



DECISION SUPPORT SYSTEM FOR PUBLIC SERVICE EVALUATION USING THE ANALYTICAL HIERARCHY PROCESS, MODIFIED SIMPLE ADDITIVE WEIGHTING, AND COPELAND SCORE

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Abstract

This research aims to evaluate the quality of public services using three methods, namely the Analytical Hierarchy Process (AHP), Modified Simple Additive Weighting (MSAW), and Copeland Score. The study was conducted at an institution that provides direct services to the public.

High-quality public services are a key indicator of government performance. However, the evaluation of public services is often subjective and not yet supported by an integrated system capable of producing objective and accurate decisions. Therefore, this research aims to design and develop a Public Service Evaluation Information System by applying a combination of the Analytical Hierarchy Process (AHP), Modified Simple Additive Weighting (MSAW), and Copeland Score methods.

The AHP method is used to determine the weights of public service evaluation criteria based on their relative importance through pairwise comparisons. Subsequently, the MSAW method is applied to normalize the data and calculate the preference values of each service alternative using the obtained weights. To generate a more comprehensive and fair final ranking, the Copeland Score method is employed as an aggregation technique to determine the ranking of alternatives based on pairwise comparisons. The results indicate that the developed information system is able to evaluate public services in a more objective, systematic, and transparent manner. The integration of these three decision-making methods has proven effective in producing accurate public service rankings and supporting decision-makers in evaluating and improving service quality. Thus, the proposed system is expected to serve as a reliable decision support tool for enhancing the quality of public services on an ongoing basis.

Keywords: Public Service, Information System, Analytical Hierarchy Process, Modified Simple Additive Weighting, Copeland Score.

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Introduction (Time New Roman 12 pt Bold)

The assessment of public services is standardized to evaluate the performance achievements of services provided to the community. Public service providers are expected to deliver high-quality services to society. However, public service assessment is often difficult to conduct due to the lack of structured and easily accessible data. This condition can hinder government institutions from measuring their performance objectively. The rapid development of information technology provides significant opportunities to improve the public service assessment process through advanced information systems. Nevertheless, implementing such technology effectively and ensuring its alignment with local needs and contexts present particular challenges. Public service assessment does not rely on a single factor but involves multiple dimensions, including availability, accessibility, responsiveness, and quality.

Public services constitute an essential aspect of governance because they directly affect people's lives. Evaluating the quality and effectiveness of public services is crucial to ensure that these services meet public needs. One approach to evaluating public services is by applying the Analytical Hierarchy Process, Modified Simple Additive Weighting, and Copeland Score methods.

Two commonly used decision-making methods are Simple Additive Weighting (SAW) and Analytical Hierarchy Process (AHP). The SAW method is well known for its simplicity in calculating alternative scores based on criterion weights and values. Meanwhile, AHP offers a more complex approach by performing pairwise comparisons among criteria to determine their relative weights. Both methods present several challenges. In SAW, determining appropriate weights is often difficult because weighting is subjective. In AHP, although it produces more detailed results, the data processing can be highly complex and requires substantial data and calculations. Furthermore, the two methods may produce different results depending on how the weights and criterion values are defined, which can influence the final decision. To address these challenges, this study employs a combination of the Analytical Hierarchy Process, Modified Simple Additive Weighting, and Copeland Score methods. This modification aims to improve the weaknesses of the traditional SAW method, utilize the advantages of AHP in determining criterion weights more objectively and systematically, and perform ranking using the Copeland Score method.

Methods

This study employed a quantitative approach. Data and information were collected through questionnaires administered to a public service institution, involving 250 data samples. After the data were obtained, the research began by identifying problems in public service delivery, such as



low community satisfaction or the absence of an objective assessment system. The objective of the assessment was then defined, namely to evaluate and rank the quality of public services objectively and systematically. The assessment criteria were determined based on public service standards and literature review.

The identified criteria were weighted using the Analytical Hierarchy Process (AHP) and arranged into a decision matrix. The data were structured in the form of a decision matrix, where rows represent alternatives and columns represent criteria, followed by data normalization using the Modified Simple Additive Weighting (MSAW) method. After normalization, the preference value of each alternative was calculated by summing the products of the normalized values and the AHP-derived criterion weights. These preference values indicate the quality level of each public service alternative. To obtain stronger and fairer ranking results, the Copeland Score method was applied.

The tools used in this research consisted of hardware and software. The hardware included a laptop with a Ryzen 7 processor, 8 GB RAM, and Windows 10 operating system. The software included Balsamiq Mockup for designing the website user interface and the Streamlit framework with the Python programming language using the JetBrains PyCharm text editor.

The initial stage of the research procedure involved a literature study to identify previous national and international journal publications relevant to the methods used. Subsequently, a field study was conducted to obtain primary and secondary data required for system development.

System development in this study employed the Extreme Programming methodology introduced by Kent Beck in 2000 to reduce the risk of failure in software development. Extreme Programming consists of five phases: planning, design, coding, testing, and release. The final stage of the research involved completing the system development and writing the research report.

The research steps using the AHP, MSAW, and Copeland Score methods to determine public service assessment are as follows:

1. Reviewing relevant theoretical foundations as conceptual references for the study.
2. Collecting data through observation and analysis of public service data provided by the relevant institution.
3. Identifying problems in public service assessment that are still subjective and not yet standardized. The research objective was set to produce an objective and measurable public service assessment system.
4. Determining criteria based on public service standards, literature, and institutional policies, and defining alternatives as service units, service periods, or types of services to be evaluated.
5. Weighting criteria using AHP by constructing a hierarchical structure (goal–criteria–alternatives), conducting pairwise comparisons among criteria, calculating the normalized



matrix and eigenvector, and testing consistency using the Consistency Ratio (CR). If $CR \leq 0.1$, the weights are considered consistent.

6. Collecting performance values of each alternative for each criterion from surveys, observations, or questionnaires and arranging them into a decision matrix.
7. Calculating alternative preference values using the Modified Simple Additive Weighting (MSAW) method by normalizing data according to criterion types (benefit or cost), multiplying normalized values by AHP weights, and summing all weighted values to obtain initial preference scores.
8. Strengthening the ranking results using the Copeland Score method by conducting pairwise comparisons among alternatives based on MSAW preference values, determining wins (+1), losses (-1), or ties (0), calculating the Copeland value as the difference between wins and losses, and determining final rankings based on the highest Copeland scores.
9. Analyzing and interpreting the results as the basis for evaluating public service quality and providing service improvement recommendations to the relevant institution.

The context diagram describes the relationship between the Public Service Assessment Information System and the involved external entities, as well as the incoming and outgoing data flows. The system functions as a central data processing unit for public service assessment using the AHP, MSAW, and Copeland Score methods. Users interact directly with the system to input public service assessment data.

The system was developed by implementing the database design and user interface design into program code to build the decision support system for public service assessment, which was subsequently tested and released. The system was built using the Streamlit framework with the Python programming language. This study applied two types of testing: black box testing and user acceptance testing (UAT). Recommendation testing was conducted after users provided ratings and obtained recommendation results. This testing aimed to examine the relevance of system-generated data for users. The results of data processing using the AHP, MSAW, and Copeland Score methods provide evaluations of the processed data, enabling users to assess in detail the suitability of the system's evaluation results. Black box testing was used to test system functionality and ensure that each function operates according to user requirements, while UAT was conducted to obtain user feedback on the evaluation results generated by the developed system to improve public service delivery.



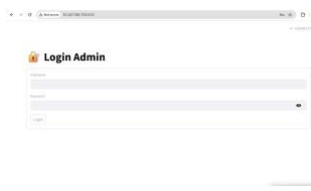
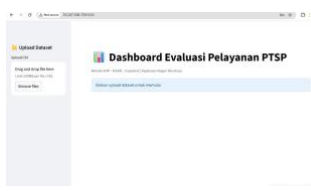
Results (or Results and Discussion)

This discussion explains the calculation process carried out through the integration of the Analytical Hierarchy Process, Modified Simple Additive Weighting, and Copeland Score methods. The steps applied in these calculations follow the process defined in the information system framework described in Chapter Three. The AHP, MSAW, and Copeland Score methods are implemented to evaluate public service assessments in accordance with the procedures established in the information system framework. The data used by the system to evaluate public service performance are obtained from visitors who have completed the questionnaires.

The first stage begins with data collection in accordance with the research requirements, followed by the determination of criteria and alternatives to be evaluated, weighting of criteria using AHP, testing the consistency of judgments, structuring the data into a decision matrix, and calculating alternative preference values using the Modified Simple Additive Weighting (MSAW) method by normalizing the data according to criterion types (benefit or cost). Subsequently, ranking is performed using the Copeland Score method, and the results are analyzed and interpreted as the basis for evaluating public service quality and providing recommendations for service improvements to the relevant institution.

The results of data processing using the AHP, MSAW, and Copeland Score methods provide an evaluation of the processed data. Functional testing of the system using black box testing is conducted to assess its conformity with user requirements and to ensure that each system function operates properly. Users can provide detailed evaluations regarding the suitability of the system's evaluation results.

Table 4.1. Black Box Testing Results of the System

No.	Test Case	Input	Expect Result	Actual Result
1.	Masuk ke browser, alamat website: ev-pelayanan-publik.online	Masukkan alamat ke URL	Menampilkan halaman Login website	
2.	Login Admin	Mengisi kolom username dan password admin	Menampilkan halaman dashboard	



3.	Evaluasi Pelayanan Publik	Memasukkan data pada tombol proses dengan label Browse files dengan file yang diupload .csv	Menampilkan Evaluasi Pelayanan Publik berupa ringkasan evaluasi, radar kualitas pelayanan dan rekomendasi perbaikan	
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User Acceptance Testing (UAT) was conducted to obtain feedback from users regarding the evaluation results generated by the developed system, with the aim of improving public service delivery based on public service assessment outcomes. In this study, UAT was carried out using three parameters—usability, security, and system performance—as the basis for constructing the questionnaire items. The testing was conducted by distributing questionnaires to system users, namely administrators. The following are the list of questions and the questionnaire recapitulation results for the developed system.

Table 4.2. User Acceptance Testing (UAT) Results for Administrators

No.	Question	Yes	No
1.	Is the login process to the system easy and fast?	V	
2.	Can the data upload process be performed quickly?	V	
3.	Can the system process data accurately?	V	
4.	Are the results of the data processing understandable to users?	V	



5.	Does the system make it easier for you to conduct public service evaluations?	V	
6.	Can the system present information clearly?	V	

The table above presents the results of User Acceptance Testing (UAT) conducted with system users, indicating ease of use in the login process, proper data management, and the system's ability to facilitate users in evaluating public services.

Discussion

Based on the research results, the use of offline data exported from the website can improve data processing within the system that is directly input by visitors. Therefore, the system can still be further developed by utilizing online data sources through web services. The system can be enhanced by adding more specific criteria and sub-criteria for public service assessment according to the type of institution, so that the evaluation results become more comprehensive and accurately reflect actual service conditions. Future studies may integrate time-based (time-series) data validation and processing mechanisms to monitor changes in public service quality periodically and continuously.

This study employs the AHP method to evaluate public service quality by involving various stakeholders. The criteria used include service reliability, responsiveness, transparency, and user satisfaction. The results indicate that AHP produces consistent criterion weights, as evidenced by Consistency Ratio (CR) values below 0.1. These findings confirm that AHP is effective in reducing subjectivity and improving the validity of public service evaluations.

The decision-making system for ranking public service quality in this study demonstrates that MSAW enhances fairness and accuracy in the ranking process by flexibly accommodating data characteristics and criterion types. The results conclude that MSAW is highly suitable for evaluation systems involving multiple criteria with different measurement scales, improving the data normalization process and increasing the accuracy of ranking outcomes. The use of the Copeland Score method integrates the results of multiple MCDM methods in public organization performance evaluation. The findings indicate that Copeland Score is effective in resolving ranking conflicts that arise due to user differences.



Conclusion and Recommendations

Based on the results and discussion of the Public Service Assessment Information System using the Analytical Hierarchy Process (AHP), Modified Simple Additive Weighting (MSAW), and Copeland Score methods, the developed system is capable of supporting public service evaluation processes. The implementation of AHP successfully determines the importance weights of each public service assessment criterion consistently based on expert or stakeholder judgments. Consistency ratio testing shows that the generated criterion weights are within an acceptable consistency level and are therefore suitable for subsequent calculation stages.

The MSAW method is able to process alternative service assessment data by performing normalization and calculating preference values based on AHP-derived criterion weights, which are then combined with the Copeland Score method. The use of Copeland Score effectively determines service rankings and resolves ranking conflicts that may arise due to user differences. Testing conducted using black box testing and User Acceptance Testing (UAT) indicates ease of login, appropriate data management, and facilitation of users in evaluating public services. Furthermore, the testing confirms that the system meets user requirements and that all system functions operate properly.





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