IMPROVING THE EFFICIENCY OF UNIVERSITY LIBRARIES IN MALAYSIA USING ZERO-SUM GAINS DEA MODEL

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ABSTRACT

Measuring the efficiency and optimizing available resources are vital for library management. This research empirically examines the measurement of efficiency of 10 public university libraries in Malaysia and provides an opportunity for inefficient libraries to improve their efficiency by proposing the appropriate number of resources. Data encompassing the number of staff, materials availability, and material circulation were gathered between 2016 and 2019. This study implements the zero-sum gains data envelopment analysis (ZSG-DEA) model to improve the efficiency. The findings show that in the early stage, five libraries were efficient in 2016 and 2018 while six libraries were efficient in 2017 and 2019. Comparable efficiency scores between conventional DEA and ZSG-DEA can be seen as all the inefficient libraries manage to attain better efficiency scores. Overall, all inefficient libraries can increase their efficiency rates. Despite the scores still not achieving the highest rate of efficiency, this study may assist librarians on managing library operations efficiently.

Keywords: *DEA, Efficiency, Malaysia, University Library, ZSG-DEA.*

1.   Introduction

The word "library" is central in the development of social knowledge for people of all ages and backgrounds. The library is a place that keeps a collection of various resources since information must be available in many formats to ease library users. Through the years, technological advancement has led to a significant increase in the number of student enrolments. The era of technology has accelerated the development of libraries (Ramayah & Aafaqi, 2004). People do not need to go to the library anymore to access the materials that they need, as everything is available at the fingertips.

An academic library or a university library is one of the places that play a vital role in providing information and knowledge, especially for students who cannot afford to buy books. The university library is the main place for these students to obtain all the resources they need (Wojciechowska, 2021). It can be said that libraries help students improve their achievements (Edzan & Abrizah, 2003). Thus, university libraries must keep improving their resource efficiency in order to ensure that sufficient resources are available to users comprising students, administration staff, researchers, academic staff, and external library users.

In Malaysian context, numerous challenges or issues have been faced by the management of academic libraries, especially public university libraries. Most of the available resources are not fully utilized by users. The issue regarding strategic planning among academic libraries in Malaysia has been discussed in the study by Shaifuddin *et al*. (2020). Thus, budgets become one of the greatest challenges for university libraries as they need to consider the inconsistent amounts of funds provided by the government. For instance, Mail (2017) has reported that public universities suffer almost 20 percent spending cut in budget 2017. As a consequence, the allocated budgets fail to keep up with the needs of users in terms of book availability, longer service hours, and others. In this aspect, the expectation or demand for resources from users keeps increasing over the years but many universities are not aware of the impact of unutilized resources and how to utilize these resources in their management. Thus, it is essential for each university library to know their efficiency score as they might not be the best provider of information to the users compared to other universities.

Most university libraries face a problem in discovering the strength of their resources. They also lack concern about improving their resources (Shaifuddin *et al*., 2020). Besides, some university libraries are uncertain of the current situation or availability of their resources, how to keep their resources, and where to situate themselves regarding their level of efficiency. Hence, it is important to measure the efficiency scores, which will help define their resource deficiencies and at the same time encourage them to compete with other universities libraries in optimizing the resources. The study about resource utilization with regard to efficiency measurement for university libraries has been extensively done in other countries including university libraries in Shanghai (Yuanrui & Jingli, 2020), university libraries in Spain (Simon *et al*., 2011) and university libraries in Taipei, Taiwan (Chen, 1997).

Another common issue faced in the education sector in Malaysia relates to the limited funds or budget cuts by the government. Consequently, the majority of university libraries rarely know how to use the allocated resources to the fullest potential, which will lead to underutilization (Abdullah, 2017). Wrong management decisions may be costly to university libraries. Therefore, the best decision is to use the readily available resources. Also, it is essential for the management to justify which resources they need to improve or remove in order to increase the efficiency of inefficient library management.

Typically, inefficient university libraries will look at efficient university libraries as a benchmark or role model to obtain the targeted efficiency score. In developing a targeted efficiency score, the selection of benchmarks and weights must be considered. The management must be careful in making the decision to assign the benchmarks; otherwise, it may result in inaccurate efficiencies (Chen *et al*., 2005).

The objective of this study is to examine the measurement of efficiency of 10 public university libraries in Malaysia and provide an opportunity for inefficient libraries to improve their efficiency by proposing the appropriate number of resources. The application of the data envelopment analysis (DEA) model helps to measure the efficiency score of the university libraries. This study also deals with the improved DEA model proposed by Bernardo *et al*. (2020), namely zero-sum gains data envelopment analysis (ZSG-DEA). This model may help to optimize the selected resource without reducing other resources.

2.   Literature review

Among the many resources of knowledge for students, professionals, and scholars, libraries have occupied a central position for centuries. Library resources allow the users to enhance their basic skills and understand complex phenomena. Today, the value of libraries has increased due to the availability of reliable information at the universities. Libraries play an important role in assisting students and academics to find appropriate information (Ata *et al*., 2020; Tijjani, 2019). Access to knowledge and intellectual freedom are the fundamental concepts of libraries. Library users' support for the principle of free service to access information encourages the management to maintain the principle continuously (Gerolami, 2018).

Previously, massive amounts of funds have been invested into academic institutions, especially public universities, to improve the management aspect. However, since a few years back, budget cuts from year to year have affected operational efficiencies and university libraries as well (Shaifuddin *et al.*, 2020; Mustafa Kamal, 2017). This scenario of budget-cuts affects the resources available to each university library since these university libraries mainly rely on government allocations for funding. However, the government believes that the funds allocated to public universities will help improve their management and operational efficiencies (Abdullah, 2017). The issues regarding funding have also been explored in prior studies (Hassan & Loon, 2012; Ismail, 2008; Shaifuddin *et al.*, 2020). Municipal libraries have to cope with uncertain political support, which has an impact on their libraries' efficiencies. As a result, these libraries have a medium-sized space that allows for a limited number of users. These libraries are encouraged to have an initiative or a back-up plan to either sustain or maximize their efficiency.

Previous studies have shown that DEA has been commonly adopted by researchers to measure library efficiencies (Kim *et al.*, 2020; Reichmann & Sommersguter-Reichmann, 2006; Tian & Zhang, 2018; Vitaliano, 1998). DEA model has been employed to evaluate the resources being used and the outputs being produced to provide good quality services to the users. The evaluation of the efficiency of multiple outputs and inputs has encouraged researchers to apply this approach compared to other tools (Tavares *et al.*, 2018).

Tian and Zhang (2018) determined library efficiency based on a library's ability to transform its input into outputs. The efficiency will show the sum of outputs (product and services) produced by the existing input (resources). Efficiency may also be determined by considering the quantity of resources needed to meet the service volume. A library is considered efficient when the service provided at a given resource level is maximized.

The DEA model was also applied in the analysis conducted by Guajardo (2020). The study examined the technical efficiency of 339 United States (US) nonprofit public libraries (NPPLs) in managing electronic-, physical-, and Internet-based programs as well as service outputs among registered users. Discretionary and nondiscretionary inputs were used in the study. The study discovered that almost all of the US NPPLs were technically inefficient. Therefore, the author suggested that the inefficient NPPLs should enhance the output amount per registered user while keeping the inputs constant to achieve full efficiency.

Nowadays, the application of DEA has evolved where the model is enhanced with an additional approach. For instance, the study recently conducted by Bernardo *et al.* (2020) on Brazilian universities allows the top management to evaluate the performance of libraries and enables the reallocation of resources within an integrated library system to improve the efficiency of inefficient libraries. The authors used the constant return to scale (CCR) DEA model in the first stage and ZSG-DEA in the second stage. In the first stage, they found five decision making units (DMUs) that reached the optimal efficiency and seven DMUs that were inefficient. This situation led to the question of how to turn the inefficient DMUs into efficient ones without decreasing the efficiency scores of other DMUs. The ZSG-DEA model allowed the authors to guarantee fairness in allocating the resources. The finding showed that library efficiency increased after the resources were redistributed. Hence, the use of ZSG-DEA models may improve resource utilization among libraries to allow them to provide improved services to their users.

Another enhancement of DEA was achieved by Del Barrio-Tellado *et al.* (2021) in their study on the public library system at Medellin City, Colombia. In their study, they measured efficiency by employing a dynamic-network-DEA model. In addition, they employed truncated bootstrap regression to assess the effects of certain contextual variables on library efficiency. They found that the trend of efficiency scores increased throughout the study with values that were marginally more beneficial in the second stage of service provision than in the stage focusing on managing the cultural program. In the second stage, they also identified the factors influencing library performance, namely education level, population density, youthfulness, and safety.

3. Methodology

Table 1 lists the universities as decision making units (DMUs) that are grouped into three categories: research universities, comprehensive universities, and focused universities. Subcategories were suggested by Ahn and Seiford in 1993 where they used sub-group concepts in their research by categorising the university into public or private. In addition, the data included as inputs are the number of staffs and material availability, while the output is the number of circulations. Data were gathered for four years between 2016 and 2019.

Table 1. List of Decision-Making Units (DMU).

DMU	Universities Library	Sources of data
	Research University Library	
1	Universiti Kebangsaan Malaysia (UKM)	
2	Universiti Malaya (UM)	
3	Universiti Putra Malaysia (UPM)	
4	Universiti Teknologi Malaysia (UTM)	Malaysian Academic Libraries Statistics webpage and Annual Year Report from 2016 until 2019 for each selected university.
	Comprehensive University Library	
5	Universiti Islam Antarabangsa Malaysia (UIAM)	
6	Universiti Malaysia Sabah (UMS)	
	Focus University Library	
7	Universiti Malaysia Perlis (UNIMAP)	
8	Universiti Pendidikan Sultan Idris (UPSI)	
9	Universiti Teknikal Malaysia Melaka (UTEM)	
10	Universiti Utara Malaysia (UUM)	

The data collection is limited to 10 public university libraries due to data unavailability in Malaysia. Public university libraries are considered in this study because the libraries are funded by the government and to achieve the homogeneity among DMUs in the analysis.

3.1 Technical Efficiency using Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is implemented in this study to measure the efficiency of Malaysian public university libraries. DEA is used due to its ability to cope with a small sample size and the determination of the production function is not compulsory with DEA. The variable return to scale (VRS) under the DEA model is employed due to the different levels of progress achieved by public universities in Malaysia. Compared to the old universities, some of the universities that were established after the year of 2000 are still struggling to grow. An unfair comparison against the most productive scale size will occur if a constant return to scale (CRS) is implemented in this study. The addition of a constraint in VRS, which is $\lambda r = 1$, will help to estimate the DMUs' operation in the region. The inefficient DMUs will be compared with DMUs of a similar size (Šebová & Maličká, 2019).

Mathematically, the objective function and the constraint for the VRS model can be expressed as in Equation 1, where n represents the number of outputs, s is the number of samples or DMUs, and $j = 1,2,3…n$.

$Minimum\ ho\ =$

$$\sum_{j}^{n} uj yj_o \tag{1}$$

$subject\ to\ ;$

$$h_o xi_o - \sum_{r=1}^{s} xi_r \lambda r \geq 0$$

$$-y_{jo} + \sum_{r=1}^{s} yj\lambda r \geq 0$$

$$\sum_{r=1}^{s} \lambda r = 1$$

$$\lambda r \geq 0$$

where;

uj = weight for each DMU
h_o = the efficiency score
xi = the input values
λr = the targets or possible benchmark weight (0 < λ <1)
yj = the amount of output

Normally, the traditional DEA will result in two possibilities: efficient or inefficient. Thus, the virtual input in this study will help in estimating the new efficiency score for each inefficient DMU. To calculate the virtual input, the justification for the reallocated input is required.

In this study, the number of staff is selected to be the only one reallocated. The main reason is the availability of materials is not justifiable. According to Library Association Malaysia (2018), the availability of materials in each university library is based on the courses offered by the university. Besides, the volume of materials cannot be reduced as it will affect the allocated budget. A budget is not viable if the management does not preserve or purchase the materials (Troll, 2002). Similarly for book circulation, a high number of circulations will provide evidence that the management of the library is good. Thus, the quantities of both variables cannot be reduced (Tindowen *et al.*, 2019).

The virtual reallocated input will provide a guide for inefficient DMUs as to whether they can achieve 100% efficiency. It will be compared against the redistributed input value. This model is also known as the reduction of inputs. This study uses the dual weight model. The dual weight represents the peer weight that can be obtained from the traditional DEA or DMUo. The concept is represented by Equation 2, where *i* refers to the reallocated variable, which is the number of staff and will be stated as 1.

$$x_{io}x_o = x_{iM}\lambda_M + x_{iQ}\lambda_Q \tag{2}$$

where;

M = input value for first reference unit DMUo
Q = input value for second reference unit DMUo
λ_M = the dual weight
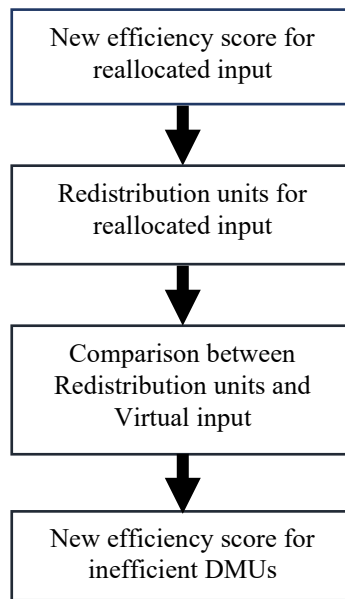λ_Q = the dual weight

Figure 1. Framework of the ZSG-DEA Model.

3.2   Improvement of Efficiency Score

Figure 1 summarizes the steps in the ZSG-DEA model proposed by Bernado *et al*. (2020). The process of this model in the present study uses Excel Solver and DEAP software.

An important step in developing the ZSG-DEA model is the measurement of h_{RO} or known as the new efficiency score for the reallocated input. h_{RO} is used to calculate the loss and gain for each DMU in the next step. The efficiency score from the traditional DEA will be invalid in measuring the input redistribution. Specifically, the measurement of the new efficiency score is for the reallocated input only. For example, the reallocated variables are variables A and B but not C. Hence, the required calculations of the new efficiency scores are for variables A and B only. Normally, the new efficiency scores in this step are correlated with the scores from the traditional DEA. A high efficiency score in the traditional DEA will result in a high new efficiency score for the reallocated input. r is the number of other DMUs and n is the number of samples. The h_{RO} formula is expressed in Equation 3.

$$h_{RO}x_o = h_O x_o \left(1 + \frac{x_o\,(1 - h_{RO})}{\sum_{r \neq o}^n x_r} \right) \tag{3}$$

where;
x_o = reallocated input value from DMUo
h_o = the efficiency score from DMUo
x_r = reallocated input value from others DMUo

Once the efficiency score for the reallocated input has been defined in the previous step, the loss and gain can be measured for each DMU. The inefficient DMUs will receive a gain and loss of the input unit to increase the efficiency. For efficient DMUs, they will only gain the input as they do not have any loss. In this model, Xu is the reallocated input value in the column, and Xj is the reallocated input value in the row. The sum of Xj or the total value of the reallocated input is obtained by subtracting Xu from DMUo. h_{RO} is the new efficiency score for the reallocated input. The formula is shown in Equation 4.

$$\text{Total gains or loss} = \frac{x_j \, x_u \, (1 - h_{RO})}{\sum_{j \neq o}^{n} x_j} \tag{4}$$

The redistribution value for the reallocated input is measured after accomplishing the calculation of gain and loss. The value in each column will be summed up to obtain the gain while the summation of each row will result in the loss for each DMU. Then, the redistribution value for each DMU can be calculated by subtracting the loss and adding the gain.

The idea of ZSG-DEA is to increase the efficiency of inefficient university libraries. The value of the reallocated input will be redistributed, while other inputs and outputs will remain constant. The ZSG-DEA model uses the same method as the traditional DEA to obtain the efficiency score. The difference with this model is that the input value in DMUo will be replaced with the redistribution input value. This value is obtained from Equation 1. *n* represents the number of outputs and *s* is the number of samples or DMUs. The ZSG-DEA model is expressed in Equation 5.

$$\text{Minimum } hRo =$$

$$\sum_{j}^{n} uj yj_o \tag{5}$$

subject to ;

$$h_o xi_o - \sum_{r=1}^{s} xi_r \lambda r \geq 0$$

$$-y_{jo} + \sum_{r=1}^{s} yj \lambda r \geq 0$$

$$\sum_{r=1}^{s} \lambda r = 1$$

$$\lambda r \geq 0$$

where;

uj	= weight for each DMU
ho	= the efficiency score
Xi	= the input values
λ_r	= the targets or possible benchmark weight $(0 < \lambda < 1)$
yj	= the amount of output

4. Results and Discussion

4.1 Efficiency Scores using DEA

The summary of efficiency scores between 2016 and 2019 is presented in Figure 2. The university libraries are arranged based on each library's mean score. For 2016, five university libraries achieve a score of 100%, which are UKM, UIAM, UNIMAP, UPSI, and UTEM. Technically, the efficiency score of 100% achieves the benchmark. However, ranking the most efficient university library might be an issue as it requires another model progression, namely super efficiency. Thus, the ranking of efficient university libraries in each year will not occur; instead, they will share the same rank. The scores obtained by inefficient DMUs are also shown in the graph. With a score below 100%, the remaining five university libraries fail to achieve full efficiency. UMS (under the comprehensive university libraries category) is ranked at the sixth place after the five fully efficient DMUs with an efficiency score of 99.3%. Based on the

result for 2016, the least efficient university library is UTM with an efficiency score of 46.2%. This score can be interpreted as UTM needing to achieve another 53.8% in its score to be fully efficient.

Overall, based on the mean scores, four university libraries achieve the optimum efficiency level across four years, namely UKM, UNIMAP, UPSI and UTEM. On the other hand, UPM, UTM, and UUM never achieve a score of 100% during this period. The highest efficiency scores for UM can be seen in 2017 and 2019. However, there is a falloff in 2018. It can be summarized that the efficiency of UM's university library is inconsistent and keeps changing throughout the period. UIAM obtains the maximum efficiency score for 2016 but starts to drop yearly from 2017. Overall, the year average shows the highest efficiency score in 2017 and the lowest in 2018.
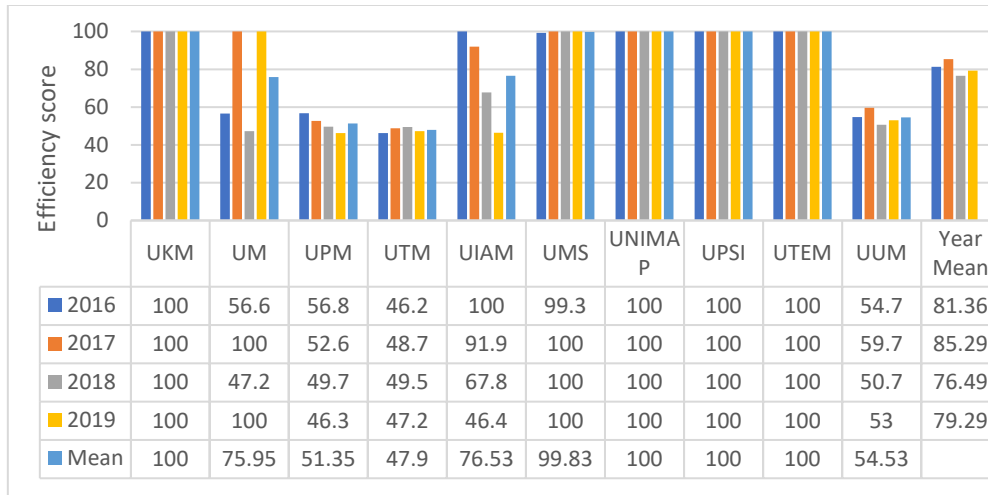

	UKM	UM	UPM	UTM	UIAM	UMS	UNIMAP	UPSI	UTEM	UUM	Year Mean
2016	100	56.6	56.8	46.2	100	99.3	100	100	100	54.7	81.36
2017	100	100	52.6	48.7	91.9	100	100	100	100	59.7	85.29
2018	100	47.2	49.7	49.5	67.8	100	100	100	100	50.7	76.49
2019	100	100	46.3	47.2	46.4	100	100	100	100	53	79.29
Mean	100	75.95	51.35	47.9	76.53	99.83	100	100	100	54.53	

Figure 2. Efficiency scores for 10 university libraries between 2016 and 2019.

4.2   Efficiency Scores using ZSG-DEA

The inefficient DMUs are assigned with a set of weights or peer weights along with the suitable benchmarks. Basically, the reallocation will require the reduction or increment of the variable's unit. As mentioned earlier, the number of staff will be reallocated. Each inefficient university library is provided with one or more peer university library through the DEA model. However, the efficient universities will not have any benchmark to be referred to as they have achieved full efficiency. Peer weight refers to the dual weight, and peer stands for the benchmark. Normally, the sum of the assigned peer weights will be equal to 1. Table 2 shows peer and peer weight for 2016 until 2019.

Table 2. Peer and Peer Weight for 2016 until 2019.

DMU	Library	2016		2017		2018		2019	
		Peer	Peer Weight	Peer	Peer Weight	Peer	Peer Weight	Peer	Peer Weight
1	UM	5,7,8	0.31,0.14,0.55	1	1.00	10,7,8	0.70,0.29,0.01	1	1.00
2	UKM	2	1.00	2	1.00	2	1.00	2	1.00
3	UPM	5,7,8	0.24,0.14,0.64	10,7,8	0.36,0.16,0.48	10,7,8	0.39,0.13,0.48	10,7,8	0.33,0.12,0.55
4	UTM	5,7,8	0.15,0.15,0.70	10,7,8	0.59,0.29,0.12	2,7,10	0.05,0.33,0.62	10,2,7	0.61,0.06,0.33
5	UIAM	5	1.00	1,2,10	0.34,0.64,0.02	10,7,8	0.44,0.47,0.09	10,7,8	0.72,0.26,0.02
6	UUM	7,9,8	0.06,0.16,0.78	7,9,8	0.13,0.09,0.78	8,9	0.73,0.27	7,9,8	0.07,0.12,0.81
7	UPSI	7	1.00	7	1.00	7	1.00	7	1.00
8	UTEM	8	1.00	8	1.00	8	1.00	8	1.00
9	UNIMAP	9	1.00	9	1.00	9	1.00	9	1.00
10	UMS	5,7,8	0.30,0.02,0.68	10	1.00	10	1.00	10	1.00

There are five benchmarks for 2016, which are UKM (DMU2), UIAM (DMU5), UPSI (DMU7), UTEM (DMU8), and UNIMAP (DMU9). This is because all these university libraries are fully efficient. The peer weight or known as reference weight of inefficient DMUs can indicate which benchmark will play a significant role in improving the efficiency score. For the inefficient university libraries, the major benchmark is DMU8 as it has the largest amount of weight. As an illustration, for DMU1 (UM), the weight scores obtained are 0.31(DMU5), 0.14(DMU7), and 0.55(DMU8). By comparing these three weight scores, the highest reference weight will be the dominant one in increasing the efficiency of UM's university library. The next stage is to compute the number of virtual staff. In this stage, DMUo stands for the DMUs from the traditional DEA. Table 3 presents the number of virtual staff along with the percentage difference between the original and the targeted input for the years 2016 until 2019.

Table 3. List of Virtual Input.

Library	2016			2017			2018			2019		
	Staff DMUo	Virtual Staff	(%)	Staff DMUo	Virtual Staff	(%)	Staff DMUo	Virtual Staff	(%)	Staff DMUo	Virtual Staff	(%)
UKM	213	213.00	0.00	202	202.00	0.00	199	199.00	0.00	189	189.00	0.00
UM	201	113.83	43.37	163	85.70	47.43	204	101.06	50.46	217	102.21	52.90
UPM	180	102.22	43.21	208	208.00	0.00	164	81.56	50.27	208	208.00	0.00
UTM	194	89.70	53.76	199	76.00	61.81	208	98.16	52.81	170	78.74	53.68
UIAM	216	216.00	0.00	114	114.00	0.00	111	111.00	0.00	112	112.00	0.00
UMS	112	111.09	0.81	220	201.96	8.20	219	86.93	60.31	215	99.78	53.59
UNIMAP	48	48.00	0.00	47	47.00	0.00	47	47.00	0.00	47	47.00	0.00
UPSI	73	73.00	0.00	73	73.00	0.00	69	69.00	0.00	69	69.00	0.00
UTEM	66	66.00	0.00	69	69.00	0.00	61	61.00	0.00	61	61.00	0.00
UUM	116	63.53	45.24	113	67.52	40.25	113	57.26	49.33	113	59.89	47.00

The university library that needs to reduce the number of staff in a large quantity in 2016 is UTM (53.76%). The public university operating expenditures in Budget 2016 and 2017 illustrate a reduction of 30.19% in the funding for UTM in 2017. The funding was RM415.64 million in 2016 and decreased to RM290.16 million in 2017 (Ministry of Finance, 2018). Hence, the suggestion to reduce the number of staff can help to deal with the budget constraint. The ZSG-DEA model is now employed to estimate the efficiency scores of inefficient university libraries after reallocating the number of staff. The initial step in developing the ZSG-DEA model is to measure the new efficiency score for staff. This part is crucial to obtain the loss and gain units. The new efficiency score for staff (*hRo)* is outlined in Table 4. Normally, the efficient DMUs will not have a new score, and the score will be stated as 100%.

Table 4. New Efficiency Score for Staff.

University Library	Year				Library Mean
	2016	2017	2018	2019	
Research University Library					
UKM	100.00	100.00	100.00	100.00	100.00
UM	60.31	100.00	51.23	100.00	77.89
UPM	60.09	55.65	52.82	49.53	54.52
UTM	49.87	52.51	53.45	51.40	51.81
Comprehensive University Library					
UIAM	100.00	93.08	71.41	50.56	78.76
UMS	99.35	100.00	100.00	100.00	99.84
Focus University Library					
UNIMAP	100.00	100.00	100.00	100.00	100.00
UPSI	100.00	100.00	100.00	100.00	100.00
UTEM	100.00	100.00	100.00	100.00	100.00
UUM	56.80	61.70	52.81	55.09	56.60
Year Mean	**82.64**	**86.29**	**78.17**	**80.66**	

In this study, the model requires the original number of staff and the efficiency score from DMUo to present the outputs. Specifically, the new efficiency score for staff is influenced by the efficiency score in DMUo. UM will be used as an example to provide a better understanding of efficiency score for staff. The new efficiency scores for UM are 60.31% in 2016 and 51.23% in 2018. The efficiency scores for UM in DMUo are 56.60% in 2016 and 47.20% in 2018 (refer to Table 2). The relationship between the efficiency scores in DMUo and the new efficiency scores can be seen as a higher score in DMUo will produce a higher score in DMUr. The measurement of the new efficiency score for staff is compulsory as the staff will be reallocated. Hence, the efficiency score for staff in DMUo is no longer valid in the next section. Staff redistribution is the suggested number of staffs to be reallocated to reach the optimal efficiency. The redistribution of staff can be calculated after the new efficiency score of staff has been obtained. The loss, gain, staff in DMUo, staff redistribution, and differences in figures are listed in Table 5.

Table 5. Summary of Staff Redistribution.

Year	Library	Loss	Gains	Staff DMUo	Redistribution Staff	Difference Staff (%)
2016	UKM	0.00	52.93	213.00	265.93	19.90
	UM	77.59	36.29	201.00	159.70	-25.86
	UPM	71.28	33.10	180.00	141.82	-26.92
	UTM	95.23	32.06	194.00	130.83	-48.28
	UIAM	0.00	53.81	216.00	269.81	19.94
	UMS	0.08	25.62	112.00	136.86	18.57
	UNIMAP	0.00	10.49	48.00	58.49	17.93
	UPSI	0.00	16.25	73.00	89.25	18.21
	UTEM	0.00	14.62	66.00	80.62	18.13
	UUM	52.54	22.22	116.00	85.68	-35.39
2017	UKM	0.00	37.74	202.00	239.74	15.74
	UM	0.00	39.05	208.00	247.05	15.81
	UPM	72.77	20.03	163.00	110.26	-47.83
	UTM	91.96	21.53	199.00	128.57	-54.78
	UIAM	14.50	38.90	220.00	244.40	9.98
	UMS	0.00	19.85	114.00	133.85	14.83
	UNIMAP	0.00	7.78	47.00	54.78	14.20
	UPSI	0.00	12.32	73.00	85.32	14.44
	UTEM	0.00	11.61	69.00	80.61	14.40
	UUM	45.46	15.88	113.00	83.42	-35.46
2018	UKM	0.00	64.84	199.00	263.84	24.58
	UM	97.82	50.52	208.00	160.70	-29.43
	UPM	77.86	41.61	164.00	127.75	-28.38
	UTM	91.96	50.48	204.00	162.53	-25.52
	UIAM	59.69	60.91	219.00	220.22	0.55
	UMS	0.00	33.69	111.00	144.69	23.28
	UNIMAP	0.00	13.59	47.00	60.59	22.43
	UPSI	0.00	20.28	69.00	89.28	22.72
	UTEM	0.00	17.82	61.00	78.82	22.61
	UUM	56.07	29.65	113.00	86.58	-30.52
2019	UKM	0.00	54.32	189.00	243.32	22.32
	UM	0.00	60.73	208.00	268.73	22.60
	UPM	85.93	36.25	170.00	120.32	-41.29
	UTM	100.85	44.51	217.00	160.66	-35.07
	UIAM	101.87	43.87	215.00	157.00	-36.94
	UMS	0.00	30.26	112.00	142.26	21.27
	UNIMAP	0.00	12.09	47.00	59.09	20.46
	UPSI	0.00	18.04	69.00	87.04	20.73
	UTEM	0.00	15.86	61.00	76.86	20.63
	UUM	53.38	26.11	113.00	85.72	-31.82

In order to obtain the redistribution of staff, the loss must be subtracted from the initial number of staff (Staff DMUo) while the gain must be added to Staff DMUo. A loss refers to the number of staff that must be reduced while a gain implies the addition of staff.

Table 5 shows the overall redistribution of staff for the 10 public university libraries. The table is organized based on the number of staff that must be reduced. A negative sign in the difference staff column illustrates the percentage of staff to be reduced and a positive sign is for the addition of staff. The addition of staff only occurs among the efficient DMUs. The staff to be reduced should be transferred to other departments as they cannot be terminated without a valid reason. The reduction of staff will not be an issue since emerging technology can replace more human tasks in this twenty first century as have been discussed in the study by Decker (2017), Hallis (2017) and Cherinet (2018).

For 2016, the UTM library which exhibits highest percentage difference needs to lose 95.23 staff and gain 32.06 staff to increase its efficiency. This can be calculated as the initial number of staff of $194 - 95.23 + 32.06 = 130.83$ or approximately 131 staff. Thus, the UTM library should reduce about 63 staff to improve their efficiency. UNIMAP, UTEM, UPSI, UKM, and UIAM obtain additional staff without incurring any loss of staff. However, the additional number of staff may not require as they have achieved the maximum efficiency. The least reduction is 25.52%, which is in 2018 for UTM. The staff redistribution will be used to measure the new efficiency scores for the inefficient university libraries.

The result in Table 6 shows six university libraries with full efficiency in 2016. UKM, UIAM, UMS, UNIMAP, UPSI and UTEM remain with a score of 100% each even with the additional staff suggested for them. For the inefficient libraries, which are UM, UPM, UTM, and UUM, they must reallocate some of their staff to maximize their respective efficiency score.

The efficiency score for UM in the first stage is 56.6% (refer to Table 2). After reducing its staff through staff redistribution, UM's efficiency score may increase to 79.8%. In the same year, UTM's initial efficiency score is lower than 50% (refer to Table 2). However, the reduction of its library staff to 130 may help to increase the efficiency to 70.8%. UUM achieves the highest increment in efficiency among the universities. In average, UUM's efficiency score increases by about 30% by replacing the number of staff through staff redistribution.

Table 6. New Efficiency Scores (put DMUr only).

University Library	Year				Library Mean
	2016	**2017**	**2018**	**2019**	
Research University Library					
UKM	100.00	100.00	100.00	100.00	100.00
UM	79.80	100.00	65.10	100.00	76.73
UPM	79.80	76.40	65.40	100.00	80.40
UTM	70.80	69.50	71.40	69.80	70.38
Comprehensive University Library					
UIAM	100.00	93.80	79.00	65.90	84.43
UMS	100.00	100.00	100.00	100.00	91.35
Focus University Library					
UNIMAP	100.00	100.00	100.00	100.00	100.00
UPSI	100.00	100.00	100.00	100.00	100.00
UTEM	100.00	100.00	100.00	100.00	100.00
UUM	85.30	88.30	81.00	84.10	84.64
Year Mean	**91.57**	**92.7**	**82.73**	**88.18**	

5.   Conclusion

Mathematically, the DEA model will produce efficient and inefficient outputs. The inefficient DMUs will be provided with a set of weights and benchmarks that are suitable for them. Both items are significant as they can help the inefficient university libraries to achieve the targeted score or virtual input. The targeted score will guide them in estimating a better efficiency score. In addition, some of the inefficient university libraries are unsure whether their resources are

being utilized to the fullest potential. The concern of incurring a high cost if they make the wrong decision encourages them to sustain the resources. Thus, it is essential for the management to justify which resources they need to improve or remove as it will help to increase the efficiency of the inefficient libraries.

The zero-sum gains DEA (ZSG-DEA) model was developed to handle the mentioned issues. The ZSG-DEA model helps to justify which resource is the most significant as it increases the efficiency of inefficient university libraries. The most significant variable in this study is the number of staff. This study only focuses on a single input ZSG-DEA model due to the limited number of variables involved. Before proceeding with the development of the ZSG-DEA model, the inefficient libraries can estimate whether they can achieve 100% efficiency by comparing the virtual input with staff redistribution.

The variables used in this study may be deficient due to the limited number of inputs and output. In this study, the selection of variables is done by considering the availability of data in Malaysia. Basically, the application of the ZSG-DEA model indicates the requirement to reduce or add staff to gain a better efficiency score. This approach will affect the university libraries that must reduce their staff in a large number. Therefore, the process of allocating staff needs to be justified and reviewed.

This study's finding has several practical implications. For instance, the government should provide appropriate budget for university to help alleviate the issue of inefficient among university libraries. Also, this study's discovery may be used as a basis by the policymakers in evaluating the existing policy with regards to resource utilization in Malaysian university libraries. In addition, the inefficient university libraries should not be taken lightly by the management. In this respect, this study suggests that the management should know the appropriate number of staff to be assigned and unemployed staff should be transferred to other departments as they cannot be terminated without a valid reason. The reduction of staff will not be an issue since emerging technology can replace more human tasks in this twenty first century. All in all, the results of this research suggest that policymakers should improve university libraries performance through preparing the staff with technology literacy skills development for the wider environment of work.

Future research is recommended to explore more resources for redistributed value to enhance the efficiency level among university libraries in Malaysia. Many resources that have not been explored in this study and past research may open up an avenue for further research on performance measurement particularly in Malaysian context. Additional research also may cooperate with other libraries and compare between public and private university libraries that may lead to better performance measurement. By exploring more resources and also more university libraries, the outcomes on their performance may become more reliable and meaningful to the government and policy makers.

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