JOURNAL OF TECHNOLOGY AND OPERATIONS MANAGEMENT
http://e-journal.uum.edu.my/index.php/jtom

How to cite this article:

Zaini, S. N. A. M., & Abu, M. Y. (2022). Development A New Costing Structure In Product And Service Operation Using Time Driven Activity- Based Costing. Journal of Technology and Operations Management, 17(1), 11–26. https://doi.org/10.32890/jtom2022.17.1.2

DEVELOPMENT A NEW COSTING STRUCTURE IN PRODUCT AND SERVICE OPERATION USING TIME DRIVEN ACTIVITY-BASED COSTING

[1]Sri Nur Areena Mohd Zaini & [2]Mohd Yazid Abu

[1,2] Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang, 26600 Pahang, Malaysia

.

Corresponding author: areena5582@gmail.com

Received: 10/01/2022 Revised:15/03/2022 Accepted: 05/04/2022 Published: 29/07/2022

ABSTRACT

In current practice of costing method in palm oil plantation, the method does not implement time equation so processing time determined by company is not in accordance with actual processing time in work station. Then, the present implementation in academic library do not illustrate the correlation between supplied resources and practical capacity. It is to develop capacity cost rate in order to interpret it in form of unused capacity. The purpose of this study is to build a new costing structure in product and service operation using time driven activity-based costing (TDABC). For product operation, this work carried on at a palm oil plantation in Prosper Palm Oil Mill Sdn. Bhd., Pahang. For service operation, data collection of academic library is taken in Universiti Malaysia Pahang. Eventually, in product operation, the total used time in all three activity centers of palm oil plantation are 3,220,928.04 minutes for mature area and 2,390,513.94 minutes for immature area. On the other hand, in service operation, the unused capacity is RM40,960.02 and RM144,202.51 in local and oversea material respectively. In terms of unused capacity, there are no significant differences when applying TDABC in product and service operation. Whereas, regarding of process dependency, activities in product operation are dependent to one another.

Keywords: Product operation, service operation, palm oil plantation, academic library, time-driven activity-based costing

INTRODUCTION

A product-oriented business is one that manufactures products capable of meeting a consumer demand, purchase or utilization. Nonetheless, the product description does not limit itself to actual objects such as a vehicle, a microwave, or a computer. As defined by the definition, which product may also be sold, it should be expanded to encompass intangible products comparable to the kind of service oriented products. In reality, palm oil is the world's greatest edible oil marketed in 17 main fats and oils. It benefits significantly to national agriculture, which produces RM 67.49 billion in 2018 (DOS, 2019), and is one of the most popular foundations of the Malaysian economy. Palm oil is well recognised for its wide range of cuisine and non-food items, owing to its diversity.

A service-oriented firm is one that offers a product that is intangible and does not include earnings, rewards, or customer pleasure. This is far more specific than the product description. Valid data and financial estimates concerning library procedures must be prioritised by library management. For example, there are no physical goods or a variety of resources available in libraries for key products other than scanning and copying (Guzman, Abbeele, & Cattrysse, 2014). The evolution of digital services, high information costs, and ongoing budgetary restrictions have increased the libraries' demand for efficiency and the provision of high-quality services at a cheaper price (Guzman, Abbeele, & Cattrysse, 2016). Libraries must develop and keep proving their importance for academic management, which is struggling to understand new responsibilities, expenses, and benefits. Despite libraries are aware of the actual movement of funds, Kont (2015) discovered that it is impossible to assess the total cost of acquisitions and cataloguing. As a result of the weak costing system, it occurred with a limited financial awareness.

LITERATURE REVIEW

Traditional costing system models were less popular until the 1980s, as the direct labour component of commodities declined. The use of the classic costing accounting technique on a specific basis, comprising direct working time, results in a less complete and clearly not portrayed economic reality. Cooper and Kaplan proposed an activity-based costing (ABC) model, which implies that various items use a variety of resources and engage in the same activities (Cooper & Kaplan, 1991). They obtained precise financial information and cost drivers for each of the operations involved, which increased the company's financial performance (Zaini, Zheng & Abu, 2020). This technique's strategy also focused on the expenses of producing, distributing, or promoting things depending on activity (Zamrud & Abu, 2020). According to Zamrud et al. (2020), this strategy is appropriate for businesses that routinely make batches of commodities.

TDABC, on the other hand, is an updated ABC that incorporates resource costs from cost objects explicitly through the capacity cost rate. According to Keel et al. (2017), the methodology's primary principle is that cost drivers are transformed into time equations, whereby reflect the time required to complete a certain operation. Time consumption data is essential for correctly assessing capacity consumption. TDABC provides a more complete knowledge of system resources and the expenses associated with evaluating processes and supporting production enhancement (Zaini & Abu, 2020). The approach further thoroughly evaluates resource utilisation, for example, in the mature area, chipping has a high inadequate capacity of RM-1,931,518.08 and internal transport has a high waste cost of RM45,771.30 (Zaini & Abu, 2020). TDABC, according to Zaini and Abu (2019), gives greater understanding of operational tools and associated expenses in analysing processes and supporting quality enhancement. Numerous TDABC-related publications have been published. In Zaini and Abu (2020), the research deficit of TDABC in journals that might be utilised as a reference to the execution of the palm oil plantation was studied. Other than that, Ghani, Zaini, and Abu (2020) argued in the automotive sector that an overcapacity station and several underutilised capacity stations provide a solid concept of the company's management for improved expenditure plans. TDABC was then employed to determine the utilised and unused capacity in the supply chain. According to Zamrud et al. (2020), the enterprise has information concerning manufacturing costs and time consumption, and appears to have a capability in using TDABC to raise the precision in determining the best procedure for every one of the electrical components. The production costs of the winding toroid core and the outstanding capacity that can enhance time efficiency have been proven to be -RM 2967504.12 and -889200.12 minutes sequentially, from Kamil et al. (2020). According to Safeiee et al. (2020), TDABC is acknowledged as one of the most truthful and detailed evaluation technique for resource consumption and underutilised capacity. The magnetic part's operating costs in electrical and electronic production have been calculated. Safeiee et al. (2020) examined the financial assistance characteristics for considering the features of ABC and TDABC and found that the two are effective in meeting the sector's demands. Safeiee et al. (2020) applied the Mahalanobis-Taguchi system (MTS) and TDABC to study workflow on a manufacturing line in the electrical and electronic sector. Kamil et al. (2020) recommended utilising the MTS and TDABC to examine critical aspects and build a time equation and capacity cost rate in the electric and electronic sectors.

In addition, Zaini and Abu (2021) found that through an examination of capacity utilisation in TDABC, the manager has a solid objective of lowering manufacturing expenses in order to improve operational performance and minimize wasteful expenditures. Zaini and Abu (2021) also concluded that time equation and capacity cost rate may serve as a tool for management representative to analyse underutilised capacity, which then can reduce the resources for better saving. Meanwhile, Zaini and Abu (2021) also developed the time equation, capacity cost rate, capacity utilization and unused capacity in the nursery of palm oil plantation and the manager has alternatives of lowering the cost of production by increasing work capacity and reducing waste costs. Kamil, Zaini and Abu (2021) concluded that Mahalanobis-Taguchi system and TDABC are a great tool and feasible to be implemented in the electronic industry. TDABC was discovered by Zaini and Abu (2021) to be in accordance with actual resource utilisation in the identification of overall costs and identified some activities with added value to the operation. Zaini and Abu (2021) also found that there is no crucial difference present in the application of TDABC in product and service operations on the unused capacity except the activities in product operations are directly interdependent while service operations are vice versa. Literature reviews based on a total of 97 research articles from year 2011 till 2019 which implementing TDABC as their cost accounting system have been studied. It is attested that there is no research in comparative study applying TDABC system between product and service operation on the previous research studies. Figure 1 shows the distribution of TDABC system in product and service operation.

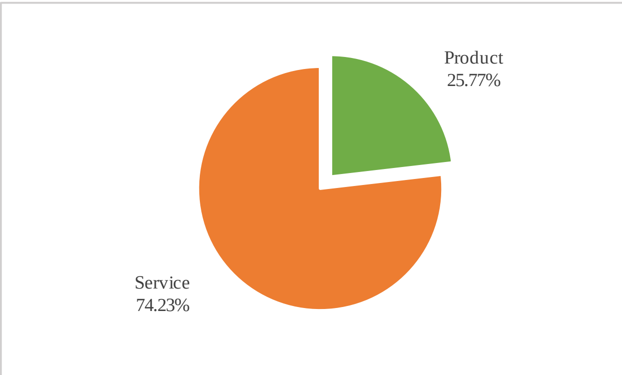

Figure 1. *Product vs Service.*

Based on Figure 1, service operation have the higher percentage which is 74.23% from 72 research articles compared to product operation that have 25.77% from 25 research articles. Then, the distribution been further classified into five different sectors. They are agriculture and industrial sectors from product operation, while library, health care and hospitality from service operation. Figure 2 shows the distribution of TDABC method which applied in five different sectors.

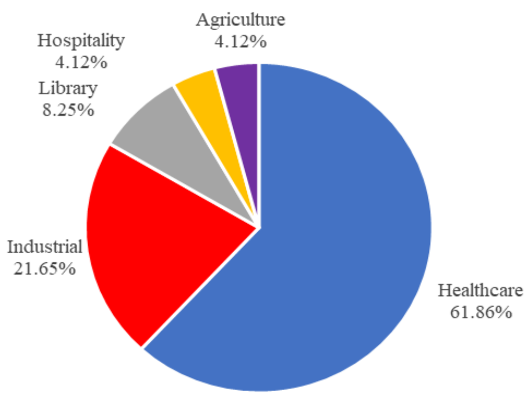

Figure 2. *Application sectors that using TDABC method*.

For the percentage of applying TDABC method in cost accounting system, agriculture sector contains the lowest percentage compared to the other four sectors with 4.12% which is only 4 from 97 research articles. Whereas for library sector, it has 8.25% with 8 research articles.

METHODOLOGY

The TDABC employs multiple steps. Every activities and sub-activities are specified through process mapping and documented resources. The time equation would then be determined by discovering the cost driver that is relative to the amount of time spent. The capacity cost rate is calculated by evaluating the existing expenses and capacities in the production operation. Lastly, the forecast is determined by calculating the unused capacity in terms of both time and cost. For product operation, this research is performed at Prosper Palm Oil Mill Sdn. Bhd. in Muadzam Shah, Pahang. It is divided into three main divisions and one of them which being Simpai Division 1 Estate, where the data for this study is obtained. As indicated in Figure 3, the estate is organised into three activity centres: nursery, replanting, and ramp. The activities were then classified into two main area which are mature and immature. All plants in the mature area are planted in 1990 and 1991, whereas the plants for the immature area are planted in 2015 and 2016.

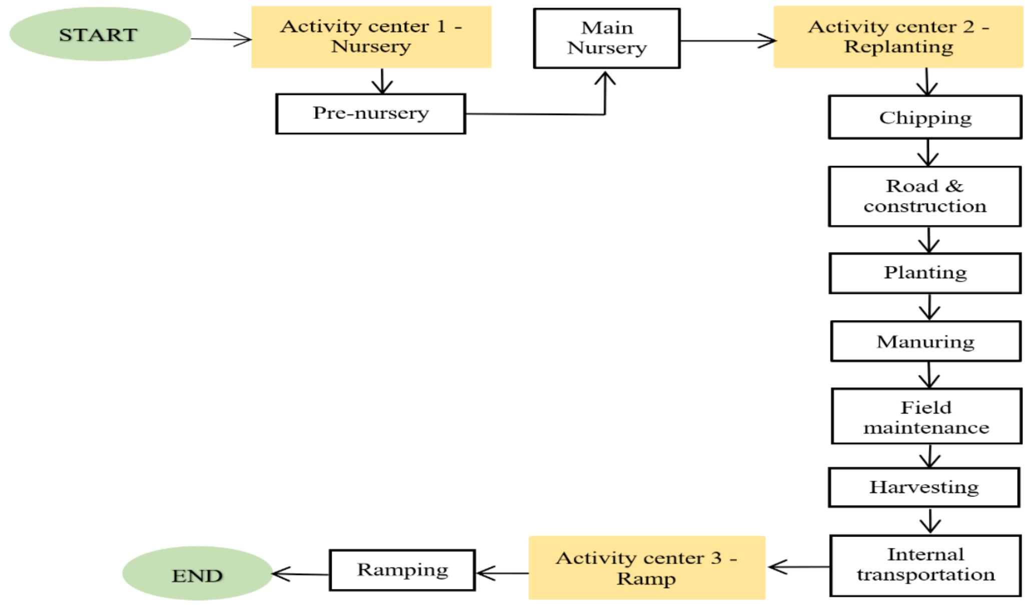

Figure 3. The flow of work in Simpai division 1 estate.

Once a detailed process map is built, the type of cost driver and its volume need to be selected and identified. Afterwards, estimation time of each sub-activities should be discovered to construct time equations. By using the time equations, the total time to carry out each of activity can be calculated. These numbers can be obtained by interviews with staff or direct observation at workplace. The TDABC time equation may combine all of the time required to complete entire sub-activities within every activity centre in one mathematical model as shown in Equation 1. Time equation for all activities in palm oil plantation are express in Table 1.

$$T_t = \beta_0 + \beta_i X_i \tag{1}$$

Where:
T_t = Time needed to perform an activity (minute)
B_0 = Standard time to perform the basic activity (minute)
β_i = Estimated time to perform the incremental activity (minute)
X_i = Quantity of the incremental activity (time)

Table 1.

Time Equations for Product Operation

Activities	Area	Time Equations
Activity center 1 - Nursery		
Pre-nursery	Mature	$5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6$
	Immature	$5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6$
Main nursery	Mature	$2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14}$
	Immature	$2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14}$
Activity center 2 -Replanting		
Chipping	Mature	$4X_{15} + 480X_{16}$
	Immature	$4X_{15} + 480X_{16}$
Road and drain	Mature	$480X_{17} + 480X_{18} + 480X_{19} + 480X_{20} + 480X_{21} + 4X_{22} + X_{23}$
constructions	Immature	$480X_{17} + 480X_{18} + 480X_{19} + 480X_{20} + 480X_{21} + 4X_{22} + X_{23}$
Planting	Mature	$480X_{24} + 0.75X_{25} + 8X_{26} + 2X_{27}$
	Immature	$480X_{24} + 0.75X_{25} + 8X_{26} + 2X_{27}$
Manuring	Mature	$0.083X_{28}$
	Immature	$0.05X_{28}$
Field	Mature	$46356X_{29} + 46356X_{30} + 40601X_{31}$
maintenance	Immature	$19638X_{29} + 19638X_{30} + 40601X_{31}$
Harvesting	Mature	$3X_{32} + 2X_{33} + X_{34}$
	Immature	$2X_{32} + 2X_{33} + X_{34}$
Internal	Mature	$15X_{35}$
transportation	Immature	$15X_{35}$
Activity center 3 - Ramp		
Ramping	Mature	$240X_{36} + 240X_{37} + 240X_{38}$
	Immature	$210X_{36} + 210X_{37} + 210X_{38}$

After the time equations for each sub-activities are generated, the time equation to determine the overall used time in a whole cycle of processes in palm oil plantation for mature and immature area are presented in Equation 2 and 3 as follows.

$T_{total(mature)} = T_{nursery(mature)} + T_{replanting(mature)} + T_{ramp(mature)}$ (2)
$= 5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6 + 2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14} + 4X_{15} + 480X_{16} + 480X_{17} + 480X_{18} + 480X_{19} + 480X_{20} + 480X_{21} + 4X_{22} + X_{23} + 480X_{24} + 0.75X_{25} + 8X_{26} + 2X_{27} + 0.083X_{28} + 46356X_{29} + 46356X_{30} + 40601X_{31} + 3X_{32} + 2X_{33} + X_{34} + 15X_{35} + 240X_{36} + 240X_{37} + 240X_{38}$

$T_{total(immature)} = T_{nursery(immature)} + T_{replanting(immature)} + T_{ramp(immature)}$ (3)
$= 5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6 + 2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14} + 4X_{15} + 480X_{16} + 480X_{17} + 480X_{18} + 480X_{19} + 480X_{20} + 480X_{21} + 4X_{22} + X_{23} + 480X_{24} + 0.75X_{25} + 8X_{26} + 2X_{27} + 0.05X_{28} + 19638X_{29} + 19638X_{30} + 40601X_{31} + 2X_{32} + 2X_{33} + X_{34} + 15X_{35} + 210X_{36} + 210X_{37} + 210X_{38}$

Table 2 explains how to calculate the entire used time on sub-activities in all activity centres by multiplying the volume or round required every month with the total time spent on each round. Activity planting in activity centre 2 has the most total used time for mature area with 996,693.84 minute/month, while activity planting has the highest total used time for immature area with 703,734.84 minute/month.

Table 2.

Used Time for Product Operation.

Activities	Volume/month		Minute/round		Used time (min/month)	
Area	Mature	Immature	Mature	Immature	Mature	Immature
Activity center 1 - Nursery						
Pre nursery	116,827.50	82,489.50	1,491.00	1,491.00	351,534.00	248,520.00
Main nursery	34,768.13	24,550.13	1,866.75	1,866.75	55,513.00	39,334.50
Total:	151,595.63	107,039.63	3,357.75	3,357.75	407,047.00	287,854.50
Activity center 2 - Replanting						
Chipping	46,556.00	32,930.00	484.00	484.00	281,424.00	226,920.00
Road and drain constructions	93,712.00	66,460.00	2,405.00	2,405.00	711,780.00	643,650.00
Planting	278,136.08	196,380.08	490.75	490.75	996,693.84	703,734.84
Manuring	46,356.00	32,730.00	0.08	0.05	3,847.55	1,636.50
Field maintenance	4.83	4.83	133,313.00	79,877.00	205,294.20	162,999.60
Harvesting	278,136.00	196,380.00	6.00	5.00	556,272.00	327,300.00
Internal transportation	193.15	136.38	15.00	15.00	2,897.25	2,045.70
Total:	743,094.07	525,021.30	136,713.83	83,276.80	2,758,208.84	2,068,286.64
Activity center 3 - Ramp						
Ramping	231.78	163.68	720	630	55,672.20	34,372.80
Total:	231.78	163.68	720	630	55,672.20	34,372.80
TOTAL:	894,921.47	632,224.60	140,791.58	87,264.55	3,220,883.04	2,390,513.94

Employee working hours have been assessed for practical capacity. Working hours at this plantation are 8 a.m. to 6 p.m. on every Monday through Saturday, and 8 a.m. to 1 p.m. on Sunday. The employees work an average of eight hours each day for Monday to Saturday (26 days per month) and five hours on Sunday (4 days a month). Then, the e Employees have an admissible capacity of 13,680 minutes per month based on their regular working hours. Table 3 represents the CCR for all sub-activities.

Table 3.

CCR for Product Operation.

Activities	Cost of all resources supplied (RM/month)		Practical capacity (min/month)		Capacity cost rate (RM/min)	
Area	Mature	Immature	Mature	Immature	Mature	**Immature**
Activity center 1 - Nursery						
Pre nursery	12,237.41	9,404.60	27,360	27,360	0.45	0.34
Main nursery	29,453.73	21,941.50	54,720	54,720	0.54	0.40
Total:	41,691.14	31,346.10	82,080	82,080		
Activity center 2 - Replanting						
Chipping	466,395.84	329,530.77	54,720	41,040	8.52	8.03
Road and drain constructions	471,009.46	333,473.76	218,880	164,160	2.15	2.03
Planting	324,875.85	391,776.77	191,520	136,800	1.70	2.86
Manuring	29,770.71	27,436.29	68,400	68,400	0.44	0.40
Field maintenance	69,354.50	48,507.40	123,120	82,080	0.56	0.59
Harvesting	40,500.00	29,550.00	246,240	177,840	0.16	0.17
Internal transportation	49,446.40	34,912.00	41,040	13,680	1.20	2.55
Total:	1,451,352.76	1195,186.99	943,920	684,000		
Activity center 3 - Ramp						
Ramping	49,446.40	34912	123,120	41,040	0.40	0.85
Total:	49,446.40	34912	123,120	41,040		
TOTAL:	1,542,490.30	1,261,446.09	1,149,120.00	807,120.00		

Consequently, implementing CCR as a phase in costing system can offer better and precise findings when calculating overall expenses. The total costs for each of the sub-activities in each activity center of palm oil plantation are depicted in Table 4.

Table 4.

Total Costs for Product Operation.

Activities	**Used time (min)**		**Capacity cost rate (RM/min)**		**Total cost (RM/month)**	
Area	**Mature**	**Immature**	**Mature**	**Immature**	**Mature**	**Immature**
Activity center 1 - Nursery						
Pre-nursery	351,534.00	248,520.00	0.45	0.34	158,190.30	84,496.80
Main nursery	55,513.00	39,334.50	0.54	0.40	29,977.02	15,733.80
Total:	407,047.00	287,854.50			188,167.32	100,230.60
Activity center 2 - Replanting						
Chipping	281,424.00	226,920.00	8.52	8.03	2,397,732.48	1,822,167.60
Road and drain constructions	711,780.00	643,650.00	2.15	2.03	1,530,327.00	1,306,609.50
Planting	996,693.84	703,734.84	1.70	2.86	1,694,379.53	2,012,681.64
Manuring	3,847.55	1,636.50	0.44	0.40	1,692.92	654.60
Field maintenance	205,294.20	162,999.60	0.56	0.59	114,964.75	259,169.37
Harvesting	556,272.00	327,300.00	0.16	0.17	89,003.52	55,641.00

Internal transportation	2,897.25	2,045.70	1.20	2.55	3,476.70	5,216.54
Total:	2,758,208.84	206,8286.64			5,831,576.90	5,462,140.25
Activity center 3 - Ramp						
Ramping	55,672.20	34,372.80	0.40	0.85	22,250.88	29,216.88
Total:	55,672.20	34,372.80			22,250.88	29,216.88
TOTAL:	**3,220,883.04**	**2,390,513.94**			**6,041,995.10**	**5,591,587.73**

For service operation, data are obtained from academic library in Universiti Malaysia Pahang. There are four main principal functions that act as activity centers which are acquisition, cataloging, circulation and document delivery process. However in this work, only two activity centers are been used which are acquisition and cataloging. In order to reduce the complexity of this work, the other two activity centers, circulation and document delivery process are not included. This is because the total number of activities in both activity centers are too high and overly complex to the existing research. The data for this analysis are taken based on direct interview and discussion, which then been validated by library division officer with the existed recorded data from the company. All activities are divided based on the type of materials, local and oversea. There are two activity centers, eight main activities and 42 sub-activities involved. This whole process is described in Figure 4.

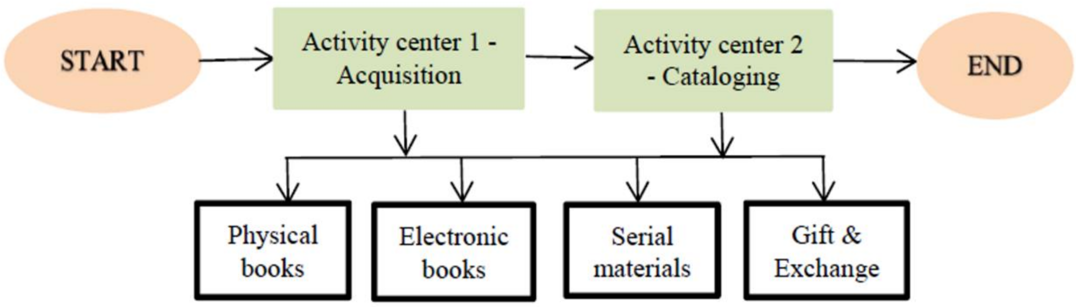

Figure 4. *The Flow of Work in UMP Library*

To compute the estimated usage time, a time equation must be established. Each anticipated time for sub-activities is the same in mature and immature areas. Time equation for all activities in academic library are reveal in Table 5.

Table 5.

Time Equations for Service Operation.

Activities	Materials	Time Equations
Activity center 1 - Acquisition		
Physical book	Local	$2400X_1 + 5X_2 + 10X_3 + 10X_4 + 5X_5 + 10X_6 + 2400X_7$
	Oversea	$2400X_1 + 5X_2 + 10X_3 + 10X_4 + 5X_5 + 10X_6 + 2400X_7$
Electronic book	Local	$2400X_8 + 5X_9 + 10X_{10} + 10X_{11} + 5X_{12} + 10X_{13} + 10X_{14} + 1440X_{15}$
	Oversea	$2400X_8 + 5X_9 + 10X_{10} + 10X_{11} + 5X_{12} + 10X_{13} + 10X_{14} + 1440X_{15}$
Serial material	Local	$480X_{16} + 480X_{17} + 10X_{18} + 5X_{19} + 15X_{20} + 15X_{21}$
	Oversea	$480X_{16} + 480X_{17} + 10X_{18} + 5X_{19} + 15X_{20} + 15X_{21}$
Gift and exchange	Local	$2400X_{22} + 480X_{23} + 1440X_{24} + 5X_{25} + 2400X_{26} + 2400X_{27} + 0X_{28}$

	Oversea	$2400X_{22} + 480X_{23} + 1440X_{24} + 5X_{25} + 2400X_{26} + 2400X_{27} + 0X_{28}$
Activity center 2 - Cataloging		
Physical book	Local	$2400X_{29} + 20X_{30} + 5X_{31} + 10X_{32} + 1440X_{33}$
	Oversea	$2400X_{29} + 20X_{30} + 5X_{31} + 10X_{32} + 1440X_{33}$
Electronic book	Local	$1440X_{34} + 15X_{35}$
	Oversea	$1440X_{34} + 15X_{35}$
Serial material	Local	$480X_{36} + 15X_{37}$
	Oversea	$480X_{36} + 15X_{37}$
Gift and exchange	Local	$2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42}$
	Oversea	$2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42}$

From Table 5, the time equation to evaluate the total used time in a whole cycle of processes in academic library for local and oversea material are presented in Equation 4 and 5 as shown below.

$$T_{total(local)} = T_{acquisition(local)} + T_{cataloging(local)} \quad (4)$$
$$= 2400X_1 + 5X_2 + 10X_3 + 10X_4 + 5X_5 + 10X_6 + 2400X_7 + 2400X_8 + 5X_9 + 10X_{10} + 10X_{11} + 5X_{12} + 10X_{13} + 10X_{14} + 1440X_{15} + 480X_{16} + 480X_{17} + 10X_{18} + 5X_{19} + 15X_{20} + 15X_{21} + 2400X_{22} + 480X_{23} + 1440X_{24} + 5X_{25} + 2400X_{26} + 2400X_{27} + 0X_{28} + 2400X_{29} + 20X_{30} + 5X_{31} + 10X_{32} + 1440X_{33} + 1440X_{34} + 15X_{35} + 480X_{36} + 15X_{37} + 2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42}$$

$$T_{total(oversea)} = T_{acquisition(oversea)} + T_{cataloging(oversea)} \quad (5)$$
$$= 2400X_1 + 5X_2 + 10X_3 + 10X_4 + 5X_5 + 10X_6 + 2400X_7 + 2400X_8 + 5X_9 + 10X_{10} + 10X_{11} + 5X_{12} + 10X_{13} + 10X_{14} + 1440X_{15} + 480X_{16} + 480X_{17} + 10X_{18} + 5X_{19} + 15X_{20} + 15X_{21} + 2400X_{22} + 480X_{23} + 1440X_{24} + 5X_{25} + 2400X_{26} + 2400X_{27} + 0X_{28} + 2400X_{29} + 20X_{30} + 5X_{31} + 10X_{32} + 1440X_{33} + 1440X_{34} + 15X_{35} + 480X_{36} + 15X_{37} + 2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42}$$

Subsequently, to construct reliable time equation, data of cost drivers and time taken for each sub-activities are identified. All data in this section are measured by considering the ideal time stated in the documented report. It then been compared with the data taken from the semi structure interview with the officer. Then, the estimated capacity required by each activity is determined by quantifying the frequency of the activity in a month. By multiplying the amount of a given activity by the time spent doing it, the total used time in each of the activities in service operation as summarized in Table 6.

Table 6.

Total Used Time for Service Operation.

Activities	Volume/month		Minute/round		Used time (min/month)	
	Local	Oversea	Local	Oversea	Local	Oversea
Activity center 1 - Acquisition						
Physical book	59.50	25.25	4,840.00	4,840.00	7,051.01	6,780.00
Electronic book	437.75	8.25	3,890.00	3,890.00	7,198.05	3,610.97
Serial material	3.41	2.66	1,005.00	1,005.00	114.30	106.80
Gift and exchange	133.08	4.67	9,125.00	9,125.00	8,280.32	7,646.40
Total:	633.75	40.83	18,860.00	18,860.00	22,643.68	18,144.17
Activity center 2 - Cataloging						
Physical book	42.00	16.50	3,875.00	3,875.00	6,850.04	6,560.70

Electronic book	73.34	1.75	1,455.00	1,455.00	2,054.80	981.05
Serial material	0.83	0.58	495.00	495.00	49.65	45.90
Gift and exchange	387.25	2.00	3,875.00	3,875.00	8,334.56	3,840.00
Total:	503.41	20.83	9,700.00	9,700.00	17,289.05	11,427.65
TOTAL:	1,137.16	61.66	28,560.00	28,560.00	39,932.73	29,571.82

In the meantime, the practical capacity also based on working hours of employees are been estimated. The regular working hours of librarians and officers are subject to government's service circular issued by public service department (JPA). The official working time are 8 a.m. to 5 p.m, an average of eight hours a day for Monday to Friday basis. Employees have an admissible capacity of 8,448 minutes per month after deducting 10% for breaks or absence and another 10% for training programmes from their working hours.

Table 7.

CCR for Service Operation.

Activities	Cost of all resources supplied (RM/month)		Practical capacity (min/month)		Capacity cost rate (RM/min)	
	Local	Oversea	Local	Oversea	Local	Oversea
Activity center 1 - Acquisition						
Physical book	4,421.54	5,115.59	8,448.00	8,448.00	0.52	0.61
Electronic book	31,479.04	1,888.27	6,336.00	6,336.00	4.97	0.30
Serial material	47,220.55	148,568.43	2,112.00	2,112.00	22.36	70.34
Gift and exchange	1,652.00	1,652.00	8,448.00	8,448.00	0.20	0.20
Total:	84,773.12	157,224.30	25,344.00	25,344.00		
Activity center 2 - Cataloging						
Physical book	1,514.25	1,514.25	6,336.00	6,336.00	0.24	0.24
Electronic book	413.00	413.00	2,112.00	2,112.00	0.20	0.20
Serial material	413.00	413.00	2,112.00	2,112.00	0.20	0.20
Gift and exchange	1,514.25	1,514.25	6,336.00	6,336.00	0.24	0.24
Total:	3,854.50	3,854.50	16,896.00	16,896.00		
TOTAL:	88,627.62	161,078.80	42,240.00	42,240.00		

Consequently, by adopting CCR, the total costs for each of the sub-activities in each activity center of academic library can be calculated as display in Table 8.

Table 8.

Total Costs for Service Operation.

Activities	Used time (min)		Capacity cost rate (RM/min)		Total cost (RM/month)	
	Local	Oversea	Local	Oversea	Local	Oversea
Activity center 1 - Acquisition						
Physical book	7,051.01	6,780.00	0.52	0.61	3,690.37	4,105.55
Electronic book	7,198.05	3,610.97	4.97	0.30	35,761.96	1,076.15
Serial material	114.30	106.80	22.36	70.34	2,555.54	7,512.84
Gift and exchange	8,280.32	7,646.40	0.20	0.20	1,619.21	1,495.25
Total:	22,643.68	18,144.17			43,627.09	14,189.79
Activity center 2 - Cataloging						
Physical book	6,850.04	6,560.70	0.24	0.24	1,637.10	1,567.95
Electronic book	2,054.80	981.05	0.20	0.20	401.81	191.84
Serial material	49.65	45.90	0.20	0.20	9.71	8.98
Gift and exchange	8,334.56	3,840.00	0.24	0.24	1,991.89	917.73
Total:	17,289.05	11,427.65			4,040.51	2,686.50
TOTAL:	39,932.73	29,571.82			47,667.61	16,876.28

FINDINGS AND DISCUSSION

Ultimately, the final step in TDABC is conducting capacity utilization analysis by calculating used time and unused time which associated to used capacity and unused capacity respectively. Both used and unused capacity can be quantified when the total used and unused time are been multiplied with CCR. Figure 1, 2, 3 and 4 shows the capacity utilization in both product and service operation. Figure 1 and 2 discussed about mature and immature area in palm oil plantation for product operation. Whereas, Figure 3 and 4 discussed about local and oversea material in academic library for service operation. Aside from unused capacity, the majority of the activities had insufficient capacity in the form of labour. Attributed to differing in CCR of each sub-activity, limited capacity does not correspond to insufficient time. In Figure 5, it shows that in both nursery and replanting centers have insufficient capacity that will affecting the performance of business. The manager can minimize the amount of insufficient capacity by increasing the quantity of worker, expanding their working hours or using their extra time with more demanding activities that require additional personnel.

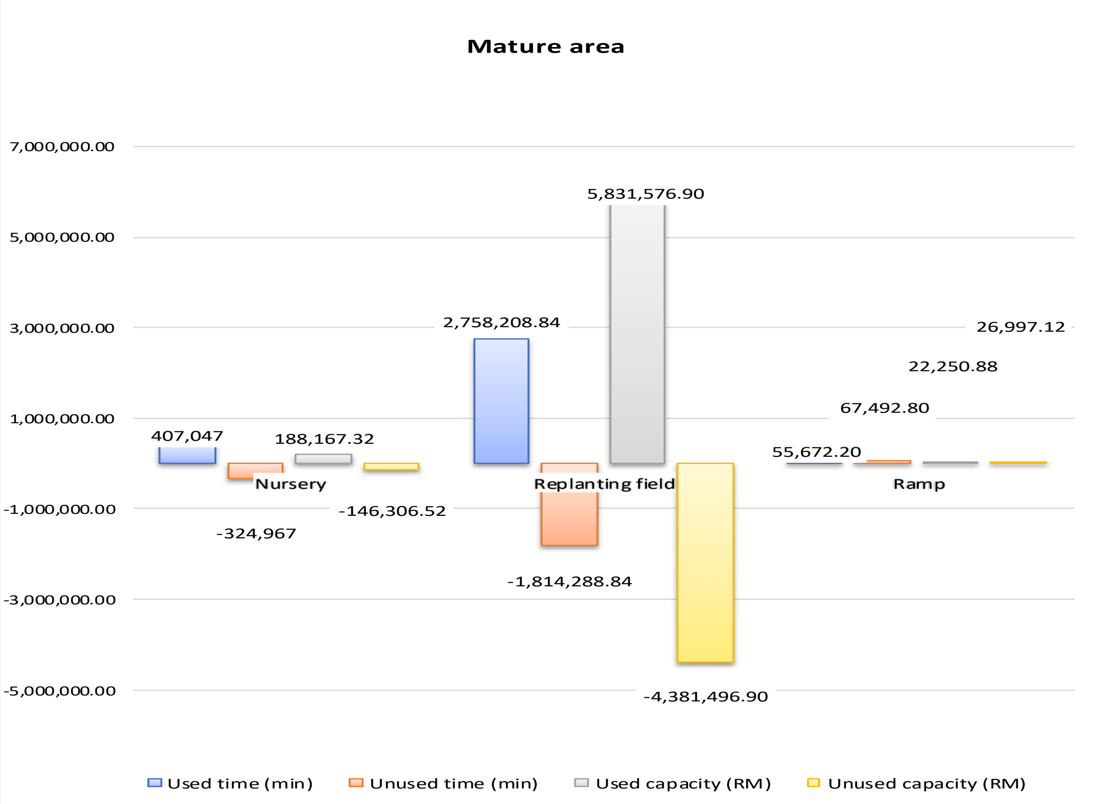

Figure 5. *Capacity Utilization of Mature Area*

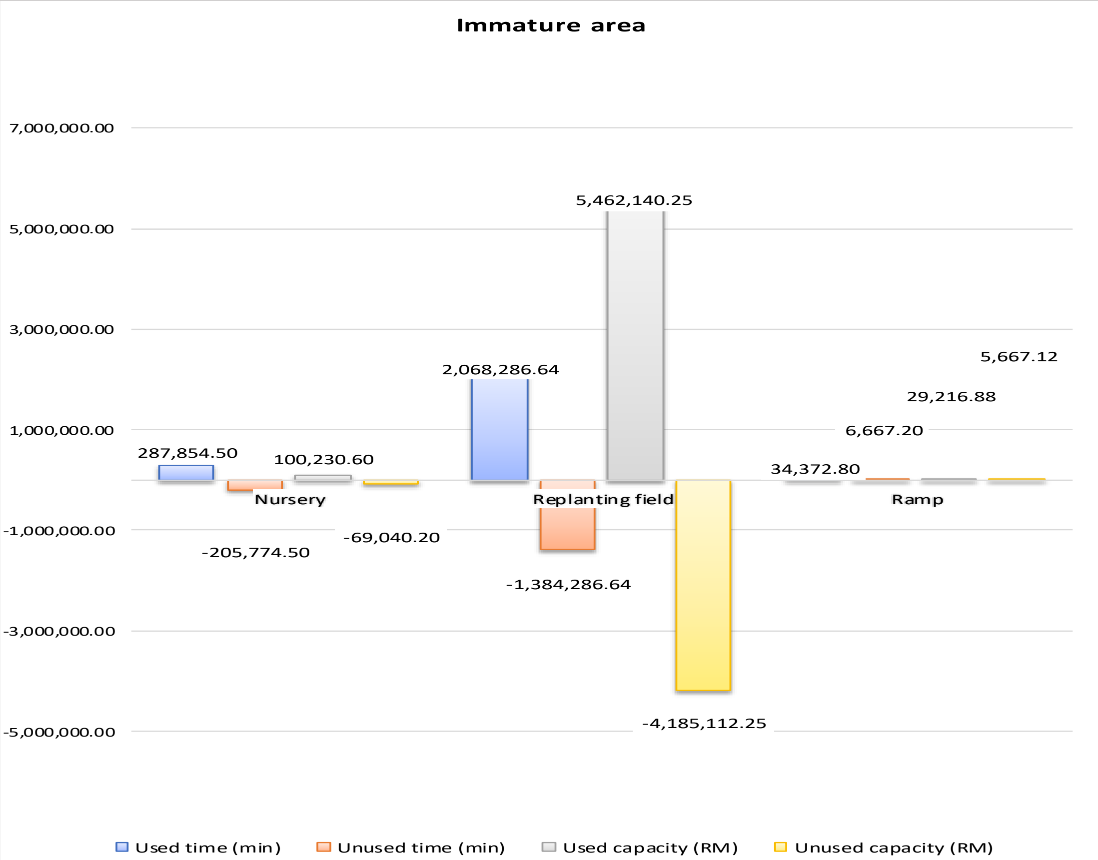

Figure 6. *Capacity Utilization of Immature Area.*

Based on Figure 6, It is clear that the replanting centre has the greatest rate for each analysis when compared to the other two centres, owing to the fact that it has the most procedures. Nevertheless, only activity center 3 ramp does not resulting any insufficient capacity. The practical capacity supplied exceeds the requirement. Only when the quantity of fresh fruit bunches decreases or increases from the overall amount harvested in each cycle will effecting the practical capacity. This is due to the fact that the ramp's sub-activities, which include grading, weighing, and external transportation of fresh fruit bunches to mill, adhere strictly to a regulated timeline. It is related with the number of trips for each sub-activity, which serves as a fundamental foundation for resource costs and practical capacity. For every activity centers, they have different CCR, so the rate to calculate the used and unused capacity are varies. In Figure 7, between both centers only cataloging center in local material have insufficient capacity. However, the negative value of unused capacity is not at worrying state which will not affecting the performance of service. The officer can fill in the staffs extra time for other complicated activities that need additional personnel. It shows that the used time in acquisition center are higher compared to cataloging center.

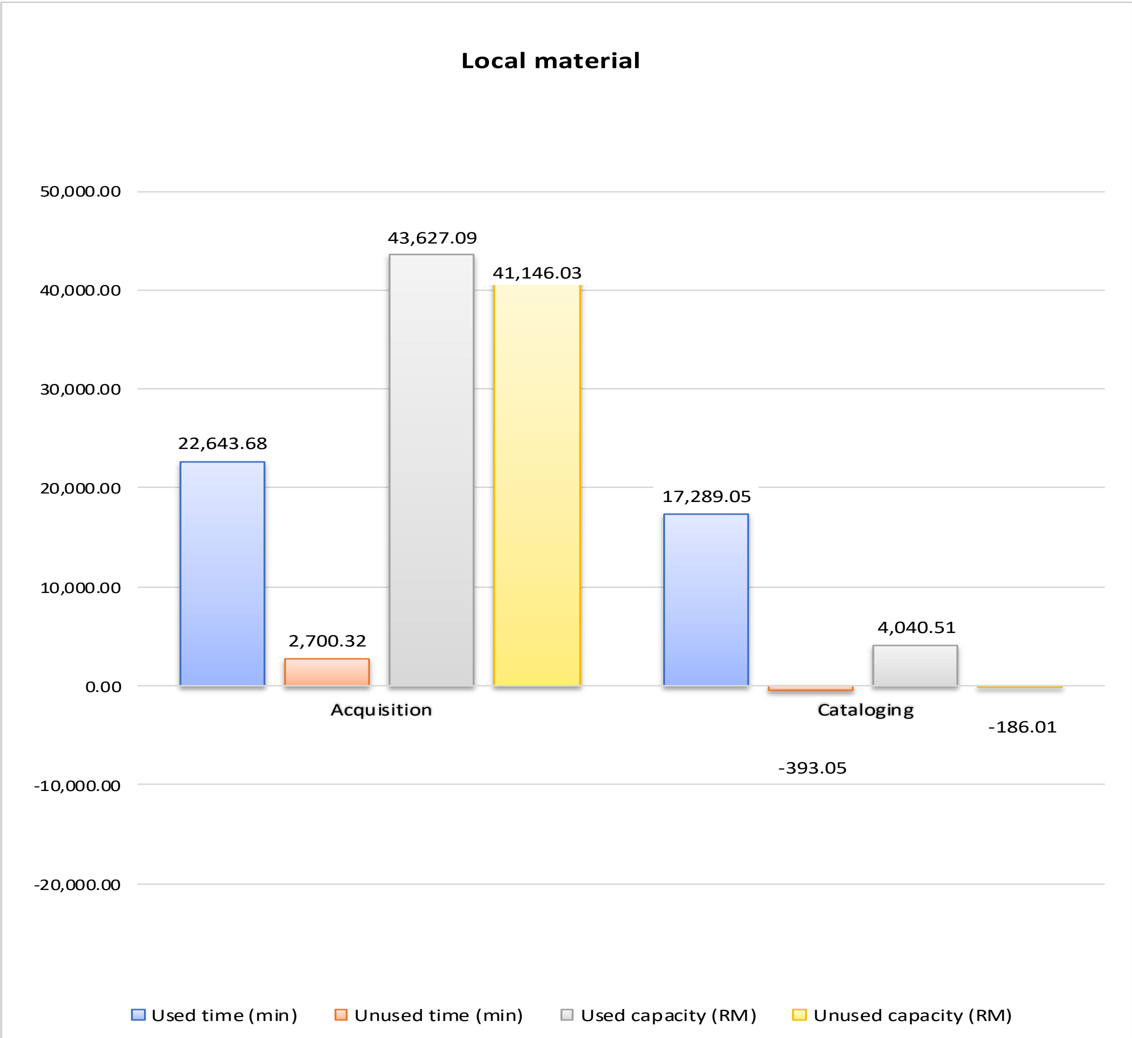

Figure 7. *Capacity Utilization of Local Material*

When a large total resource cost is split by a little total consumed time, the CCR value increases. There is an activity in academic library that have the highest unused capacity because of the high percentage of the CCR which is serial material in acquisition center as shown in Figure 8. The CCR of 70.34 causing to loss of RM141,055.60 in oversea material of serial material activity. The excess of RM1,979.91 from RM143,034.51 in unused capacity are from activity physical book, electronic book, and gift and exchange.

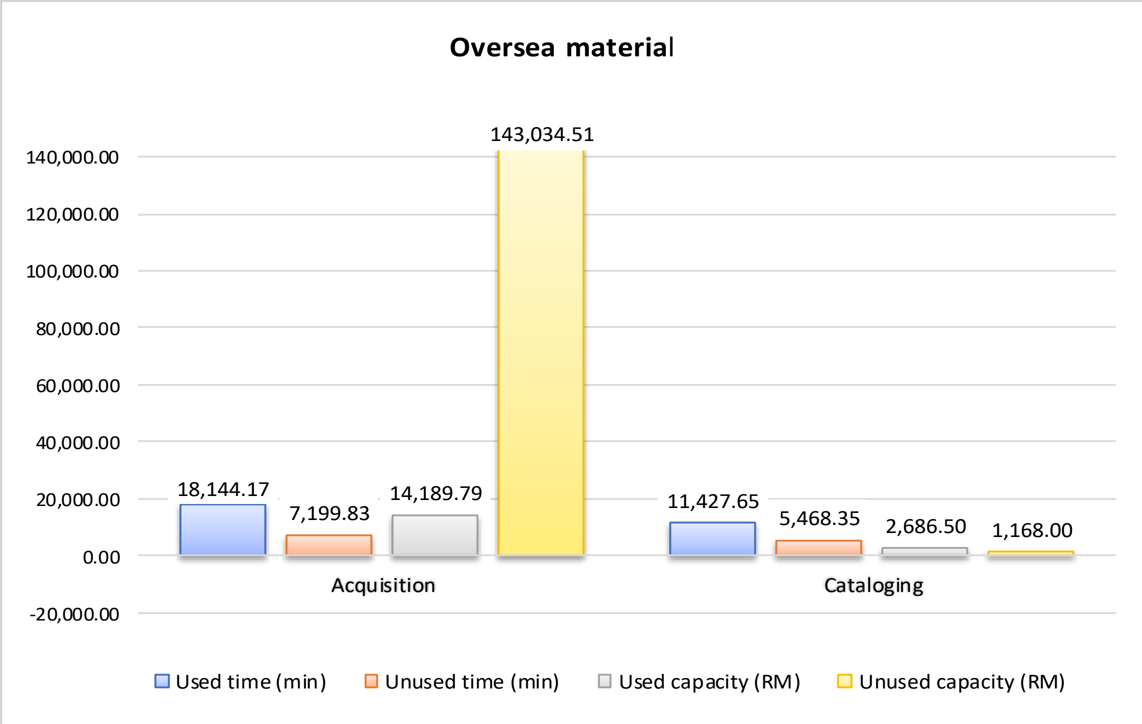

Figure 8. *Capacity Utilization of Local Material.*

Waters (2015) determined that TDABC is more suited for use in service operations. A review article was resorted to in order to design a comparative study between product and service operation while adopting the TDABC approach. There are 12 criteria from Zhuang and Chang (2017) that characterise the key distinctions between ABC and TDABC. The criteria are cost allocation, driver determination, action taken for an additional activity, cost consideration for implementation, system building, system update, information provided by each method, transparency, cost overestimation, service level differentiation, oversimplification of activities, and capacity forecast and planning. In this work, only eight criteria to be discussed. There are four criteria that are ignored in this discussion which are system building, system update, information given from each method and differentiation of service level as no specific information on this topic are given in the cited article.

CONCLUSION

This work able to calculate the time equation, capacity cost rate, used and unused capacity in palm oil plantations for product operation and academic library for service operation. The manager and officer thus have a significant focus on lowering production costs by measuring capacity consumption to achieve high efficiency of working capacity and lower waste costs. Then, to do comparative study between both operations, a summary of the strength of TDABC implementation in product and service operation using selected criteria is been drawn. In terms of unused capacity, there are no significant differences when applying TDABC in product and service operation. In a nutshell, in terms of process dependency, activities in product operation is dependent to one another. While activities in service operation is independent. As a suggestion, this work may be applied in a variety of research areas despite of the kind of operation to detect and optimise unused capacity.

ACKNOWLEDGMENT

This research is completely sponsored by RDU1903105, and the authors gratefully appreciate University Malaysia Pahang for the authorised funding that allows this study to take place.

REFERENCES

Department of Statistics Malaysia. (2019). Annual Economic Statistics 2018. Retrieved from https://www.dosm.gov.my/v1/.

Guzman, L. S., Abbeele, A. V., & Cattrysse, D. (2014). Time-Driven Activity-Based Costing Systems for Cataloguing processes: A Case Study. Liber Quarterly, 23(3), 160-186.

Guzman, L. S., Abbeele, A. V., & Cattrysse, D. (2016). Using Time-Driven Activity-Based Costing to Identify Best Practices in Academic Libraries. The Journal of Academic Librarianship, 42(3), 232-246.

Kont, K. -R. (2015). What Do Acquisition Activities Really Cost? A Case Study in Estonian University Libraries. Library Management, 36(6/7), 511-534.

Cooper, R., & Kaplan, R. S. (1991). Profit Priorities from Activity-Based Costing. Harvard Business Review, 3(69), 130-135.

Zaini, S. N. A. M., Zheng, C. W., & Abu, M. Y. (2020). Costing Structure Improvement using Activity-Based Costing in Palm Oil Plantation of Malaysia. Journal of Modern Manufacturing Systems and Technology, 4(1), 95-109.

Zamrud, N. F., & Abu, M. Y. (2020). Comparative Study: Activity-based Costing and Time Driven Activity-Based Costing in Electronic Industry. Journal of Modern Manufacturing Systems and Technology, 4(1), 68-81.

Zamrud, N. F., Abu, M. Y., Kamil, N. N. N. M., & Safeiee, F. I. M. (2020). A Comparative Study of Product Costing by Using Activity-Based Costing (ABC) and Time-Driven Activity-Based Costing (TDABC) Method. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 171-178.

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.

Zaini, S. N. A. M., & Abu, M. Y. (2020). Implication of Time Equation in Mature and Immature Area of Ramp Using Time Driven Activity-Based Costing. Journal of Modern Manufacturing Systems and Technology, 4(1), 36-39.

Zaini, S. N. A. M., & Abu, M. Y. (2020). Assessment the Capacity Utilization of Mature and Immature Area of Replanting Using Time Driven Activity-Based Costing. Journal of Modern Manufacturing Systems and Technology, 4(2), 7-11.

Zaini, S. N. A. M., & Abu, M. Y. (2019). Development a New Costing Structure for Palm Oil Industry Using Time-Driven Activity-Based Costing. The 2nd Joint International Conference on Emerging Computing Technology and Sports 2019 (JICETS 2019), 1529(5), 1-7.

Ghani, N. F. A., Zaini, S. N. A. M., & Abu, M. Y. (2020). Assessment the Unused Capacity using Time Driven Activity based Costing in Automotive Manufacturing Industry. Journal of Modern Manufacturing Systems and Technology, 4(1), 82-94.

Zamrud, N. F., Abu, M. Y., Kamil, N. N. N. M., & Safeiee, F. L. M. (2020). The Impact of Capacity Cost Rate and Time Equation of Time-Driven Activity-Based Costing (TDABC) on Electric Component. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 81-87.

Kamil, N. N. N. M., 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. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 74-80.

Safeiee, F. L. M., Abu, M. Y., Kamil, N. N. N. M., & Zamrud, N. F. (2020). The Application of Time-Driven Activity-Based Costing System on Inductors in Electrics and Electronics Industry. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 88-95.

Safeiee, F. L. M., Abu, M. Y., Kamil, N. N. N. M., & Zamrud, N. F. (2020). Diagnosis and Costing Optimization on Inductors in Electrics and Electronics Industry. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 121-127.

Kamil, N. N. N. M., Abu, M. Y., Zamrud, N. F., & Safeiee, F. L. M. (2020). Proposing of Mahalanobis-Taguchi System and Time-Driven Activity-Based Costing on Magnetic Component of Electrical & Electronic Industry. International Manufacturing Engineering Conference & The Asia Pacific Conference on Manufacturing Systems, 108-114.

Waters, P. M. (2015). Value in Pediatric Orthopaedic Surgery Health Care: The Role of Time-Driven Activity-Based Cost Accounting (TDABC) and Standardized Clinical Assessment and Management Plans (SCAMPs). Journal of Pediatric Orthopedics, 35(5), 45-47.

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.

Zaini, S.N.A.M., & Abu, M.Y. (2021). Development a New Costing Structure Using Time Driven Activity-Based Costing for Palm Oil Plantation. International Journal of Engineering Technology and Science, 7(1), 11-25.

Zaini, S.N.A.M., & Abu, M.Y. (2021). Constructing a New Cost Structure Using Time-Driven Activity Based Costing for Replanting at Palm Oil Plantation. International Journal of Engineering Technology and Science, 7(1), 55-69.

Zaini, S.N.A.M., & Abu, M.Y. (2021). Measuring the Unused Capacity for Mature and Immature Area in Palm Oil Nursery Using Time Driven Activity-Based Costing, Lecture Notes in Mechanical Engineering, 33-41.

Kamil, N.N.N.M., Zaini, S.N.A.M., & Abu, M.Y. (2021). Feasibility Study on the Implementation of Mahalanobis Taguchi System and Time Driven Activity-Based Costing in Electronic Industry. International Journal of Industrial Management, 10(1), 160-172.

Zaini. S.N.A.M., & Abu, M.Y. (2021). Optimization of Capacity Utilization Using Time-Driven Activity-Based Costing for Library System. IOP Conference Series: Materials Science and Engineering, 1092, 1-10.

Zaini. S.N.A.M., & Abu, M.Y. (2021). Comparative Study Between Product- and Service-Based Operations Using Time-Driven Activity-Based Costing. IOP Conference Series: Materials Science and Engineering, 1092, 1-8.