Volume 01, Issue 01, Juni 2026 : ISSN: xxx–xxx Received: Mei 27, 2026. Revised: Juni 23, 2026

Journal of Adaptive Intelligent Systems

A Web-Based Decision Support System for Social Assistance Beneficiary Selection in Wringin Telu Village Using the ELECTRE Method

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Abstract: Social assistance is a government program designed to support vulnerable individuals, families, and communities by providing financial aid or essential resources to improve their welfare and ensure a decent standard of living. The selection of eligible beneficiaries requires an objective and transparent decision-making process based on predefined criteria. A Decision Support System (DSS) can facilitate this process by assisting decision-makers in evaluating multiple alternatives under semi-structured decision conditions. This study aims to develop a web-based Decision Support System for selecting social assistance beneficiaries in Wringin Telu Village using the Elimination and Choice Translating Reality (ELECTRE) method. The proposed system evaluates applicants based on established selection criteria and generates recommendations by ranking eligible beneficiaries according to the ELECTRE decision-making process. The implementation results demonstrate that the developed system effectively supports village officials in making objective, accurate, and efficient decisions regarding social assistance allocation.

Keywords: Decision Support System, ELECTRE, Multi-Criteria Decision Making, Social Assistance, Web-Based System.

1. Introduction

According to the Indonesian Ministry of Social Affairs (2011), social assistance is a temporary government program intended to improve the welfare of individuals, families, and communities through financial or material assistance. The implementation of social assistance programs reflects the government's commitment to ensuring social protection while promoting fairness, rationality, and public welfare.

Despite the implementation of various social assistance programs, several challenges remain in ensuring that assistance is distributed accurately and fairly. Many eligible citizens have not fully received their social rights due to weaknesses in the existing distribution process. The major challenges include the lack of an integrated beneficiary database, inaccurate beneficiary information, delays in aid distribution, and inconsistencies in the allocation process. These issues highlight the need for a systematic and objective approach to support decision-making during beneficiary selection.

A Decision Support System (DSS) is an information system designed to assist decision-makers in solving semi-structured and unstructured problems by evaluating multiple alternatives based on predefined criteria. DSS has been widely adopted in various decision-making applications because it improves the accuracy, consistency, and transparency of the decision process [1]. In the context of social assistance, a DSS can help village officials objectively identify eligible beneficiaries while minimizing subjectivity during the selection process.

This study employs the Elimination and Choice Translating Reality (ELECTRE) method as the decision-making technique. ELECTRE is a Multi-Criteria Decision-Making (MCDM) method based on the outranking concept, in which alternatives are compared pairwise according to multiple evaluation criteria to determine the most preferred alternative [2]. Previous studies have demonstrated that the ELECTRE method is effective in solving decision-making problems involving multiple criteria, including scholarship selection, supplier selection, housing assistance, and other beneficiary selection systems [2], [3].

Based on these considerations, this study proposes a Web-Based Decision Support System for Social Assistance Beneficiary Selection in Wringin Telu Village Using the ELECTRE Method. The proposed system is expected to assist village officials in selecting eligible beneficiaries objectively, efficiently, and transparently, thereby improving the effectiveness and accountability of the social assistance distribution process.

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2. Related Works

Several previous studies have investigated the application of Decision Support Systems (DSS) and the ELECTRE method in solving multi-criteria decision-making problems, particularly in beneficiary selection and public service applications.

Maffirotin et al. developed a Decision Support System for social assistance beneficiary selection in Kutai Kartanegara Regency using the ELECTRE method. Their study demonstrated that the proposed system was capable of assisting social service officers in selecting eligible beneficiaries based on predefined criteria and generating objective recommendations through the ELECTRE decision-making process [4].

Fauzi proposed a Decision Support System for selecting recipients of Rumah Tidak Layak Huni (RUTILAHU) housing assistance using the ELECTRE method. The study showed that the developed system effectively supported the Community Empowerment Institution in making objective, efficient, and unbiased decisions regarding housing assistance allocation [5].

Another related study was conducted by Chess and Pinem, who designed a web-based social assistance mapping system during the COVID-19 pandemic. Their research emphasized the importance of information systems in supporting local governments and village administrations in managing social assistance data more effectively, improving transparency, and facilitating the distribution of aid to economically vulnerable communities [6].

Although previous studies have successfully demonstrated the effectiveness of the ELECTRE method in various decision support applications, most of them primarily focused on implementing the decision-making algorithm or developing information systems for beneficiary selection. In contrast, this study develops a web-based Decision Support System for social assistance beneficiary selection in Wringin Telu Village that integrates the ELECTRE method into the beneficiary evaluation process based on predefined eligibility criteria. The proposed system is expected to improve the accuracy, transparency, and efficiency of social assistance allocation at the village level.

3. Research Method

A. Research Framework

The development of the proposed Web-Based Decision Support System for Social Assistance Beneficiary Selection in Wringin Telu Village was conducted through a structured research framework to ensure that the resulting system effectively addresses the identified problems. The research process began with data collection through observations, interviews, and literature review to understand the existing social assistance distribution process. The collected information was then analyzed to identify system requirements and define the scope of the proposed solution. Based on the identified requirements, the system was designed, implemented, tested, and evaluated before deployment. The overall research framework is illustrated in Figure 1.

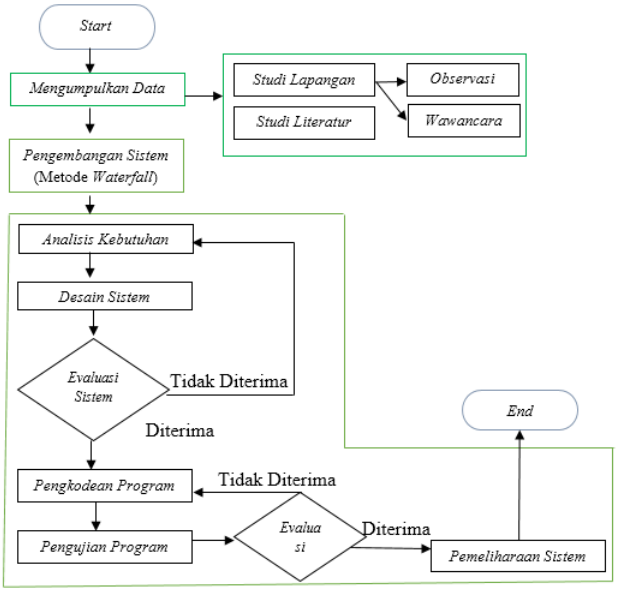

Figure 1. Research Framework

B. System Development Method

This study adopts the Waterfall Software Development Life Cycle (SDLC) as the system development methodology. The Waterfall model is a sequential software development approach in which each phase must be completed before proceeding to the next stage. This model provides a systematic framework for software development and is suitable for applications with clearly defined requirements

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[7]. The development process consists of five main phases, as illustrated in Figure 2.

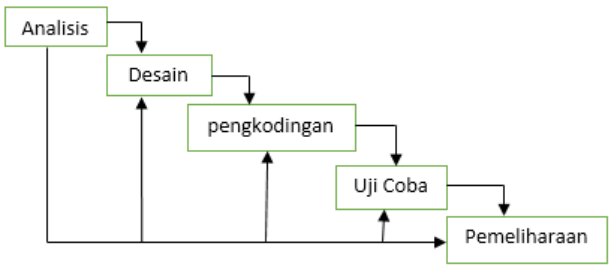

Figure 2. Waterfall Development Process

1) Requirements Analysis

The first phase focuses on identifying and analyzing system requirements. Data were collected through direct observation, interviews with village officials, and literature review to obtain accurate information regarding the social assistance beneficiary selection process. The results of this phase serve as the basis for system design and implementation.

2) System Design

Based on the identified requirements, the proposed system was designed to provide an efficient and user-friendly decision support application. The system design includes process modeling using flowcharts, Data Flow Diagrams (DFD), and Entity Relationship Diagrams (ERD) to describe data flow, system processes, and database structure before implementation [8].

3) System Implementation

After completing the analysis and design phases, the proposed system was implemented as a web-based application. The implementation phase transformed the system design into a functional software application capable of managing beneficiary data, processing ELECTRE calculations, and generating recommendation results efficiently.

4) System Testing

System testing was conducted to verify that all system functions operated according to the specified requirements. The evaluation included both internal testing to validate system functionality and external testing to ensure that the developed application met user expectations and supported the beneficiary selection process effectively.

5) System Maintenance

Following successful testing and deployment, system maintenance was performed to ensure the long-term reliability and usability of the application. Maintenance activities include periodic system monitoring, error correction, performance improvement, and system updates to accommodate future operational requirements.

C. ELECTRE Method

The Elimination and Choice Translating Reality (ELECTRE) method is a Multi-Criteria Decision-Making (MCDM) approach that applies the concept of outranking to compare alternatives based on multiple evaluation criteria. The method is particularly suitable for decision-making problems involving several alternatives, where alternatives that do not satisfy the established criteria can be eliminated to identify the most appropriate solution [9].

The ELECTRE method consists of several computational stages, beginning with the construction of a decision matrix and ending with the selection of the preferred alternative. The first step in the ELECTRE procedure is the normalization of the decision matrix.

1) Decision Matrix Normalization

The first step is to normalize the decision matrix so that all criteria values become comparable. Each element xij of the decision matrix is transformed into a normalized value rij using the vector normalization formula

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

for i = 1, 2, …, m and j = 1, 2, …, n,

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where m denotes the number of alternatives and n denotes the number of criteria. The resulting normalized matrix is represented as

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \quad (2)$$

The matrix R represents the normalized decision matrix, where (m) denotes the number of alternatives, (n) denotes the number of evaluation criteria, and (r_{ij}) represents the normalized performance value of the (i)-th alternative with respect to the (j)-th criterion. The normalized decision matrix serves as the basis for constructing the weighted normalized decision matrix used in the subsequent stages of the ELECTRE method [9].

Subsequent ELECTRE steps include the construction of the weighted normalized matrix, the determination of concordance and discordance sets, the calculation of concordance and discordance matrices, the construction of dominant concordance and discordance matrices, and the formation of the aggregate dominance matrix to obtain the final ranking of alternatives [9].

2) Construction of the Weighted Normalized Decision Matrix

After constructing the normalized decision matrix, each column of matrix R is multiplied by the corresponding criterion weight ((w)) assigned by the decision-maker. This process produces the weighted normalized decision matrix, denoted as V, which is calculated as follows [9]:

$$V - R.W \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} =$$

$$\begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix} \quad (3)$$

The matrix W represents the weighting matrix, R denotes the normalized decision matrix, and V represents the weighted normalized decision matrix obtained by multiplying the normalized decision matrix by the weighting matrix. The weighted normalized decision matrix is used as the basis for the subsequent concordance and discordance analyses in the ELECTRE decision-making process [9].

$$W = \begin{bmatrix} w_1 & 0 & \cdots & 0 \\ 0 & w_2 & \cdots & 0 \\ \vdots & \vdots & \cdots & \vdots \\ 0 & 0 & \cdots & w_n \end{bmatrix} \quad (4)$$

3) Determination of the Concordance and Discordance Sets

For each pair of alternatives k and l (k, l= 1,2,3, …, m and k ≠l), the set of evaluation criteria is partitioned into two subsets: the concordance set and the discordance set. The concordance set consists of criteria for which the performance value of alternative (A_k) is greater than or equal to that of alternative (A_l). It is defined as follows [9]:

$$C_{kl} = \{j, v_{kj} \geq v_{lj}\} \text{ for j = 1,2,3,…n.} \quad (5)$$

Conversely, the discordance set is the complement of the concordance set. It contains the criteria for which the performance value of alternative (A_k) is lower than that of alternative (A_l), and is defined as follows [9]:

$$D_{kl} = \{j, v_{kj} < v_{lj}\} \text{ for j = 1,2,3,…n.} \quad (6)$$

4) Calculation of the Concordance and Discordance Matrices

After determining the concordance and discordance sets, the next step is to compute the concordance matrix and the discordance matrix. The concordance value for each pair of alternatives is obtained by summing the weights of all criteria included in the corresponding concordance set. Mathematically, the concordance index is calculated as follows [9]:

$$c_{kl} = \sum_{j \in c_{kl}} w_j \quad (7)$$

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The discordance matrix is computed to determine the discordance index for each pair of alternatives. The discordance index is obtained by dividing the maximum difference between the performance values of criteria included in the discordance set by the maximum difference among all evaluation criteria. Mathematically, the discordance index is expressed as follows [9]:

$$d_{kl} = \frac{max\{|v_{kj} - v_{lj}|\}_{j \in D_{kl}}}{max\{|v_{kj} - v_{lj}|\}_{\forall J}} \quad (8)$$

where (d_{kl}) denotes the discordance index for alternatives (A_k) and (A_l), (D_{kl}) represents the discordance set, and (v_{kj}) and (v_{lj}) denote the weighted normalized values of alternatives (A_k) and (A_l) with respect to the (j)-th evaluation criterion.

5) Construction of the Dominant Concordance and Discordance Matrices

The next step is to construct the dominant concordance matrix and the dominant discordance matrix. The dominant concordance matrix, denoted by F, is established using a predefined threshold value. Each element of the concordance matrix is compared with the concordance threshold to determine whether the corresponding pair of alternatives satisfies the concordance dominance condition. The elements of the dominant concordance matrix are defined as follows [9]:

$C_{kl} \geq \underline{C}$ with value of *threshold* (c) :

$$\underline{C} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} C_{kl}}{m(m-1)} \quad (9)$$

Accordingly, the elements of the dominant concordance matrix F are determined as follows :

$$f_{kl} = \begin{cases} 1, jika\ C_{kl} \geq \underline{C} \\ 0, jika\ C_{kl} < \underline{C} \end{cases}$$

The dominant discordance matrix, denoted by G, is constructed using a predefined discordance threshold. Each element of the discordance matrix is compared with the threshold value to determine whether the corresponding pair of alternatives satisfies the discordance dominance condition. The dominant discordance matrix is established based on the following criterion.

$$\underline{d} = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} d_{kl}}{m(m-1)} \quad (10)$$

The elements of the dominant discordance matrix G are defined as follows

$$g_{kl} = \begin{cases} 1, if\ d_{kl} \geq \underline{d} \\ 0, if\ d_{kl} < \underline{d} \end{cases} \quad (11)$$

6) Construction of the Aggregate Dominance Matrix

The final step in the ELECTRE method is the construction of the aggregate dominance matrix, denoted by E. This matrix is obtained by multiplying the corresponding elements of the dominant concordance matrix (F) and the dominant discordance matrix (G). The aggregate dominance matrix represents the overall outranking relationship between each pair of alternatives and is mathematically expressed as follows. : $e_{kl} = f_{kl} \times g_{kl}$

7) Elimination of Less Favorable Alternatives

The final ranking of alternatives is determined using the aggregate dominance matrix (E). If (e_{kl}=1), then alternative (A_k) is considered to outrank alternative (A_l). Conversely, if (e_{kl}=0), alternative (A_k) does not dominate alternative (A_l). Therefore, alternatives with the fewest dominance relationships are eliminated, while the alternative that dominates the greatest number of other alternatives is identified as the most preferred solution. This ranking process enables the selection of the most eligible social assistance beneficiaries based on the predefined evaluation criteria [9].

4. Result and Discussion

A. Data Collection Results

Following the data collection process, the existing social assistance beneficiary selection system was analyzed to identify its limitations and determine the system requirements. Based on the findings, a new web-based Decision Support System (DSS) was developed using the Waterfall Software Development Life Cycle (SDLC). The development

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process consisted of five sequential phases: requirements analysis, system design, implementation, testing, and maintenance. The collected data served as the foundation for designing and implementing the proposed decision support system.

B. System Design

Based on the functional and non-functional requirements identified during the analysis phase, the system architecture was designed to satisfy the operational needs of the proposed application. The system design aimed to develop a computerized decision support system capable of improving the effectiveness and efficiency of the social assistance beneficiary selection process. Several system modeling tools were employed during this stage, including Flowcharts, Data Flow Diagrams (DFDs), and Entity Relationship Diagrams (ERDs), to describe the system processes, data flow, and database structure before implementation.

C. Flowchart

A flowchart was developed to illustrate the workflow of the proposed system and to provide a clear representation of the decision-making process. The flowchart describes the sequence of activities performed by the system, beginning with data input, beneficiary evaluation using the ELECTRE method, and ending with the generation of beneficiary recommendations. Furthermore, the flowchart facilitates a comparison between the existing manual process and the proposed computerized system, thereby highlighting the improvements achieved in terms of efficiency, accuracy, and transparency

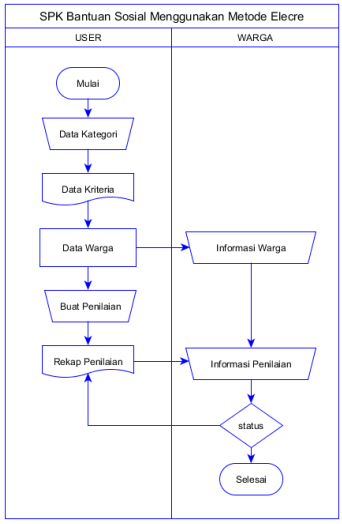

Figure. 3. Existing System Flowchart

Figure. 4. Proposed System Flowchart.

D. Data Flow Diagram (DFD)

The Data Flow Diagram (DFD) was developed to illustrate the flow of data within the proposed Decision Support System. It provides a graphical representation of how data move between external entities, system processes, data stores, and outputs, thereby facilitating the analysis and design of the system's information flow. The DFD also serves as a foundation for designing the database structure and ensuring that data are processed efficiently throughout the system.

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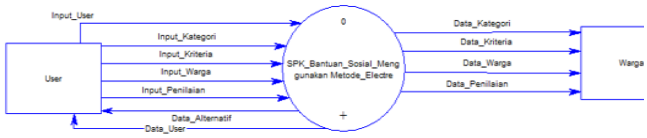

Figure. 5.. Level 0 Data Flow Diagram

E. Hierarchy Diagram

The Hierarchy Diagram provides a high-level overview of the functional structure of the proposed Decision Support System. It illustrates the hierarchical organization of system modules and their relationships, thereby providing a clear representation of the overall system architecture. This diagram facilitates the understanding of the main processes and functional decomposition before proceeding to the detailed system implementation. The hierarchy diagram of the proposed system is presented in Figure. 6.

Figure. 6.. Hierarchy Diagram of the Proposed System

F. Entity Relationship Diagram (ERD)

The Entity Relationship Diagram (ERD) was designed to model the database structure of the proposed Decision Support System. It illustrates the relationships among the system entities, their attributes, and the interactions required to support data processing and decision-making. The ERD serves as the conceptual foundation for database implementation, ensuring data integrity, consistency, and efficient management throughout the system.

The proposed ERD consists of several interconnected entities that collectively support the system's operational processes, including user management, beneficiary data management, evaluation criteria, alternative assessments, and recommendation results. The Entity Relationship Diagram of the proposed system is presented in Figure. 7.

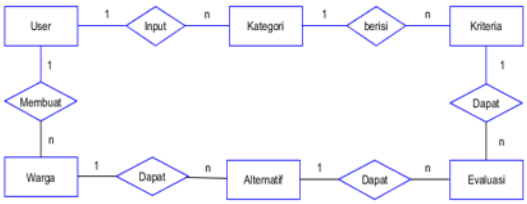

Figure 7. Entity Relationship Diagram (ERD) of the Proposed System

G. Login Page and Main Menu

The Login Page serves as the authentication interface of the proposed Decision Support System. Only registered administrators are authorized to access the system by providing valid login credentials. This authentication mechanism ensures that only authorized users can manage system operations, maintain data integrity, and perform decision-making processes related to social assistance beneficiary selection.

After successful authentication, the administrator is redirected to the Main Menu, which provides access to the primary system functions, including beneficiary data management, evaluation criteria management, alternative assessment, ELECTRE calculation, and report generation. The login interface of the proposed system is presented in Figure. 8 and Figure 9, respectively.

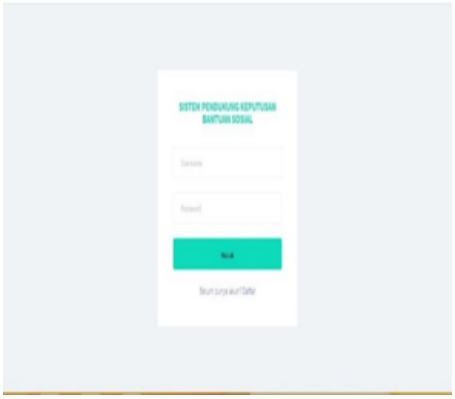

Figure 8. Login Page

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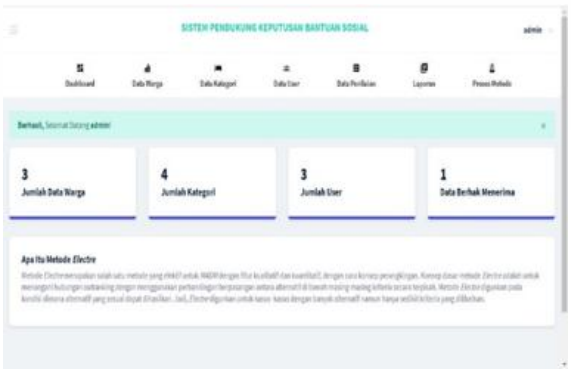

Figure 9. Main Menu

H. ELECTRE Processing Page

The ELECTRE Processing Page displays the calculation results generated by applying the ELECTRE method to the beneficiary data stored in the system. The page presents the evaluation results for each alternative based on the predefined criteria and their corresponding weights. Through this process, the system performs the ELECTRE calculations to determine the ranking of eligible social assistance beneficiaries.

The calculation results presented on this page provide an objective basis for decision-making, enabling administrators to identify the most suitable beneficiaries according to the established evaluation criteria. The implementation of the ELECTRE processing page is shown in Figure. 10.

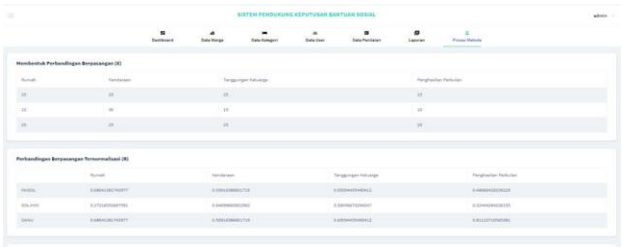

Figure. 10. ELECTRE Processing Page

I. Internal Testing

The developed Decision Support System was evaluated through internal testing using the Black-Box Testing approach. This testing method focuses on verifying the external behavior and functional requirements of the system without considering the internal program structure or source code. Each functional module was tested by providing various input scenarios and observing the corresponding outputs to ensure that the system operated according to the specified requirements.

The testing results indicate that all major system functions, including user authentication, beneficiary data management, criteria management, ELECTRE computation, and report generation, performed successfully without functional errors. Therefore, the proposed system satisfies the specified functional requirements and is suitable for supporting the social assistance beneficiary selection process. The results of the internal testing are presented in Figure 11.

No	Pengujian	Uraian	Hasil yang diharapkan	Kesesuaian		Ket
				Ya	Tidak	
1.	Form Login	Input Username	Dapat menginput username	√		
		Input Password	Dapat membaca inputan password	√		
		Tombol Login	Dapat menampilkan halaman apabila berhasil	√		
2.	Form Data Warga	Tombol Tambah Data	Dapat menampilkan tampilan inputan data warga yang jika kllik tombol simpan pada tampilan inputan data maka akan menambah data di *database* tabel warga	√		

Figure 11. Internal Testing Results

J. External Testing

External testing was conducted to evaluate the usability and operational performance of the proposed Decision Support System under actual usage conditions. The evaluation involved both the system administrator and end users, who interacted directly with the application to assess its functionality, ease of use, and overall performance.

The participants performed representative tasks, including user authentication, beneficiary data management, criteria evaluation, ELECTRE-based decision processing, and result verification. The evaluation confirmed that the system functions correctly in a real-world environment and effectively supports the social assistance beneficiary selection

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process. Furthermore, the users reported that the system was easy to operate and assisted them in making more objective and efficient decisions. The results of the external testing are presented in Figure 12.

No	Admin	Jawaban Pertanyaan ke					Total
		Q 1	Q 2	Q 3	Q 4	Q 5	
1	Perespon	4	3	2	3	3	15

Figure 12. External Testing Results

5. Conclusion

This study successfully developed a web-based Decision Support System (DSS) for social assistance beneficiary selection in Wringin Telu Village by implementing the Elimination and Choice Translating Reality (ELECTRE) method. The proposed system applies the ELECTRE algorithm to evaluate multiple alternatives based on predefined criteria, eliminate less favorable alternatives, and identify the most eligible beneficiaries through an objective ranking process.

The implementation results demonstrate that the developed system effectively supports village officials in selecting social assistance beneficiaries in a more objective, accurate, efficient, and transparent manner. By automating the evaluation and recommendation process, the system reduces subjectivity in decision-making and improves the overall effectiveness of social assistance distribution. Therefore, the proposed Decision Support System can serve as a practical tool for assisting village administrations in allocating social assistance based on established eligibility criteria.

Conflicts of Interest

The author declare that there are no conflicts of interest related to this study

Author Contribution

Conceptualization, Siti Qomaria and Wahab Sya'roni; methodology, Siti Qomaria and Wahab Sya'roni; software, Siti Qomaria; validation, Wahab Sya'roni and Ratri Enggar Pawening; formal analysis, Siti Qomaria; investigation, Siti Qomaria; data curation, Siti Qomaria; writing—original draft preparation, Siti Qomaria; writing—review and editing, Wahab Sya'roni and Ratri Enggar Pawening; visualization, Siti Qomaria; supervision, Wahab Sya'roni; project administration, Wahab Sya'roni; funding acquisition, Wahab Sya'roni and Ratri Enggar Pawening. All authors have read and agreed to the published version of the manuscript.

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