Measuring the Unused Capacity for Mature and Immature Area in Palm Oil Nursery Using Time Driven Activity-Based Costing

S. N. A. M. Zaini and M. Y. Abu

Abstract The emergence of Malaysia, the world's leading palm oil producer, has driven the industry to thrive as never before. Recently, there are few issues happen in this plantation which are difficult to observe the establishment of time equation to interpret deviation of activities, the rate establishment do not precisely illustrate the correlation between supplied resources and practical capacity, and the manager do not have a tool to monitor the unused capacity. The aim of this work is to measure the unused capacity for mature and immature area at nursery for a better accuracy. Time-driven activity-based costing (TDABC) is applied as time efficiency can be calculated effectively, idle capacity accurately defined and used and unused capacity individually listed. It also provides more comprehensive understanding of practical resources and its associated costs while measuring processes and encouraging quality improvement. This work considers a data in 2017 to develop the solution. This work found that in pre nursery, the unused capacity of time in mature and immature are −324,174 min and −221,160 min respectively while the unused capacity of allocated cost in mature and immature are RM-145878.30 and RM-75194.40 respectively. Meanwhile, in main nursery, the unused capacity of time in mature and immature are −793 min and 15,385.5 min respectively while the unused capacity of allocated cost in mature and immature are RM-428.22 and RM6154.20 respectively.

Keywords Nursery · Palm oil plantation · Time-driven activity-based costing · Capacity cost rate · Time equation

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1 Introduction

Palm oil is the world's largest edible oil traded in the 17 major global market oils and fats. This makes a vital contribution to the Gross Domestic Product (GDP) for national agriculture, producing RM 67.49 billion of export revenues in 2018 [1] and is one of Malaysia's foundations of economy. The wide range of products of palm oils and palm oils in food and non-food products is well known worldwide, primarily due to their versatility. With developments in the international economy, different issues have become international obstacles in the field of sustainable management in terms of production and consumption [2, 3] stated that top management, quality control and organizational capabilities are really important towards sustainable services on green practices. Somehow, adoption happened due to the improper costing structure with lack of financial understanding. Until the 1980s, conventional standard cost systems were prevalent because the product's direct labor value plummeted. The costing operation introduced by Cooper and Kaplan is Activity based costing (ABC), and it assumes that many products apply the same activities, demanding resources in various proportions [4]. For each operations, it allocated real cost information and right cost drivers, and eventually made the productivity of the company more accurate [5]. This also emphasizes on the expense of producing, distributing or supporting the goods concerned for activity-based products [6]. Thus, the method is more suitable for the company whom frequently produces batches of product [7].

On the other hand, TDABC is a modified ABC which directly assigns the costs of resources from cost objects through capacity cost rate. The basic principle of this methodology is that it converts cost drivers into time equations, which represent time required to perform a given activity [8]. In automotive sector, [9] concluded that station with overused capacity and several stations with underused capacity gives a clear overview to the management of the company for better investment strategy [10] proved that the company gained information on manufacturing costs and time utilization for those activities and have the opportunity to use TDABC to enhance the accuracy in determining the appropriate process for any kind of product. Through the analysis on magnetic component, [11] confirmed that loss manufacturing cost winding toroid core is identified at −RM2967504.12 and unused capacity is −889,200.12 min is capable to improve the time efficiency. Thus, [12] concluded that TDABC is considered the most sophisticated and precise method to measure the resources utilization and unused capacity.

2 Research Methodology and Results

There are several steps in order to implement the TDABC. Process mapping is identified all the activities and sub-activities, and detailing all possible resources. Then, time equation is developed by identifying their cost driver which directly proportional to the activities cost. Establishment the capacity cost rate is achieved by estimating

all the capacity cost been supplied and determining the practical capacity currently used in the production. Finally, the forecasting is achieved by measuring the unused capacity with respect to time and expenses cost. This work is conducted at the plantation located in Muadzam Shah, Pahang. The estate was categorized into two main areas which are mature and immature area. This work also considered data of 2017 for further analysis. This work is considered nursery as the activity center which consists of two activities namely pre-nursery with six sub-activities and main nursery with eight sub-activities. The estimated capacity required by each activity was 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, one could calculate the total time spent on the activity. The volumes of cost-drivers for the activity centers is shown in Table 1.

A time equation is needed to be developed to calculate the estimated used time. The estimated time for each activity was determined based on the motion and time study principles. Each estimated time taken for sub-activities are same for both mature and immature areas. The total time taken for every round for each activity in activity center 1, nursery can be observed respectively. The total time taken per round in activity 1, pre-nursery is 1491 min, while main nursery takes 1866.75 min. From those two activities, it sums into a total of 3357.75 min for every single round per month. TDABC time equation is able to incorporate all the time needed to undertake all sub-activities in each activity center within a single equation as shown in Table 2.

In Table 3, it shows on how to get the actual used capacity for sub-activities in all activity centers by multiplying the value of quantity or round needed for sub-activities per month with total time taken for every round. For mature area, the total used capacity for pre-nursery and main nursery are 351,534 and 55,513 respectively. Then for immature area, the total used capacity for pre-nursery and main nursery are 248,520 and 39,334.5 respectively. The actual time spent (used capacity) in nursery for mature area is 407,047 min and in immature area is 287,854.50 min.

For the practical capacity, working hours of employees are been estimated. The plantation's working hours are Monday to Saturday, 8 a.m. to 6 p.m. and on Sunday from 8 a.m. to 1 p.m. The employees work an average of eight hours a day for Monday to Saturday basis (26 days a month) and five hours on Sunday (4 days a month). There are no deductions for breaks, training and maintenance from these working hours, meaning employees have an acceptable capacity of 13,680 min each per month. Estimated costs of all the resources used in the sub-activities are summarized in Table 4.

Based on the same approach, the total costs of utilization for each of the sub-activities in the nursery is shown in Table 5.

Table 1 Volume of cost-drivers for the nursery

Var.	Driver	Quantity/month (mature)	Quantity/month (immature)
Pre nursery			
X_1	HyPlug trays filling (amount of HyPlug)	58,409.00	41,240.00
X_2	Planting seeds into the HyPlugs (amount of seeds)	58,409.00	41,240.00
X_3	Manuring (foliar spraying)	8.00	8.00
X_4	Hand weeding (frequency/month)	0.50	0.50
X_5	Pest and disease control (pesticide, foliar and prophylactic spraying) (frequency/month)	0.50	0.50
X_6	Culling (frequency/month)	0.50	0.50
Main nursery			
X_7	Polybags filling (amount of bag)	11,589.00	8183.00
X_8	Transplanting from pre-nursery into large polybags (amount of bag)	11,589.00	8183.00
X_9	Mulching (frequency/month)	0.13	0.13
X_{10}	Manuring programme based mainly on controlled/slow release fertilizer (SRF) (rounds)	0.25	0.25
X_{11}	Chemical weeding (Herbicide spraying) (frequency/month)	0.13	0.13
X_{12}	Pest and disease control (pesticide, foliar and prophylactic spraying) (frequency/month)	0.25	0.25
X_{13}	Culling (frequency/month)	0.38	0.38
X_{14}	The seedlings are being loaded onto lorries/tractors to be transported to the field (rounds)	11,589.00	8183.00

Table 2 Time equations for nursery

No.	Activities	Area	Time equations
1	Pre-nursery	Mature	$5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6$
		Immature	$5X_1 + X_2 + 45X_3 + 480X_4 + 480X_5 + 480X_6$
2	Main nursery	Mature	$2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14}$
		Immature	$2X_7 + 2X_8 + 2X_9 + 420X_{10} + 480X_{11} + 480X_{12} + 480X_{13} + 0.75X_{14}$

3 Discussion and Conclusion

Figure 1 shows the comparison between practical capacity with utilization cost and unused capacity with waste cost in mature and immature areas for activity pre-nursery. Insufficient capacity in mature area is higher than in immature area with 103,014 min difference.

Meanwhile, Fig. 2 shows the comparison between practical capacity with utilization cost and unused capacity with waste cost in mature and immature areas for activity main nursery. Immature area has much higher quantity of unused capacity and waste cost compared in mature area.

In conclusion, this work successfully developed the time equation, capacity cost rate, used and unused capacity for mature and immature for the nursery of palm oil plantation. The manager therefore has an obvious view of lowering the cost of production by assessing capacity utilization with a focus on increasing work capacity and reducing waste costs.

Table 3 Total used time for sub-activities of nursery

Var	Driver	Quantity/month		Minute/round		Used capacity (min/month)	
	Area	Mature	Immature	Mature	Immature	Mature	Immature
Pre nursery							
X_1	HyPlug trays filling (amount of HyPlug)	58,409.00	41,240.00	5.00	5.00	292,045.00	206,200.00
X_2	Planting seeds into the HyPlugs (amount of seeds)	58,409.00	41,240.00	1.00	1.00	58,409.00	41,240.00
X_3	Manuring (foliar spraying)	8.00	8.00	45.00	45.00	360.00	360.00
X_4	Hand weeding (frequency/month)	0.50	0.50	480.00	480.00	240.00	240.00
X_5	Pest and disease control (pesticide, foliar and prophylactic spraying) (frequency/month)	0.50	0.50	480.00	480.00	240.00	240.00
X_6	Culling (frequency/month)	0.50	0.50	480.00	480.00	240.00	240.00
	Total	116,827.50	82,489.50	1491.00	1491.00	351,534.00	248,520.00
Main nursery							
X_7	Polybag filling (amount of bag)	11,589.00	8183.00	2.00	2.00	23,178.00	16,366.00
X_8	Transplanting from pre-nursery into large polybags (amount of bag)	11,589.00	8183.00	2.00	2.00	23,178.00	16,366.00
X_9	Mulching (frequency/month)	0.13	0.13	2.00	2.00	0.25	0.25
X_{10}	Manuring programme based mainly on controlled/slow release fertilizer (SRF) (rounds)	0.25	0.25	420.00	420.00	105.00	105.00
X_{11}	Weeding (herbicide spraying) (frequency/month)	0.13	0.13	480.00	480.00	60.00	60.00

(continued)

Table 3 (continued)

Var	Driver	Quantity/month		Minute/round		Used capacity (min/month)	
	Area	Mature	Immature	Mature	Immature	Mature	Immature
X_{12}	Pest and disease control (pesticide, foliar and prophylactic spraying) (frequency/month)	0.25	0.25	480.00	480.00	120.00	120.00
X_{13}	Culling (frequency/month)	0.38	0.38	480.00	480.00	180.00	180.00
X_{14}	The seedlings are being loaded onto lorries/tractors to be transport to the field (rounds)	11,589.00	8183.00	0.75	0.75	8691.75	6137.25
Total		34,768.13	24,550.13	1866.75	1866.75	55,513.00	39,334.50
Total		151,595.63	107,039.63	3357.75	3357.75	407,047.00	287,854.50

Table 4 Labor, equipment, machinery and other equipment costs within the nursery

Sub-activities	Labor costs		Overheads		Cost of all resources supplied	
Area	Mature	Immature	Mature	Immature	Mature	Immature
Pre nursery	8732.90	6930.20	3504.51	2474.40	12,237.41	9404.60
Main nursery	11,931.18	9569.50	17,522.55	12,372.00	29,453.73	21,941.50
Total	20,664.08	16,499.70	21,027.06	14,846.40	41,691.14	31,346.10

Table 5 Total production costs for nursery

Activities	Used capacity (min)		Capacity cost rate (RM/min)		Total cost (RM/month)	
	Mature	Immature	Mature	Immature	Mature	Immature
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

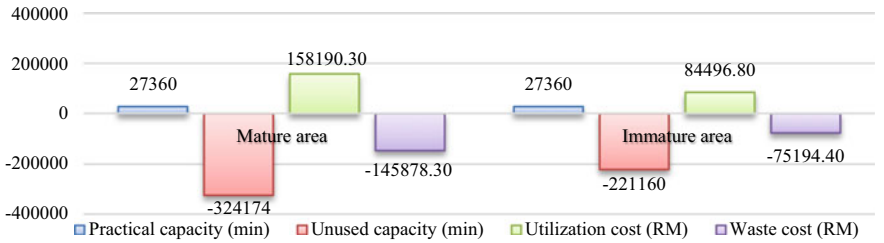

Fig. 1 Used capacity and waste costs in pre-nursery

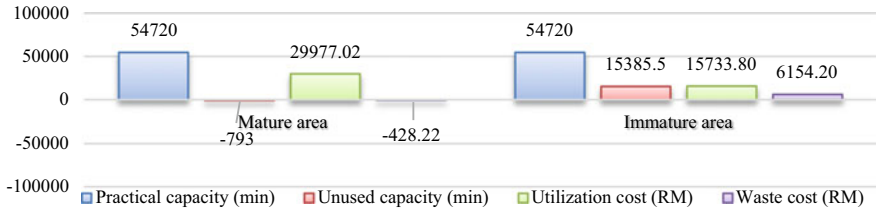

Fig. 2 Used capacity and waste costs in main nursery

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