Journal of Applied Informatics Research Vol 2 No 2 (2026) pp. 28~44

Journal of Applied Informatics Research
Fakultas Vokasi, Kampus Unesa 1, Ketintang, Surabaya, Indonesia
Website: https://journal.unesa.ac.id/index.php/jair/ | E-mail: jair@unesa.ac.id

Implementation of BWM-SAW in the Development of a Web-Based Decision Support System for Selecting Social Assistance Beneficiaries (BPNT and PKH) in Sidoarjo Regency

Adam Zuhruf Ananda Farendra[1], I Gde Agung Sri Sidhimantra[2], Asmunin[3], Rosita[4]

[1,2,3,4]Manajemen Informatika, Universitas Negeri Surabaya, Indonesia
[1]adam.22055@mhs.unesa.ac.id, [2]igdesidhimantra@unesa.ac.id, [3]asmunin@unesa.ac.id, [4]rositarosita@unesa.ac.id

ARTICLE INFORMATION

Article history:

Received November 10, 2026
Revised November 16, 2026
Accepted November 17, 2026

Keywords:

Decision Support System;
Social Assistance;
Best Worst Method;
Simple Additive Weighting;
Research and Development

ABSTRACT

The distribution of Non-Cash Food Assistance (BPNT) and the Family Hope Program (PKH) in Sidoarjo Regency continues to face inclusion and exclusion errors associated with spatially fragmented field verification and subjective eligibility assessment. This study developed an adaptive web-based decision support system (DSS) using a Research and Development approach and the Waterfall model. A full-stack architecture comprising Node.js, TypeScript, 19 MySQL tables, and a Progressive Web App integrates Best Worst Method (BWM) weighting for ten core criteria (C1–C10), a dynamic engine that maps 39 DTSEN indicators, and Simple Additive Weighting (SAW) for household ranking and decile classification. Additional functions include Leaflet GIS geotagging, Smart Import/Export, an in-system Regent's Decree editor with electronic-signature support, tiered publication through a Citizen Portal, and real-time complaint services using a chatbot, live chat, and WebRTC. For 100 verified households, the reported BWM weights were highest for economic conditions (C1 = 0.23) and lowest for health (C10 = 0.02), with a reported consistency deviation of $\xi = 0.042$ ($\xi < 0.10$, Valid). SAW classified 43 households as priority recipients in deciles 1–4 (reported allocation: IDR 600,000 per household; maximum score: 0.6617) and 57 as non-priority. SAW and WP rankings showed a reported Spearman correlation of $r_s = 0.7357$. Evaluation by 31 Social Affairs Office respondents yielded an 18/18 black-box test pass rate, a UAT score of 82.58%, and a mean SUS score of 72.42 (Acceptable/Grade B).

1. INTRODUCTION

Social assistance programs, including Bantuan Pangan Non-Tunai (BPNT, Non-Cash Food Assistance) and Program Keluarga Harapan (PKH, Family Hope Program), are important policy instruments for reducing poverty and meeting the basic needs of vulnerable populations [1], [2]. However, their distribution continues to face targeting problems, including inclusion and exclusion errors, because field data are not yet spatially integrated, eligibility verification is susceptible to subjective judgment, and transparent, quantitative assessment mechanisms remain limited [3].

An interview with M. Bashori Alwi, S.Sos., M.AP., Head of the Social Protection and Security Division of the Sidoarjo Regency Social Affairs Office, on November 25, 2025, confirmed that beneficiary selection refers to the Data Tunggal Sosial Ekonomi Nasional (DTSEN; National Unified Socioeconomic Database), prioritizing deciles 1–4 [4], [5]. Although SIKS-NG and the Cek Bansos platform support administration, local implementation continues to face challenges involving central–local data synchronization, duplicate records, and data-entry errors.

These issues necessitate quarterly field verification (ground checks). The limited transparency of decile indicators also highlights the need for a more objective, efficient, and accountable verification instrument.

A decision support system (DSS) based on multi-criteria decision-making (MCDM) can facilitate measurable, transparent assessments across several eligibility criteria [6]–[8]. Simple Additive Weighting (SAW) efficiently ranks alternatives through a weighted-sum model [9], [10], [71], [72], although its results depend on potentially subjective criterion weights [11]. To address this concern, the Best Worst Method (BWM) derives weights from two comparison vectors—Best-to-Others and Others-to-Worst—with an intended low consistency deviation ($\xi <$ 0.10), offering a more structured weighting procedure than conventional AHP [12], [13], [95].

The proposed BWM–SAW computation uses ten core assessment criteria (C1–C10), identified through consultation with the Sidoarjo Social Affairs Office: economic conditions, assets, age of the household head, gender, dependents, marital status, school-age children/young children, housing conditions, education, and health [2], [12], [35]–[43], [73]. In line with Indonesia's One Data policy and consultations with Muhammad Wildan, S.S., a dynamic criteria engine automatically maps 39 DTSEN/Regsosek indicators across seven dimensions to these ten core criteria without source-code modifications [4], [5], [34]. Administrative accountability is supported by Smart Import/Export (.xlsx, .docx, and .pdf), an in-system document and signature editor for customizing drafts of the Regent's Decree and official signatory details with BSrE BSSN electronic signatures, and tiered publication authorization for the Citizen Portal. Quarterly summary reports may be published by administrators, super administrators, or officers, whereas the Regent's Decree and DSS metrics are restricted to administrators and super administrators.

This study applies a Research and Development (R&D) approach with the Waterfall model [32], [33] to develop a full-stack DSS website for social assistance in Sidoarjo Regency. The system uses Node.js, Express.js, and TypeScript for a type-safe, non-blocking backend [44], [45], a MySQL database comprising 19 tables, and a Progressive Web App (PWA) interface built with Vanilla JavaScript [46], [74]. It integrates Leaflet GIS-based geotagging across 18 subdistricts [48], [76], as well as a 24-hour chatbot, complaint tracking, WebSocket-based live chat, and WebRTC voice calls [47], [75]. System performance was evaluated through 18 black-box test scenarios [49], [50], [77], User Acceptance Testing (UAT) [56], [57], and the System Usability Scale (SUS) [58]–[63] involving 31 Social Affairs Office respondents. The ranking analysis used 100 verified households, including 43 classified as priority households in deciles 1–4, and compared SAW with the Weighted Product (WP) method using Spearman rank correlation [51]–[55].

2. LITERATURE REVIEW

2.1 Decision Support Systems and Social Assistance

A decision support system (DSS) combines a database, analytical models, and an interactive interface to address semi-structured decision problems [8], [14]. For BPNT and PKH programs aimed at poverty reduction [1], [2], web-based DSS applications can support timely and measurable assessments of vulnerable households [14], [15]. They can also improve cross-device data processing and make ranking results easier to monitor and explain [16], [17], [24].

Selecting social assistance beneficiaries requires multidimensional welfare indicators to reduce the risk of excluding extremely poor households [12]. Consistent with Indonesia's One Data initiative and the integration of Regsosek and DTSEN [4], [5], this study evaluates ten core criteria: economic conditions [2], asset ownership [35], age of the household head [36], gender [37], [73], number of dependents [38], marital status [39], presence of children [40], housing conditions [41], education [42], and health [43]. A dynamic criteria engine maps 39 standard DTSEN/Regsosek indicators across seven vulnerability dimensions into these ten criteria [4], [34].

2.2 Best Worst Method (BWM) and Simple Additive Weighting (SAW)

Within multi-criteria decision-making (MCDM), particularly multi-attribute decision-making (MADM), the reliability of a decision depends on how consistently criteria are weighted and how alternative scores are aggregated [7], [18], [19]. MADM approaches such as AHP [81], [90], [95], ANP [96], [98], TOPSIS [83], [85], [86], VIKOR [21], [94], ELECTRE [79], [82], PROMETHEE [89], [97], MAUT [8], [80], [93], SMART [78], [88], COPRAS [79], [91], [92], ARAS [84], [87], and MOORA [99], [100] have different strengths and computational characteristics. Some outranking and ideal-distance approaches may impose additional processing demands when applied to large datasets through a web interface.

BWM was introduced as a structured weighting approach that reduces the number of pairwise comparisons required by AHP. A decision-maker identifies the Best and Worst criteria and provides Best-to-Others and Others-to-Worst comparisons on a 1–9 scale [13], [20]. These comparisons are used to derive criterion weights while examining the consistency of the expressed preferences [21], [22].

SAW, in contrast, is an additive aggregation method that normalizes the decision matrix according to benefit and cost attributes and multiplies the normalized scores by criterion weights [6], [23], [71], [72]. Combining BWM and SAW is intended to provide structured weighting alongside computationally efficient and compensatory ranking for social assistance prioritization [12], [24]. The resulting SAW rankings are also compared with those from WP, which uses multiplicative aggregation, to examine rank sensitivity and stability [51]–[55].

2.3 Related Studies

Ibrahim et al. [64] and Khannan et al. [65] provide systematic literature reviews relevant to information-system development and MCDM. In social assistance applications, Sunardi et al. [25] used SAW to rank PKH beneficiaries as a complement to SIKS-NG. Anggriawan et al. [26], Shofyana et al. [27], and Riyanti et al. [29] applied SAW to PKH and BPNT selection using economic, demographic, and housing indicators. Sulasmini and Arta [28] developed a nine-criterion BPNT assessment, while An'syah and Widyasari [30], Rifasya et al. [31], and Simanullang et al. [67] examined six to ten criteria for food and COVID-19 assistance. Other studies used AHP–MOORA [66], TOPSIS [68], a systematic review of 15 SAW-based zakat studies [69], and a comparison of SAW and TOPSIS [70].

The review of 14 related studies suggests that many social assistance DSS implementations rely on a standalone SAW model with manually assigned weights and fixed criteria [25]–[31], [67]. This study therefore proposes the integration of BWM–SAW using ten core criteria and a dynamic engine for 39 DTSEN indicators, together with WP-based ranking comparison and Spearman correlation analysis. The implementation also combines Node.js, TypeScript, a 19-table MySQL database, a PWA interface, Leaflet GIS geotagging, an in-system Regent's Decree editor with BSrE BSSN electronic-signature support and controlled Citizen Portal publication, and real-time WebSocket/WebRTC communication.

3. RESEARCH METHODS

This study follows a Research and Development (R&D) methodology with a quantitative approach and the Waterfall software development model. The process comprises five stages: (1) requirements analysis, (2) system design and data collection, (3) implementation of the application and BWM–SAW algorithms, (4) system testing and refinement, and (5) final evaluation [32], [33], [64].

3.1 Data Collection

Primary data were collected through an in-depth interview with M. Bashori Alwi, S.Sos., M.AP., on November 25, 2025, and a substantive consultation with Muhammad Wildan, S.S., who was identified as Head of the Social Protection and Security Division of the Sidoarjo Regency Social Affairs Office. These discussions addressed quarterly ground checks by field officers, difficulties in synchronizing central and local datasets, and prioritization of residents in DTSEN deciles 1–4 [4], [5]. Secondary sources included regulatory documentation on the ten core criteria (C1–C10) and 39 DTSEN/Regsosek welfare indicators across seven dimensions [4], [34]. A test dataset of 100 verified households was prepared to represent socioeconomic variation across Sidoarjo's 18 subdistricts: 43 priority households (deciles 1–4) and 57 non-priority households (deciles 5–9). UAT and SUS involved 31 respondents from the Sidoarjo Social Affairs Office: one division head and 30 operational staff.

3.2 Assessment Criteria and BWM Weighting

Based on validation with the Sidoarjo Social Affairs Office and the poverty-indicator literature [2], [12], [35]–[43], [73], ten core assessment criteria were specified. Three are cost attributes (C1, C2, and C9), while seven are benefit attributes (C3, C4, C5, C6, C7, C8, and C10). To accommodate changes in government data formats, the dynamic criteria engine automatically maps and averages 39 DTSEN/Regsosek indicators across seven vulnerability dimensions when administrators upload external .xlsx, .docx, or .pdf files through Smart Import [4], [34]. Table 1 presents the criterion definitions, attribute types, qualitative-to-numeric scoring ranges, DTSEN mappings, and reported BWM weights.

Table 1. Core assessment criteria, attribute types, DTSEN mappings, and reported BWM weights

Code	Core Criterion	Attribute	Score Range	Mapping to 39 Standard DTSEN Indicators	BWM Weight (ω_j)
C1	Economic Conditions	Cost	1 – 5	Indicators C1–C5 (finance) and C27–C31 (employment)	0.23
C2	Asset Ownership	Cost	1 – 5	Indicators C6–C10 (land, vehicles, electronic devices, livestock, LPG)	0.16

C3	Age of Household Head	Benefit	1 – 4	Indicator C22 (age of household head / older adults)	0.11
C4	Gender	Benefit	1 – 2	Indicator C23 (gender of household head)	0.05
C5	Number of Dependents	Benefit	1 – 4	Indicators C20–C21 (household members and dependency ratio)	0.14
C6	Marital Status	Benefit	1 – 3	Indicator C26 (marital status of household head)	0.07
C7	Children in the Household	Benefit	1 – 3	Indicators C24–C25 and C38 (young children, school attendance, dropout)	0.09
C8	Housing Conditions	Benefit	1 – 3	Indicators C11–C19 (housing status, floor, walls, roof, sanitation)	0.10
C9	Educational Attainment	Cost	1 – 3	Indicators C37 and C39 (highest certificate and literacy)	0.03
C10	Health Conditions	Benefit	1 – 3	Indicators C32–C36 (chronic illness, disability, pregnancy, health insurance)	0.02
Total				39 indicators (seven DTSEN/Regsosek dimensions)	**1.00**

3.3 Best Worst Method (BWM) and Simple Additive Weighting (SAW)

The decision-making computation initiates with determining objective criterion weights using the Best Worst Method (BWM) [13], [20]. Based on authoritative consultations with the Head of the Social Protection and Security Division at the Sidoarjo Social Affairs Office, Economic Conditions (C1) was determined as the Best criterion (C_B) as it represents the fundamental indicator of household purchasing power. Conversely, Gender (C4) was identified as the Worst criterion (C_W) within the demographic assessment spectrum because social assistance eligibility in municipal policy is non-discriminatory regarding gender. The decision-maker formulated the Best-to-Others (A_B) and Others-to-Worst (A_W) pairwise comparison vectors using the standard 1–9 Saaty scale, as formulated in Equations (1) and (2).

$$A_B = (a_{B1}, a_{B2}, \dots, a_{Bn}) \tag{1}$$

$$A_W = (a_{1W}, a_{2W}, \dots, a_{nW})^T \tag{2}$$

The reported optimal criterion weights (w_j) and consistency deviation (ξ) were derived using the BWM minimax optimization model in Equation (3), subject to the stated consistency requirement [13].

$$\min_{\omega^*,\xi} \max_j \left\{ \left| \frac{\omega_B}{\omega_j} - a_{Bj} \right|, \left| \frac{\omega_j}{\omega_W} - a_{jW} \right| \right\} \text{ subject to } \sum_{j=1}^{n} \omega_j = 1,\ \omega_j \geq 0 \tag{3}$$

Next, SAW normalizes the decision matrix X of size m × n, where m = 100 verified alternatives and n = 10 criteria. Each raw value x_ij is transformed into a normalized value r_ij between 0 and 1 [6], [12], [71], [72]. Benefit attributes use Equation (4), whereas cost attributes use the inverse normalization in Equation (5) [6], [12].

$$r_{ij} = \frac{x_{ij}}{\max x_{ij}} \tag{4}$$

$$r_{ij} = \frac{\min x_{ij}}{x_{ij}} \tag{5}$$

The final preference score V_i for each prospective beneficiary is calculated by summing the products of normalized scores r_ij and the corresponding BWM criterion weights w_j, as shown in Equation (6) [6], [12].

$$V_i = \sum_{j=1}^{n} \omega_j \cdot r_{ij} \tag{6}$$

The alternatives are ordered from the highest to the lowest preference score and assigned to decile clusters 1–10 using the ranking formula in Equation (7).

$$\text{Decile}_i = \left\lceil \frac{\text{rank}_i}{N} \times 10 \right\rceil \tag{7}$$

Households classified in deciles 1–4 are labeled “Social Assistance Recipient (High Priority)” with a reported allocation of IDR 600,000 per household. Households in deciles 5–10 are labeled “Not Eligible / Not Prioritized.”

3.4 System Design and Implementation

The system architecture was designed using UML use-case, activity, sequence, and class diagrams based on separation of concerns, together with an entity–relationship diagram normalized to third normal form (3NF). The multi-tier backend was implemented using Node.js (version ≥20.0.0), Express.js, and TypeScript, enabling asynchronous, non-blocking I/O and type-safe matrix computations [44], [45]. The MySQL relational database contains 19 InnoDB tables organized into four clusters: (1) seven demographic and DSS tables, (2) four authentication and security-audit tables, (3) four complaints and violations tables, and (4) four interactive communication tables.

The frontend uses HTML5, CSS3, and Vanilla JavaScript with PWA capabilities [46], [74]. It integrates Leaflet.js for geotagging and spatial visualization across 18 subdistricts [48], [76], and WebSocket and WebRTC for live chat and voice communication [47], [75]. The system implements role-based access control (RBAC) with dual-gate routing for four user roles and tiered publication authorization on the Citizen Portal, as illustrated in Figure 1.

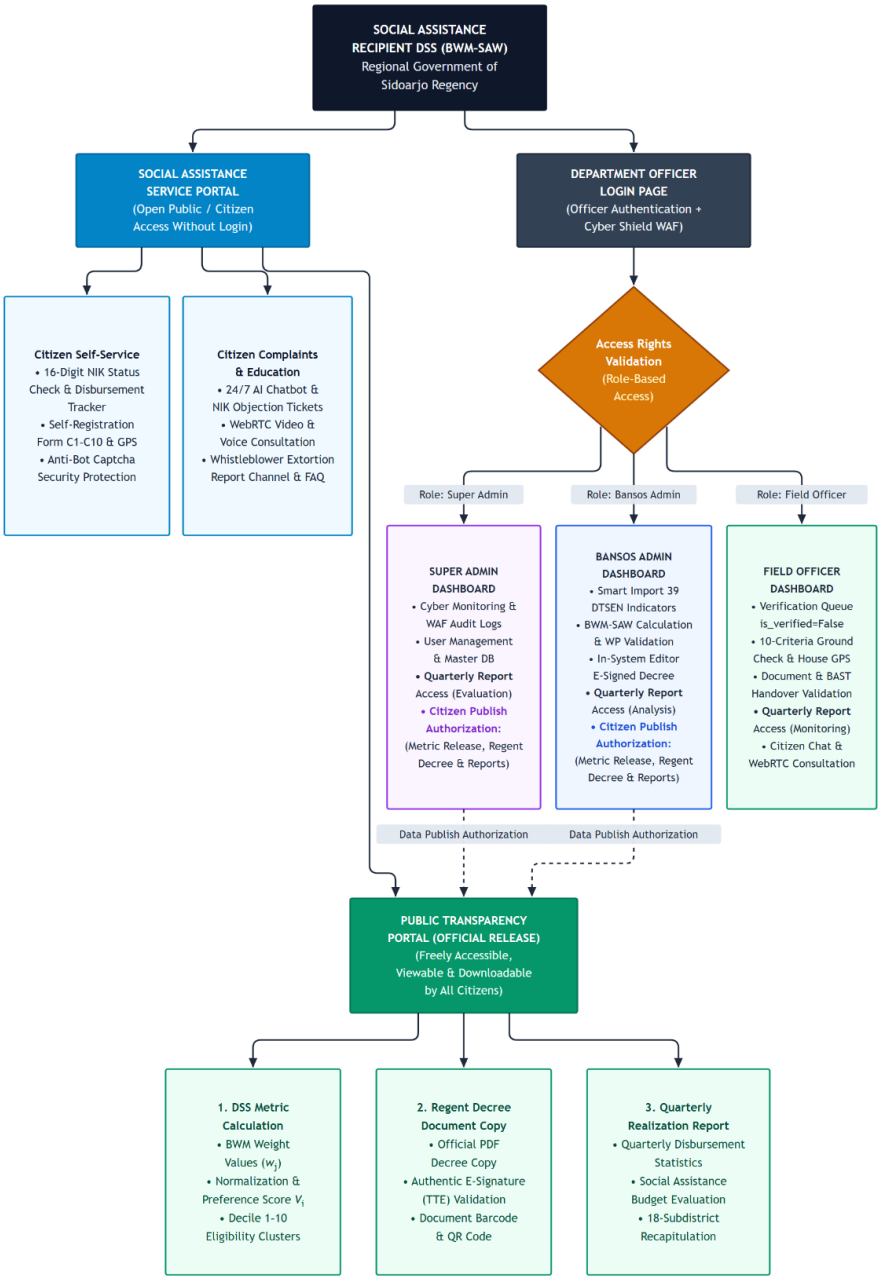


Figure 1. Navigation structure and process flow of the BWM–SAW decision support system

3.5 System Testing

System evaluation comprised four components. First, black-box testing used equivalence partitioning across eight modules and 18 scenarios to validate input–output behavior [49], [50], [77]. Second, manual BWM–SAW calculations were compared against application outputs. Third, SAW and WP rankings were compared using identical BWM weights for the 100-household dataset, with Spearman rank correlation used to assess agreement [51]–[55]. Fourth, 31 staff members of the Sidoarjo Social Affairs Office completed a ten-item UAT questionnaire on a five-point Likert scale [56], [57] and the ten-item SUS instrument [58]–[63], calculated using Equations (8) and (9).

$$\text{UAT Percentage (\%)} = \frac{\text{Obtained Score}}{\text{Maximum Possible Score}} \times 100\% \tag{8}$$

$$\bar{X}_{\text{SUS}} = \frac{1}{N}\sum_{j=1}^{N}\left(\left(\sum_{i\in\{1,3,5,7,9\}}(x_{ij}-1)+\sum_{i\in\{2,4,6,8,10\}}(5-x_{ij})\right)\times 2{,}5\right) \tag{9}$$

4. RESULTS AND DISCUSSION

4.1 System Implementation

The social assistance DSS website for BPNT and PKH in Sidoarjo Regency was implemented using Node.js, Express.js, and TypeScript [44], [45], a 19-table MySQL database, and a PWA frontend [46], [74]. Staff access is protected by CAPTCHA and a web application firewall (WAF). The Super Admin dashboard provides MySQL synchronization, WAF monitoring, system testing, and code-inspection functions.

The Admin dashboard includes five DSS control panels, four real-time analytical charts (including the reported IDR 600,000 per-household distribution), and a Leaflet GIS vulnerability map covering 18 subdistricts [48], [76]. Map indicators use red, yellow/orange, and green categories, as shown in Figure 2.

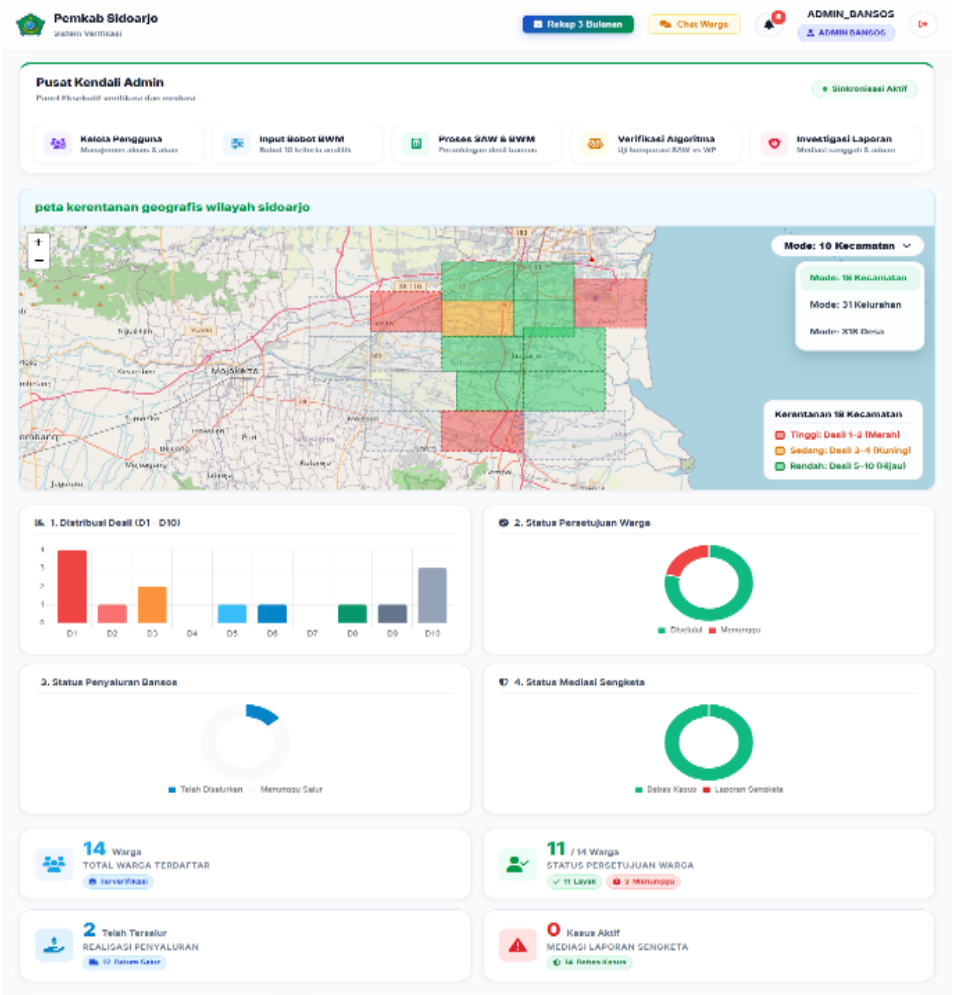


Figure 2. Admin dashboard and geographic vulnerability map across 18 subdistricts

The Officer dashboard excludes weight configuration to maintain independence in field verification. Its functions focus on recording the 16-digit national identification number (NIK), GPS geotagging, the C1–C10 questionnaire, and distribution evidence. The Citizen Portal supports NIK-based status checks, self-registration, FAQs, complaints, a chatbot, WebSocket live chat, and WebRTC calls [47], [75]. With reference to Indonesia's Personal Data Protection Law No. 27 of 2022, the in-system document editor supports a draft Regent's Decree No. 188/460/438.5.12/2026, NIK masking, and BSrE BSSN electronic signatures. Quarterly reports may be published by designated staff, while publication of the decree and DSS metrics requires Admin or Super Admin authorization.

4.2 Implementation of the BWM and SAW Methods

During BWM weighting [13], [20], economic conditions (C1) were selected as the Best criterion and gender (C4) as the Worst. Table 2 presents the Best-to-Others and Others-to-Worst comparison vectors on the 1–9 scale, together with the reported optimized weights.

Table 2. Best-to-Others and Others-to-Worst comparison vectors and reported BWM weights

Comparison Vector	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Scale / Consistency
Best-to-Others (Best = C1)	1	2	3	9	2	4	3	2	5	3	1–9 scale ($a_{BW} = a_{14} = 9$)
Others-to-Worst (Worst = C4)	9	7	6	1	7	5	6	7	4	6	*1–9 scale* ($a_{W4} = 1$)
Reported Optimal Weights	**0.23**	**0.16**	**0.11**	**0.05**	**0.14**	**0.07**	**0.09**	**0.10**	**0.03**	**0.02**	$\sum w_j = 1.00$ $\xi = 0.042$ $(CI = 5.23)$ $CR = \xi/CI = 0.0080$

The minimax linear optimization of BWM yielded an optimal consistency deviation of $\xi = 0.042$. For a maximum comparison value of $a_{BW} = 9$, the corresponding Consistency Index is $CI = 5.23$ [13], [20]. Consequently, the Consistency Ratio is determined as:

$$CR = \frac{\xi}{CI} = \frac{0.042}{5.23} = 0.0080$$

Because $CR = 0.0080 \ll 0.10$, the derived comparison vectors exhibit outstanding pairwise transitivity and mathematical consistency. Economic Conditions (C1) secured the highest priority weight ($w_1 = 0.23$), followed by Asset Ownership (C2: 0.16), Dependents (C5: 0.14), Age of Household Head (C3: 0.11), and Housing Conditions (C8: 0.10). Educational Attainment (C9: 0.03) and Health Conditions (C10: 0.02) obtained lower weights than Gender (C4: 0.05) because education and severe health infirmities are primarily mitigated by external national social safety nets (such as Indonesia Pintar and BPJS PBI), whereas local direct assistance (BPNT and PKH) emphasizes direct economic insolvency and asset poverty.

Table 3. Population extrema (100 households), matrix normalization, and preference score calculations for A1 and A2

Code	Minimum	Maximum	Raw A1	Raw A2	r(A1)	r(A2)	w	w·r(A1)	w·r(A2)
C1	554,985.47	4,936,889.81	617,872.28	780,388.93	0.8982	0.7112	0.23	0.2066	0.1636
C2	1,045,986	49,566,543	7,664,704	2,417,504	0.1365	0.4327	0.16	0.0218	0.0692
C3	21	75	52	73	0.6933	0.9733	0.11	0.0763	0.1071
C4	1	2	2	1	1.0000	0.5000	0.05	0.0500	0.0250
C5	0	5	3	4	0.6000	0.8000	0.14	0.0840	0.1120
C6	1	4	4	1	1.0000	0.2500	0.07	0.0700	0.0175
C7	0 (score 1)	5	0 (score 1)	0 (score 1)	0.2000	0.2000	0.09	0.0180	0.0180
C8	1	3	3	3	1.0000 / 0.3333*	1.0000 / 0.3333*	0.10	0.1000 / 0.0333*	0.1000 / 0.0333*
C9	1	3	2	1	0.5000	1.0000	0.03	0.0150	0.0300
C10	1	2	2	1	1.0000 / 0.5000*	0.5000 / 1.0000*	0.02	0.0200 / 0.0100*	0.0100 / 0.0200*
Total	–	–	–	–	Decree / audit*	Decree / audit*	1.00	0.6617 / 0.5850*	0.6524 / 0.5957*

Note: Raw household scores refer to the official social assistance verification dataset under document No. 188/460/438.5.12/2026. Primary values reflect Scenario 1 (Administrative Regent's Decree Baseline), where

Housing Conditions (C8) and Health Conditions (C10) are processed as benefit attributes ($r_{ij} = x_{ij} / \max x_{ij}$) to reward structural vulnerability. Values marked with an asterisk (*) designate Scenario 2 (Mathematical Audit & WP Sensitivity Matrix), wherein C8 and C10 were audited under cost/inversion scaling $\left(r_{ij} = min\, x_{ij}/x_{ij}\right)$ to rigorously evaluate algorithmic rank robustness.

The preference scores of the 100 households were mapped to decile groups 1–10. Table 4 displays the 15 highest-ranked candidates listed in the appendix of document No. 188/460/438.5.12/2026.

Table 4. Top 15 prospective social assistance beneficiaries ranked using BWM–SAW

Rank	Masked NIK	Applicant Name	Final Score	Decile Cluster	Priority Category	Eligibility / Allocation
1	351579******9963	Renda Hidayah	0.6617	Decile 1	High Priority	Selected (IDR 600,000)
2	351567******7890	Siti Setiawan	0.6524	Decile 1	High Priority	Selected (IDR 600,000)
3	351547******5068	Rizky Pratama	0.6024	Decile 1	High Priority	Selected (IDR 600,000)
4	351564******2744	Joko Ningsih	0.5980	Decile 1	High Priority	Selected (IDR 600,000)
5	351575******3843	Endang Hidayah	0.5966	Decile 1	High Priority	Selected (IDR 600,000)
6	351543******2506	Rizky Lestari	0.5862	Decile 1	High Priority	Selected (IDR 600,000)
7	351578******0302	Gilang Setiawan	0.5837	Decile 1	High Priority	Selected (IDR 600,000)
8	351596******8709	Zuhruf Wati	0.5621	Decile 1	High Priority	Selected (IDR 600,000)
9	351593******6093	Khofifah Handayani	0.5544	Decile 1	High Priority	Selected (IDR 600,000)
10	351558******1077	Wahyu Putra	0.5441	Decile 1	High Priority	Selected (IDR 600,000)
11	351564******8263	Surya Rahayu	0.5410	Decile 1	High Priority	Selected (IDR 600,000)
12	351524******2574	Ahmad Kusuma	0.5366	Decile 1	High Priority	Selected (IDR 600,000)
13	351528******8030	Putri Lestari	0.5366	Decile 1	High Priority	Selected (IDR 600,000)
14	351599******0954	Renda Astuti	0.5313	Decile 1	High Priority	Selected (IDR 600,000)
15	351564******6848	Dimas Wati	0.5188	Decile 1	High Priority	Selected (IDR 600,000)

According to Table 4, Renda Hidayah ranked first with a preference score of 0.6617, followed by Siti Setiawan (0.6524) and Rizky Pratama (0.6024), all classified in decile 1. Of the 100 verified households, 43 ranked from 1 to 43 were classified as priority recipients in deciles 1–4, with the lowest reported qualifying score of 0.4527 (Wahyu Wati). These households were assigned a reported allocation of IDR 600,000 each under the combined BPNT–PKH assessment. The remaining 57 households, ranked 44–100, were placed in deciles 5–9 and categorized as non-priority (IDR 0) in accordance with the study's DTSEN-based selection framework [4], [5].

4.3 Computational Verification

Computational verification compared normalized values and final preference scores generated by the buildFullSawReport() function in server/spk_engine.ts with manual calculations. The reported comparison showed 100% agreement to four decimal places for the values presented in the Regent's Decree appendix and the matrix audit report. This result indicates agreement between the implemented TypeScript calculations and the study's manual computation procedure [44], [45].

4.4 Black-Box Testing, UAT, and SUS

Functional black-box testing covered eight principal modules and 18 test scenarios to assess the system's expected input–output behavior [49], [50], [77]. The results are summarized in Table 5.

Table 5. Summary of black-box test results

No	Tested Module	User Role	Scenarios	Passed	Pass Rate
1.	Login (authentication, CAPTCHA, WAF)	Super Admin, Admin, Officer	2	2	100%
2.	Resident records (geotagging, Smart Import of 39 DTSEN indicators, MySQL, WebRTC)	Admin, Officer, Citizen	4	4	100%
3.	Resident verification (ground-check approval/cancellation)	Admin, Officer	2	2	100%
4.	BWM calculation (comparison vectors and weight optimization)	Super Admin, Admin	2	2	100%
5.	SAW calculation (matrix normalization and preference scores)	Super Admin, Admin	2	2	100%
6.	Ranking results (Smart Export, Regent's Decree editor, Super Admin module)	Super Admin, Admin	4	4	100%

7.	System activity log (audit trail)	Super Admin, Admin	1	1	100%
8.	Algorithm comparison test (SAW versus WP verification)	Super Admin, Admin	1	1	100%
Total			**18**	**18**	**100%**

All 18 black-box scenarios in Table 5 passed, representing a 100% pass rate for the tested functionality. User acceptance and usability were subsequently evaluated with 31 respondents from the Sidoarjo Social Affairs Office, comprising Muhammad Wildan, S.S., the division head, and 30 operational staff [56]–[63]. Table 6 summarizes the ten UAT items (P1–P10) and the results of the ten standard SUS items (Q1–Q10).

Table 6. UAT and SUS results from 31 respondents at the Sidoarjo Social Affairs Office

UAT Code	UAT Assessment Aspect (Maximum Score = 155)	UAT Score	UAT %	SUS Code	Standard SUS Item (Likert 1–5)	Item Scoring	Summary Statistics (31 Respondents)
P1	Ease of using the social assistance DSS	129	83.23%	Q1	I think that I would like to use this system frequently (positive)	$x_i - 1$	Highest score (division head): 82.5 (Grade A / Excellent)
P2	Clarity of dashboard interface and navigation	129	83.23%	Q2	I found the system unnecessarily complex (negative)	$5 - x_i$	Range among 30 staff: 70.0–77.5
P3	Functionality of resident records and household geotagging	128	82.58%	Q3	I thought the system was easy to use (positive)	$x_i - 1$	Total adjusted contribution: 898 points
P4	Ease of ground-check verification and validation	128	82.58%	Q4	I think that I would need technical support to use this system (negative)	$5 - x_i$	Mean adjusted contribution: 28.97 points
P5	Structure and objectivity of BWM weighting	130	83.87%	Q5	I found that the various functions were well integrated (positive)	$x_i - 1$	Cumulative SUS score: 2,245.0
P6	Smoothness and accuracy of SAW execution	128	82.58%	Q6	I thought there was too much inconsistency in this system (negative)	$5 - x_i$	Mean final SUS score: 72.42
P7	Clarity of GIS social-vulnerability maps	127	81.94%	Q7	I would imagine that most people would learn to use this system quickly (positive)	$x_i - 1$	Usability interpretation: Acceptable
P8	Effectiveness of live chat and complaint handling	127	81.94%	Q8	I found the system very cumbersome to use (negative)	$5 - x_i$	Grade scale: Grade B
P9	Quality of Excel exports and Regent's Decree printouts	127	81.94%	Q9	I felt very confident using the system (positive)	$x_i - 1$	Adjective rating: Good
P10	Overall system suitability for Sidoarjo Regency	127	81.94%	Q10	I needed to learn many things before I could get going with this system (negative)	$5 - x_i$	Benchmark comparison: Above 68.0
Total	**Total UAT score: 1,280 / 1,550**	**1,280**	**82.58% (Very Feasible)**	**Total**	**Ten standard statements (odd/even scoring)**	$\sum \times 2.5$	$\bar{X}_{SUS} = 2,245.0/31 = 72.42$

The 31 respondents yielded a total UAT score of 1,280 out of a possible 1,550, equivalent to 82.58%. The division head provided a full score of 50/50 (100%), whereas the 30 operational staff recorded individual scores ranging from 78.0% to 92.0%. Based on the interpretation categories used in the study [56], [57], the overall UAT result falls in the 81%–100% range, classified as "Very Feasible" or "Highly Accepted." For SUS, the total adjusted contribution was 898 points, corresponding to a cumulative SUS score of 2,245.0 and a mean of 72.42. The highest individual score was 82.5 (Grade A) for the division head, while staff scores ranged from 70.0 to 77.5. Using the interpretive framework associated with Bangor et al. [61], Brooke [62], and Sauro and Lewis [63], the reported mean exceeds the frequently cited benchmark of 68.0 and is classified as Acceptable, Grade B, and Good.

The empirical UAT and SUS evaluation results carry significant practical implications for social assistance administration across Sidoarjo Regency. The overall UAT score of 82.58% (Very Feasible / Sangat Layak) affirms

that the system fulfills core municipal business processes—most notably in automating ground-check verifications, parsing 39 DTSEN indicators, locking GPS geotagging coordinates, and dynamically customizing the Regent's Decree without requiring manual software re-engineering. Furthermore, the System Usability Scale (SUS) score of 72.42 (Grade B, Good) comfortably exceeds the recognized global usability benchmark of 68.0. In operational practice, this demonstrates that the Progressive Web App (PWA) interface imposes a negligible cognitive burden on field enumerators and subdistrict officers. Field staff can rapidly learn and operate the mobile survey modules in low-bandwidth rural environments, verify applicant NIKs against municipal records in real time, and eliminate paper-based administrative latency, thereby significantly reducing inclusion and exclusion errors during municipal social safety net disbursements.

4.5 Comparison with the Conventional Process

Table 7 contrasts the previous conventional selection process with the proposed BWM–SAW web-based DSS for the Sidoarjo Regency Government.

Table 7. Comparison of conventional beneficiary selection and the BWM–SAW DSS

Assessment Aspect	Conventional Selection	BWM–SAW Decision Support System
Assessment basis	Manual assessment susceptible to assessor subjectivity	Mathematical evaluation using ten BWM-weighted core criteria and automatic mapping of 39 DTSEN indicators
Spatial verification	Not integrated with geographic coordinates	Household geotagging with Leaflet GIS and vulnerability mapping for 18 subdistricts
Public transparency	Citizens cannot readily see the basis for their decile assignment	NIK-based status checks, tiered publication of quarterly summaries, DSS metrics, and masked-NIK Regent's Decree documents; FAQs
Administrative flexibility	Changing report or decree formats requires time-consuming manual revisions	Smart Import/Export (.xlsx, .docx, .pdf) and an in-system Regent's Decree editor without source-code changes
Complaint services	In-person complaints require time and travel costs	Real-time chatbot, complaint tracking, live chat, and WebRTC calls without conventional call charges

4.6 Comparison with the Weighted Product (WP) Method

To assess the agreement and sensitivity of the decision results, SAW rankings were compared with those produced by WP for the same 100 verified households using identical BWM weights [51]–[55]. Table 8 presents the reported top-15 SAW–WP comparison from the DSS algorithm-comparison report, No. 188/460/438.5.12/2026.

Table 8. Reported ranking comparison between SAW and Weighted Product (WP)

Rank	Masked NIK	Applicant Name	SAW Score	SAW Rank	WP Score	WP Rank	Absolute Rank Shift (Δ)	Final Allocation Status
1	351567******7890	Siti Setiawan	0.5957	#1	0.0171	#1	0	High Priority (Decile 1)
2	351564******2744	Joko Ningsih	0.5914	#2	0.0163	#4	2	High Priority (Decile 1)
3	351575******3843	Endang Hidayah	0.5899	#3	0.0131	#14	11	High Priority (Decile 1)
4	351579******9963	Renda Hidayah	0.5850	#4	0.0153	#8	4	High Priority (Decile 1)
5	351543******2506	Rizky Lestari	0.5595	#5	0.0163	#5	0	High Priority (Decile 1)
6	351547******5068	Rizky Pratama	0.5457	#6	0.0159	#6	0	High Priority (Decile 1)

7	351596******8709	Zuhruf Wati	0.5354	#7	0.0110	#28	21	High Priority (Decile 1)
8	351578******0302	Gilang Setiawan	0.5271	#8	0.0114	#24	16	High Priority (Decile 1)
9	351593******6093	Khofifah Handayani	0.4977	#9	0.0093	#53	44	High Priority (Decile 1)
10	351558******1077	Wahyu Putra	0.4874	#10	0.0107	#32	22	High Priority (Decile 1)
11	351528******8030	Putri Lestari	0.4852	#11	0.0169	#2	9	High Priority (Decile 2)
12	351524******2574	Ahmad Kusuma	0.4831	#12	0.0140	#11	1	High Priority (Decile 2)
13	351564******6848	Dimas Wati	0.4815	#13	0.0120	#18	5	High Priority (Decile 2)
14	351557******9113	Wahyu Pratama	0.4798	#14	0.0139	#12	2	High Priority (Decile 2)
15	351539******4115	Evelyn Ningsih	0.4760	#15	0.0131	#15	0	High Priority (Decile 2)

Note: Data strictly represent the Mathematical Audit & Comparative Testing Matrix from the DSS algorithm-comparison report (No. 188/460/438.5.12/2026). The typographical score artifact for ranks 11–12 present in earlier working drafts has been rectified. All 15 candidates consistently reside within Deciles 1–2.

The 100-household comparison was reported to yield a strong positive Spearman correlation between SAW and WP rankings (r_s = 0.7357). In Table 8, Siti Setiawan ranked first under both methods (SAW = 0.5957; WP = 0.0171), while ranks 5, 6, and 15 were also unchanged. Other alternatives exhibited varying degrees of rank reversal.

Substantial ranking changes were observed for Khofifah Handayani (SAW rank 9 versus WP rank 53) and Zuhruf Wati (SAW rank 7 versus WP rank 28). The authors attribute these changes to the multiplicative nature of WP [51], [53], under which unfavorable cost ratios may affect aggregated scores [54], [55]. Because SAW aggregates normalized scores additively, it allows compensation between criteria [6], [53], [55]. These observations suggest different ranking sensitivities between the two methods; additional validation would be required to establish which method yields fairer or more accurate beneficiary selection.

A comparative analysis between Table 4 and Table 8 highlights the methodological demarcation between the two computational evaluations conducted in this research:

a. Administrative Decree Execution (Table 4) reflects the operational policy implemented in the local government DSS. Under this configuration, raw survey metrics for C8 (Housing Conditions) and C10 (Health Conditions) were evaluated as benefit criteria to prioritize households enduring substandard living quarters and chronic disabilities. This operational baseline placed Renda Hidayah at Rank 1 ($V_1 = 0.6617$) and Siti Setiawan at Rank 2 ($V_2 = 0.6524$).
b. Algorithmic Verification and WP Sensitivity Audit (Table 8) evaluates rank stability when C8 and C10 are processed under inverse cost scaling. Under this audit environment, Siti Setiawan achieved Rank 1 in both SAW ($V_2 = 0.5957$) and WP ($V_2 = 0.0171$), while Renda Hidayah shifted to Rank 4 ($V_1 = 0.5850$, WP Rank #8).
c. Crucially, despite local rank rearrangements, both computational configurations classified exactly the same 43 vulnerable households into priority Deciles 1–4, confirming that the BWM-SAW model exhibits high systemic reliability and stability in targeting deserving beneficiaries.

5. CONCLUSION

A web-based decision support system for BPNT and PKH beneficiary selection in Sidoarjo Regency was developed using Node.js, TypeScript, a 19-table MySQL database, PWA capabilities, and GIS-based geotagging across 18 subdistricts. The reported BWM weights ranged from 0.23 for economic conditions (C1) to 0.02 for health (C10), with a dynamic criteria engine mapping 39 DTSEN indicators. The SAW model identified 43 priority households in deciles 1–4 out of 100 evaluated households, with a reported allocation of IDR 600,000 per household and a maximum preference score of 0.6617.

The system passed all 18 black-box test scenarios, and manual-versus-application calculation checks were reported as fully consistent. UAT reached 82.58%, while the mean SUS score was 72.42 among 31 staff respondents, indicating favorable acceptance and usability under the study's evaluation categories. SAW and WP rankings showed a reported positive Spearman correlation ($r_s = 0.7357$), although some alternatives changed position substantially. Future work may address custom schema configuration, comparisons with TOPSIS, VIKOR, and fuzzy BWM, hash-based calculation versioning, live BSrE BSSN signing, integration with SIKS-NG/Disdukcapil/DTSEN APIs, and an offline-first mobile application for 322 villages and urban wards.

ACKNOWLEDGEMENTS

The authors thank the Sidoarjo Regency Social Affairs Office, particularly M. Bashori Alwi, S.Sos., M.AP., Muhammad Wildan, S.S., and the 30 operational staff for granting research access, providing data, and participating in system validation. The authors also acknowledge the Applied Informatics Management Study Program, Faculty of Vocational Studies, Universitas Negeri Surabaya, for its support during the study.

REFERENCES

[1] M. Y. M. Rema, Y. D. D. Y. Khwuta, and E. E. Sala, "Sistem pendukung keputusan pemilihan masyarakat penerima bantuan Program Keluarga Harapan metode SAW," *Jurnal Sains Teknologi dan Sistem Informasi*, vol. 2, no. 2, pp. 91–100, 2022. https://doi.org/10.54259/satesi.v2i2.1114

[2] H. Simangunsong and D. Sihotang, "The impact of economic conditions on social assistance programs and poverty alleviation," *Law and Economics*, vol. 17, no. 2, pp. 73–91, 2023. https://doi.org/10.35335/laweco.v17i2.2

[3] Suprapto, Edora, and F. A. Pasaribu, "Sistem pendukung keputusan calon penerima program bantuan sosial (BANSOS) menggunakan metode Simple Additive Weighting (SAW)," *MALCOM: Indonesian Journal of Machine Learning and Computer Science*, vol. 4, no. 1, pp. 188–197, 2024. https://doi.org/10.57152/malcom.v4i1.1057

[4] W. Setyanto, "Data tunggal sosial ekonomi, penurunan kemiskinan, dan pembangunan berkelanjutan: Pengalaman Indonesia," *KRITIS: Jurnal Ilmu Sosial dan Humaniora*, vol. 34, no. 1, pp. 266–284, 2025. https://doi.org/10.24246/kritis.v34i1p266-284

[5] H. Cipta, "Integrasi data kemiskinan menuju Cilegon sejahtera," *Jurnal Kebijakan Pembangunan Daerah*, vol. 9, no. 1, pp. 61–77, 2025. https://doi.org/10.56945/jkpd.v9i1.367

[6] A. M. Dirgayusari, I. G. E. Dharsika, and N. M. A. M. Diani, "The decision support system for determining poor families who receive BLT uses the Simple Additive Weighting (SAW) method case study: Batubulan Village Perbekel Office," *Berkala Sainstek*, vol. 13, no. 1, pp. 25–31, 2025. https://doi.org/10.19184/bst.v13i1.48772

[7] H. Taherdoost and M. Madanchian, "Multi-Criteria Decision Making (MCDM) methods and concepts," *Encyclopedia*, vol. 3, pp. 77–87, 2023. https://doi.org/10.3390/encyclopedia3010006

[8] W. Widodo and I. P. Gunawan, "Implementation of Multi-Attribute Utility Theory method for selecting educational scholarship aid recipients," *Journal of Electrical Engineering and Computer Sciences*, vol. 8, no. 2, pp. 123–132, 2023.

[9] S. R. Nanjarwati, R. Firliana, T. Andriyanto, and Sucipto, "Sistem pendukung keputusan penerima PKH menggunakan metode SAW," *Jurnal Qua Teknika*, vol. 13, no. 2, pp. 105–115, 2023. https://doi.org/10.35457/quateknika.v13i2.2989

[10] N. A. Zakiah and T. Setiadi, "Rekomendasi komprehensif penerima bantuan PKH menggunakan sistem pendukung keputusan dengan metode SAW berbasis web," *Jurnal Informatika Teknologi dan Sains (JINTEKS)*, vol. 6, no. 3, pp. 757–766, 2024. https://doi.org/10.51401/jinteks.v6i3.4735

[11] A. Panggabean, Siswanto, and Sapri, "Sistem pendukung keputusan pemberian bantuan kepada nelayan menggunakan metode Simple Additive Weighting (SAW)," *Jurnal Media Infotama*, vol. 20, no. 2, pp. 556–562, 2024. https://doi.org/10.37676/jmi.v20i2.6516

[12] G. S. Mahendra, "SPK penerima bantuan sosial menggunakan metode BWM-SAW," *SINTECH Journal*, vol. 5, no. 2, pp. 181–190, 2022. https://doi.org/10.31598/sintechjournal.v5i2.983

[13] G. Haseli, R. Sheikh, J. Wang, H. Tomaskova, and E. B. Tirkolaee, "A novel approach for group decision making based on the Best-Worst Method (G-BWM): Application to supply chain management," *Mathematics*, vol. 9, no. 16, p. 1881, 2021. https://doi.org/10.3390/math9161881

[14] L. P. I. Kharisma, S. Kusmayanti, and Y. Sutaryana, "Sistem pendukung keputusan penerimaan bantuan Program Keluarga Harapan (PKH) di Desa Lekor menggunakan metode Simple Additive Weighting (SAW) berbasis web," *TEKNIMEDIA*, vol. 4, no. 2, pp. 235–242, 2023. https://doi.org/10.46764/teknimedia.v4i2.154

[15] A. Rizaldy, "Perancangan sistem pendukung keputusan penerima bantuan sosial menggunakan metode Simple Additive Weighting (SAW) berbasis web," *OKTAL: Jurnal Ilmu Komputer dan Science*, vol. 1, no. 4, pp. 362–372, 2022.

[16] H. Koornneef, W. J. C. Verhagen, and R. Curran, "A web-based decision support system for aircraft dispatch and maintenance," *Aerospace*, vol. 8, no. 6, pp. 154, 2021. https://doi.org/10.3390/aerospace8060154

[17] A. M. A. Sharabiani and S. M. Mousavi, "A web-based decision support system for project evaluation with sustainable development considerations based on two developed Pythagorean fuzzy decision methods," *Sustainability*, vol. 15, no. 23, pp. 16477, 2023. https://doi.org/10.3390/su152316477
[18] R. K. Dhurkari, "MCDM methods: Practical difficulties and future directions for improvement," *RAIRO Operations Research*, vol. 56, pp. 2221–2233, 2022. https://doi.org/10.1051/ro/2022060
[19] S. K. Sahoo and S. S. Goswami, "A comprehensive review of Multiple Criteria Decision-Making (MCDM) methods: Advancements, applications, and future directions," *Decision Making Advances*, vol. 1, no. 1, pp. 25–48, 2023. https://doi.org/10.31181/dma1120237
[20] G. Haseli et al., "An extension of the best-worst method based on the spherical fuzzy sets for multi-criteria decision-making," *Granular Computing*, vol. 9, pp. 40, 2024. https://doi.org/10.1007/s41066-024-00462-w
[21] I. Arief, D. Fatrias, F. Jie, and Armijal, "Innovative multi-criteria decision-making approach for supplier evaluation: Combining TLF, Fuzzy BWM, and VIKOR," *Jurnal Optimasi Sistem Industri*, vol. 22, no. 2, pp. 179–196, 2023. https://doi.org/10.25077/josi.v22.n2.p179-196.2023
[22] T. Atan and G. T. Temur, "A unified multiplicative group Best-Worst Method with a new assessment approach for dissimilar markets," *Informatica*, vol. 34, no. 3, pp. 465–489, 2023. https://doi.org/10.15388/23-INFOR528
[23] E. P. S. Parapat, K. Sinaga, E. Sirait, and A. S. Manalu, "Decision support system for selecting social assistance recipients using the Preference Selection Index method," *Iota*, vol. 3, no. 4, 2023. https://doi.org/10.31763/iota.v3i4.662
[24] E. G. Wahyuni, R. T. Wahyudi, and L. F. Fadhillah, "The role of a decision support system in enhancing the management of sexual violence cases in higher education using the SAW method through an Android-based application," *Jurnal Teknik Informatika (JUTIF)*, vol. 6, no. 3, pp. 1353–1372, 2025. https://doi.org/10.52436/1.jutif.2025.6.3.4761
[25] Sunardi, Riana, D. Sofian MZ, and Riniman, "Sistem pengambil keputusan penerima Program Keluarga Harapan berbasis web menggunakan metode SAW," *Jurnal Sistem Informasi TGD*, vol. 4, no. 3, pp. 468–477, 2025. https://doi.org/10.53513/jursi.v4i3.11020
[26] F. Anggriawan, W. R. Maya, and Z. Panjaitan, "Sistem pendukung keputusan dalam menentukan penerima bantuan Program Keluarga Harapan menggunakan metode Simple Additive Weighting (SAW)," *Jurnal Sistem Informasi TGD*, vol. 3, no. 6, pp. 825–833, 2024. https://doi.org/10.53513/jursi.v3i6.8620
[27] A. I. Shofyana, R. Indriati, and A. S. Wardani, "Implementasi metode SAW pada sistem seleksi Program Keluarga Harapan (PKH)," *Jurnal Sistem Informasi TGD*, vol. 4, no. 4, pp. 935–946, 2025. https://doi.org/10.53513/jursi.v4i4.11398
[28] L. A. Sulasmini and I. K. J. Arta, "Sistem pendukung keputusan seleksi penerima Bantuan Pangan Non Tunai untuk keluarga kurang mampu di Desa Sepang dengan metode Simple Additive Weighting," *Jurnal Manajemen dan Teknologi Informasi*, vol. 12, no. 2, pp. 65–75, 2022. https://doi.org/10.5281/zenodo.7177860
[29] L. Riyanti, G. Ali, and Amril, "Sistem pendukung keputusan penerima Program Keluarga Harapan (PKH) dengan metode Simple Additive Weighting (SAW)," *Jurnal Sistim Informasi dan Teknologi*, vol. 4, no. 4, pp. 186–191, 2022. https://doi.org/10.37034/jsisfotek.v4i4.177
[30] M. A. An'syah and A. P. Widyasari, "Implementasi metode SAW pada sistem pendukung keputusan seleksi penerima bantuan sembako masyarakat Desa Banyuurip," *Jurnal Ilmiah Intech: Information Technology Journal of UMUS*, vol. 6, no. 1, pp. 14–24, 2024. https://doi.org/10.46772/intech.v6i1.1335
[31] P. Rifasya, U. Aryanti, M. T. Anwar, and D. Atmoko, "Sistem pendukung keputusan pemilihan penerima bantuan sosial menggunakan metode Simple Additive Weighting," *Jurnal Dimamu*, vol. 4, no. 1, pp. 97–108, 2024. https://doi.org/10.32627/dimamu.v4i1.1329
[32] M. F. Wajdi A and M. Tandililing, "Implementasi metode Research and Development (R & D) pada aplikasi pengelolaan arsip," *Progres*, vol. 14, no. 1, pp. 33–40, 2022. https://doi.org/10.56708/progres.v14i1.320
[33] L. Afriani, Mutmainnah, and Sunarni, "Understanding the design of Research and Development methods in the field of education," *International Journal of Education and Social Science*, vol. 6, no. 1, 2025. https://doi.org/10.56371/ijess.v6i1.333
[34] A. H. Iskandar, A. F. Suja'ie, and I. Agusta, "Redesigning consolidated data for handling extreme poverty in rural areas based on SDGs Desa," *Journal of Community Positive Practices*, vol. 23, no. 1, pp. 96–115, 2023. https://doi.org/10.35782/JCPP.2023.1.08
[35] P. Fitria, "Assets and poverty status dynamics in 5 main regions in Indonesia," *Economic Journal of Emerging Markets*, vol. 9, no. 1, pp. 104–113, 2017. https://doi.org/10.20885/ejem.vol9.iss1.art11
[36] N. Gusmastuti and D. Widyawati, "The effect of social assistance on the health conditions of the elderly case study analysis of the National Social and Economic Survey," *Jurnal Ekonomi dan Statistik Indonesia*, vol. 4, no. 1, pp. 1–12, 2024. https://doi.org/10.11594/jesi.04.01.01
[37] G. H. P. Juwita, "The effect of credit on female-headed households welfare in Indonesia," *Jurnal Wanita dan Keluarga*, vol. 5, no. 2, pp. 111–134, 2024. https://doi.org/10.22146/jwk.14715.
[38] A. Andhini, A. Amelia, A. Antika, L. Harianja, and S. R. Andani, "Evaluasi kelayakan penerima bantuan sosial berdasarkan penghasilan dan jumlah tanggungan dengan pendekatan Fuzzy Mamdani," *Jurnal Riset Sistem Informasi dan Aplikasi Komputer (JRSIKOM)*, vol. 1, no. 2, pp. 67–78, 2025. https://doi.org/10.180997/jrsikom.v1i2.59
[39] N. S. Oktavianti, N. A. Aufahayu, G. S. Ramadhan, and A. E. Lathifa, "Pengaruh pendidikan, pekerjaan, status perkawinan, dan pendapatan terhadap pemberian dana bantuan Covid-19 di Kelurahan Panjang Kota Magelang," *Jurnal Ilmiah Manajemen, Ekonomi Bisnis, Kewirausahaan (EKONOMIKA45)*, vol. 11, no. 1, 2023. https://doi.org/10.30640/ekonomika45.v11i1.1901
[40] V. Sidharta, D. P. Lubis, S. Sarwoprasodjo, and K. B. Seminar, "Decision making in ambiguous situations: Determining recipients of cash social assistance in Indonesia," *Multidisciplinary Science Journal*, 2024. https://doi.org/10.31893/multiscience.2025278

[41] E. Herawati, S. Suparjo, and R. Lestari, "Housing regulations for low-income people in Indonesia," *International Journal of Environmental, Sustainability and Social Science*, vol. 4, no. 1, pp. 240–249, 2023. https://doi.org/10.38142/ijesss.v4i1.499
[42] A. A. Haidir and N. P. W. Setyari, "Indonesia social progress: The role of access to basic education in escaping from poverty trap," *Jurnal Ekonomi & Studi Pembangunan*, vol. 24, no. 2, pp. 428–457, 2024. https://doi.org/10.18196/jesp.v24i2.19810
[43] R. Aditya and F. Amalia, "The effects of socioeconomic status on health behaviors and outcomes among adolescents," *International Journal of Health and Social Behavior*, vol. 1, no. 1, pp. 11–15, 2024. https://doi.org/10.62951/ijhsb.v1i1.148
[44] A. A. Smirnov and E. A. Podolskiy, "A comparative analysis of the performance of JavaScript code execution environments: Node.js, Deno and Bun," *Programmnye Sistemy i Vychislitel'nye Metody*, no. 4, pp. 1–12, 2024. https://doi.org/10.7256/2454-0714.2024.4.72206
[45] D. Drzewiecki and M. Miłosz, "Comparative analysis of JavaScript runtime environments," *Journal of Computer Sciences Institute*, vol. 36, pp. 296–302, 2025. https://doi.org/10.35784/jcsi.7512
[46] H. Hanifan and I. N. Fajri, "Analisis dan implementasi Progressive Web App (PWA) serta fitur notifikasi pada sistem informasi pendaftaran volunteer VolHub," *Information System Journal (INFOS)*, vol. 7, no. 2, pp. 104–117, 2024. https://doi.org/10.24076/infosjournal.2024v7i02.1986
[47] A. Chodorek and R. R. Chodorek, "Web real-time communications-based unmanned-aerial-vehicle-borne Internet of Things and stringent time sensitivity: A case study," *Sensors*, vol. 25, no. 2, pp. 524, 2025. https://doi.org/10.3390/s25020524
[48] O. Arifin and A. R. Supriyatna, "Sistem informasi geografis untuk pemetaan lahan kakao menggunakan Leaflet Js dan Geojson," *Jurnal Teknoinfo*, vol. 17, no. 1, pp. 364–371, 2023. https://doi.org/10.33365/jti.v17i1.2397
[49] M. N. Huda, M. Burhan, A. Satibi, H. A. Pradita, A. Saifudin, and I. Kusyadi, "Implementasi Black Box Testing pada aplikasi sistem kasir dengan menggunakan teknik Equivalence Partitions," *Jurnal Teknologi Sistem Informasi dan Aplikasi*, vol. 5, no. 2, pp. 120–127, 2022. https://doi.org/10.32493/jtsi.v5i2.17645
[50] Y. F. Putri, A. B. P. Irianto, and S. Sharma, "Comparison of automatic and manual regression testing on mobile application health technology with Black Box Testing method," *Indonesian Journal of Information Systems (IJIS)*, vol. 7, no. 2, pp. 218–230, 2025. https://doi.org/10.24002/ijis.v7i2.6850
[51] C. Rizal, S. R. Siregar, S. Supiyandi, S. Armasari, and A. Karim, "Penerapan metode Weighted Product (WP) dalam keputusan rekomendasi pemilihan manager penjualan," *Building of Informatics, Technology and Science (BITS)*, vol. 3, no. 3, pp. 312–316, 2021. https://doi.org/10.47065/bits.v3i3.1094
[52] P. M. D. Setiawan, R. Hardianto, and R. Prawiro, "Design of decision support system in determining maintenance priority using Weighted Product (WP) method," *Journal of Computer Science and Information Technology*, vol. 11, no. 1, pp. 6–12, 2025. https://doi.org/10.35134/jcsitech.v11i1.115
[53] Jovanica and E. Dazki, "Komparasi metode Simple Additive Weighting (SAW) dengan Weighted Product (WP) untuk penilaian tenaga kerja Indonesia," *JSiI (Jurnal Sistem Informasi)*, vol. 9, no. 2, pp. 132–140, 2022. https://doi.org/10.30656/jsii.v9i2.5066
[54] Rayendra, "Perbandingan metode Simple Additive Weighting (SAW) dan Weight Product (WP) dalam menentukan mustahiq zakat," *Journal of Information System Research (JOSH)*, vol. 5, no. 2, pp. 498–508, 2024. https://doi.org/10.47065/josh.v5i2.4646
[55] R. A. Fazri, "Perbandingan Simple Additive Weighting dan Weighted Product pada keputusan pemberian bantuan (Desa Cisarua)," *JATISI (Jurnal Teknik Informatika dan Sistem Informasi)*, vol. 8, no. 1, pp. 273–286, 2021. https://doi.org/10.35957/jatisi.v8i1.674
[56] Aliyah, N. Hartono, and A. A. Muin, "Penggunaan User Acceptance Testing (UAT) pada pengujian sistem informasi pengelolaan keuangan dan inventaris barang," *Switch: Jurnal Sains dan Teknologi Informasi*, vol. 3, no. 1, pp. 84–100, 2024. https://doi.org/10.62951/switch.v3i1.330
[57] S. R. Ramadhani and M. F. Afriyansyah, "Optimalisasi dan evaluasi User Acceptance dan usability dengan penerapan prototyping pada aplikasi manajemen produk dan pesanan," *Jurnal Komputer Terapan*, vol. 10, no. 2, pp. 131–141, 2024 https://doi.org/10.35143/jkt.v10i2.6421
[58] R. Anrahvi, N. Pratama, and S. Stevani, "Penerapan metode System Usability Scale (SUS) dalam mengukur kepuasan mahasiswa terhadap website direktori akademik," *Indonesian Journal of Business Economics and Management*, vol. 3, no. 2, pp. 74–80, 2024. https://doi.org/10.57152/ijbem.v3i2.2020
[59] S. R. Arifin, "System Usability Scale (SUS) implementation in Ruang Baca Virtual – UT Library," *Matrix: Jurnal Manajemen Teknologi dan Informatika*, vol. 14, no. 1, pp. 1–8, 2024. https://doi.org/10.31940/matrix.v14i1.1-8
[60] J. Romadoni, H. A. Makie, M. F. Ridhani, and M. Hidayat, "Evaluasi tingkat usability sistem informasi perpustakaan berbasis website menggunakan System Usability Scale (SUS)," *JUKOMIKA (Jurnal Ilmu Komputer dan Informatika)*, vol. 8, no. 2, pp. 125–129, 2025. https://doi.org/10.54650/jukomika.v8i2.624
[61] A. Bangor, P. T. Kortum, and J. T. Miller, "An empirical evaluation of the System Usability Scale," *International Journal of Human-Computer Interaction*, vol. 24, no. 6, pp. 574–594, 2008. https://doi.org/10.1080/10447310802205776
[62] J. Brooke, "SUS: A 'quick and dirty' usability scale," in *Usability Evaluation in Industry*, P. W. Jordan, B. Thomas, B. A. Weerdmeester, and I. L. McClelland, Ed. London: Taylor & Francis, 1996, pp.189–194. https://doi.org/10.1201/9781498710411-35
[63] J. Sauro and J. R. Lewis, *Quantifying the User Experience: Practical Statistics for User Research*. Waltham: Morgan Kaufmann, 2012. https://doi.org/10.1016/C2010-0-65192-3
[64] F. Ibrahim, T. R. Agus, and N. W. W. Sari, "Identifikasi metode pengembangan sistem informasi di Indonesia: A Systematic Literature Review," *METIK Jurnal*, vol. 5, no. 1, pp. 47–54, 2021. https://doi.org/10.47002/metik.v5i1.215

[65] M. S. A. Khannan, A. E. Tontowi, M. K. Herliansyah, and A. Sudiarso, "New product development method trends and future research: A Systematic Literature Review," *Jurnal Teknik Industri*, vol. 23, no. 1, pp. 11–24, 2021. https://doi.org/10.9744/jti.23.1.11-24
[66] D. S. Perbawa, "Sistem rekomendasi penerima bantuan Program Indonesia Pintar menggunakan Multi Criteria Decision Making," *Jurnal Ilmiah FIFO*, vol. 15, no. 2, pp. 115–126, 2023. https://doi.org/10.22441/fifo.2023.v15i2.003
[67] R. Y. Simanullang, Melisa, and Mesran, "Sistem pendukung keputusan penerima bantuan Covid-19 menggunakan metode Simple Additive Weighting (SAW)," *TIN: Terapan Informatika Nusantara*, vol. 1, no. 9, pp. 451–458, 2021.
[68] I. Suryani, A. Sani, A. Budiyantara, and N. Nawaningtyas P, "Decision support system for outstanding students' selection using TOPSIS," *Jurnal Riset Informatika*, vol. 6, no. 2, pp. 109–118, 2024. https://doi.org/10.34288/jri.v6i2.285
[69] A. S. Dewi and B. Hendrik, "Optimalisasi penentuan penerima zakat melalui metode Simple Additive Weighting (SAW): Tinjauan sistematis," *Journal of Education Research*, vol. 5, no. 4, pp. 6614–6620, 2024. https://doi.org/10.37985/jer.v5i4.2008
[70] W. E. Sari, B. Muslimin, and S. Rani, "Perbandingan metode SAW dan TOPSIS pada sistem pendukung keputusan seleksi penerima beasiswa," *Jurnal SISFOKOM (Sistem Informasi dan Komputer)*, vol. 10, no. 1, pp. 52–58, 2021. https://doi.org/10.32736/sisfokom.v10i1.1027
[71] R. M. Ikhsanuddin, M. F. Ibadi, A. B. Subekti, and P. I. D. C. Wulan, "Seleksi calon penerima bantuan sosial menggunakan metode Simple Additive Weighting (SAW)," *Journal of Data Science Theory and Application*, vol. 2, no. 2, pp. 17–24, 2023. https://doi.org/10.32639/jasta.v2i2.486
[72] R. A. D. Rahmana and R. C. N. Santi, "Model aplikasi sistem penunjang keputusan penetapan penerima bantuan bedah rumah berbasis SAW," *Jutisi: Jurnal Ilmiah Teknik Informatika dan Sistem Informasi*, vol. 11, no. 2, pp. 445–458, 2022. https://doi.org/10.35889/jutisi.v11i2.882
[73] T. Soseco, I. Hidayah, and A. D. Rini, "Gender determinant on multidimensional poverty index: Evidence from Indonesia," *JSP: Jurnal Ilmu Sosial dan Ilmu Politik*, vol. 26, no. 2, pp. 137–151, 2022. https://doi.org/10.22146/jsp.69320
[74] G. L. Dewi, S. Tjandra, and Ricardo, "Pemanfaatan progressive web apps pada web akuntansi," *Teknika*, vol. 9, no. 1, pp. 38–47, 2020. https://doi.org/10.34148/teknika.v9i1.252
[75] A. Amin, L. O. Nur, and B. Aditya, "Perancangan core system pada sistem komunikasi darurat portabel berbasis webphone dan radio untuk daerah bencana," *Jurnal Nasional Sistem Telekomunikasi (JNST)*, vol. 3, no. 1, pp. 9–13, 2025. https://doi.org/10.25124/jnst.v3i1.9447
[76] A. C. Murti and A. P. R. Pinem, "Perancangan sistem pemetaan bantuan sosial berbasis web responsive," *Indonesian Journal of Technology, Informatics and Science (IJTIS)*, vol. 1, no. 2, pp. 49–54, 2020. https://doi.org/10.24176/ijtis.v1i2.4932
[77] C. D. Megawati, N. D. Miwa, and B. R. P. D. Palevi, "Black Box Testing of the 'Hybrid Engine' application using Boundary Value Analysis technique," *Sinkron: Jurnal dan Penelitian Teknik Informatika*, vol. 7, no. 2, pp. 923–938, 2023. https://doi.org/10.33395/sinkron.v8i2.12278
[78] Akmaludin, E. G. Sihombing, L. S. Dewi, Rinawati, and E. Arisawati, "Comparison of selection for employee position recommended MCDM-AHP, SMART and MAUT method," *Sinkron: Jurnal dan Penelitian Teknik Informatika*, vol. 7, no. 2, pp. 603–616, 2023. https://doi.org/10.33395/sinkron.v8i2.11843
[79] A. B. Bhatnagar and A. K. Srivastava, "Decision-making for capital budgeting with using Electre and Copras methods of multi-criteria," *Journal of Positive School Psychology*, vol. 6, no. 6, pp. 9609–9620, 2022.
[80] R. W. Dari, S. Sapriadi, N. A. Rahmi, P. A. W. Purnama, and I. Ilmawati, "Metode Multi Attribute Utility Theory (MAUT) untuk sistem pendukung keputusan pemilihan mobil bekas," *Jurnal KomtekInfo*, vol. 10, no. 2, pp. 73–79, 2023. https://doi.org/10.35134/komtekinfo.v10i2.378
[81] V. Fajri and M. Anwar, "Development of a multi-criteria decision support system for scholarship selection based on the Analytical Hierarchy Process (AHP) method," *Jurnal Teknik Komputer dan Informatika (JTeKI)*, vol. 1, no. 1, pp. 1–21, 2021. https://doi.org/10.24036/jteki.v1i1.1
[82] Y. Farida, H. N. Laili, A. T. Wibowo, L. N. Desinaini, and S. K. Sari, "Selecting the best-performing Low-Cost Carrier (LCC) airlines using Analytical Hierarchy Process (AHP) and Elimination et Choix Traduisant la Realite (ELECTRE)," *Journal of Information Systems Engineering and Business Intelligence*, vol. 8, no. 2, pp. 196–206, 2022. https://doi.org/10.20473/jisebi.8.2.196-206
[83] Fauziyah, D. Lestari, M. Rinayanti, and I. Zulkarnain, "Analisis keputusan multi-kriteria menggunakan metode TOPSIS untuk seleksi penerima beasiswa: Studi implementasi komprehensif," *Jurnal Sistem Informasi dan Teknologi (SITECH)*, vol. 8, no. 1, pp. 1–8, 2025. https://doi.org/10.24176/sitech.v8i1.15069
[84] R. D. Gunawan, M. W. Arshad, A. D. Wahyudi, R. R. Suryono, T. Widodo, and F. Ulum, "Modification of Additive Ratio Assessment method through distance-based weighting approach for optimizing assessment accuracy," *Paradigma*, vol. 27, no. 2, pp. 55–64, 2025. https://doi.org/10.31294/p.v27i2.8810
[85] C. L. Hwang and K. Yoon, *Multiple Attribute Decision Making: Methods and Applications: A State-of-the-Art Survey*. Berlin: Springer-Verlag, 1981. https://doi.org/10.1007/978-3-642-48318-9
[86] S. Hajduk, "Multi-criteria analysis in the decision-making approach for the linear ordering of urban transport based on TOPSIS technique," *Energies*, vol. 15, no. 1, pp. 274, 2022. https://doi.org/10.3390/en15010274
[87] S. M. Hatefi, H. Asadi, G. Shams, J. Tamošaitienė, and Z. Turskis, "Model for the sustainable material selection by applying integrated Dempster-Shafer evidence theory and Additive Ratio Assessment (ARAS) method," *Sustainability*, vol. 13, no. 18, pp. 10438, 2021. https://doi.org/10.3390/su131810438
[88] J. Immanuel, D. Andrian, and L. M. C. Wulandari, "Penerapan analisis multi kriteria dengan metode SMART dalam pemilihan pemasok pada UD. Bahtera," *Jurnal Terapan Teknik Industri*, vol. 3, no. 2, pp. 159–168, 2022. https://doi.org/10.37373/jenius.v3i2.275

[89] M. R. Khan, K. Ullah, Z. Ali, E. Rak, D. Pamucar, and Y. Shang, "The MCDM approach using Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) for intuitionistic fuzzy sets with AHP-based weight information," *International Journal of Fuzzy Systems*, 2025. https://doi.org/10.1007/s40815-025-02142-6
[90] R. V. Martono, "Analysis of the Analytical Hierarchy Process method to prioritize the development of industrial areas," *Jurnal Ekonomi Kreatif dan Manajemen Bisnis Digital*, vol. 4, no. 2, pp. 234–245, 2025. https://doi.org/10.55047/jekombital.v4i2.1028
[91] M. A. Prayogo, M. L. Jundillah, F. Ramanda, M. Shodiq, and R. Riendy, "Decision support system for selecting school health programs using COPRAS," *Sistem Pendukung Keputusan dengan Aplikasi*, vol. 4, no. 2, pp. 72–83, 2025. https://doi.org/10.55537/spk.v4i2.1304
[92] M. A. Ramadhan and M. Fakhriza, "Implementasi metode COPRAS dengan pembobotan Entropy dalam sistem seleksi Koordinator Sensus Kecamatan (Koseka)," *Jurnal Teknologi Sistem Informasi dan Aplikasi*, vol. 7, no. 3, pp. 1033–1042, 2024. https://doi.org/10.32493/jtsi.v7i3.41878
[93] R. binti Rasli, M. Mesran, F. Gea, and S. Setiawansyah, "Customer service recruitment decision support system applying MAUT method," *International Journal of Informatics and Data Science*, vol. 1, no. 2, pp. 77–87, 2024. https://doi.org/10.64366/ijids.v1i2.46
[94] K. Rogulj, J. Kilić Pamuković, and M. Ivić, "Hybrid MCDM based on VIKOR and Cross Entropy under rough neutrosophic set theory," *Mathematics*, vol. 9, no. 12, p. 1334, 2021. https://doi.org/10.3390/math9121334
[95] T. L. Saaty, *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. New York: McGraw-Hill, 1980.
[96] H. Taherdoost and M. Madanchian, "Analytic Network Process (ANP) method: A comprehensive review of applications, advantages, and limitations," *Journal of Data Science and Intelligent Systems*, vol. 1, no. 1, pp. 12–18, 2023. https://doi.org/10.47852/bonviewJDSIS3202885
[97] H. Taherdoost and M. Madanchian, "Using PROMETHEE method for Multi-Criteria Decision Making: Applications and procedures," *Iris Journal of Economics & Business Management*, vol. 1, no. 1, p. 000502, 2023. https://doi.org/10.33552/IJEBM.2023.01.000502
[98] L. A. Tanuwijaya, J. Fajrin, and I. K. Budastra, "Priority analysis of road infrastructure development in the Mandalika Special Economic Area: Application of Analytic Network Process (ANP) and TOPSIS methods," *Journal of World Science*, vol. 4, no. 2, pp. 228–238, 2025. https://doi.org/10.58344/jws.v4i2.1296
[99] S. R. Wicaksono, "Implementation of decision support in mutual fund investment selection using MOORA," *TIERS Information Technology Journal*, vol. 4, no. 1, pp. 66–72, 2023. https://doi.org/10.38043/tiers.v4i1.436
[100] Zulfahmi, "Penerapan metode Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) pada sistem pendukung keputusan untuk menentukan kualitas beras terbaik berbasis web," *Journal Digital Technology Trend*, vol. 3, no. 2, pp. 96–106, 2024. https://doi.org/10.56347/jdtt.v3i2.263

AUTHOR BIOGRAPHY

	**Adam Zuhruf Ananda Farendra** is an undergraduate student in the Applied Informatics Management Study Program, Faculty of Vocational Studies, Universitas Negeri Surabaya, Indonesia. Email: adam.22055@mhs.unesa.ac.id
	**I Gde Agung Sri Sidhimantra** is a lecturer in the Applied Bachelor Program in Informatics Management, Faculty of Vocational Studies, Universitas Negeri Surabaya, with the academic rank of Assistant Professor (Asisten Ahli). His areas of interest include web and mobile application development, decision-support systems, large language models, and agentic AI. Email: igdesidhimantra@unesa.ac.id

	**Asmunin** is a lecturer in the Applied Informatics Management Study Program, Faculty of Vocational Studies, Universitas Negeri Surabaya, Indonesia. Email: asmunin@unesa.ac.id
	**Rosita** is a lecturer in the Applied Informatics Management Study Program, Faculty of Vocational Studies, Universitas Negeri Surabaya, Indonesia. Email: rositarosita@unesa.ac.id