The design of the cse-ucla evaluation model using topsis and ahp methods for optimizing digital library services in badung regency

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Abstract. The Regional Archives and Library Office of Badung Regency must optimize the services provided in order to achieve excellent service quality. In its implementation, the office encountered difficulties in prioritizing aspects of services that require optimization. The purpose of this study was to design a Center for the Study of Evaluation-University of California in Los Angeles (CSE-UCLA) evaluation model using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) and Analytical Hierarchy Process (AHP) to provide recommendations on which aspects of services need to be optimized. The research method used stages that included problem identification, problem formulation, literature review, data collection, data analysis, design, and conclusions. The TOPSIS and AHP methods had the ability to rank a variety of aspects in the CSE-UCLA model. Aspect with the lowest ranking was considered as the aspect that is prioritized for optimization. That aspects used five service criteria: tangible, reliability, assurance, responsiveness, and empathy, all of which were classified in the "benefit" category. Each criterion had a value of 0.200, 0.200, 0.200, 0.200, 0.200 for the weight values for system assessment, program planning, program implementation, and program improvement, while for program certification: 0.556, 0.111, 0.111, 0.111, 0.111, respectively.

1. Introduction

The transformation of information technology today demands for a service that users can access anytime and anywhere. Libraries are also expected to fulfill various aspects today, in line with the demands of the information technology era. In accordance with this issue, libraries are evolving through the use of information technology to offer services in digital form. Through the Regional Archives and Library Office, the Badung Regency Government seeks to implement one of the missions to improve the quality of public services by introducing a digital library service called PustakaGita.

There are several issues encountered in implementing digital library services. Regulations that explicitly control digital library service activities has not been developed, so there is still no precise and comprehensive legal framework for managing the services. The number of supporting infrastructure and competence workers is still considered inadequate. The relatively low user interest in accessing the services offered is another issue related to the PustakaGita service. Limited resources encourage the office to set a priority scale in order to resolve a number of issues facing the implementation of PustakaGita services.
The PustakaGita digital library service should be committed to provide excellent service quality in an attempt to carry out one of the predetermined missions as a form of public services. Excellent service quality can be achieved if the number of service issues can be minimized, so the office must always optimize the quality of services offered.

With regard to some of the problems mentioned above, it is necessary to optimize the digital library services. The digital library services that are carried out need to be evaluated. Evaluation is used as recommendation to make the correct decisions as a basis for decision makers [1]. Evaluation is the method of gathering and reviewing data in order to receive appropriate recommendations [2]. CSE-UCLA evaluation model can be applied to evaluate digital library services. The evaluation model is combined with TOPSIS and AHP as a ranking mechanism for aspects included in the evaluation component. In each CSE-UCLA evaluation component, the aspect with the lowest ranking will be considered as the aspect that is prioritized for optimization.

CSE-UCLA is suitable for the evaluation of service programs such as banking systems, cooperatives, libraries, e-learning, e-government, and others [3]. This is one of the aspects that underlies the use of the CSE-UCLA to evaluate PustakaGita digital library services.

TOPSIS and AHP methods used in this research was due to their ability to rank a number of aspects of the CSE-UCLA evaluation component. Results process by the two methods created aspects from highest to the lowest ranking of the evaluation component. Aspects with the lowest rank were recommended to be optimized. TOPSIS was used as a Multiple Criteria Decision Making (MCDM) tool because the principle is simple and its computation mechanism can calculate the best alternatives in a simple mathematical form [4]. AHP has advantages over other decision support methods. AHP offers a measure of consistency in the preferences of decision makers and also enables decision makers to begin from pairwise comparisons that are easy enough to deal with [5].

It is not yet known the level of effectiveness of CSE-UCLA evaluation model components combined with TOPSIS and AHP as a supporting tool for decision making. To solve this problem, it is important to design a CSE-UCLA evaluation model combined with TOPSIS and AHP in an effective and accurate way for the optimization of Pustaka Gita digital library services.

Based on the existing problems, the questions proposed in this research were: how was the design of TOPSIS and AHP as a ranking mechanism based on the evaluation model aspects of CSE-UCLA to optimize the PustakGita digital library services? The purpose of this research was to design a CSE-UCLA evaluation model by using TOPSIS and AHP as a ranking mechanism for aspects of the evaluation component of PustakaGita digital library services that will be optimized.

Previous research related to and used as a reference was the study carried out by Divayana et al. [6] in 2018 about CSE-UCLA combined with Weighted Product for optimizing the digital library services at computer college in Bali. The results from this study were the sketch of the CSE-UCLA combined with the Weighted Product. A design outcome that can rank each CSE-UCLA evaluation component was the advantage of this study. The weaknesses identified in this research were this research did not rank aspects of each component of the CSE-UCLA evaluation, and did not make comparisons with other MCDM tool to assess the level of effectiveness of each method. Another study used as a reference was the research by Divayana et al. [7] in 2018. This research evaluating digital library services using the CSE-UCLA combined with Weighted Product. The advantage of this research was able to rank each CSE-UCLA evaluation component from lowest to highest. The weakness of this research is that it did not assess the effectiveness level of the Weighted Products. Research carried out by Widianta et al. [8] in 2018 was another reference which has similarities with this research in terms of the use of TOPSIS and AHP. The difference lies in the item being evaluated, where Widianta et al. evaluated the placement of employees in the company, while researchers evaluated the digital library services. Another distinction was the number of methods used. The results of the accuracy conducted by Widianta et al. were TOPSIS 95%, Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) 93.34%, Simple Additive Weighting (SAW) 81.67%, and AHP 50%. This research concluded that in the decision making process that had many criteria, TOPSIS was reasonably superior.
Since the accuracy percentage showed a significant difference in outcomes between the methods of TOPSIS and AHP, researchers want to use the methods of TOPSIS and AHP for comparison.

Based on the problems faced by the PustakaGita digital library service, the purpose of the research, and referring to several previous studies, the researchers were interested in investigating how the design of the CSE-UCLA evaluation model using TOPSIS and AHP methods for optimizing digital library services in Badung Regency.

2. Literature Review

There have been a number of supporting theories in this research, including: Digital Library, Quality of Service, CSE-UCLA, TOPSIS, and AHP.

2.1 Digital Library

Digital library contains information objects, resources, organization, and preserves those objects through digital media [9]. Digital library is a collection of documents and digital books that can be accessed via internet or global computer networks [6]. The conclusion drawn based on this description is that the digital library uses information technology for collection, management, and services, which can be accessed any time and from anywhere using the internet or global computer networks.

2.2 Quality of Service

The quality of service describes differences between client standards and perceptions of service [10]. There were five dimensions of quality of service: 1) Tangible as a dimension that represents the physical appearance and services to be obtained by users; 2) Reliability as a dimension that defines the capacity to deliver the promised services correctly and reliably; 3) Assurance as a dimension that defines certainty, such as knowledge, courtesy, and the capacity of staff to promote trust; 4) Responsiveness as a dimension that describes in the form of a desire and awareness to help users and offer services quickly; and 5) Empathy as a dimension related to the form of individual attention provided to users [11]. The delivery of quality services results in customer satisfaction [12]. Based on the description above, it could be concluded that the quality of the service has a close relationship with the satisfaction of those who obtain the services, such that the satisfaction of the users is the measure of the quality of the service.

2.3 CSE-UCLA

CSE-UCLA has five evaluation phases need to be followed [6]. There are five types of evaluations: 1) System assessment is a facility for providing information on the state or condition of the system; 2) Program planning is an evaluation related to the provision of information that will allow decision makers to make decision planning in order to determine between alternatives process; 3) Program implementation has the purpose of ensuring that implemented program complies with the description formulated in the program planning decision; 4) Program improvement has the purpose of providing information on the relative success of the program components; and 5) Program certification is an evaluation that offers information to decision makers in order to make decisions about the program as a whole and its ability that can be used to other situations. Based on these, it could be summarized that the CSE-UCLA is a method of evaluation that focuses on five aspects, namely: system assessment, program planning, program implementation, program improvement, and program certification.

2.4 TOPSIS

Yoon and Hwang introduced TOPSIS as a method to evaluate alternative performance through the same ideal solution [13]. TOPSIS applies the idea that the selected alternative for a positive ideal solution must have the closest distance and for a negative ideal solution has the farthest distance geometrically. Euclidean distance was used to decide the relative proximity of the alternative with an optimum solution [14]. TOPSIS has the following steps to take: 1) Build a decision matrix with reference to m alternatives and n criteria; 2) Create a normalized decision matrix by transforming each element; 3) Construct a weighted normalized decision matrix; 4) Determine the positive and negative ideal solution; 5) Calculate
an alternative separation refers to the negative and positive ideal solution; 6) Decide the relative proximity of each alternative to each ideal solution; and 7) Order the alternative from the largest to the smallest [15].

2.5 AHP
Saaty first suggested the AHP method [16]. AHP is a tool to solve a complex condition that provided alternative comparisons, and also helps decision maker to represent a hierarchical relationship [17]. In general AHP consists of several steps, namely decompose complex problem into a hierarchical structure, determine the relative weights of criteria, and determine the alternatives ranking [18]. The fundamental concepts of the AHP are as follows:

- The principle of a hierarchy is a mechanism for solving problems into separate elements by describing them in a hierarchy;
- The principle of evaluating the priority of decisions. Scaled number was used to demonstrate how many times the element is more dominant over the other elements, that could be seen in Table 1. Results of the scaled number then arranged into pairwise comparison. The product of the pairwise comparison matrix $A$ then normalized according to equation (1) called $A'$. The average value $w_i$ of each row $i$ in $A'$ was calculated using equation (2). $w_i$ was the Eigen vector as the weight of the $i$-th objective;

$$\sum_i a_{ij} = 1$$

$$w_j = \frac{1}{n} \sum_i a'_{ij}$$

- Consistency test for weight vector $w$. First, determine the value of $t$ using equation (3). Consistency Index ($CI$) calculated using equation (4). For $CI$ whose value 0 then it was consistent. For other $CI$ value, using the random index in Table 2. If $CI/RI_n$ less than equal to 0.1 then it was quite consistent, and if more than 0.1 it was very inconsistent;

$$t = \frac{1}{n} \sum_{i=1}^{n} \left( \text{i-th element in } (A')(w^T) \right)$$

$$CI = \frac{t-n}{n-1}$$

- Calculate the total score, and get the score from the largest to the lowest.

| Intensity of Interest | Explanation | Reciprocity of the above |
|-----------------------|-------------|--------------------------|
| 1                     | One level of importance | If element $i$ has one of the non-zero numbers above when compared to element $j$, then $j$ has the opposite value when compared to $i$ |
| 3                     | One element is slightly more important than the other |
| 5                     | One element is more important than the other |
| 7                     | One element is clearly more important than others |
| 9                     | One element is absolutely essential compared to others |
| 2, 4, 6, 8             | The adjacent values between the two values are considered |

Table 1. Ratio scale of criteria.

Table 2. Random index.

| $N$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | … |
|-----|---|---|---|---|---|---|---|---|
| $RI_n$ | 0.000 | 0.580 | 0.900 | 1.120 | 1.240 | 1.320 | … |
3. Research Method
In general, the research design used stages that included problem identification, problem formulation, literature review, data collection, data analysis, design, and conclusions. The category ("benefit" or "cost") and weighting values of each service criterion were also decided at this stage.

The aim of the research was describing the design of CSE-UCLA evaluation model combined with TOPSIS and AHP to provide recommendations on which aspects of PustakaGita services need to be optimized. Research subjects for the design were PustakaGita management staff and an expert. The location of this research was the Regional Archives and Library Office of Badung Regency. The location of which was chosen because it is one of the governments in Bali that provided digital library services.

The data collection technique refers to the triangulation technique, which was a combination mechanism of data collection techniques and various data sources that are already available. The types of data collection techniques used in this study include questionnaires, observations, interviews, and documentation studies. While the complementary instruments include interview guidelines, observation guidelines, and documentation.

The data analysis process was used to obtain accurate results of the study. A selection and simplification process was conducted for the data that was obtained. The data was then organized and tabulated, so that it could be used to compile the required evaluation aspects of the CSE-UCLA model, and got the weight values for TOPSIS and AHP as a ranking mechanism.

4. Results and Discussion
The results of the research activities were the design of the CSE-UCLA evaluation model combined with TOPSIS and AHP for optimizing PustakaGita digital library services that could be seen in Figure 1. Data collection instruments applied to the management staff were used to compile the evaluation aspects variables and service criteria contained in each component of the CSE-UCLA. Complementary instruments were also used as a method for field observations in order to gather additional data. The PustakaGita services were evaluated using the CSE-UCLA components, and each component had evaluation aspects (shown in Figure 1) to be ranked from the highest to the lowest. Aspects with the lowest rank were recommended to be optimized.
Figure 1. The design of CSE-UCLA evaluation model using TOPSIS and AHP methods.

The TOPSIS and AHP methods were used in the ranking process, which used five criteria: tangible (C1), reliability (C2), assurance (C3), responsiveness (C4), and empathy (C5). Each of these criteria was categorized as "benefit" based on a questionnaire filled out by an expert and the results could be seen in Table 9. At the weighting stage of the criteria, the questionnaire results were in a numerical form refer to the intensity of interest value in Table 1. Results of the questionnaire by the expert were seen in Table 3 and Table 4. Questionnaire results then converted into pairwise comparison which could be seen in Table 5 and Table 6. The next step was to normalize the pairwise comparison value using equation (1) and the results could be seen in Table 7 and Table 8. Using equation (2) to the normalization results, the Eigen vector value for system assessment for C1 was obtained as follows:

\[ w_1 = \frac{1}{5} (0.200 + 0.200 + 0.200 + 0.200 + 0.200) = 0.200 \]

| C1 | C2 | C3 | C4 | C5 |
|----|----|----|----|----|
| C1 | 1  | 1  | 1  | 1  | 1  |
| C2 | 1  | 1  | 1  | 1  | 1  |
| C3 | 1  | 1  | 1  | 1  | 1  |
| C4 | 1  | 1  | 1  | 1  | 1  |
| C5 | 1  | 1  | 1  | 1  | 1  |

| C1 | C2 | C3 | C4 | C5 |
|----|----|----|----|----|
| C1 | 1  | 5  | 5  | 5  | 5  |
| C2 | 1  | 1  | 1  | 1  | 1  |
| C3 | 1  | 1  | 1  | 1  | 1  |
| C4 | 1  | 1  | 1  | 1  | 1  |
| C5 | 1  | 1  | 1  | 1  | 1  |
Table 5. Pairwise comparison in system assessment, program planning, program implementation, and program improvement.

|    | C1   | C2   | C3   | C4   | C5   |
|----|------|------|------|------|------|
| C1 | 1.000| 1.000| 1.000| 1.000| 1.000|
| C2 | 1.000| 1.000| 1.000| 1.000| 1.000|
| C3 | 1.000| 1.000| 1.000| 1.000| 1.000|
| C4 | 1.000| 1.000| 1.000| 1.000| 1.000|
| C5 | 1.000| 1.000| 1.000| 1.000| 1.000|

Table 6. Pairwise comparison in program certification.

|    | C1   | C2   | C3   | C4   | C5   |
|----|------|------|------|------|------|
| C1 | 1.000| 5.000| 5.000| 5.000| 5.000|
| C2 | 0.200| 1.000| 1.000| 1.000| 1.000|
| C3 | 0.200| 1.000| 1.000| 1.000| 1.000|
| C4 | 0.200| 1.000| 1.000| 1.000| 1.000|
| C5 | 0.200| 1.000| 1.000| 1.000| 1.000|

Table 7. Normalization results in system assessment, program planning, program implementation, and program improvement.

|    | C1   | C2   | C3   | C4   | C5   |
|----|------|------|------|------|------|
| C1 | 0.200| 0.200| 0.200| 0.200| 0.200|
| C2 | 0.200| 0.200| 0.200| 0.200| 0.200|
| C3 | 0.200| 0.200| 0.200| 0.200| 0.200|
| C4 | 0.200| 0.200| 0.200| 0.200| 0.200|
| C5 | 0.200| 0.200| 0.200| 0.200| 0.200|

Table 8. Normalization results in program certification.

|    | C1   | C2   | C3   | C4   | C5   |
|----|------|------|------|------|------|
| C1 | 0.556| 0.556| 0.556| 0.556| 0.556|
| C2 | 0.111| 0.111| 0.111| 0.111| 0.111|
| C3 | 0.111| 0.111| 0.111| 0.111| 0.111|
| C4 | 0.111| 0.111| 0.111| 0.111| 0.111|
| C5 | 0.111| 0.111| 0.111| 0.111| 0.111|

Complete results of the Eigen vector values for system assessment, program planning, and program implementation were 0.200 (C1), 0.200 (C2), 0.200 (C3), 0.200 (C4), and 0.200 (C5). Eigen vector values for program certification were 0.556 (C1), 0.111 (C2), 0.111 (C3), 0.111 (C4), and 0.111 (C5).

Consistency test was performed against the Eigen vector values. The result of a calculation using equation (3) was \( t = 1.000 \), for both of the Eigen vector values results. The CI value was then calculated using equation (4), where the value of \( n \) was 5. The result of CI was -1.800 for each of evaluation component. Calculation was continued by using the random index value in Table 2, because the CI value was not equal to 0. With the value of \( RI_s = 1.120 \), the result of \( CI/RI \) was -1.607 which was less equal to 0.1, then it was quite consistent. The Eigen vector values obtained were being used as the weights criteria for TOPSIS and AHP method, as shown in Table 9.

Table 9. The categories and weights for TOPSIS and AHP method.

| No. | Evaluation Components | Service Criteria | Categories | Weights |
|-----|------------------------|-----------------|------------|--------|
| 1   | System assessment,     | Tangible        | Benefit    | 0.200  |
|     | program planning,      | Reliability     | Benefit    | 0.200  |
|     | program implementation,| Assurance       | Benefit    | 0.200  |
|     | program improvement    | Responsiveness  | Benefit    | 0.200  |
|     |                        | Empathy         | Benefit    | 0.200  |
| 2   | Program certification  | Tangible        | Benefit    | 0.556  |
|     |                        | Reliability     | Benefit    | 0.111  |
|     |                        | Assurance       | Benefit    | 0.111  |
|     |                        | Responsiveness  | Benefit    | 0.111  |
|     |                        | Empathy         | Benefit    | 0.111  |

Both research by Divayana et al. [6][7] evaluated digital library services using the CSE-UCLA combined with Weighted Product that was used as a model comparison to this research. Research by Divayana et al. ranked each CSE-UCLA evaluation component, meanwhile this research ranked aspect
of each component of the CSE-UCLA. The ranking process against aspects of each component of the CSE-UCLA evaluation is expected to facilitate decision maker to set a priority scale in order to optimize the lowest rank of aspect for each evaluation component. This research was designed to measure accuracy results by TOPSIS and AHP refer to the design in Figure 1. The information were obtained as to which method had more accuracy as a result of comparison between TOPSIS and AHP to provide decision recommendations.

The constraint of the research design result was that it could not decide which the most aspect need to be optimized from all existing aspects. This research design only recommended the lowest ranking aspect of each CSE-UCLA evaluation component for optimization. For the future work, it is necessary to make a design that is able to decide the most aspect need to be optimized from all existing aspects.

5. Conclusions

There were a number of conclusions that can be drawn based on previous results and discussion. Research activities produced the design of CSE-UCLA evaluation model combined with TOPSIS and AHP as could be seen in Figure 1, which described the stages of optimizations for digital library services in Badung Regency. The TOPSIS and AHP methods had the ability to rank a variety of aspects included in the evaluation component of the CSE-UCLA. That aspects used five service criteria: tangible, reliability, assurance, responsiveness, and empathy, all of which were classified in the "benefit" category. Each criterion had a value of 0.200, 0.200, 0.200, 0.200, 0.200 for the weight values for system assessment, program planning, program implementation, and program improvement, while for program certification: 0.556, 0.111, 0.111, 0.111, 0.111, respectively.

The results of this design were still preliminary research. TOPSIS and AHP methods were compared to obtain about which method is more effective to provide decision recommendations. In the future, it will be necessary to consider adding experts to decide the weights of the TOPSIS and AHP methods, as comparison thus increasing the accuracy of the results.

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