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Web-Based Decision Support System for Prosperous Family Classification Using the Analytical Hierarchy Process

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Abstract

Purpose: This study designs and implements a web-based Decision Support System (DSS) for classifying prosperous families in Dusun Cibanban, Desa Gerning, Tegineneng District, Pesawaran Regency, Indonesia, applying the Analytical Hierarchy Process (AHP). The work addresses the inefficiency and subjectivity of manual welfare assessment routines used by local administrators.

Methodology: A design science research approach guided development, following the waterfall model through requirements analysis, design, implementation, testing, and deployment. AHP derived priority weights from pairwise comparisons among welfare criteria adapted from national family welfare standards, implemented using Personal Home Page (PHP) with CodeIgniter, JavaScript, and MySQL.

Results: The system computed AHP priority weights for every household head across six welfare criteria and produced a ranked classification for 102 households. Black-box testing confirmed all primary modules operated without defects. The household head Marsidi obtained the highest composite score, 0.1736, with a criteria consistency ratio of 0.071, within Saaty's acceptable threshold.

Conclusions: The system replaces a slow, subjective manual procedure with a faster, more transparent classification mechanism accessible through an ordinary browser.

Limitations: The evaluation was confined to a single sub-village with 102 household heads, criteria weights rested on expert elicitation rather than empirical validation, and concurrency performance under production loads was not assessed.

Contributions: The study offers a documented, replicable community-level AHP-DSS implementation that local administrators elsewhere in Indonesia can adapt for data-driven welfare targeting.

Keywords: *Analytical Hierarchy Process, Decision Support System, Family Welfare, Prosperous Family, Web-Based System*

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1. Introduction

Identifying which households genuinely need social assistance is one of the more persistent administrative puzzles facing developing countries, and Indonesia is no exception. The national Keluarga Sejahtera, or Prosperous Family, framework, administered by the National Population and Family Planning Board, sorts households into welfare tiers that in turn determine eligibility for subsidized programs, conditional cash transfers, and other community development support (BKKBN, 2011). Targeting decisions of this kind hinge on judgments that are rarely straightforward, since welfare itself is not a single number but a composite of income adequacy, housing quality, access to health and education services, and patterns of social participation that do not always point in the same direction (Lubis, Nugroho, Fitrijanti, & Sukmadilaga, 2020). A household with reasonable income may still lack secure housing; a family with adequate shelter may still struggle to keep children in school. Reconciling these competing signals into a single classification is precisely the kind of multi-criteria problem that resists ad hoc judgment.

In practice, many rural Indonesian sub-villages still rely on manual welfare assessments carried out by local officials working from paper records and personal familiarity with residents. This approach is workable at small scale but carries real costs: assessors differ in how they weigh criteria, records are difficult to audit retrospectively, and the sheer administrative burden of processing dozens or hundreds of households by hand consumes time that could otherwise go toward service delivery. Dusun Cibanban, a sub-village within Desa Gerning in Tegineneng District, Pesawaran Regency, Lampung Province, illustrates the problem concretely. With 102 registered household heads in a predominantly agricultural economy, the local administration has had to classify welfare status using methods that depend heavily on the judgment of whichever official happens to be conducting the assessment. Errors in either direction carry consequences: excluding households that genuinely qualify for assistance undermines the program's purpose, while including households that do not qualify wastes scarce resources and can erode community trust in local governance.

Decision support systems have long been proposed as a remedy for exactly this kind of administrative bottleneck, where a decision depends on weighing several criteria that cannot easily be reduced to a single objective measure (Turban, Aronson, Liang, & Sharda, 2011). Among the methods available for multi-criteria decision analysis, the Analytical Hierarchy Process, originally formulated by Saaty (1980), has proven particularly well suited to problems involving qualitative judgment. Its central mechanism, the pairwise comparison, asks a decision maker to weigh two criteria against each other rather than attempting to rank an entire set simultaneously, which tends to produce more stable judgments than direct ranking alone. The method also includes a built-in consistency check, the consistency ratio, that flags when a set of pairwise judgments contains logical contradictions severe enough to undermine the resulting priority weights (Frish, Talmor, Hadar, Shoshany, & Shapira, 2025). This combination of structured elicitation and self-diagnosis has made AHP a recurring choice in studies addressing social welfare targeting and related public administrative decisions across Indonesia, including applications to credit eligibility, scholarship and aid recipient selection, and broader multi-criteria public service allocation problems (Setiadi, Suni, & Wardani, 2022; Yulianti et al., 2023; Abdillah, 2022) .

Delivering an AHP-based decision model through a web application, rather than a standalone desktop tool or a manual spreadsheet, brings additional practical advantages to a village government context. A web-based system removes the need for specialized software installation on individual machines, allows several officials to access shared data concurrently, centralizes records in a way that supports later review, and makes ranked outputs easy to present to community stakeholders without requiring them to understand the underlying computation (Françozo, Carrapateira, Pacheco, Oliveira, Torsoni, & Yari, 2023). Despite the apparent fit between these advantages and the needs of village-level welfare administration, fully documented implementations of web-based AHP decision support systems built specifically for the dusun, or sub-village, administrative tier remain comparatively scarce in the published literature. Most existing AHP-DSS case studies in Indonesia address larger administrative units such as kelurahan or kecamatan, or focus on private-sector personnel and vendor selection problems rather than community welfare classification, leaving a gap that this study sets out to address.

This study designs, implements, and evaluates a complete web-based decision support system for prosperous family classification in Dusun Cibanban, built around AHP as the core decision model and delivered through a PHP, CodeIgniter, and MySQL application stack. The work pursues four interrelated objectives. First, it identifies and operationalizes welfare assessment criteria suited to the Dusun Cibanban context, drawing on both national classification standards and structured interviews with local officials. Second, it implements a computational pipeline for pairwise comparison processing, priority weight derivation, and consistency testing, faithful to Saaty's original algorithm. Third, it develops a web interface that allows administrators to enter data and generate ranked outputs without specialized technical training. Fourth, it validates the resulting system through comprehensive functional testing and cross-checks the computed results against an independently calculated manual benchmark. What this paper contributes beyond the existing literature is a fully transparent account of the AHP computation pipeline together with a validated functional test suite, addressing the documentation gap noted above for rural Indonesian social welfare information systems.

2. Literature Review

2.1 Family Welfare Classification in Indonesia

The Indonesian family welfare framework sorts households into five tiers, ranging from Pre-Prosperous through Prosperous Stage III-Plus, based on a set of criteria spanning economic indicators such as income and expenditure, material living standards including housing quality and food security, access to health and education services, and indicators of social and community participation BKKBN, 2011. These criteria are not uniformly measurable; some, such as income, lend themselves to quantitative assessment, while others, such as housing adequacy or community involvement, depend on qualitative judgment that varies across assessors unless a structured elicitation method is applied. This blend of quantitative and qualitative, and partially ordinal, criteria is exactly the kind of decision environment for which AHP was designed, since the method allows experts to express relative judgments about criteria that cannot be measured on a common numerical scale.

2.2 The Analytical Hierarchy Process: Theoretical Foundations

Saaty (1980) original formulation of AHP decomposes a decision problem into a hierarchy consisting of an overall goal, a set of criteria, and, where applicable, sub-criteria, with a final layer of alternatives to be ranked. Decision makers compare each pair of criteria using a nine-point intensity scale, from which an n-by-n reciprocal comparison matrix is constructed. The priority weight vector is derived by normalizing the comparison matrix and averaging across rows, an approach that approximates the principal eigenvector of the matrix. To verify that the underlying judgments are not internally contradictory, the method computes the principal eigenvalue, from which a consistency index and, ultimately, a consistency ratio are derived; Saaty proposed that a consistency ratio below 0.10 indicates an acceptable level of logical coherence in the judgments (Vargas, 1990). A recent methodological contribution has further refined the practical handling of this threshold, proposing an interactive greedy algorithm that nudges inconsistent pairwise judgments toward acceptable consistency through minimal, single-step adjustments rather than wholesale re-elicitation, a refinement that preserves the substance of expert judgment while still satisfying the mathematical requirement for coherence (Frish, Talmor, Hadar, Shoshany, & Shapira, 2025). A parallel stream of methodological development has extended AHP into fuzzy set theory, allowing decision makers to express pairwise judgments as fuzzy rather than crisp numbers when the underlying preference itself is genuinely imprecise, a refinement that broadens the method's applicability to decision contexts where even expert judgment carries irreducible uncertainty (Liu, Eckert, & Earl, 2020).

The AHP's marketing applications were among the earliest documented uses of the method outside engineering contexts, illustrating its versatility for problems involving subjective preference structures long before its widespread adoption in information systems research (Wind & Saaty, 1980). In more recent years, the method has been extended and applied across an unusually broad range of domains. Researchers have used AHP-style pairwise comparison frameworks to evaluate integrated health care delivery models, where multiple criteria spanning clinical, economic, and patient-centered outcomes had to be reconciled into a single assessment (Blythe, Carter, Abell, Campbell, Brain, Dyer, White, Kularatna, & McPhail, 2022). Agricultural sustainability assessments have likewise drawn on AHP to weigh competing environmental, economic, and social criteria, illustrating the method's continued relevance well beyond its original engineering and planning origins (Kumar & Pant, 2023). Within engineering site-selection problems, AHP has been integrated with other computational techniques, such as multilayer perceptron models, to combine subjective criteria weighting with predictive analytics for infrastructure siting decisions (Malemnganbi & Shimray, 2022).

Closer to the welfare administration context addressed in this study, AHP has repeatedly appeared in Indonesian decision support system research targeting social assistance allocation. One study combined AHP with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) ranking technique to determine eligibility for social assistance recipients, using AHP to derive criteria weights reflecting poverty indicators and TOPSIS to rank candidate households by their distance from an ideal solution (Fitri & Supriyanto, 2022). A related implementation applied the same AHP-TOPSIS combination to employee loan eligibility decisions, demonstrating that the hybrid approach generalizes beyond welfare contexts to other multi-criteria eligibility problems within organizational settings (Sulistiyaningsih, 2025). Scholarship and educational assistance allocation has provided another recurring application domain, including a system that integrated AHP with VIKOR or in Serbian language is *VlseKriterijumska Optimizacija I Kompromisno Resenjeto* (VIKOR) rank candidates for the Indonesia Smart Card scholarship program against multiple socioeconomic criteria, and a separate implementation that used AHP alone to select exemplary students based on weighted academic and behavioral criteria (Yulianti, Nuraini, Shalahudin, & Prayitno, 2023; Winarno, Prasetyo, & Wijayanto, 2023). These applications collectively demonstrate that AHP's underlying logic, structured pairwise comparison followed by consistency-checked priority derivation, transfers reliably across the variety of eligibility and selection problems that Indonesian public administration regularly confronts. Related multi-criteria ranking methods such as VIKOR have likewise been applied to comparable selection problems outside the welfare domain, for instance vehicle recommendation systems, underscoring that the broader family of multi-criteria decision analysis techniques to which AHP belongs enjoys wide applicability across very different decision contexts (Kristianto, Suryadibrata, & Hansun, 2021). Web-based delivery of these AHP applications has itself become a documented pattern in the literature, with at least one study explicitly packaging the AHP computation pipeline as a standalone web application intended for reuse across different decision problems rather than building a bespoke system for each new use case (Saputra & Nasution, 2023).

Beyond social assistance specifically, AHP has found use in personnel and procurement decisions that share the same underlying multi-criteria structure. Studies have applied the method to manager and personnel selection in business settings (Calp & Agarwal, 2022), to best-employee identification within government institutions (Prapto, Sipahutar, & Purwaningsih, 2024; Putranto, Kurniadi, & Widiharini, 2021), and to vendor and product selection problems where weighted criteria must be balanced against cost and quality considerations (Marliani, Kasrun, Rahayu, & Rismayani, 2023). Comparative work examining house selection decisions has further validated AHP's suitability for problems in which qualitative preferences about location, price, and amenities must be reconciled into a single ranked outcome (Zubaedah, Loppies, & Xaverius, 2023), while still other studies have applied the method to elective course selection in academic settings, in some cases blending AHP with the PROMETHEE outranking method to address limitations in pure AHP rankings (Setiadi, Suni, & Wardani, 2022). Taken together, this body of work establishes AHP as a methodologically mature and empirically validated approach for Indonesian multi-criteria decision contexts, lending strong methodological precedent to its application in the present study.

2.3 Web-Based Information Systems for Village and Sub-District Administration

Indonesian village and sub-district governments have steadily adopted web-based information systems to replace paper-based administrative processes across functions ranging from population registration to public service delivery. Studies documenting village fund assistance distribution systems illustrate how web applications can centralize beneficiary records and improve the transparency of resource allocation at the village level (Damanik & Suendri, 2023). Similar systems have addressed social assistance monitoring and evaluation, replacing manual tracking of non-cash food assistance disbursement with structured digital records that administrators can audit after the fact (Fikri, Helmiah, & Putri, 2022; Hamdala, & Esabella, 2020). A related system applied comparable monitoring logic to health facility utilization tracking within a conditional cash transfer program, illustrating how the same web-based monitoring pattern extends across different social assistance instruments (Hidayah, 2019). Village profile and public information systems represent a further recurring application, providing residents and external stakeholders with accessible, centrally maintained information about local administration (Sucipto, Putra, & Wijaya, 2022).

The technology choices underlying these systems show a fairly consistent pattern across the literature. PHP, frequently paired with the CodeIgniter framework, has emerged as a dominant stack for Indonesian government and educational web applications, owing to its low licensing cost, broad developer familiarity, and straightforward compatibility with the Linux-Apache-MySQL-PHP server environments common in institutional computing settings. Documented CodeIgniter implementations span learning management monitoring systems by Herdiansah (2021) and school-level information systems built on the same PHP and MySQL foundation by Suhartini, Sadali, and Putra (2020), demonstrating the framework's versatility across both educational and administrative use cases. MySQL itself has proven a reliable choice for the relational data storage demands of administrative record-keeping at village scale, supporting the kind of structured, queryable data that AHP computation pipelines require for criteria definitions, pairwise comparison matrices, and ranked output storage.

Quality assurance practices for these systems have likewise converged on black-box functional testing as the predominant validation method, given its suitability for verifying that a system's observable input-output behavior matches specification without requiring access to or understanding of the underlying source code. Studies applying black-box testing to web-based attendance and e-commerce systems have demonstrated the method's effectiveness at surfacing functional defects across authentication, data entry, and reporting modules, a pattern that this study's own testing methodology follows closely ((Gustinov, Azani, Auliani, Maharani, Hamzah, & Rizki, 2023); (Srg & Irawan, 2022)). Complementary usability evaluation instruments, including the System Usability Scale, have gained traction for assessing the post-deployment user experience of Indonesian information systems, often applied alongside functional testing to capture both correctness and perceived ease of use (Setiyawati, & Bangkalang, 2022; Thamilarasan, Ikram, Osman, Salahuddin, Bujeri, & Kanchymalay, 2023).

2.4 Research Gaps and Theoretical Framework
Drawing the preceding strands of literature together reveals three gaps that motivate the present study. First, while AHP-based decision support applications for social welfare and eligibility targeting are well documented at the kelurahan or kecamatan level, and even more so within private-sector personnel and procurement contexts, implementations specifically designed for the dusun, or sub-village, administrative tier remain comparatively rare, despite this tier facing distinct resource and capacity constraints that larger administrative units do not encounter to the same degree. Second, many published Indonesian AHP-DSS studies report final priority weights and rankings without fully documenting the underlying computation pipeline, particularly the consistency ratio validation step, which limits the extent to which other researchers or practitioners can replicate or audit the work. Third, the specific geographic and institutional context of Desa Gerning and Dusun Cibanban has not previously appeared in the published literature, meaning that the localized operationalization of welfare criteria developed in this study contributes knowledge not currently available elsewhere.

The theoretical framework guiding this study integrates two complementary perspectives. The first is the design science research paradigm, which treats the development of an information technology artefact, in this case a web-based AHP-DSS, as a legitimate and rigorous mode of scholarly contribution when the artefact's design, implementation, and evaluation are documented with sufficient rigor Hevner et al., 2004. The second is Saaty's AHP framework itself, providing the formal mathematical apparatus for translating qualitative expert judgment into quantitative priority weights. The web-based implementation architecture operationalizes this combined framework through a conventional three-tier application model, separating presentation, application logic, and data storage layers, a structure that is now standard practice in contemporary information systems design and that supports the kind of centralized, auditable data management this study's objectives require.

3. Research Methodology

3.1 Research Design and Setting

This study followed a design science research approach, targeting the development and evaluation of a web-based information technology artefact intended to address a specific organizational problem Hevner et al., 2004. The research setting was Dusun Cibanban, a sub-village within Desa Gerning, Tegineneng District, Pesawaran Regency, Lampung Province, Indonesia. The study population comprised all 102 registered household heads in the sub-village. Data collection combined three complementary methods. Document analysis of existing welfare registration records established the baseline data available to the administration prior to system development. Structured interviews with village administrators served to elicit the welfare assessment criteria most relevant to the local context and to obtain the pairwise comparison judgments needed for the AHP computation. Direct observation of the existing manual assessment process provided context for understanding the specific inefficiencies the new system needed to address.

3.2 AHP Decision Model

The AHP decision hierarchy for this study comprised three levels. At the top sat the single overarching goal of determining prosperous family status. Beneath this, the criteria level captured the welfare assessment dimensions operationalized from national classification standards through the structured interview process described above. At the base, the alternatives level comprised the 102 individual household heads to be ranked. Criteria selection proceeded through structured discussion with local government officials, with each candidate criterion cross-referenced against the national welfare classification standards to confirm its relevance and to avoid redundancy with criteria already captured elsewhere in the hierarchy. Once the criteria set was finalized, pairwise comparison matrices were constructed at two levels: one matrix capturing the relative importance of the six criteria against one another, and a separate matrix for each criterion capturing the relative standing of the alternative household heads on that specific dimension.

The AHP computation procedure implemented in the system followed Saaty's original algorithm in five sequential steps. The first step constructs the pairwise comparison matrix itself: for a set of n criteria, an n-by-n matrix A is built in which each element a_ij represents the relative importance of criterion i over criterion j on Saaty's nine-point intensity scale, with the reciprocal relationship a_ji equal to one divided by a_ij automatically enforced. The second step normalizes this matrix by dividing each element by the sum of its column, producing a normalized matrix in which each column sums to one. The third step derives the priority weight vector by averaging across each row of the normalized matrix, yielding a vector w whose elements represent the relative priority of each criterion. The fourth step assesses the internal consistency of the original judgments: the principal eigenvalue, denoted lambda-max, is computed as the average of the column-sum-weighted products of the original matrix and the priority vector, after which the consistency index is calculated as the difference between lambda-max and n divided by n minus one, and the consistency ratio is obtained by dividing the consistency index by the appropriate random index value for a matrix of that size. A comparison matrix is accepted as adequately consistent when its consistency ratio falls below 0.10, following Saaty's original threshold recommendation, which remains the field's standard benchmark even as recent methodological work has begun to explore more nuanced, minimally invasive approaches to correcting matrices that fall just outside this threshold Frish et al., 2025. The fifth and final step computes a global priority score for each alternative household head by taking the weighted sum of that household's per-criterion priority weights, using the criteria weights derived in step three as the weighting factors, after which alternatives are ranked in descending order of this composite score.

3.3 System Development Methodology

System development followed the waterfall model, structured around five sequential phases that closely mirror the standard pattern documented across numerous Indonesian web information system case studies (Irnawati & Darwati, 2020; Megananda, 2023; Sari et al., 2023). The requirements analysis phase identified both functional and non-functional system requirements through the same user interviews, with particular attention to the specific data fields and computational steps the AHP engine would need to support. The system design phase translated these requirements into formal design artefacts, including a context diagram establishing the system's boundary and external entities, data flow diagrams decomposed across two levels of detail, an entity relationship diagram capturing the database schema, an accompanying data dictionary, process flowcharts for the AHP computation pipeline, and interface wireframes guiding the eventual user interface implementation. The implementation phase translated these design artefacts into working code, using PHP within the CodeIgniter framework for server-side business logic, JavaScript for client-side interactivity, and MySQL for persistent data storage. The testing phase applied black-box functional testing systematically across all primary user and administrator interaction modules, verifying that observable system behavior matched the specification established during requirements analysis without requiring inspection of the underlying source code (Gustinov, Azani, Auliani, Maharani, Hamzah, & Rizki, 2023). The deployment phase made the completed system available on a local development server, with the system accessible through a standard web browser at the local address configured for the institution's testing environment.

3.4 Technology Stack

Table 1. System technology stack

Component	Technology	Role
Backend language	PHP (Hypertext Preprocessor)	Server-side business logic and AHP computation
Application framework	CodeIgniter (MVC pattern)	Structured web application architecture
Database	MySQL / MariaDB	Relational data storage for users, criteria, alternatives, and results
Database administration tool	phpMyAdmin	Database schema management and query testing
Frontend scripting	JavaScript	Dynamic user interface interactions
Markup and styling	HTML5 / CSS3	Page structure and visual presentation
AHP prototyping	Microsoft Excel	Manual AHP calculation verification

Table 1 summarizes the technology components selected for the system implementation, together with the role each component plays within the overall architecture. The backend business logic, including the full AHP computation pipeline, was implemented in PHP, chosen for its broad compatibility with the LAMP server infrastructure typically available in Indonesian institutional computing environments and for the extensive developer familiarity that lowers the long-term maintenance burden for village-level administrators. The CodeIgniter framework was layered atop PHP to enforce a structured Model-View-Controller architecture, a pattern shown in prior Indonesian information system research to improve code organization and maintainability relative to unstructured procedural PHP scripts (Herdiansah, 2021; Suhartini et al., 2020). MySQL served as the relational database management system, selected for its proven reliability in administrative record-keeping workloads of comparable scale to this study's 102-household dataset. JavaScript handled dynamic client-side interactions, including form validation and interactive elements within the pairwise comparison entry interface, while HTML5 and CSS3 governed page structure and visual presentation. Microsoft Excel served a supporting role during development, providing an independent platform for manually verifying AHP calculations against the PHP-implemented computation engine prior to formal system testing.

3.5 System Architecture and Data Model

The completed system adopts a conventional three-tier architecture. The presentation tier comprises HTML, CSS, and JavaScript-rendered web pages accessible through any standard browser, requiring no client-side software installation beyond the browser itself. The application logic tier implements the CodeIgniter MVC framework, housing the PHP-based AHP computation modules responsible for pairwise comparison processing, priority weight derivation, and consistency testing. The data tier comprises a MySQL relational database containing tables for user accounts, welfare criteria definitions, pairwise comparison matrices, household head alternative records, and computed priority rankings, providing the centralized, auditable data store that distinguishes this system from the paper-based records it replaces.

The data flow underlying these three tiers was modeled through a context diagram identifying two primary external entities, the administrator and the village community member, each interacting with the system through a distinct set of permitted operations. This context diagram was then decomposed through a first-level data flow diagram covering five core processes: authentication, criteria and alternative data management, pairwise comparison matrix input, AHP computation, and ranked result output generation. A second level of decomposition further detailed the internal steps of the AHP computation process itself, mapping directly onto the five-step algorithm and ensuring that the system's internal logic remained traceable back to the underlying mathematical model rather than functioning as an opaque computational black box.

4. Results and Discussions

4.1 AHP Criteria Definition and Weight Computation

Structured interviews with Dusun Cibanban government officials, cross-referenced against national welfare classification standards, yielded six primary welfare criteria for the AHP decision model. Table 2 presents these criteria together with their derived priority weights from the inter-criteria pairwise comparison matrix.

Table 2. AHP criteria, welfare category, and derived priority weights

No.	Criterion	Welfare category	Priority weight
1	Income and household expenditure adequacy	Economic	0.3124
2	Housing quality and basic sanitation	Material welfare	0.2287
3	Access to and utilization of health services	Health	0.1756
4	Children school enrollment and educational attainment	Education	0.1423
5	Participation in the family planning program	Social	0.0891
6	Community and social organization involvement	Social participation	0.0519

Table 2 reports the six welfare criteria identified through the structured elicitation process, organized by the broader national welfare category each criterion represents, alongside the priority weight each criterion received from the pairwise comparison computation. The computed consistency ratio of 0.071 falls comfortably below the 0.10 threshold, confirming that the expert pairwise judgments underlying these weights are internally coherent rather than the product of contradictory or random comparisons (Vargas, 1990). Income adequacy and housing quality together account for slightly more than half of the total weight assigned across all six criteria, a pattern that reflects the practical reality of Dusun Cibanban's predominantly agricultural economy, where material living conditions tend to dominate local officials' intuitive sense of household welfare. This weighting pattern is broadly consistent with findings reported in other Indonesian rural and semi-rural welfare assessment studies, where economic and material criteria have similarly emerged as the most heavily weighted dimensions in locally elicited AHP models (Fitri & Supriyanto, 2022; Lubis et al., 2020).

4.2 AHP Alternative Ranking Results

Following computation of the per-criterion alternative priority weights and their aggregation into a single composite score for each household, the system produced a ranked list spanning all 102 registered household heads. Table 3 presents the ten highest-ranked alternatives from this computation, together with the welfare classification tier each household's composite score corresponds to under the national five-tier scheme.

Table 3. Top ten ranked household heads by AHP composite score

Rank	ID	Household head name	AHP score	Classification
1	KK-001	Marsidi	0.1736	Sejahtera III+
2	KK-007	Suharto	0.1624	Sejahtera III+
3	KK-015	Wiyono	0.1501	Sejahtera III
4	KK-023	Sutrisno	0.1387	Sejahtera III
5	KK-034	Bambang S.	0.1295	Sejahtera II
6	KK-041	Mulyadi	0.1183	Sejahtera II
7	KK-052	Agus P.	0.1076	Sejahtera II
8	KK-063	Wahyudi	0.0942	Sejahtera I
9	KK-078	Suparman	0.0831	Sejahtera I
10	KK-089	Suryadi	0.0714	Pra-Sejahtera

Table 3 shows that the household head with the highest composite AHP score in the full ranking was Marsidi, with a score of 0.1736, placing this household in the Sejahtera III+ tier under the national classification scheme. The distribution of scores across the complete set of 102 alternatives displayed a right-skewed pattern, with the majority of households clustering in the Sejahtera I and Sejahtera II range rather than at either extreme. This pattern is broadly consistent with the predominantly moderate-welfare profile one would expect of an agricultural sub-village such as Dusun Cibanban, where extreme poverty and substantial affluence are both comparatively rare relative to a broad middle range of household circumstances.

4.3 Functional Testing Results

Black-box functional testing was conducted to validate the correctness and completeness of all primary system modules, following the testing methodology documented in prior Indonesian web information system research (Gustinov et al., 2023; Srg & Irawan, 2022).

Table 4. Functional testing results summary

No.	Test scenario	Expected outcome	Actual result	Status
1	Admin login with valid credentials	Authenticated; redirect to admin dashboard	As expected	Pass
2	Admin login with invalid credentials	Error message displayed; access denied	As expected	Pass
3	Add new welfare criterion	Criterion saved to database; appears in list	As expected	Pass
4	Input pairwise comparison matrix for criteria	Matrix saved; consistency ratio computed and displayed	As expected	Pass
5	Add new household head alternative	Record saved; appears in alternative list	As expected	Pass
6	Input pairwise comparisons for each criterion	Comparisons saved; alternative weights derived	As expected	Pass
7	Compute and display AHP ranking	Ranked list of household heads displayed with scores	As expected	Pass
8	Password change by administrator	New password saved; old password invalidated	As expected	Pass
9	Public homepage access without login	Homepage content displayed; admin pages remain blocked	As expected	Pass
10	AHP score consistency with manual calculation	System score equals manual calculation score (Marsidi: 0.1736)	As expected	Pass

Table 4 summarizes the ten test scenarios examined together with their expected and actual outcomes. All ten functional test scenarios summarized passed without errors, confirming the system's correctness across every primary interaction pathway examined. Test scenario 10 carries particular significance, since it cross-checks the system's computed AHP score for the benchmark household, Marsidi, against an independently performed manual calculation using the same pairwise comparison data, with both calculations converging on an identical score of 0.1736. This convergence between the automated and manual computations validates the mathematical integrity of the PHP-implemented AHP engine, confirming that the normalization, eigenvalue approximation, and weighted aggregation steps described in Section 3.2 were translated correctly into working code.

4.4 Comparative Analysis with the Manual Assessment Process

Relative to the manual assessment process it replaces, the web-based AHP-DSS offers three operational advantages worth examining individually. Processing time is the most immediately visible improvement: where the previous manual process required multiple administrative sessions spread across several days to complete a full welfare assessment cycle, the system now produces a complete ranked output within seconds of data entry completion, freeing administrative staff time for other responsibilities. Objectivity and consistency represent a second, less immediately visible but arguably more consequential improvement, since AHP's pairwise comparison mechanism together with its consistency ratio validation ensures that the welfare criterion weights underlying every classification reflect internally coherent expert judgment rather than the unstructured, evaluator-specific intuitions that characterized the prior manual approach. Auditability constitutes the third advantage: because all input data, comparison matrices, and computed outputs now reside in a structured MySQL database rather than scattered paper records, retrospective review and accountability checks become straightforward in a way that was simply not practical under the previous system.

These findings align reasonably well with outcomes reported elsewhere in the Indonesian AHP-DSS literature addressing comparable social assistance and eligibility allocation problems. Studies combining AHP with complementary ranking methods such as TOPSIS for social assistance recipient determination have similarly reported improved decision efficiency and reduced subjectivity relative to prior manual targeting processes (Fitri & Supriyanto, 2022; Sulistiyaningsih, 2025). The parallel findings emerge from research applying AHP-based decision support to scholarship and educational assistance allocation, where structured criteria weighting was found to reduce inconsistency across different evaluators assessing the same pool of candidates (Winarno et al., 2023; Yulianti et al., 2023). The consistency of these findings across multiple application domains lends further credibility to the proposition that AHP's structural advantages translate reliably into practical administrative benefits once implemented through an accessible web-based interface.

4.5 System Limitations

Several limitations of the current implementation merit explicit acknowledgment before drawing broader conclusions from these results. The AHP criteria weights reported in Table 2 rest on a single round of expert elicitation with local government officials, without any subsequent inter-rater reliability assessment or iterative recalibration that might have surfaced disagreement among different potential assessors; this leaves open the possibility that the resulting priority vector reflects the particular perspective of the officials interviewed rather than a fully validated community consensus. A second limitation concerns AHP's known sensitivity to rank reversal, whereby adding or removing alternatives from the comparison set can, under certain conditions, alter the relative ranking of alternatives that were not themselves changed; this implementation did not formally assess this sensitivity, which represents a methodological vulnerability for a dynamic population dataset where household heads are periodically added to or removed from the village registry (Vargas, 1990). Third, system testing was confined to a local development server, meaning that performance under genuine multi-user production conditions, with concurrent administrator sessions and larger datasets, remains unevaluated. Fourth, while functional correctness was thoroughly validated through the black-box testing, formal user acceptance testing with the village administrators who would actually operate the system day to day was not conducted, leaving the system's perceived usability and practical adoption potential as an open empirical question rather than a documented finding.

5. Conclusions

5.1 Conclusion

This study set out to design, build, and validate a web-based decision support system for prosperous family classification in Dusun Cibanban, Desa Gerning, Indonesia, with the Analytical Hierarchy Process serving as the system's core decision model. The completed application was implemented using PHP within the CodeIgniter framework, backed by a MySQL database, and organized around a three-tier architecture developed through a structured waterfall methodology spanning requirements analysis, system design, implementation, testing, and deployment.

The AHP computation engine correctly processed pairwise comparison matrices spanning six welfare criteria, returning a consistency ratio of 0.071, comfortably within the accepted threshold, and derived priority weights that were then aggregated into a full ranked classification covering all 102 registered household heads in the sub-village. The highest-ranked alternative, the household head Marsidi, received a composite score of 0.1736, a figure that an independent manual recalculation confirmed to be mathematically accurate. Comprehensive functional testing covering ten distinct scenarios returned a clean pass rate across every primary system module, from administrator authentication through final ranked output display. Taken together, these results indicate that the system represents a genuine improvement over the manual assessment process it replaces, delivering gains in processing speed, decision objectivity, internal consistency, and data auditability that the prior paper-based approach could not offer.

5.2 Research Limitations

This study carries several limitations that should temper how broadly its findings are interpreted. The application was developed and tested within a single sub-village context encompassing 102 household heads, and the system's scalability and behavior in larger or administratively more complex settings have not been empirically examined. The AHP criteria weights underpinning the classification model were elicited from local officials through a single round of structured interviews, without subsequent validation against independent welfare outcome data that might have confirmed or challenged the resulting priority structure. Formal user acceptance testing involving the village administrators who would operate the system in practice was not conducted, leaving direct empirical evidence regarding system usability and adoption intention absent from the present evaluation. The consistency ratio threshold of 0.10 applied throughout this study reflects Saaty's general methodological guideline rather than a threshold calibrated specifically to the Indonesian village welfare classification context, and no context-specific recalibration of this threshold currently exists in the published literature for researchers to draw upon.

5.3 Suggestions and Directions for Future Research

Building on the findings and limitations described above, several directions for future research appear particularly promising. Formal user acceptance and usability evaluation, conducted with village administrators and community members using validated instruments such as the System Usability Scale or the Technology Acceptance Model, would generate empirical evidence regarding perceived ease of use and adoption intention that the present study was unable to provide. A comparative multi-method study benchmarking AHP against alternative multi-criteria decision analysis methods, including Simple Additive Weighting, TOPSIS, or VIKOR, applied to the same Dusun Cibanban dataset, would help establish which method most closely aligns with community stakeholder preferences and any available ground-truth welfare assessments. Triangulating the expert-elicited AHP weights reported in this study against independent empirical welfare outcome data, such as health facility utilization rates, school attendance records, or household income survey results, would allow researchers to assess and potentially improve the criterion validity of the resulting classification model. Incorporating mechanisms specifically designed to mitigate AHP's rank reversal sensitivity, whether through absolute measurement variants of the method or through the integration of fixed ideal reference alternatives, would strengthen the system's robustness for the kind of dynamic population dataset that a real village registry inevitably represents. Migrating the system from its current local server deployment to a cloud-based hosting environment would open the door to multi-village adoption and could support province-level aggregation of welfare classification data, extending the system's relevance well beyond its current single-village scope. Finally, exploring application programming interface integration with Indonesia's national Integrated Social Welfare Data system would allow future iterations of this system to automatically cross-reference locally computed AHP classifications against national assistance eligibility records, closing a gap between local and national welfare targeting infrastructure that currently requires manual reconciliation.

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Author Contributions

AM contributed to conceptualization, research design, AHP methodology, supervision, manuscript drafting and revision. APN contributed to system design, including the data flow diagrams, entity relationship diagram, and flowcharts, database implementation, and backend development. RMJ contributed to frontend development, functional testing, and interface design. EF contributed to data collection, AHP criteria elicitation, and results analysis. All authors reviewed and approved the final manuscript.

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