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Automated Decision Support System for Social Assistance Eligibility Based on House Images Using Deep Learning

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Abstract

Social assistance is one of the government programs aimed at improving the welfare of underprivileged communities. However, the process of determining eligible beneficiaries is still largely conducted manually, leading to subjectivity, inaccurate targeting, and time-consuming decision-making. This study proposes an automated decision support system for determining social assistance eligibility based on house images using Deep Learning and the Analytical Hierarchy Process (AHP). The proposed system consists of a house image classification model developed using the MobileNetV2 architecture, a web-based application developed with the Laravel framework, and the integration of image classification results with the AHP method. MobileNetV2 is employed to classify house conditions into eligible and ineligible categories while generating confidence scores. These confidence scores are converted into a 1–10 assessment scale and used as the House Condition criterion in the AHP calculation together with income, occupation, number of dependents, and house ownership. The study utilized a dataset of 300 house images for model training and evaluation. Experimental results show that the MobileNetV2 model achieved an accuracy of 74.00%. Furthermore, the developed system successfully integrates automatic house image classification with AHP-based decision-making, producing more objective, consistent, and accurate recommendations for social assistance recipients while assisting local governments in improving the efficiency and transparency of the beneficiary selection process.

1. INTRODUCTION

Social assistance programs play an important role in improving the welfare of low-income communities and reducing poverty in Indonesia. Programs such as Direct Cash Assistance (BLT), the Family Hope Program (PKH), and Non-Cash Food Assistance (BPNT) are designed to support vulnerable households in meeting their basic needs. However, the process of determining eligible beneficiaries is still predominantly conducted manually using administrative records and field observations. This approach often results in subjective assessments, inaccurate targeting, outdated beneficiary data, and inefficient decision-making processes. Therefore, an objective and automated decision support system is required to improve the transparency, accuracy, and efficiency of beneficiary selection [1], [2].

House condition is one of the important indicators used to evaluate the socio-economic status of a household. The physical characteristics of a house, including the roof, walls, floor, and overall building condition, can represent the economic condition of its occupants. Recent advances in Artificial Intelligence, particularly Deep Learning, have enabled automatic image analysis with high classification accuracy [3], [4]. In this study, MobileNetV2, a Convolutional Neural Network (CNN) architecture, is employed to classify house images into eligible and ineligible categories. The classification results are subsequently integrated into a decision support system to support the social assistance selection process.

Several previous studies have investigated decision support systems for social assistance selection. Susanto et al. (2025) implemented the AHP and TOPSIS methods to rank beneficiaries based on socio-economic criteria [5]. Setyaningrum et al. (2024) developed a web-based system using the Simple Additive Weighting (SAW) method for BLT-DD recipient selection [6]. Masroni et al. (2023) proposed the ROC and SMART methods to determine health insurance assistance recipients using socio-economic data [7]. Suherwin and Junaid (2025) applied the SAW method to determine BPNT beneficiaries, while Sembiring et al. (2025) also implemented SAW to select social assistance recipients based on administrative criteria [8]. These studies demonstrated that decision support systems can improve consistency and transparency in beneficiary selection; however, they mainly relied on numerical and administrative data without utilizing visual information regarding house conditions.

Although previous studies have successfully implemented multi-criteria decision-making methods, the assessment process still depends on manually collected socio-economic data and does not incorporate computer vision to evaluate the actual physical condition of houses. Consequently, the resulting decisions may not fully represent real field conditions. This limitation indicates the need for an approach that combines image-based assessment with multi-criteria decision-making to improve the reliability of beneficiary selection [3], [4].

This research proposes an automated decision support system for social assistance eligibility by integrating MobileNetV2-based house image classification with the Analytical Hierarchy Process (AHP) [9]. Unlike previous studies, the confidence score produced by the CNN model is converted into a numerical score and used as the House Condition criterion together with income, occupation, number of dependents, and house ownership in the AHP calculation. The developed web-based system automatically integrates visual and administrative information to generate objective, consistent, and transparent recommendations for social assistance recipients. Therefore, the objective of this study is to develop and implement an automated decision support system that integrates Deep Learning and AHP to improve the accuracy and efficiency of social assistance beneficiary selection.

2. METHODS

This study employed the Waterfall software development model to develop an automated decision support system for social assistance eligibility. The Waterfall model was selected because it provides a structured and sequential development process consisting of problem identification, literature review, data collection, system analysis, system design, implementation, system testing, and evaluation. Each stage was completed before proceeding to the next stage to ensure systematic system development [10].

The research was conducted using two main data sources: house image data and administrative data of prospective social assistance recipients. The administrative data consisted of household income, occupation, number of dependents, and house ownership status. House images were collected from the research area and used to train and evaluate the image classification model. A total of 300 house images were utilized in this study.

The proposed system integrates Deep Learning with a multi-criteria decision-making approach. House image classification was performed using MobileNetV2, a Convolutional Neural Network (CNN) architecture that supports transfer learning and efficient feature extraction [3]. Before model training, all images were resized to 224 × 224 pixels and preprocessed through normalization and data augmentation to improve model generalization. The trained model classified house conditions into two categories, namely Eligible and Ineligible, while also producing confidence scores for each prediction.

The confidence score generated by MobileNetV2 was converted into a numerical scale ranging from 1 to 10 and used as the House Condition criterion in the Analytical Hierarchy Process (AHP) [9]. Four additional criteria, namely income, occupation, number of dependents, and house ownership, were incorporated into the decision-making process. AHP was applied by constructing a pairwise comparison matrix, calculating normalized weights, verifying consistency, and computing the final preference value for each candidate. The final recommendation was generated automatically based on the weighted evaluation of all criteria.

The application was implemented as a web-based system using the Laravel framework, while the MobileNetV2 model was developed in Python using TensorFlow and Keras. The trained model was integrated into the web application through Flask, enabling automatic image classification after users uploaded house images. The classification results were subsequently processed by the AHP module to generate recommendations for social assistance eligibility.

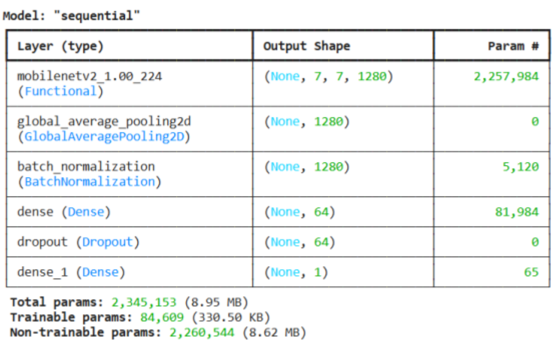
System evaluation consisted of functional testing using the Black Box method, performance evaluation of the MobileNetV2 model, and validation of the AHP calculation results by comparing manual calculations with the system output. These evaluations were conducted to verify that the developed system performed accurately and consistently in determining social assistance eligibility.

3. RESULTS AND DISCUSSION

The proposed system was successfully implemented as a web-based decision support system that integrates MobileNetV2 image classification with the Analytical Hierarchy Process (AHP). The system allows users to input citizen data, upload house images, classify house conditions automatically, perform AHP calculations, and generate recommendations for social assistance eligibility. This integration reduces manual assessment and provides a more systematic decision-making process.

3.1 MobileNetV2 Model Implementation

The proposed system employs MobileNetV2 as the Deep Learning model for automatic house image classification. The model was trained using a dataset of 300 house images, which were divided into training, validation, and testing datasets. Before the training process, all images were resized to 224 × 224 pixels, normalized, and augmented to improve the model's generalization capability. Transfer Learning was adopted by utilizing the pre-trained MobileNetV2 model to reduce training time while maintaining classification performance.


Model: "sequential"

Layer (type)	Output Shape	Param #
mobilenetv2_1.00_224 (Functional)	(None, 7, 7, 1280)	2,257,984
global_average_pooling2d (GlobalAveragePooling2D)	(None, 1280)	0
batch_normalization (BatchNormalization)	(None, 1280)	5,120
dense (Dense)	(None, 64)	81,984
dropout (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 1)	65

Total params: 2,345,153 (8.95 MB)
Trainable params: 84,609 (330.50 KB)
Non-trainable params: 2,260,544 (8.62 MB)

Figure 1. MobileNetV2 Architecture

After the preprocessing stage, the model was trained to classify house conditions into two categories, namely Eligible and Ineligible for social assistance. The training process demonstrated stable convergence between the training and validation datasets, indicating that the selected architecture was capable of learning representative visual features from house images.

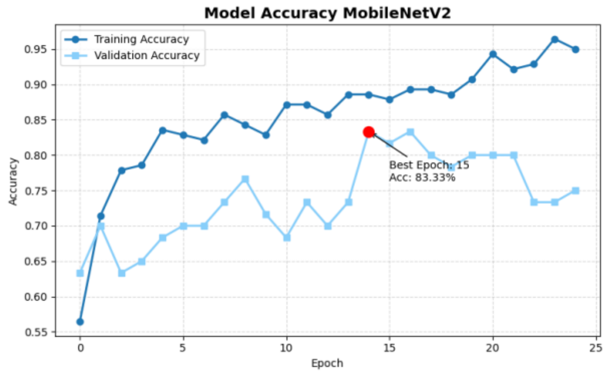


Figure 2. Training Accuracy and Validation Accuracy

3.2 MobileNetV2 Performance Evaluation

The trained model was evaluated using testing data to determine its classification performance. The evaluation results showed that the proposed MobileNetV2 model achieved an accuracy of 74.00%, demonstrating that the model was able to classify house conditions with satisfactory performance for supporting the decision-making process. Besides classification labels, the model also generated confidence scores representing the prediction certainty for each uploaded house image. These confidence scores were subsequently used in the AHP calculation.

Table 1. MobileNetV2 Performance

Parameter	Value
Dataset	300 House Images
Architecture	MobileNetV2
Accuracy	74.00%
Output Classes	Eligible / Ineligible

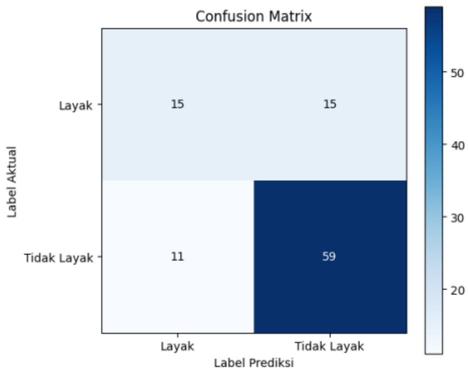


Figure 3. Confusion Matrix

The confusion matrix indicates that most testing samples were correctly classified into their respective classes, although several misclassifications remained. These errors mainly occurred because some house images possessed similar visual characteristics, making them difficult to distinguish automatically. Nevertheless, the obtained performance was considered adequate for supporting the subsequent AHP-based decision-making process.

3.3 Integration of MobileNetV2 and AHP

One of the main contributions of this research is the integration of Deep Learning and the Analytical Hierarchy Process (AHP). Unlike previous studies that relied solely on administrative information, this study incorporates house image classification into the decision-making process.

The confidence score produced by MobileNetV2 was converted into a numerical score ranging from 1 to 10, which represented the House Condition criterion. This criterion was then combined with four additional criteria, namely income, occupation, number of dependents, and house ownership, to calculate the final preference value using the AHP method.

Table 2. CNN Confidence Score Conversion

Kategori Layak	
Persentase CNN	Nilai Rumah
90%–100%	10
80%–89,99%	9
70%–79,99%	8
60%–69,99%	7
<60%	6
Kategori Tidak Layak	
Persentase CNN	Nilai Rumah
90%–100%	1
80%–89,99%	2
70%–79,99%	3
60%–69,99%	4
<60%	5

The AHP method calculated the weighted contribution of each criterion and automatically generated recommendations regarding social assistance eligibility. This integration enables the system to evaluate both visual evidence and socio-economic information simultaneously, resulting in more comprehensive decision-making.

3.4 System Implementation and Functional Testing

The developed application was implemented as a web-based decision support system using the Laravel framework. Users can manage citizen data, upload house images, perform automatic image classification, execute AHP calculations, and obtain final recommendations through a single integrated platform.

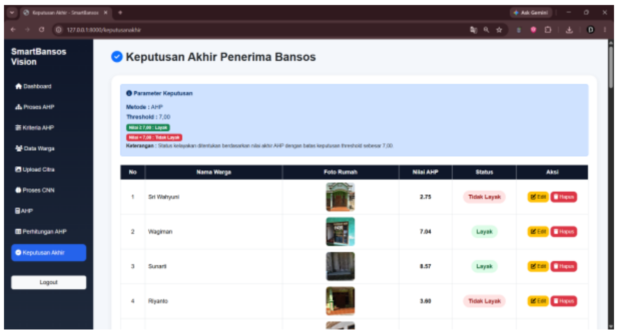
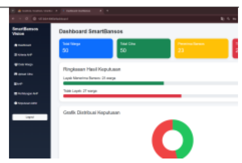
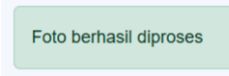
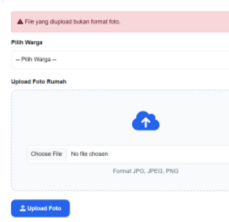
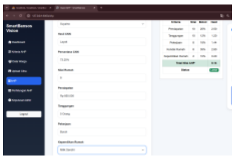


Figure 4. Final Decision Interface

System functionality was evaluated using Black Box testing. The testing results demonstrated that all primary system functions—including login, citizen data management, image uploading, image classification, AHP calculation, and recommendation generation—operated successfully according to the specified functional requirements.

Table 3. Black Box Testing Results

No	Skenario Pengujian	Hasil yang Diharapkan	Hasil Pengujian	Keterangan
1	Pengguna memasukkan email dan	Sistem menampilkan halaman dashboard	Berhasil	

	password			
2	Pengguna mengunggah file citra rumah	Citra berhasil diunggah dan diproses	Berhasil	
3	Mengunggah file selain format citra	Sistem menolak file yang tidak sesuai	Berhasil	
4	Sistem memproses citra rumah	Hasil klasifikasi rumah ditampilkan	Berhasil	
5	Pengguna memasukkan data penilaian	Data berhasil diproses oleh sistem	Berhasil	
6	Sistem menghitung nilai berdasarkan bobot kriteria	Nilai AHP berhasil ditampilkan	Berhasil	
7	Sistem memproses seluruh kriteria	Status Layak/Tidak Layak ditampilkan	Berhasil	

3.5 Discussion

The proposed approach successfully combines computer vision and multi-criteria decision-making into a single automated system for determining social assistance eligibility. Compared with previous studies that only utilized administrative data, the proposed system incorporates visual assessment of house conditions through MobileNetV2 before performing AHP calculations. Consequently, the resulting recommendations are expected to be more objective, consistent, and representative of actual field conditions.

The implementation also demonstrates that integrating Deep Learning with AHP can reduce manual assessment, improve decision consistency, and assist village governments in identifying eligible beneficiaries more efficiently. Therefore, the developed system provides a practical solution for improving the transparency and effectiveness of social assistance distribution.

4. CONCLUSION

This study successfully developed an automated decision support system for determining social assistance eligibility by integrating MobileNetV2-based house image classification with the Analytical Hierarchy Process (AHP). The proposed system automatically classifies house conditions, converts the classification confidence score into a numerical assessment, and combines it with socio-economic criteria, including income, occupation, number of dependents, and house ownership, to generate recommendations for social assistance recipients. Experimental results demonstrated that the MobileNetV2 model achieved an accuracy of **74.00%**, indicating that the proposed approach is capable of supporting the decision-making process. Furthermore, the developed web-based system successfully integrates image classification and AHP calculation into a single platform, providing a more objective, consistent, transparent, and efficient approach to social assistance beneficiary selection. Therefore, the proposed system has the potential to assist local governments in improving the accuracy and effectiveness of social assistance distribution.

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