different areas like environment, engineering, healthcare etc. For environment, concept of ABC has been used to develop an optimal decision-making model for Taiwan's hybrid green power strategy [24]. The results were management able to make better decision making in order to get the maximum profits for green power planning. For engineering, a costing model for raw material handling section was developed based on concept of ABC in an Indian steel plant [14]. The results obtained from this model were all the activities are clearly defined and operate under efficiency resources. The steel plant allowed to minimize the manufacturing costs with an efficient resource planning. For healthcare, an ABC approach was used to develop a cost estimation model to identify cost information for an assisted reproductive technology treatment in Italy [25]. The results obtained from this model was the actual cost information of particular treatment has been clearly defined. Management also allowed to set up an efficient budget in order to maintenance the efficiency of particular treatment. Surprisingly, [26] applied ABC in the palm oil plantation while [27-29] developed a distinctive pattern of crankshaft and identify the critical and non-critical parameter of crankshaft based on the Mahalanobis Taguchi System, then applied ABC as a method of estimation for the remanufacturing cost of crankshaft.

However, TDABC may overcome the limitation of conventional ABC by systematically enhancing resources utilization by defining the opportunities of cost reduction without compromising outcome. The TDABC provides costs of activities with base in consume of time per activities [30]. It has been developed from the traditional ABC method which requires significant processing in data collection and cost allocation [31]. TDABC simplifies the complex formulations for ABC especially when there is any additional activity to be taken into account, the time equation can be easily extended [32]. In addition, TDABC is a bottom-up approach that determines cost by estimating the cost of each resource and the time each resource is used during each activity involved over the full course of treatment. This allows for better and more transparent estimates of the expenses incurred by providers in providing treatment [33]. This costing method also is commonly used in manufacturing and other service industries to assign costs accurately [34] because it provides a granular view of costs which directly reflect resource use and duration, thus providing actionable cost data to improve particular processes [35]. TDABC entailed developing process maps to represent the steps of each component of treatment including the personnel, equipment and consumable supplies involved in delivering care. Estimating time required for each personnel member and equipment by interviewing personnel involved in patient care, estimating the costs of personnel, equipment, and supplies according to salary data, equipment purchasing information, and direct discussion with medical centre administration to estimate facilities costs. It also estimating of the capacity cost rate (CCR) for each staff member and equipment item by calculating the total annual capacity of each resource and then dividing the annual cost by the capacity and calculating the total cost of patient care by multiplying the CCR for each resource by the time estimate for that process and adding any additional costs of consumable supplies. Obviously, TDABC approach overcame traditional ABC difficulties and had some advantages. The advantage over ABC is it simplifies the costing process and eliminates the costly process of particular activities in order to collect information on the cost allocation of resources and activities before directing it to the cost object. Work by [36-41] precisely applied the TDABC in electronic industry which every single activities and sub-activities are clearly stated the process for a single product.

According to [42], TDABC provides both accurate and estimates of care cycle costs as well as greater transparency into the drivers of those costs. TDABC able to calculate true cost of care for individual patients and identified process whose efficiency can be improved without affecting the outcome [43], able to deal with variability of industrial process, helped efficiently cost processes and overcome challenge associated with current cost-accounting methods, provided detailed baseline calculations for comparison and further optimization of cost-benefit effectiveness [44], revealed cost reduction and quality improvements and able to discover technique cost effectiveness [45]. Moreover, TDABC provided valuable insights into process variability and resource utilization [46].

METHODOLOGY

This work collects the data from the electric & electronic industry located at Kuantan, Pahang. Two methods will be compared such as ABC and TDABC.

The ABC assigns the indirect costs to centres and costs from the centres and also the costs from activities to cost objects. Step one is to define activities that involved in the production process. Different

companies will have different types of products. So, there will have different number of activities centre. The manufacturing cost is more accurate when there is larger the number of activities centre. However, there might consists some activities that may or may not be directly relevance in the production process. In order to reduce the complexity of ABC method, the critical activities been selected under junior assistant manager. Identify proper cost drivers for each activity would be the second step. After identifying the activities involved in the production, the proper cost drivers of each activity should be identified. Cost driver is the root cause that effect the expense of a production operation. Management would allow to determine the real causes to perform an activity. Third step is allocating resources cost to each activity. Firstly, the resources cost used to operate each activity has to be measure. A unit of work done within the organization are the activities that done within the organization. Next, the amount of overhead cost required by those activities has to be forecast and allocated in percentage. In fact, the resources costs are already recorded in the existing accounting system like the salaries, supplies and utilities. Overhead cost apportioned into different activities. Besides, overhead cost would be apportioned based on percentage for categories such as consumables, salaries, materials cost and other costs. The cost information obtained is more accurate when the larger the number of categories. Estimating the cost per unit of activity driver would be the fourth step. The purpose of an activity driver is as a cost drive to estimate the required cost of an activity. The activity cost or the cost consumed by the cost object should be proportional to the activity driver. For example, the direct labor cost will drive the cost of activity labor cost. The more employees required, the more the direct labor cost. A process or product that required two employees to work will be allocated twice as much in direct labor cost. The list of the activities performed in the business and total activity cost would be the outcome. The cost obtained is more accurate when the larger the number of activity driver of activity cost. However, there is only one or two activity drivers be considering in order to reduce the complexity of the costing. The last step is preparing a list of activities for each of the product. Any product for which the management wants a separate cost measure is a cost object. Total yearly expenses would be obtained after annual quantity if cost driver consumed multiply with the cost per unit of activity driver. The outcome is a total expense for each product, which includes a list of activities and costs of the product. Therefore, the accurate profitability will be obtained. As a result, actual cost information and proper cost drivers will be obtained using this ABC method. Therefore, accurate profitability will be calculated and it's moving the production from moving based to activity based.

TDABC consists of three phases as shown in Figure 1. Phase 1 consists of identification of process and development of process mapping in the electronic industry. The objective is to find the appropriate scope to focus for detail analysis. Once the scope is identified, phase 2 is very important to develop the capacity cost rate. It consists of collection of data, direct and indirect cost i.e. working hour, salary rate and historical data. During phase 3, the collected data is processed and analyzed to identify the unused capacity with respect to the duration and cost.

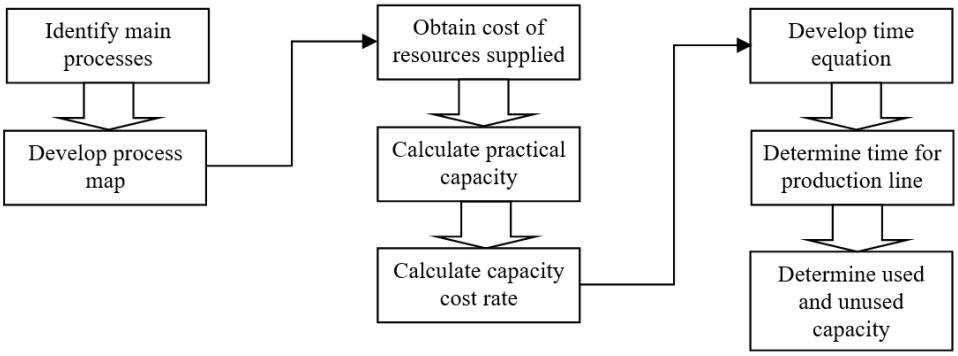

Figure 1 A flow chart of research methodology.

Phase 1:
1. Identifying main processes in production line and defining focus of study.
2. Develop a process map associated with production incorporated with capacity supplying resources including personnel, facilities, equipment and consumables.
Phase 2:
1. Obtain the direct cost (i.e. salary and maintenance) to determine the cost of capacity supplied.
2. Determine time (minutes) required for productive work in a year without non-value activities to estimate the practical capacity of supplied resources.

3. Develop capacity cost rate for the production line.
Phase 3:
1. Develop time equation to represents the basic time required for each activity with the incremental time associated with each variation that can occur.
2. Multiply the capacity cost rate with the time equation to determine the cost of a resource being used.
3. Determine used an un-used capacity in production line.

RESULT AND DISCUSSION

There are 12 items that describes major differences between ABC and TDABC. There are number of stages for cost allocation in ABC and TDABC, determination of drivers, action taken for an additional activity, cost consideration for implementation, system building, system update, information given from each method, transparency, overestimation of cost, differentiation of service level, oversimplification of activities and capacity forecast and planning. In this chapter, there are 9 items to be discussed. However, there are 3 items that is abandoned in this discussion which is system building, system update and differentiation of service level as the cited paper did not clearly state information regarding the issue.

Cost allocation
Cost allocation is a process of classifying, collecting and assigning cost to cost objects. There are 2 stages in ABC. The first stage allocates the indirect costs to the activity centers and the second stage assigns the allocated costs of these centers to the cost objects, using the activity drivers. Table 1 shows direct and indirect cost being allocated to the activity center. There are 13 workstations and 4 category of cost which is labor, maintenance, material and consumable. The total of all cost resources supplied for every workstation is MYR 3,782,377,14.

Table 1 Labor, maintenance, material and consumable cost for all workstation.

Workstation	Labor (MYR)	Maintenance (MYR)	Material (MYR)	Consumable (MYR)	Cost of all resources supplied (MYR)
1. Winding	24,000.00	26,449.89	576,000.00	nil	626,449.89
2. Flattening	48,000.00	70.00	nil	144.00	48,214.00
3. Trimming	48,000.00	nil	nil	192.00	48,192.00
4. Forming	48,000.00	nil	nil	192.00	48,192.00
5. Soldering	24,000.00	nil	nil	445,064.32	469,064.32
6. Epoxy application	24,000.00	nil	1,440,000.00	201,600.00	1,665,600.00
7. Assembly 1	72,000.00	nil	480,000.00	403.20	552,403.20
8. Assembly 2	48,000.00	nil	nil	268.80	48,268.80
9. Oven curing	24,000.00	nil	nil	24.00	24,024.00
10. Boundary inspection	24,000.00	nil	nil	134.40	24,134.40
11. Laser marking	24,000.00	626.53	nil	nil	24,626.53
12. Co-planarity and VMI test	24,000.00	nil	nil	130,824.00	154,824.00
13. Packaging	24,000.00	nil	nil	24,384.00	48,384.00
Total	456,000.00	27,146.42	2,496,000.00	803,230.72	3,782,377.14

Next, the second stage, it is to assign activity center to cost object. It is shown in Table 2, where cost driver rate is calculated with respect to the activity center.

Table 2 Cost driver rates for all workstations.

Activity	Cost driver	Assigned cost (MYR)	Cost driver quantity	Cost driver rate (MYR)
1. Winding	Amount of raw material (g)	626,449.89	8,697,600	0.07
2. Flattening	Hydraulic press machine (frequency)	48,214.00	960,000	0.05
3. Trimming	Pneumatic machines (frequency)	48,192.00	2,400,000	0.02

4. Forming	Pneumatic machines (frequency)	48,192.00	2,400,000	0.02
5. Soldering	Amount of material used (g)	469,064.32	2,400,000	0.20
6. Epoxy application	Amount of material used (g)	1,665,600.00	4,800,000	0.35
7. Assembly 1	Amount of material (quantity)	552,403.20	4,800,000	0.12
8. Assembly 2	Amount of material (quantity)	48,268.80	4,800,000	0.01
9. Oven curing	Clipping process (frequency)	24,024.00	4,800,000	0.01
10. Boundary inspection	Product items (quantity)	24,134.40	4,800,000	0.01
11. Laser marking	Laser marking machine (frequency)	24,626.53	4,800,000	0.01
12. VMI and co-planarity inspection	Inspection (frequency)	154,824.00	4,800,000	0.03
13. Packaging	Product items (quantity)	48,384.00	4,800,000	0.01
Total		3,782,377.14		

As for TDABC, the allocation of cost is in 1 stage. In TDABC, total time taken is used to allocate cost to the activities. Table 3 shows an activity, the usage of time and cost to complete the work. The usage of time for winding is 1,043.71 minutes with total cost of MYR 2,644.96. The total cost of winding with respect to time is related to information in Table 6 which will be discussed later.

Table 3 Capacity utilization of TDABC.

Activity	Sub-activities	Practical capacity	Used time (min)	Total cost (RM)	Unused time (min)	Unused cost (MYR)
1.Winding	1.Wind wires using CNC machine	218,400	1,043.71	2,644.96	246,156.29	623,804.93

The usage of time as mention in Table 3 is derived from information from Table 4 and Table 5. In Table 4, the standard of time for winding activity is shown which is 0.12 minutes. X_1 is the variable of time of this activity.

Table 4 Standard time of winding activity.

Activity	Sub-activities	Time equations
1.Winding	1. The wire are winded using CNC machine	$0.12X_1$

In Table 5 shows the information describing the time variable in winding activity. The time variable is the quantity of the driver which is 8,697.6 kg.

Table 5 Time variable of winding activity.

Activity	Var.	Sub-activities	Driver	Quantity/year
1.Winding	X1	1. The wire are winded using CNC machine	Amount of raw material (kg)	8,697.6

In terms of cost in TDABC, Table 6 shows the total cost of resources supplied for winding activity which is MYR 626,449.89. The given practical capacity is 247,200 minutes. By using the information gained, capacity cost rate for winding activity is generated as much as MYR 2.53. The capacity cost rate (CCR) is used to generate total cost in the activity as in Table 3. The total cost for winding is MYR 2,644.96.

Table 6 Capacity cost rate for winding activity.

Activity	Sub-activities	Cost of all resources supplied (MYR) [1]	Practical capacity (min) [2]	Capacity cost rate (MYR) [1]/[2]=[3]
1. Winding	1. The wire are winded using CNC machine	626,449.89	247,200	2.53

Indeed, the TDABC allocates cost in one stage where the process is connected directly to the time and cost with respect to the activity itself.

The determination of driver

Cost driver is the activity that contributes the most of cost in an activity. Both ABC and TDABC have drivers in the costing but is determined with different method. For ABC, the driver is determined by the time spent per activity as in Table 7. The time spent for flattening activity is 1.27% of all 13 activities identified in ABC. The time spent by operator to complete the task given is identified through surveying. The time spent is collected as an average, by interview session and by observation at the workstation.

Table 7 Percentage of time spent for flattening activity.

Activity	Time spent (%)
Flattening	1.27

While TDABC treats each activity using a time driver and does not determine the activity driver according to the property of that activity, as is the case with ABC. Table 8 demonstrates flattening and the sub-activities occur at the workstation with standard time and variables. There are 2 sub-activities in this workstation, therefore 2 equations produced which is $10.00X_2$ and $0.22X_3$.

Table 8 Standard time and variable for flattening activity.

Activity	Sub-activities	Time equations
Flattening	1. Pick up the coils from winding station	$10.00X_2$
	2. Flatten the coils by using hydraulic press machines	$0.22X_3$

In Table 9, the variable for flattening activity is described. To produce the time equations, the value of X_2 and X_3 is substitute with quantity of 480 and 960,000 respectively.

Table 9 Variables of flattening activity.

Var.	Driver	Quantity/year
X_2	1. Pick up the coils from winding station	480
X_3	2.0Flatten the coils by using hydraulic press machines	960,000

Thus, the determination of driver in ABC and TDABC is different that the driver in ABC is subjective to the time estimations through surveying process. The determination of driver in TDABC is objective because it uses the time equations with respect to each activity and sub-activity.

Consideration of an additional activity

Additional activity is any new activity added to the production line. ABC and TDBC act differently when there is an additional activity in the production line. For ABC, this method needs to do a thorough resurvey on the activities that involved with the additional activity. Additional activity affects time allocation for all workstation as shown in Table 10, when a new activity is added, the total percentage of time spent changes.

Table 10 Percentage of time spent in ABC.

Activity	Time spent (%)
Flattening	1.27

With TDABC, when a new activity is added, only the unit time for the new activity must be estimated and a thorough subsequent resurvey, which is the case for ABC, is avoided. Once a new activity is added, a new time and variable is added to the original equation as shown in equation below.

$$T \text{ sub-activities} = 0.12X_1 + 10.00X_2 + 0.22X_3 + 10.00X_4 + 0.13X_5 + 0.17X_6 + 0.72X_7 + 0.18X_8 + 0.15X_9 + 2.7X_{10} + 0.07X_{11} + 0.14X_{12} + 40X_{13} + 0.05X_{14} + 0.05X_{15} + 0.52X_{16} + 3.00X_{17}$$

Therefore, with TDABC, the process is simpler and removes time consuming process.

Cost consideration

This topic is focusing on cost consideration of steps in ABC and TDABC. In ABC, for every workstation, the time spent by operators to complete the task given is identified. The time spent is collected as an average, by interviewing the operators and by observation. In Table 11, it is shown the time spent for winding activity which is 16.56% of all other 12 activities. This is the result from surveying process.

Table 11 Time spent for winding workstations.

Activity	Time spent (%)
Winding	16.56

In TDABC, it simplifies the costing process by skipping the possible interviews or surveys made to the employees for allocating the resource costs to the activities. In this manner, TDABC avoids the costly, time-consuming, and subjective activity- surveying task of ABC. Thus, TDABC allows employees to concentrate more on the production time, so that the company gains a sustainable competitive advantage. This benefits manufacturers, especially as industry is now going through a low-margin era.

Informative

A system is considered informative when it is able to deliver useful or interesting information. It is understood that a method is more informative than the other when it offers more information to the management especially in terms of capacity utilization. Figure 2 shows the five steps of applying ABC method. In ABC, cost driver information is highlighted as it is used as rate and to forecast the product cost. It is beneficial to the company for decision making in the future.

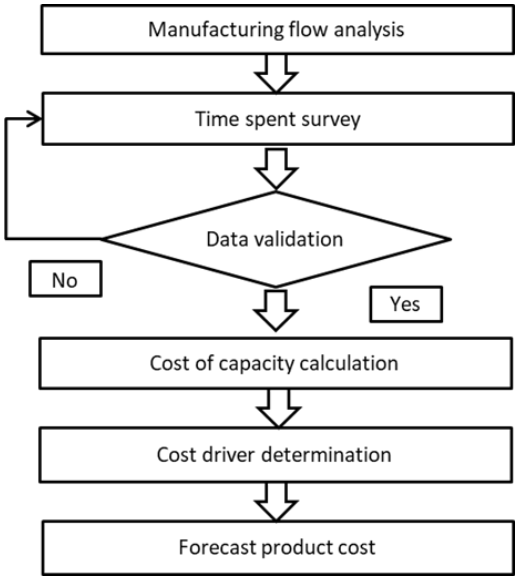

Figure 2 Steps of ABC.

In Figure 3, it shows the eight steps of TDABC. By using time equation and capacity cost rate, the capacity utilization analysis can be done. This is useful as it delivers information of efficiency and productivity of every activity and sub-activity.

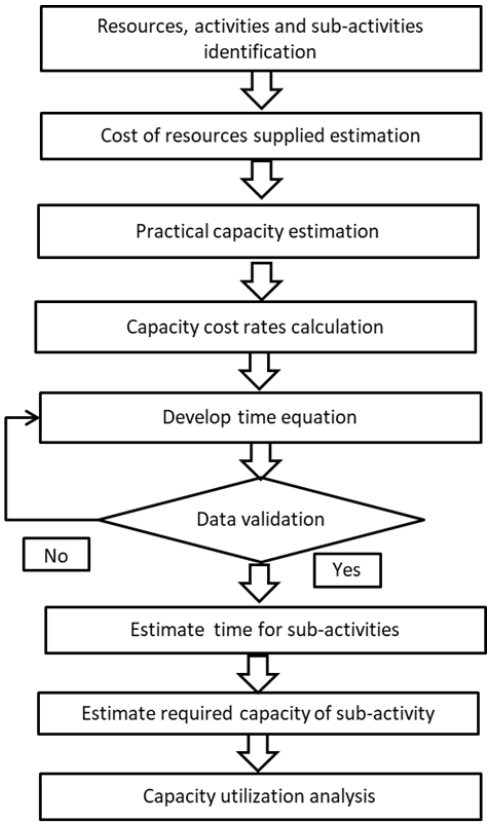

Figure 3 Steps of TDABC.

Therefore, TDABC can benchmark the efficiency of production activities and gives more information about the idle capacity.

Transparency

Transparency is an ability to show in detail the duration of an activity. ABC and TDABC both have time allocated for the activities but differ in the method to display the time needed. Table 12 displays the time equation for trimming activity, $10.00X_4$ and $0.13X_5$.

Table 12 Time equations of TDABC.

Activity	Sub-activities	Time equations
Trimming	1. Pick up the coils from flattening station	$10.00X_4$
	2. Trim the coils by using pneumatic press machines	$0.13X_5$

The value of X_4 and X_5 are substitute with the value in Table 13 which are 480 and 2,400,000 respectively.

Table 13 Variables of time in TDABC.

Var.	Driver	Quantity/year
X_4	Pick up the coils from flattening station (rounds)	480
X_5	Number of pneumatic press machine operating (frequency/month)	2,400,000

Eventually, in Table 14, the used and unused time of the activities are obtained. For sub-activity 2 in trimming activity, there is amount of -312,000 minutes of used time and -58,800 minutes of unused time. Thus, TDABC is able to portray transparency better than ABC in showing duration of time for activities.

Table 14 Used time and unused time in TDABC.

Sub-activities	Used time (min)	Unused time (min)
1. Pick up the coils from flattening station	4,800	118,800
2. Trim the coils by using pneumatic press machines	312,000	58,800

The method uses cost drivers to allocate indirect costs to products, thus the method is transparent.

Oversimplification of activities
ABC assumes that each activity uses a single cost driver, but in practice, an activity can have multiple cost drivers. In contrast, TDABC can use multiple cost drivers, in the form of time drivers, for an activity. In Table 15, ABC assumes single cost driver for soldering.

Table 15 Cost driver for soldering.

Activity	Cost driver
Soldering	Amount of material used (g)

On the contrary, as shown in Table 16, TDABC uses more than one cost driver for soldering activity. There are two drivers which are amount of flux and amount of solder used.

Table 16 Variations cost driver in TDABC.

Var.	Driver	Quantity/year
X_7	Amount of flux used (litre)	432
X_8	Amount of solder used (kg)	2,400

Capacity forecast and planning
Forecast and planning step is crucial as it predicts the future action and scenario. This step needs to be amplified with convincing data of the current situation. Both ABC and TDBAC have the ability to forecast however, the depth of the information sets a level between the two methods. For example, ABC is able to forecast using cost driver rates to determine the product unit cost. The company would have insight of appropriate cost and price for future references. According to Table 17, the forecast product unit cost is MYR 0.79.

Table 17 Forecasting of ABC product cost.

Activity	Activity cost driver	Cost driver rate (MYR)	Cost driver quantity	Total cost (MYR)
1. Winding	Amount of raw material (g)	0.07	9,567,360	689,094.88
2. Flattening	Hydraulic press machine (frequency)	0.05	1,056,000	53,035.40
3. Trimming	Pneumatic machines (frequency)	0.02	2,640,000	53,011.20
4. Forming	Pneumatic machines (frequency)	0.02	2,640,000	53,011.20
5. Soldering	Amount of material used (g)	0.20	2,640,000	515,970.75
6. Epoxy application	Amount of material used (g)	0.35	5,280,000	1,832,160.00
7. Assembly 1	Amount of material (quantity)	0.12	5,280,000	607,643.52
8. Assembly 2	Amount of material (quantity)	0.01	5,280,000	53,095.68
9. Oven curing	Clipping process (frequency)	0.01	5,280,000	26,426.40
10. Boundary inspection	Product items (quantity)	0.01	5,280,000	26,547.84
11. Laser marking	Laser marking machine (frequency)	0.01	5,280,000	27,089.18
12. VMI and co-planarity inspection	Co-planarity inspection (frequency)	0.03	5,280,000	170,306.40
13. Packaging	Product items (quantity)	0.01	5,280,000	53,222.40
			Total (MYR)	4,160,614.85

Unit (MYR)	0.79

As for TDABC, Table 18 displays the details of co-planarity and VMI activity. It shows information of used and unused time and cost. The sub-activity is to inspect inductors for co-planarity and VMI and has used time of 2,496,000 minutes and unused time of -2,248,800 minutes. TDABC separates the used resources and unused resources. By doing that, TDABC successfully gained knowledge on the performance of each activity. In TDABC, forecast can be done using reference of capacity utilization. Therefore, TDABC can be point of reference for efficiency of production activities and provides evidence about the idle capacity.

Table 18 Capacity utilization in TDABC.

Activity	Sub-activities	Used time (min)	Total cost (MYR)	Unused time (min)	Unused cost (MYR)
12.Co-planarity and VMI	Inspect inductors for co-planarity and VMI	2,496,000	1,563,271.46	-2,248,800	-1,408,447.46

Table 19 summarizes the finding based of the comparison between ABC and TDABC in the industry.

Table 19 Summary of ABC and TDABC comparison.

Item	ABC	TDABC
Cost allocation	Two stages	One stage
Determination of drivers	Subjective	Objective
Action taken for an additional activity	A thorough resurvey	Only the unit time of this activity is to be estimated
Cost consideration for implementation	Monetary and time-costly	Easy to build and maintain
System building	Per season or per year	By-event
System update	Time-costly	Flexible
Information given from each method	Less	Offer more precise information
Transparency	Good	Better
Overestimation of cost	Over-estimations of both unit-cost and sale price that can induce possible market loss	No over-estimation
Differentiation of service level	No	Yes
Oversimplification of activities	Yes	No
Capacity forecast and planning	Neglected the unused capacity	Able to perform further capacity analysis

CONCLUSIONS

This work has successfully compares the methodology between ABC and TDABC in electronic industry through cost allocation, determination of drivers, action taken for an additional activity, cost consideration for implementation, system building, system update, information given from each method, transparency, overestimation of cost, differentiation of service level, oversimplification of activities and capacity forecast and planning. For example, according to Table 14, the used and unused time of the trimming activity is amount of -312,000 minutes of used time and -58,800 minutes of unused time. Thus, TDABC is able to portray transparency better than ABC in showing duration of time for activities. In overall, it concludes that both have their strength according to the industry needs.

ACKNOWLEDGEMENT

The author would like to be obliged to University Malaysia Pahang for providing financial assistance under RDU1903105.

REFERENCES

[1] Cooper. R. (1993). Implementing Activity-Based Cost Management: Moving from Analysis to Action. Inst of Management Accountants. Retrieved from http://ci.nii.ac.jp/naid/20001705171/en/
[2] Esmalifalak, H., Albin, M. S. & Behzadpoor, M. (2015). A comparative study on the activity based costing systems: Traditional, fuzzy and Monte Carlo approaches. Health Policy and Technology, 4(1),58–67.
[3] Kaplan, R. S. & Anderson, S. R. (2007). Time-Driven Activity-Based Costing: A Simpler and More Powerful Path to Higher Profits. Boston: Harvard Business School Press.
[4] Barros, R. S. & Da Costa Ferreira, A. M. D. S. (2017). Time-driven activity-based costing: Designing a model in a Portuguese production environment. Qualitative Research in Accounting and Management, 14(1),2–20.
[5] Fito M.A., Llobet J. & Cuguero N. (2018). The activity-based costing model trajectory: A path of lights and shadows. Intangible Capital, 14(1),146-161.
[6] Alsmadi M., Almani A. & Khan, Z. (2014). Implementing an integrated ABC and TOC approach to enhance decision making in a Lean context. International Journal of Quality & Reliability Management, 31(8),906-920.
[7] Kolosowski M. & Chwastyk, P. (2014). Economic aspects of company processes improvement. Procedia Engineering, 69,222-230.
[8] Kont K.R. (2011). New cost accounting models in measuring of library employees' performance. Library Management, 33(1/2),50-65.
[9] Kim S., Ko W. & Bang S. (2015). Assessment of activity-based pyro process costs for an engineering-scale facility in Korea. Nuclear Engineering and Technology, 47(7),849-858.
[10] Gregorio L.T.D. & Soares C.A.P. (2013). Comparison between the mix-based costing and the activity-based costing methods in the costing of construction Projects. Journal of Cost Analysis and Parametrics, 6(2),77-95.
[11] Tsai W.-H. (2018). Carbon taxes and carbon right costs analysis for the tire industry. Energies, 11(8),1-22.
[12] Khataie A.H. & Bulgak A.A. (2013). A cost of quality decision support model for lean manufacturing: activity-based costing application. International Journal of Quality & Reliability Management, 30(7),751-764.
[13] Gottmann J., Pfeffer M. & Sihn W. (2013). Process oriented production evaluation. Procedia CIRP, 12,336-341.
[14] Dwivedi R. & Chakraborty S. (2016). Adoption of an activity based costing model in an Indian steel plant. Verslas: teorija ir praktika, 17(4),289-298.
[15] Fang Y. & Ng, S.T. (2011). Applying activity-based costing approach for construction logistics cost analysis. Construction Innovation, 11(3),259-281.
[16] Parker L.D. (2016). From scientific to activity based office management: a mirage of change. Journal of Accounting & Organizational Change, 12(2),177-202.
[17] Tsai W.-H., Tsaur T.-S., Chou Y.-W., Liu J.-Y., Hsu J.-L. & Hsieh C.-L. (2014). Integrating the activity-based costing system and life-cycle assessment into green decision-making. International Journal of Production Research, 53(2),451-465.
[18] Kostakis H., Albayrak T., Boskou G. & Palisidis, G. (2011). Modelling activity-based costing in restaurants. Journal of Modelling in Management, 6(3),243-257.
[19] Orji I. & Wei S. (2016). A detailed calculation model for costing of green manufacturing. Industrial Management & Data Systems, 116(1),65-86.
[20] Jing H. & Songqing L. (2011). The research of environmental costs based on activity based cost. Procedia Environmental Sciences, 10,147-151.
[21] Tsai W.-H., Chen H.-C., Leu J.-D., Chang Y.-C. & Lin T.W. (2013). A product-mix decision model using green manufacturing technologies under activity-based costing. Journal of Cleaner Production, 57,178-187.

[22] Lau H., Nakandala D., Samaranayake P. & Shum P. (2016). A hybrid multi-criteria decision model for supporting customer-focused profitability analysis. Industrial Management & Data Systems, 116(6),1105-1130.
[23] Marinho Neto H.F., Agostinho F., Almeida C.M.V.B., Moreno García R.R. & Giannetti B.F. (2018). Activity-based costing using multicriteria drivers: an accounting proposal to boost companies toward sustainability. Frontiers in Energy Research, 36(6),1-12.
[24] Yang C.-H. (2018). An optimization portfolio decision model of life cycle activity-based costing with carbon footprint constraints for hybrid green power strategies. Computers & Operations Research, 96,256-27.
[25] Cassettari L., Mosca M., Mosca R., Rolando F., Costa M. & Pisaturo, V. (2016). IVF cycle cost estimation using Activity Based Costing and Monte Carlo simulation. Health Care Manag Sci, 19(1),20-30.
[26] Zheng, C.W. & Abu, M.Y. (2019). Application of activity based costing for palm oil plantation. Journal of Modern Manufacturing Systems and Technology, 2,1-14.
[27] Abu, M.Y., Mohd Nor, E.E. & Abd Rahman, M.S. (2018). Costing improvement of remanufacturing crankshaft by integrating Mahalanobis-Taguchi System and Activity based Costing. IOP Conference Series: Materials Science and Engineering, 342,1-10.
[28] Nik Mohd Kamil, N.N. & Abu, M.Y. (2018). Integration of mahalanobis-taguchi system and activity based costing for remanufacturing decision. Journal of Modern Manufacturing Systems and Technology, 1,39-51.
[29] Abu, M.Y., Jamaludin, K.R. & Zakaria, M.A. (2017). Characterisation of activity based costing on remanufacturing crankshaft. International Journal of Automotive and Mechanical Engineering, 14(2),4211-4224.
[30] Da Silva Medeiros, H., Santana, A. F. B. & Da Silva Guimarães, L. (2017). The use of costing methods in Lean Manufacturing industries: A literature review. Gestao e Producao, 24(2), 395–406.
[31] Pongwasit, R. & Chompu-inwai, R. (2015). Analysis of wooden toy manufacturing costs through the application of a time-driven activity-based costing system. Memoirs of The Muroran Institute of Technology, 65,7-14.
[32] Zhuang, Z. Y. & Chang, S. C. (2017). Deciding product mix based on time-driven activity-based costing by mixed integer programming. Journal of Intelligent Manufacturing, 28(4),959–974.
[33] Bauer-Nilsen, K., Hill, C., Trifiletti, D. M., Libby, B., Lash, D. H., Lain, M., Christodoulou, D., Hodge, C. & Showalter, T. N. (2018). Evaluation of delivery costs for external beam radiation therapy and brachytherapy for locally advanced cervical cancer using time-driven activity-based costing. International Journal of Radiation Oncology Biology Physics, 100(1),88–94.
[34] Keel, G., Savage, C., Rafiq, M. & Mazzocato, P. (2017). Time-driven activity-based costing in health care: A systematic review of the literature. Health Policy, 121(7),755–763.
[35] Yu, Y. R., Abbas, P. I., Smith, C. M., Carberry, K. E., Ren, H., Patel, B., Nuchtern, J.G. & Lopez, M. E. (2017). Time-driven activity-based costing: A dynamic value assessment model in pediatric appendicitis. Journal of Pediatric Surgery, 52(6),1045–1049.
[36] Zamrud, N.F., Abu, M.Y., Kamil N.N.N.M. & Safeiee F.L.M. (2020). A comparative study of product costing by using activity-based costing (ABC) and time-driven activity-based costing (TDABC) method. Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 171-178.
[37] Mohd Safeiee, F.L., Abu, M.Y., Nik Mohd Kamil, N.N. & Zamrud, N.F. (2020). Diagnosis and costing optimization on inductors in electrics and electronics industry. Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 121-127.
[38] Nik Mohd Kamil, N.N., Abu, M.Y., Zamrud, N.F. & Mohd Safeiee, F.L. (2020). Proposing of mahalanobis-taguchi system and time-driven activity-based costing on magnetic component of electrical & electronic industry. Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 108-114.
[39] Mohd Safeiee, F.L., Abu, M.Y., Nik Mohd Kamil, N.N. & Zamrud N.F. (2020). The application of time-driven activity based costing system on inductors in electrics and electronics industry. Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 88-95.
[40] Nik Mohd Kamil, N.N., Abu, M.Y., Zamrud, N.F. & Safeiee F.L.M. (2020). Analysis of magnetic component manufacturing cost through the application of time-driven activity-based costing.

Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 74-80.

[41] Zamrud, N.F., Abu, M.Y., Nik Mohd Kamil, N.N. & Safeiee, F.L.M. (2020). The impact of capacity cost rate and time equation of time-driven activity-based costing (TDABC) on electric component. Proceedings of the International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 81-87.

[42] Kaplan, R. S. & Haas, D. (2018). Defining, measuring, and improving value in spine care. Seminars in Spine Surgery, 30(2), 80–83.

[43] Beriwal, S. & Chino, J. (2018). Time-Driven Activity-Based Costing in Oncology: A Step in the Right Direction. International Journal of Radiation Oncology Biology Physics, 100(1),95–96.

[44] Andreasen, S. E., Holm, H. B., Jørgensen, M., Gromov, K., Kjærsgaard-Andersen, P. & Husted, H. (2017). Time-driven Activity-based Cost of Fast-Track Total Hip and Knee Arthroplasty. Journal of Arthroplasty, 32(6),1747–1755.

[45] van der Linden, Y. T. K., Govaert, J. A., Fiocco, M., van Dijk, W. A., Lips, D. J. & Prins, H. A. (2017). Single center cost analysis of single-port and conventional laparoscopic surgical treatment in colorectal malignant diseases. International Journal of Colorectal Disease, 32(2),233–239.

[46] Anzai, Y., Heilbrun, M. E., Haas, D., Boi, L., Moshre, K., Minoshima, S., Kaplan, R. & Lee, V. S. (2017). Dissecting Costs of CT Study: Application of TDABC (Time-driven Activity-based Costing) in a Tertiary Academic Center. Academic Radiology, 24(2),200–208.