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Optimization of capacity utilization using time-driven activity-based costing for library system

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Abstract. Library system encourages and offers a number of opportunities to access the resource of desired information. Nonetheless, there is a problem in the current practice in library system which do not explain the relation between supplied resources and practical capacity. To view it in the form of unused capacity, they should establish capacity cost rates (CCR). In efforts to support in reducing costs and divert the workforce for far more important activities, unused capacity analysis is ultimately critical in forecast planning. This work aims to develop a new costing system for optimization of capacity utilization in library system. Time-driven activity-based costing (TDABC) was applied in UMP library. While TDABC can enhance costs control for a range of library processes, it only focuses on acquisition and cataloging processes in this work. The analysis of data is carried out through four steps which are process mapping, time equation, CCR and forecast analysis. In this work, the total unused capacity at the acquisition center, in both local and overseas are 2,700,32 and 7,199,83 minutes. While in cataloging center, the total unused capacity are -393.05 and 5,468.35 minutes in local and oversea material respectively.

1. Introduction

Libraries have been continuously evolving in the last decades. The need for libraries for efficiency and their urgency to deliver high-quality services at lower costs was increased by emerging digital services, the high cost of information and the ongoing financial constraints [1]. More than ever before, libraries must develop and keep proving their importance to academic management, which is having trouble recognizing new library functions, costs and value. While libraries know precisely how much money they have spent on each publication, for example, the entire costs of acquisitions and cataloging are challenging to determine [2]. Somehow, it occurred with a lack of financial awareness due to the inadequate costing structure. Until the 1980s, traditional standard cost systems were less popular, as the direct labour content of products reduced. [3] proposed implementing a new economic model to produce high income for society, growth and integration, contributing to a better quality of life. The implementation of the conventional approach on a particular basis, like direct working time leads to a less detailed and economic fact clearly not represented. Assume the cost of operations and then orders, goods and consumers to develop a better costing structure. Activity-based costing (ABC), proposed by Cooper and Kaplan is a costing methodology that presumes that multiple products consume the same activities and require a variety of resources [4]. TDABC provides more comprehensive understanding of practical resources and its associated costs while measuring processes and encouraging quality improvement [5]. The method also precisely evaluates the resources utilization such as in the mature area, chipping has high insufficient capacity with RM-1,931,518.08



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and internal transport has high waste cost with RM45,771.30 [6]. It offers a better understanding of operating instruments and associated costs when assessing processes and promoting improvements in quality [7]. There are several published works related to TDABC. [8] compared the advantages of ABC and TDABC by analyzing the features towards the costing sustainment and it concluded that both have their strength according to the industry needs. [9] identified the used and unused capacity in the production line using TDABC. 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] performed a comparative study for electronic component between ABC and TDBAC. [11] diagnosed the process on production line in electric and electronic industry using Mahalanobis-Taguchi system and TDABC. [12] proposed of Mahalanobis-Taguchi system and TDABC in electric and electronic industry to evaluate the significant parameters and develop time equation and capacity cost rate respectively. [13] applied TDABC method in electric and electronic industry. [14] analyzed the manufacturing cost of magnetic component incurred on production in electric and electronic industry using TDABC. [15] analyzed the manufacturing process cost for electronic component using TDABC. [16] explored the research gap of TDABC in the journals that can be used as guideline in applying TDABC system in palm oil plantation.

2. Methodology

TDABC is not a new practise as dozens of related study is carried out in the library field. But the application of TDABC in Malaysia's academic library is almost insufficient. The data are taken from academic library in Universiti Malaysia Pahang, Pekan, Pahang. There are four main principal functions that acts as main activity centers which are acquisition, cataloging, circulation and document delivery process. In this work, however, only two acquisition and cataloging activity centers are used. Both activities were categorized into local and oversea materials. There are two activity centers, eight main activities and 42 sub-activities involves. The TDABC is implemented through many stages. Using process mappings and documented resources all activities and sub-activities are described. The time equation is then developed by directly classifying the cost driver in proportion to the operating costs. The capacity cost rate (CCR) is determined through an estimate of all the cost of capacities capacities delivered and the capacity presently being used in the production process. Eventually, the forecast is made through the evaluation of unused capacity in time and cost.

A time equation is needed to be developed to calculate the estimated used time. Each estimated time taken for sub-activities are same for both local and oversea materials. 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 1.

Table 1. Time equations.

Activities	Material	Time Equations
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	$2400X_{22} + 480X_{23} + 1440X_{24} + 5X_{25} + 2400X_{26} + 2400X_{27} + 0X_{28}$
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	$2400X_{38} + 20X_{39} + 5X_{40} + 10X_{41} + 1440X_{42}$

3. Result and discussion

The total used capacity required by each activity was determined by quantifying the volume of the activity in a month with the amount of time spent doing it. Then, one could calculate the total time spent on the activity as shown in Table 2.

Table 2. Total used capacity.

Driver	Material	Volume/month [1]	Minute/round [2]	Used capacity (min/month) [1] x [2] = [3]
Acquisition				
Physical book	Local	59.50	4,840.00	7,051.01
	Oversea	25.25	4,840.00	6,780.00
Electronic book	Local	437.75	3,890.00	7,198.05
	Oversea	8.25	3,890.00	3,610.97
Serial material	Local	3.41	1,005.00	114.30
	Oversea	2.66	1,005.00	106.80
Gift and exchange	Local	133.08	9,125.00	8,280.32
	Oversea	4.67	9,125.00	7,646.40
Total:	Local	633.75	18,860.00	22,643.68
	Oversea	40.83	18,860.00	18,144.17
Cataloging				
Physical book	Local	42.00	3,875.00	6,850.04
	Oversea	16.50	3,875.00	6,560.70
Electronic book	Local	73.34	1,455.00	2,054.80
	Oversea	1.75	1,455.00	981.05
Serial material	Local	0.83	495.00	49.65
	Oversea	0.58	495.00	45.90
Gift and exchange	Local	387.25	3,875.00	8,334.56
	Oversea	2.00	3,875.00	3,840.00
Total:	Local	503.41	9,700.00	17,289.05
	Oversea	20.83	9,700.00	11,427.65

In addition, reliable practical capacity data and costs of all supplies of resources are required in order to measure the capacity cost rate. Working hours of employees are estimated for practical capacity. The general 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, which are 22 days in a month. There are 10% deductions for breaks or leave and another 10% for training and workshop from these working hours, meaning employees have an acceptable capacity of 8448 minutes each per month.

Six personnel consist of a 44-grade officer, a 22-grade officer and four staffs in 19 grades in activity centre 1, acquisition. Whereas, there are only one officer with grades 41 and three staffs in grade 19 at the second activity center, cataloging which also known as metadata units.

If all used resources are subject to the same activity, costs may be explicitly allocated. After all, an allocation system based on acceptable cost drivers must be used when resources are used for multiple operations. Cost are assigned depending on the types of services for each task. In this work, it is divided into two categories, labor costs and overhead costs, including costs for materials, shipping costs and office supplies. These costs are assumed for operations that are carried out after the total amount of batch for books and material handled each month.

The costs involved in this analysis are those for the researched year. The labor cost are based on salary chart issued by public service department (JPA) following the current grade for each staff. The cost is taken from the recorded information of the library. Estimated costs of all the resources used in each of the activities are summarized in Table 3.

Table 3. Resources costs.

Driver	Material	Labor costs	Overheads	Cost of all resources supplied
Acquisition				
Physical book	Local	3,449.00	972.54	4,421.54
	Oversea	3,449.00	1,666.59	5,115.59
Electronic book	Local	1,239.00	30,240.04	31,479.04
	Oversea	1,239.00	649.27	1,888.27
Serial material	Local	413.00	46,807.55	47,220.55
	Oversea	413.00	148,155.43	148,568.43
Gift and exchange	Local	1,652.00	0.00	1,652.00
	Oversea	1,652.00	0.00	1,652.00
Total:	Local	6,753.00	78,020.12	84,773.12
	Oversea	6,753.00	150,471.30	157,224.30
Cataloging				
Physical book	Local	1,514.25	0.00	1,514.25
	Oversea	1,514.25	0.00	1,514.25
Electronic book	Local	413.00	0.00	413.00
	Oversea	413.00	0.00	413.00
Serial material	Local	413.00	0.00	413.00
	Oversea	413.00	0.00	413.00
Gift and exchange	Local	1,514.25	0.00	1,514.25
	Oversea	1,514.25	0.00	1,514.25
Total:	Local	3,854.50	0.00	3,854.50
	Oversea	3,854.50	0.00	3,854.50

By adopting CCR as one of the step in cost accounting, it can provides more accurate results to draw analysis of capacity utilization. Table 4 shows the CCR for every activities involved.

Table 4. Capacity cost rate.

Driver	Material	Cost of all resources supplied (RM/month)	Practical capacity (min/month)	CCR (RM/min)
Acquisition				
Physical book	Local	4,421.54	8,448.00	0.52
	Oversea	5,115.59	8,448.00	0.61
Electronic book	Local	31,479.04	6,336.00	4.97
	Oversea	1,888.27	6,336.00	0.30
Serial material	Local	47,220.55	2,112.00	22.36
	Oversea	148,568.43	2,112.00	70.34
Gift and exchange	Local	1,652.00	8,448.00	0.20
	Oversea	1,652.00	8,448.00	0.20
Total:	Local	84,773.12	25,344.00	
	Oversea	157,224.30	25,344.00	
Cataloging				
Physical book	Local	1,514.25	6,336.00	0.24
	Oversea	1,514.25	6,336.00	0.24

Electronic book	Local	413.00	2,112.00	0.20
	Oversea	413.00	2,112.00	0.20
Serial material	Local	413.00	2,112.00	0.20
	Oversea	413.00	2,112.00	0.20
Gift and exchange	Local	1,514.25	6,336.00	0.24
	Oversea	1,514.25	6,336.00	0.24
Total:	Local	3,854.50	16,896.00	
	Oversea	3,854.50	16,896.00	

Based on the same approach, the total costs of utilization for each of the activities are shown in Table 5.

Table 5. Total cost.

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

Figure 1, 2, 3 and 4 shows the used capacity, unused capacity, utilization cost and waste cost respectively for activity center of acquisition. Whereas Figure 5, 6, 7 and 8 show the information in activity center of cataloging.

Based on Figure 1, the used capacity in acquisition center for local material shows higher value of usage compared to oversea material. Gift and exchange have the highest used capacity which are 8,280.32 minutes and 7,646,40 minutes for local and oversea materials separately.

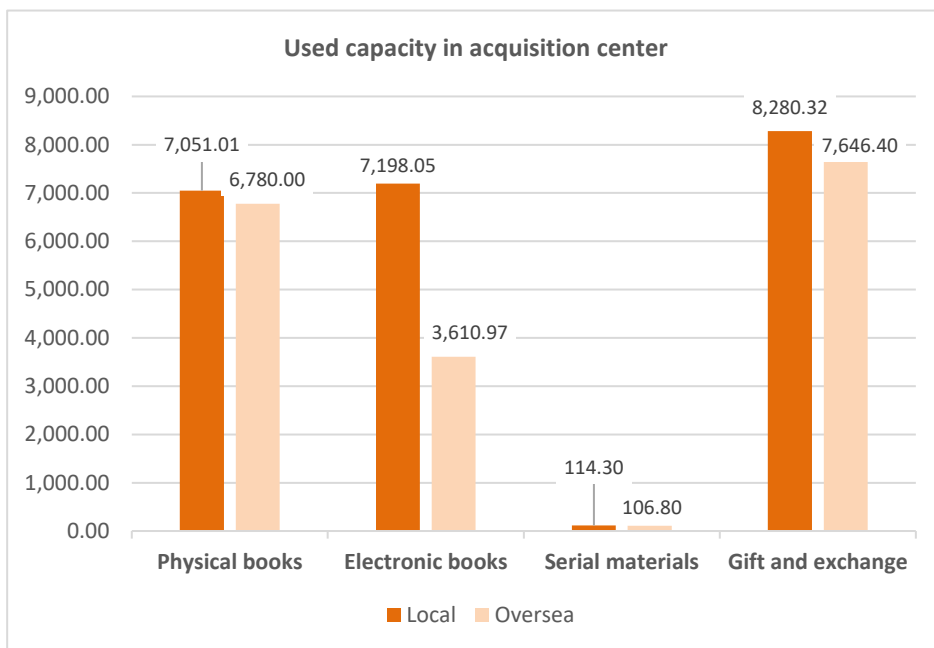


Figure 1. Used capacity in acquisition center.

Figure 2 shows the used capacity in cataloging center. The values in serial material are the lowest to be compared with other activities. In local material, the used capacity is 49.65 minutes, while in oversea material, the value is 45.90 minutes, with only 3.75 minutes different.

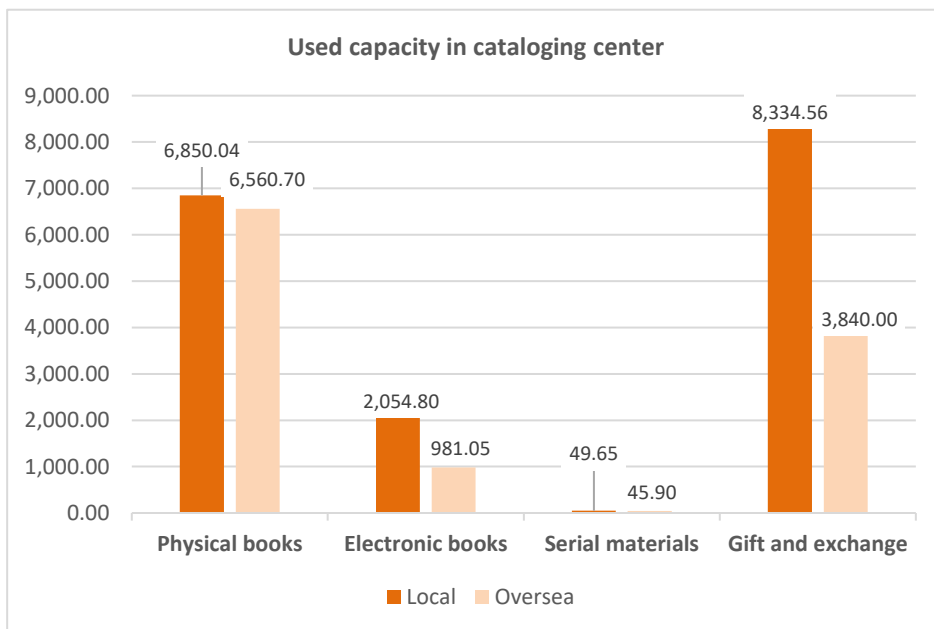


Figure 2. Used capacity in cataloging center.

In figure 3, as other activities experienced unused capacity, it shows that only electronic book in local material have insufficient capacity which is -862.05 minutes. Contrastively, oversea material have the highest unused capacity with an excess of 2,725.03 minutes.

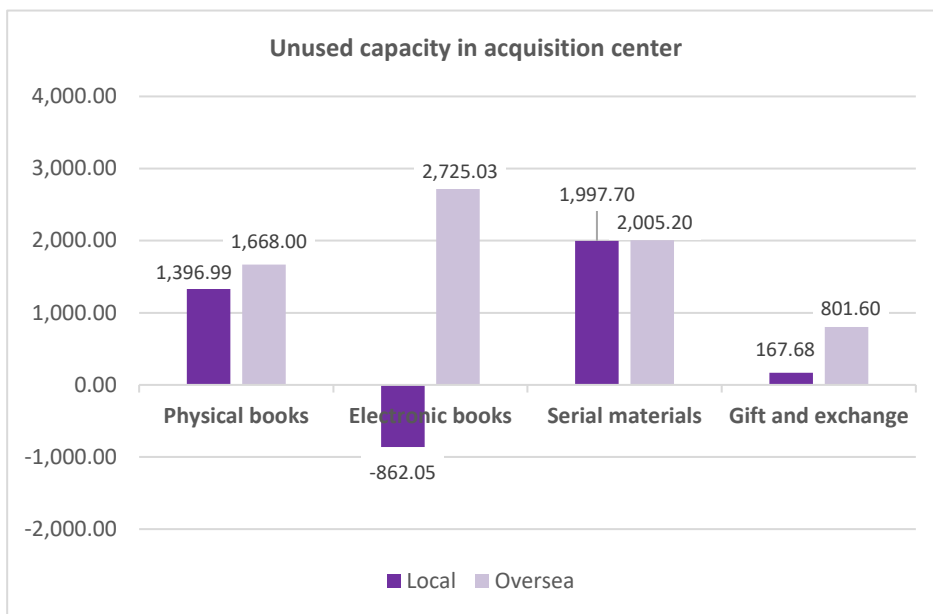


Figure 3. Unused capacity in acquisition center.

The highest unused capacity in cataloging center is from overseas material in gift and exchange activity with 2,486 minutes. While the lowest value is 57.2 minutes from local material in electronic book activity.

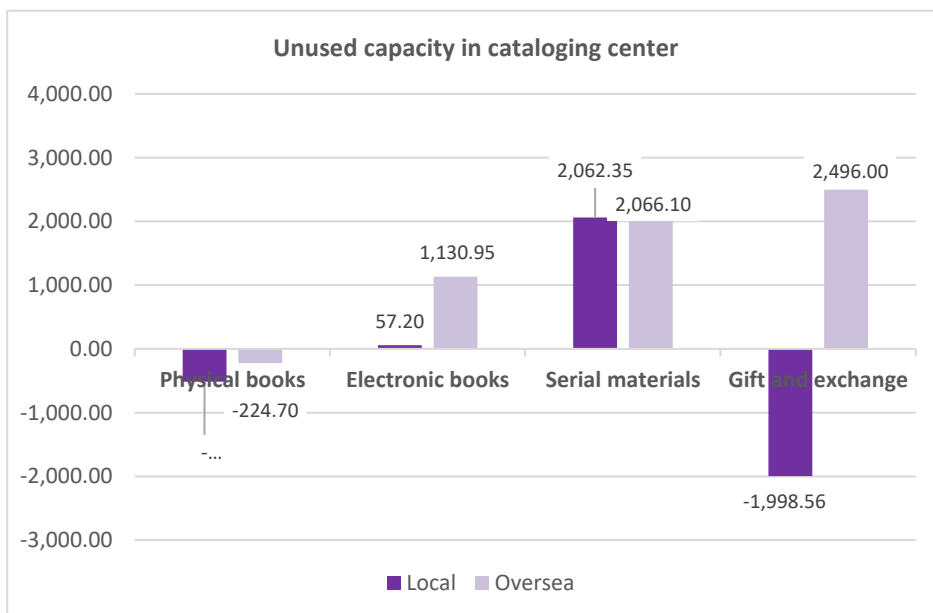


Figure 4. Unused capacity in cataloging center.

The used capacity will affecting the value of utilization cost which portray in Figure 5 and 6. The CCR for every sub-activities are different, so the rate to identify the utilization cost will be unlike. The acquisition activity center had the higher rate for every analysis compared to the cataloging activity centers in view of the fact that it consists the most number of processes.

For an example, the used capacity of serial material in oversea material is not the highest with 106.80 minutes, but it have much higher value of utilization cost which is RM 7,512.84 due to its big CCR value, 70.34.

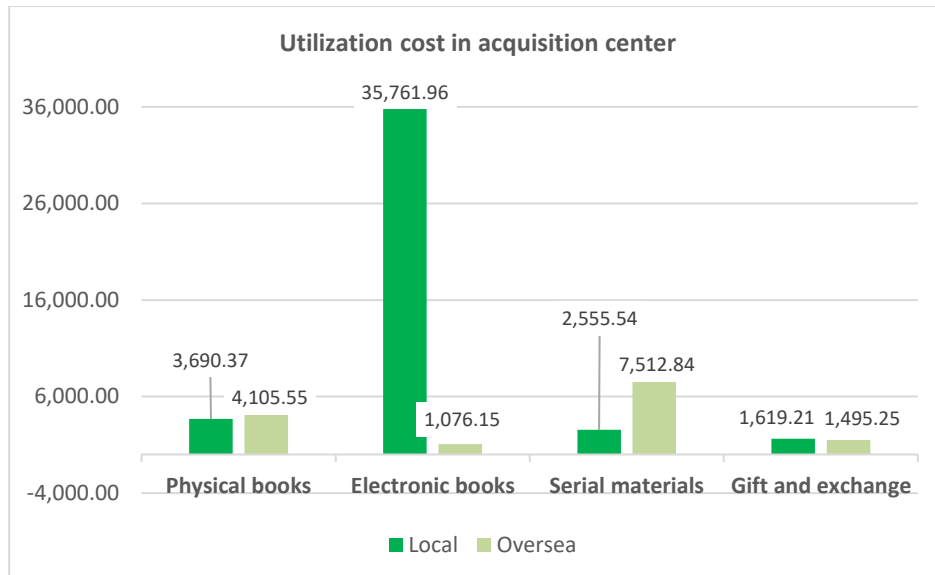


Figure 5. Utilization cost in acquisition center.

In cataloging center, the lowest utilization costs are from serial material with RM9.71 and RM8.98 for local and oversea materials accordingly.

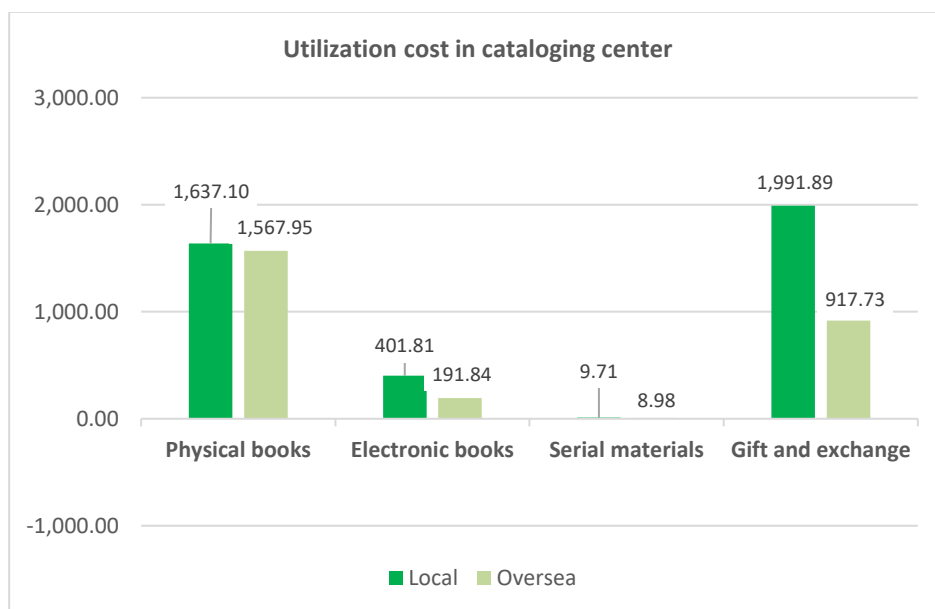


Figure 6. Utilization cost in cataloging center.

Moreover, the unused capacity will have an impact on the value of waste cost which display in Figure 7 and 8. Based on the identical point of view from utilization cost, the rate to measure the waste cost will be different separately because the CCR for every sub-activities are different. CCR value will become bigger when a huge total resources costs divided with a small total used capacity.

There is an activity that have the highest waste costs because of the high percentage of the CCR which is serial material in acquisition center. The CCR of 22.36 causing to loss of RM44,665.00 in local material, while the CCR of 70.34 causing to loss of RM141,055.60 in oversea material. While the lowest waste cost is from gift and exchange activity, RM32.79 and RM156.75 for local and oversea materials respectively.

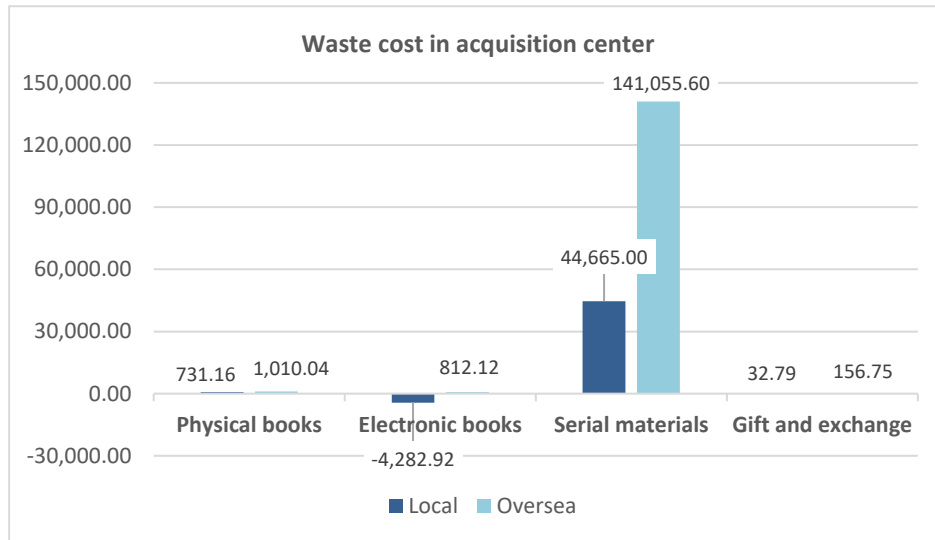


Figure 7. Waste cost in acquisition center.

In figure 8 it shows there are three activity with negative value of waste cost as it experienced insufficient capacity. Local material in gift and exchange have the highest negative value of waste cost with -RM477.64. Whereas, the highest waste cost is of oversea material from the same activity with RM596.52.

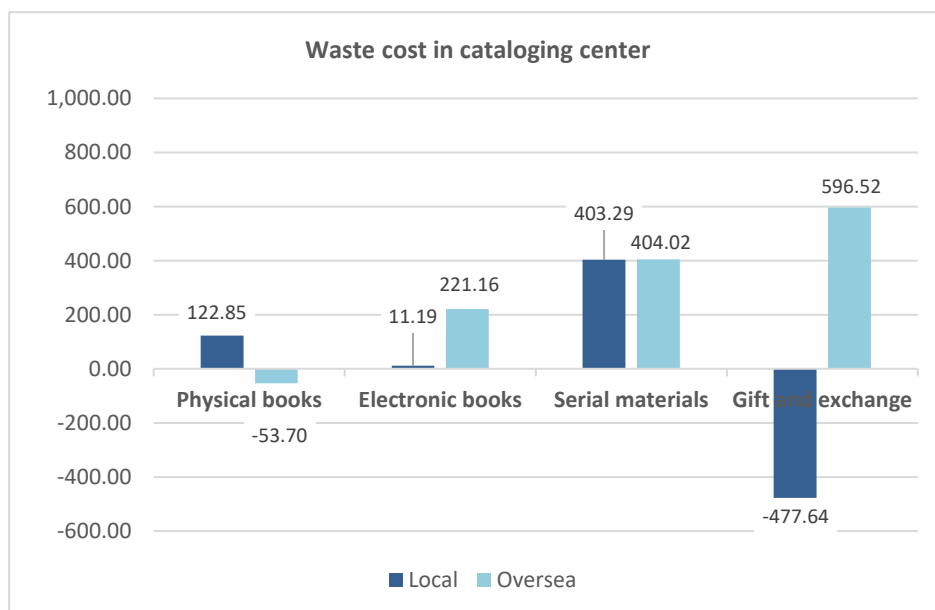


Figure 8. Waste cost in cataloging center.

4. Conclusion

Overall, this work managed to establish the time equation, capacity cost rate, used and unused capacity of acquisition and cataloging centers in library system for local and oversea materials. It has been found that TDABC is in compliance with the real resource usage of the research institution in the identification of overall costs. The costs of each activity was found to vary because of the various factors influencing resources and capacity costs. Complicated activity takes more time and several process steps tend to be very expensive. The research findings presented the organization with a clear view of what could be changed with a focus on reducing waste costs and increasing working capacities. The analysis has highlighted which activities add value and which activities can be reduced its provided capacity. Resource waste, particularly by improving practical capacity resources, can be reduced through efficiency improvement.

Acknowledgment

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