

Decision Support System for Zakat Asnaf Selection among UiTM Melaka Students Using Artificial Neural Networks

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DOI: <https://dx.doi.org/10.47772/IJRISS.2025.923MIC3ST250015>

Received: 12 August 2025; Accepted: 20 August 2025; Published: 24 October 2025

ABSTRACT

This study developed a Decision Support System for Zakat Asnaf Selection (DSSZAS) to address inefficiencies in the manual distribution of zakat among students at Universiti Teknologi MARA (UiTM) Cawangan Melaka. The current process faces challenges in accurately identifying eligible asnaf and distributing promptly. Therefore, to solve this, the DSSZAS leverages Artificial Neural Networks (ANN) to automate the classification of students into asnaf categories (faqr, miskin, and fisabilillah) based on socioeconomic data. The system was designed and trained with historical data using the Waterfall methodology. A comparison method was deployed between the generated result and human decision to test the result reliability. It achieves an accuracy rate of 1.0% with a minimized Mean Squared Error (MSE) of 0.06. The system significantly reduces human bias and enhances efficiency through automated decision-making and email notifications that inform students of their application status., DSSZAS strengthens the fairness and reliability of zakat distribution by providing a transparent and data-driven approach.

Keywords: Artificial Neural Networks (ANN), Classification, Decision Support System (DSS), Zakat Distribution

INTRODUCTION

Zakat, the third pillar of Islam, is an obligatory charitable contribution that Muslim must give annually from their wealth and income. It plays a critical role in the welfare of the Muslim community, aiming to reduce poverty and inequality. By distributing wealth to the less fortunate, zakat fosters social harmony and financial stability (Othman, S. H. B. et. al, (2020)). Each Muslim individual's possessions, include wealth and income, should be considered to the obligatory annual payment under Islamic law (Saad, A. Y. Q., & Al Foori, A. M., 2020). There is a zakat institution in the Muslim community engage with collects and distribute the zakat to accomplish establishing the welfare of people (Othman et al., 2020). While those people that are involved in receiving zakat aid during distribution activities are called zakat recipients or asnaf, which has 8 categories. Zakat funds is redistribute to eight groups from eligible asnaf which are poor, needy, amil, muallaf, al-Gharimin, fisabilillah, and Ibnussabil notably the utmost focus are the poor and needy (Zulkifli et al., (2021)).

In Malaysia, the management of zakat is carried out by each State Islamic Religious Council, with zakat institutions responsible for collecting and distributing funds. These institutions follow a structured process to ensure that zakat reaches the rightful recipients, known as *asnaf*, who fall into eight categories including the *faqr* (poor), *miskin* (needy), and *fisabilillah* (in the cause of Allah) and others deserving of assistance (Radzi, N. M., & Kenayathulla, H. B. (2017)). While efforts have improved zakat collection in several states, the

distribution process remains complex, often requiring manual assessments and interviews to determine eligibility, which can delay assistance to those in need (Salleh, M. C. M., & Chowdhury, M. A. M. (2020)).

At Universiti Teknologi MARA (UiTMCM), a similar system exists for distributing zakat to students. UiTMCM, one of the university's branches, manages zakat distribution through the *Wakaq, Zakat, and Infaq (EL-WAZIF) Unit*. Here, students from lower-income households (B40) who meet the criteria for *asnaf*—such as *faqr*, *miskin*, and *fisabilillah*—can apply for zakat assistance. However, the current process involves manual interviews and decision-making, which presents challenges in terms of efficiency and timely distribution.

This paper addresses the challenges of zakat distribution at UiTM Cawangan Melaka by developing a decision-making model using Artificial Neural Networks (ANN). It highlights the inefficiencies of the manual process for selecting eligible *asnaf* students, which is time-consuming and complex. The proposed Decision Support System for Zakat Asnaf Selection (DSSZAS) uses ANN to automate student classification and prioritisation based on socioeconomic data to solve this. The ANN model is trained with historical data, providing a more accurate and fair distribution of zakat. The system improves the ranking of applicants, reduces processing time, and enhances transparency.

LITERATURE REVIEW

Zakat Implementation in Malaysian Universities

Several universities in Malaysia have developed tailored systems to manage zakat distribution effectively for their students and staff. Universiti Putra Malaysia (UPM), through its Centre for Management of Waqf, Zakat, and Endowment (WAZAN), manages zakat in collaboration with the Selangor Zakat Board. UPM is authorised to distribute zakat to five categories of *asnaf*—*fakir* (destitute), *miskin* (poor), *muallaf* (new converts), *ibn sabil* (wayfarers), and *fisabilillah* (in the cause of Allah). The UPM-ID system facilitates this process by allowing students to submit applications online, which are validated through interviews before approval. The process ensures transparency and accountability, with notifications sent via email before the zakat aid is transferred to student bank accounts (Pusat Pengurusan Wakaf, Zakat dan Infak, 2022).

Similarly, Universiti Teknologi Malaysia (UTM) and Universiti Tun Hussein Onn Malaysia (UTHM) have adopted digital systems to manage student zakat distribution. UTM's Islamic Center administers the Zakat Distribution System through the MyUTM Student portal, where students can apply for various forms of Zakat aid, including tuition and subsistence assistance, with results communicated via email (Hamzah, N. B. et. al. (2021)). UTHM, on the other hand, uses student portal for zakat application submission including show the results. Any notification is shared through social media such as Whatsapp and Telegram (Pusat Islam Unit Pengurusan Zakat UTHM (2025)). Although these systems differ in their features—such as notification methods and had *kifayah* calculations, they all aim to streamline zakat distribution and provide timely financial assistance to eligible students.

Zakat Implementation in UiTM Melaka

UiTM Cawangan Melaka has also introduced a zakat distribution system to support its student body, particularly those from the B40 income group, who face financial challenges. Managed by the Islamic Affairs Unit (UHEI) and supported by the Academy of Contemporary Islamic Studies (ACIS), the zakat distribution process is overseen by three Islamic Affairs Officers across three campuses: Kampus Alor Gajah, Kampus Bandaraya Melaka, and Kampus Jasin. The zakat funds are allocated to students who fall under *faqr*, *miskin*, *fisabilillah*, and *muallaf*. Eligible students receive zakat funds every semester, helping alleviate their financial burdens.

Initially, zakat distribution was done manually, but starting in the 2021/2022 session, UiTM Melaka introduced the eZakat system within the eHEP platform to digitize the process. Students complete an eight-section application covering personal, family, and financial details, with the system automatically calculating the *kifayah* limit based on family income and dependents. Interviews are conducted with students whose applications contain uncertainties, and final decisions are made following an approval process involving

campus management. Once approved, zakat funds are transferred to the student's bank accounts, typically during the final examination period. The shift to eZakat has improved efficiency and transparency, enabling quicker processing and more straightforward communication with students via the UHEI Facebook page and the eZakat system.

Artificial Neural Networks (ANN) in Zakat Implementation

Artificial Neural Networks (ANN), a powerful Artificial Intelligence (AI) tool, offer a transformative approach to enhancing zakat implementation, particularly in automating the identification and prioritization of *asnaf*. ANN models are adept at analyzing complex socioeconomic data, such as income levels and household sizes, to classify recipients more precisely. By learning from historical data, ANN systems can continuously refine their decision-making process, ensuring that zakat funds are distributed based on objective, data-driven criteria. This minimizes human bias, speeds up decision-making, and ensures that resources are allocated equitably, with the most vulnerable recipients receiving priority (Bahri E. S. et. al, (2022))

Moreover, ANN improves the overall efficiency of zakat management by streamlining operations and reducing fraud. These systems can detect anomalies in application data, identify fraudulent claims and ensure that funds are directed to those genuinely in need (Alhajeri R. and Alhashem A. (2023)). The scalability of ANN makes it ideal for large-scale zakat systems, processing thousands of applications in a fraction of the time required for manual assessments. When combined with blockchain technology, ANN further enhances transparency by creating tamper-proof records of zakat transactions, enabling stakeholders to track funds with greater accountability. Integrating ANN into zakat distribution systems makes the entire process more efficient, fair, and secure, significantly improving the system's ability to alleviate poverty and support vulnerable communities (Miftahur A. H. et. al. (2020), Sulaiman H. and Jamil N. (2014))

There are two techniques of data obtain that can be manage by the ANN. The unlabelled data is group by according to similarities among the example inputs and labelled dataset is being classify to train these datas (Khalil et al., 2019). To distinguish it is from the type of data that are labeled or unlabeled data. The discovered from numerous studies is classification of neural network is more efficient and more accurate to tackle real-world problems due to their capability of self-learning and self-adapting (Al-Mubayyed et al., 2019). Classification phase starts of with the network is trained on a set of paired input and output data to determine its mapping. After the weight of the connections between neurons are fixed, the network can classify the new set of data. For unlabelled sample or unordered data, clustering method is used by grouping objects according to measured intrinsic characteristics or similarity into homogeneous group (Raptodimos & Lazakis, 2018).

RESEARCH METHODOLOGY

This section outlines the approach taken to developing an efficient and transparent zakat distribution system, leveraging system design principles and Artificial Neural Networks (ANN) to optimize decision-making. The methodology is divided into two subsections: the first focuses on the design of the Decision Support System for *Asnaf* Zakat Selection (DSSZAS), detailing the workflow, data collection, and implementation processes; the second subsection discusses the use of ANN in enhancing the system's ability to classify and prioritize *asnaf* applicants, ensuring a fair and data-driven distribution of zakat funds.

System Design

The development of the DSSZAS begins with gathering input and analyzing the requirements of the existing business process. This phase is crucial for understanding the current workflow, which involves determining eligible *asnaf* applicants, conducting interviews, and assigning appropriate zakat amounts. This process clearly defines the system's requirements, forming the foundation for creating relevant diagrams such as the Use Case Diagram, Data Flow Diagram (DFD), and Domain Class Diagram (DCD).

Once the requirements are collected, the system design phase begins. This involves constructing a Use Case Diagram to represent the interactions between users such as students, evaluators, and administrators and the

system. The Data Flow Diagram (DFD) defines the system's boundaries. It outlines how data flows between external entities and the system as shown in Figure 1 and Figure 2. Additionally, a Domain Class Diagram (DCD) is created to design the database structure, ensuring that all necessary data elements, such as student information, evaluation results, and zakat records, are captured efficiently. These diagrams provide a comprehensive view of how the system will function and how various users will interact with it.

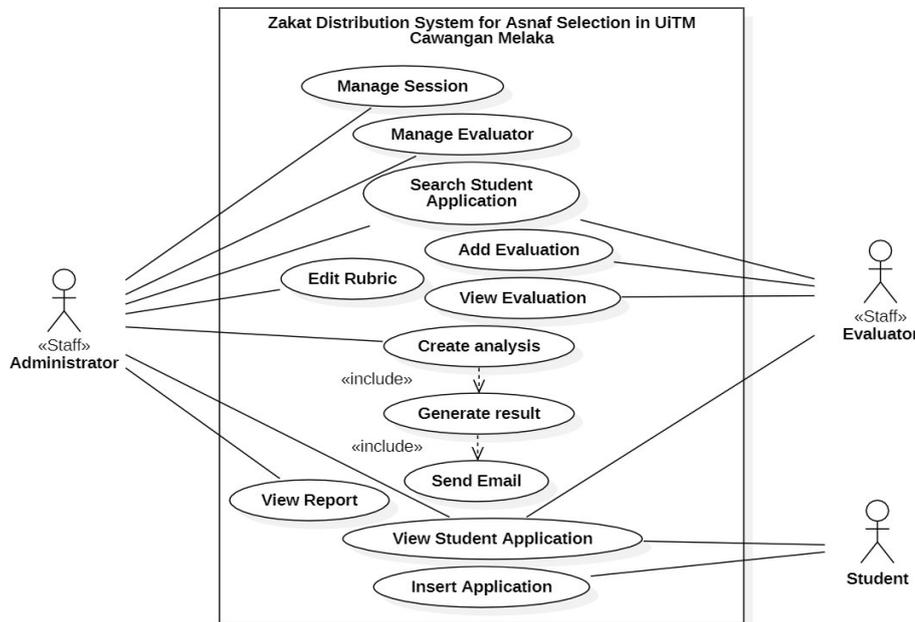


Figure 1: Use case diagram

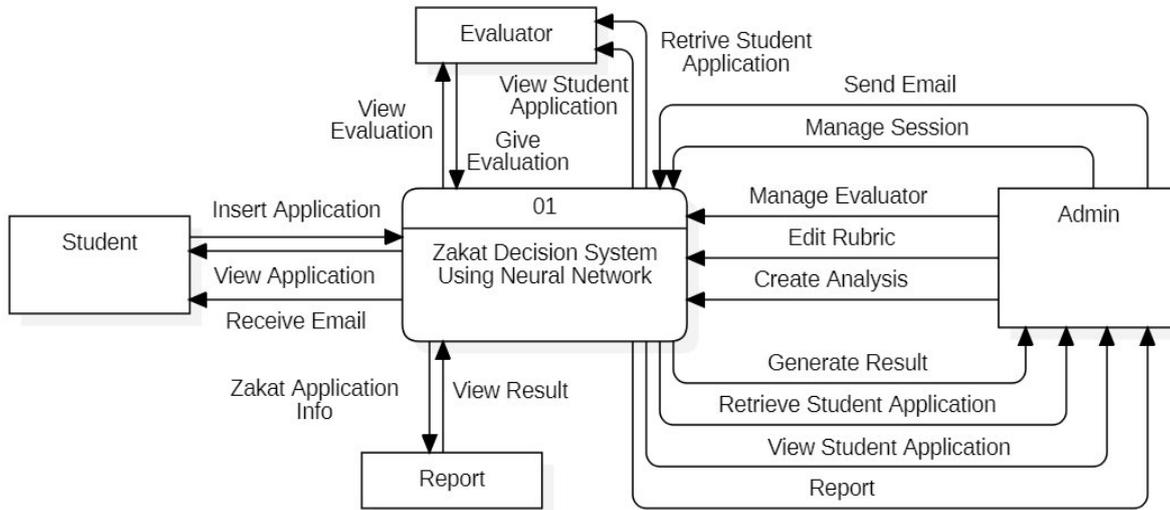


Figure 2: Context Diagram for Zakat Distribution System

The system flowchart Figure 3, outlines the complete process from application submission to final approval. Initially, students submit their applications through the eZakat platform, where their eligibility is automatically filtered based on had *kifayah*, ensuring that only students from the B40 income group (family income below RM4,000) proceed. Following this, the applications undergo an evaluation phase where the evaluators review and resolve any uncertainties in the data. The flowchart demonstrates how Artificial Neural Networks (ANN) will be used in the final decision-making process. By combining student data with evaluator input, the system ensures that zakat funds are distributed fairly and accurately. Once the evaluation is completed, the results are saved in a report format accessible to both administrators and evaluators for final approval. This flowchart provides a clear, step-by-step depiction of the system's workflow, ensuring an efficient and transparent zakat distribution process.

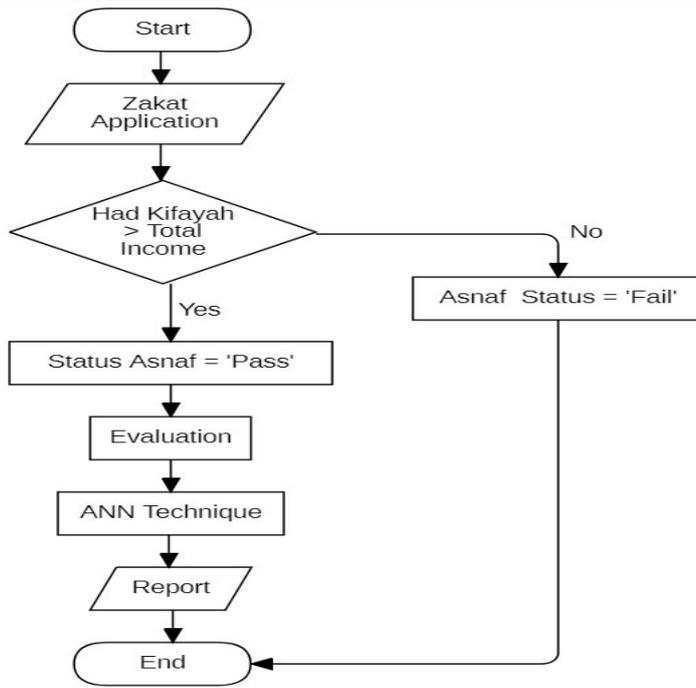


Figure 3: System Flowchart

Artificial Neural Network (AN) Strategy

The Artificial Neural Network (ANN) strategy is vital in automating and optimizing the zakat allocation process. It combines student information with evaluator inputs to determine the appropriate zakat distribution. The ANN model is designed to ensure fairness, accuracy, and efficiency in decision-making, considering various socioeconomic factors related to students' financial needs.

The ANN model begins by gathering inputs, including student data such as CGPA, number of siblings, outstanding loans, and an evaluator-assigned ranking. These inputs are critical to determining the student's eligibility as *asnaf faqr*, *miskin*, or *fisabilillah*. Collected data is transformed into a numerical range of 0.0 and 1.0. For example, the asnaf numerical for faqr as 0.9, miskin as 0.5 and fisabilillah as 0.2. As shown in Table 1, the weight for each input is decided by domain experts, with the flexibility to adjust the values as needed. For instance, the number of siblings and loan balances hold a higher weight (0.9) compared to CGPA (0.5), while ranking holds the maximum weight (1). These weights ensure that the most financially vulnerable students are prioritised during the zakat allocation process.

Table 1: Weight of the Input

No	Input	Importance
1	CGPA	0.5 (0.4)
2	Number of siblings that is studying	0.9 (0.7)
3	Reminder of loan	0.9 (0.8)
4	Ranking	1 (0.5)

*During the first test, the results are poor. As the value changes, this is the most importance that showing less MSE

Next, the ANN strategy proceeds with data normalization, where input values from the database are transformed into smaller, standardized values. This step is necessary to improve the efficiency of the neural network by ensuring that all inputs fall within a comparable range. The data is split into two sets: 80% is used for training, while the remaining 20% is reserved for testing the model's accuracy. Using a sigmoid function,

the feedforward method, is applied to process the data. The resulting output is between 0 and 1, representing whether the student qualifies as *asnaf*. A loss function is employed within the model to evaluate errors between the predicted and actual outputs. To reduce this error, backpropagation is used to adjust the weights within the neurons, ensuring that the system improves with each iteration. The Mean Squared Error (MSE) function is employed to quantify the difference between predicted and target values, providing the model's continuous learning.

The ANN model is structured with three layers: one input layer, three hidden layers, and one output layer. The input neurons receive the student data, and the hidden layers process the information, calculating intermediate outputs. The weights assigned to each neuron are based on the significance of the input, as outlined by the experts. During this process, the ANN model runs in multiple iterations, adjusting the weights to minimise errors between the predicted and actual results. As backpropagation update the weights, the model becomes more accurate in predicting the final classification of *asnaf*.

The ANN model ultimately outputs a determined classification whether the student falls into one of the three *asnaf* categories. After training and testing the model, the system should reliably identify eligible students and determine the appropriate zakat distribution. This approach ensures that the zakat allocation is based on a data-driven and unbiased process, improving the fairness and efficiency of the overall system.

RESULT AND DISCUSSION

The developed zakat distribution system DSSZAS is built on the Model-View-Controller (MVC) framework, which separates the system into three distinct layers: the view (user interface), the controller (business logic), and the model (data access). This architecture ensures efficient communication between the components, where the front end interacts with users and sends operations to the controller, while the model handles data storage, retrieval, and manipulation. The core objective of this system is to build a decision support system that can accurately classify students into one of three *asnaf* categories. The system achieves this through integrating data input from students, staff rankings, and an Artificial Neural Network (ANN) model. Additionally, the system includes an email notification feature to inform students of the successful completion of their applications.

The ANN model used in the system was trained using a batch-size method to handle student data. The model required training data that consisted of previous student information with corresponding *asnaf* classifications, as depicted in Figure 4 and Figure 5. During the training phase, the feed-forward method was applied to process the input data, with the Mean Squared Error (MSE) used to calculate the loss between the predicted and actual outputs. Backpropagation was employed to minimize this loss by adjusting the neuron weights. After training, the model was tested to assess its accuracy in classifying students. The initial test with 14 data points yielded an accuracy of 0.35 with a 4-1-1 architecture. As the training data set increased to 200 data points, the accuracy improved to 0.39%, and the MSE was reduced to 0.11.

```

TrainSet [4 ; 1]
[Cgpa,numStud,remloan,rank] ; [Fakir, Miskin, Fisab]
0: [0.54, 5.0, 0.2, 0.9] >-||-< [0.9]
1: [0.65, 3.0, 0.14, 0.2] >-||-< [0.2]
2: [0.28, 4.0, 0.26, 0.5] >-||-< [0.5]
3: [0.82, 1.0, 0.18, 0.2] >-||-< [0.2]
4: [0.78, 1.0, 0.17, 0.9] >-||-< [0.9]
5: [0.43, 3.0, 0.15, 0.9] >-||-< [0.9]
6: [0.49, 3.0, 0.0, 0.2] >-||-< [0.2]
7: [0.84, 1.0, 0.0, 0.5] >-||-< [0.5]
8: [0.68, 1.0, 0.0, 0.5] >-||-< [0.5]
9: [0.91, 4.0, 0.15, 0.2] >-||-< [0.2]
    
```

Figure 4: Train Dataset

```
TEST [Output],MSE
1: [0.6072029137837428]0.042865066848365184
2: [0.6071060258332133]0.08286765813485646
3: [0.6071737948998223]0.005743111156614584
4: [0.6065862249232086]0.08265617914865298
5: [0.6068843834595522]0.04295838232994342
6: [0.6071464083113585]0.042881613082468795
7: [0.6070695573638276]0.08285281226619126
8: [0.6066677019264631]0.005688999317136394
9: [0.6065736273670769]0.0056789690250882785
10: [0.6071809998401498]0.08289818331541204
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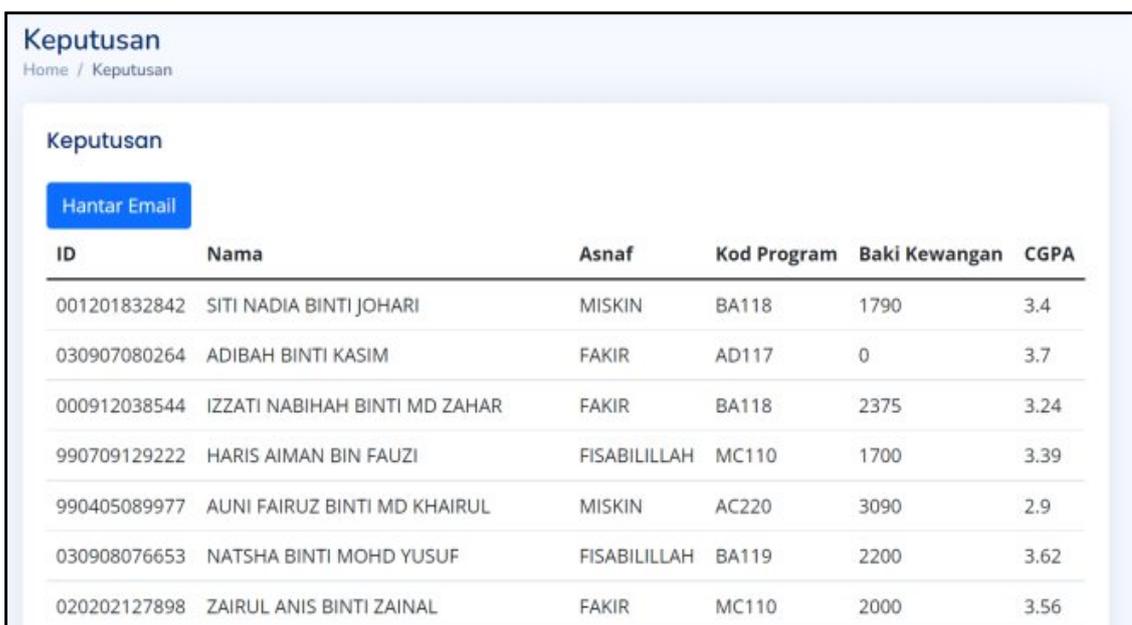
Figure 5: Test Dataset

The first training with the initial weight results in an accuracy drop. Perform more testing by changing the importance of weight to lower importance especially the ranking weight because the data is less varied with only three distinct values. The ranking weight becomes 0.5 because most of the training data points are correctly assigned, leading to 1.0 accuracy. To compare the system-generated *asnaf* classifications with the panel’s original results, the testing data was modified to incorrect *asnaf* classification only. During panel justification, panel can modify the students' ranking to correct the assigned *asnaf*. After the testing data is completed, the *asnaf* classification is compared with the previous results and it comes out similar as shown in Table 2.

Table 2: Asnaf Test Result

	Current Asnaf	Expected Asnaf Result	Test 1	Test 2	Test 3
Dataset 1	Miskin	Faqr	Not Match	Not Match	Match
Dataset 2	Fisabilillah	Miskin	Not Match	Not Match	Match

Further refinement of the ANN model included increasing the neurons in the hidden layer. As demonstrated by the third test with an expanded hidden layer, the accuracy rose to 1.0%, and the MSE was further minimized to 0.06. This indicates the system's performance improves as more data is trained, and the network architecture is optimized. The final result shows that the ANN model is highly effective in classifying *asnaf* categories with an acceptable level of accuracy, as shown in Figure 6. The decision support system generated by the DSSZAS successfully mirrors the decisions typically made by human evaluators, demonstrating that the system can be relied upon to automate the selection process while maintaining the integrity and fairness of zakat distribution.



ID	Nama	Asnaf	Kod Program	Baki Kewangan	CGPA
001201832842	SITI NADIA BINTI JOHARI	MISKIN	BA118	1790	3.4
030907080264	ADIBAH BINTI KASIM	FAKIR	AD117	0	3.7
000912038544	IZZATI NABIHAH BINTI MD ZAHAR	FAKIR	BA118	2375	3.24
990709129222	HARIS AIMAN BIN FAUZI	FISABILILLAH	MC110	1700	3.39
990405089977	AUNI FAIRUZ BINTI MD KHAIRUL	MISKIN	AC220	3090	2.9
030908076653	NATSHA BINTI MOHD YUSUF	FISABILILLAH	BA119	2200	3.62
020202127898	ZAIRUL ANIS BINTI ZAINAL	FAKIR	MC110	2000	3.56

Figure 6: Asnaf Zakat Selection Generated by DSSZAS

Overall, the results confirm that the ANN-based decision support system is a viable solution for automating the classification and selection of *asnaf* recipients. The system's accuracy and ability to minimize errors through backpropagation and MSE demonstrate that it can significantly streamline zakat distribution processes, improving efficiency and transparency. By integrating data-driven techniques with automated decision-making, the system provides a robust and scalable solution for zakat management in educational institutions.

CONCLUSION

This study successfully developed an ANN-based decision support system to automate and optimize zakat distribution for students in UiTM Cawangan Melaka. By classifying students into *asnaf* categories of *faqr*, *miskin* and *fisabilillah* based on socioeconomic data, the system effectively addressed the inefficiencies of manual zakat processing. The ANN model demonstrated improved decision-making accuracy, reaching up to 1.0% with a minimized Mean Squared Error (MSE) of 0.06, indicating the system's ability to make reliable and data-driven decisions. Integrating a Model-View-Controller (MVC) framework ensured smooth interaction between users, evaluators, and the system's database. Overall, the system significantly improved the fairness, efficiency, and transparency of zakat allocation.

Future research could focus on expanding the dataset used for training the ANN model, as larger datasets might further increase the system's accuracy and robustness. Integrating real-time data updates and dynamically adjusting weights could also refine the decision-making process. Additionally, exploring the use of blockchain technology to enhance security and traceability of transactions could add another layer of transparency and accountability. Expanding the system to include multiple universities or national zakat institutions could create a centralized platform for zakat management, benefiting a broader population. These improvements would continue to enhance the efficiency and equity of zakat distribution, further supporting social welfare.

ACKNOWLEDGMENTS

This paper is the starting point of Final Year Project conducted at the Faculty of Computer and Mathematic Sciences, Universiti Teknologi MARA.

REFERENCES

1. Othman, S. H. B., Ismon, A. B. M., & Fahurruzi, M. F. (2020). The Study on The Development of Asnaf fisabilillah by The Islamic Religious Council of Malacca. *International Journal of Academic Research in Business and Social Sciences*, 10(2). <https://doi.org/10.6007/ijarbss/v10-i2/6929>
2. Radzi, N. M., & Kenayathulla, H. B. (2017). Educational Equity for Malaysian Urban Poor Muslim Students. *Malaysian Online Journal of Educational Management*, 5(4), 47–62. <https://doi.org/10.22452/mojem.vol5no4.4>
3. Salleh, M. C. M., & Chowdhury, M. A. M. (2020). Technological Transformation in Malaysian Zakat Institutions. *International Journal of Zakat*, 5(3), 44–56. <https://doi.org/10.37706/ijaz.v5i3.263>
4. Pusat Pengurusan Wakaf, Zakat dan Infak (2022, Oct 14). https://wazan.upm.edu.my/permohonan_zakat/permohonan_zakat_pelajar/bagaimana_proses_permohonan_zakat-63697
5. Hamzah, N. B., Masroom, Mohd. N. B., Ruskam, A. B., & Saim, A. I. B. (2021). Penggunaan Wang Bantuan Zakat Dalam Kalangan Asnaf Fisabilillah Dan Asnaf Gharim Di Universiti Teknologi Malaysia. *AZKA International Journal of Zakat & Social Finance*, 1(2), 187–209. <https://doi.org/10.51377/azjaf.vol1no2.37>
6. Pusat Islam Unit Pengurusan Zakat UTHM (2025, Mac 21). <https://pi.uthm.edu.my/index.php/zakat>
7. Bahri E. S., Salamun A, and Arif Z. (2022), Measuring the Effectiveness of Zakat Disbursement at Amil Zakat Institution Dewan Da'wah Utilizing Zakat Core Principle Approach, *Al- Maal: Journal of Islamic Economics and Banking*, vol. 4, no. 1, p. 119, <https://doi.org/10.31000/almaal.v4i1.5937>.
8. Alhajeri R. and Alhashem A. (2023), Using Artificial Intelligence to Combat Money Laundering, *Intelligent Information Management*, vol. 15, no. 4, pp. 284–305, <https://doi.org/10.4236/iim.2023.154014>.

9. Miftahur A. H., Leni S, and Kholidah (2020), Ziswaf Collection Strategy on LAZISMU X, Indonesia, Proceedings of the 1st Borobudur International Symposium on Humanities, Economics and Social Sciences (BIS-HESS 2019), <https://doi.org/10.2991/assehr.k.200529.098>.
10. Sulaiman H. and Jamil N. (2014), Information security governance model to enhance zakat information management in Malaysian zakat institutions, Proceedings of the 6th International Conference on Information Technology and Multimedia, <https://doi.org/10.1109/icimu.2014.7066630>.
11. Radzi, N. M., & Kenayathulla, H. B. (2017). Educational Equity for Malaysian Urban Poor Muslim Students. *Malaysian Online Journal of Educational Management*, 5(4), 47–62. <https://doi.org/10.22452/mojem.vol5no4.4>
12. Saad, A. Y. Q., & Al Foori, A. M. (2020). Zakat and Tax: A Comparative Study in Malaysia. *International Journal of Innovation, Creativity and Change*, 10(12), 140–151. https://www.ijicc.net/images/vol10iss12/101213_Saad_2020_E_R.pdf
13. Zulkifli, M. F., Taha, R., Awang, R. @ N., Mohd Nor, M. N., & Ali, A. (2021). Combating Poverty in Malaysia: The Role of Zakat. *The Journal of Asian Finance, Economics and Business*, 8(5), 505–513. <https://doi.org/10.13106/jafeb.2021.vol8.no5.0505>
14. Khalil, A. J., Barhoom, A. M., Abu-Nasser, B. S., Musleh, M. M., & Abu-Naser, S. S. (2019). Energy Efficiency Predicting using Artificial Neural Network. *International Journal of Academic Pedagogical Research (IJAPR)*, 3(9), 1–8. <http://dstore.alazhar.edu.ps/xmlui/handle/123456789/487>
15. Al-Mubayyed, O. M., Abu-Nasser, B. S., & Abu-Naser, S. S. (2019). Predicting Overall Car Performance Using Artificial Neural Network. *International Journal of Academic and Applied Research (IJAAR)*, 3(1), 1–5. <http://dstore.alazhar.edu.ps/xmlui/handle/123456789/127>
16. Raptodimos, Y., & Lazakis, I. (2018). Using artificial neural network-self-organising map for data clustering of marine engine condition monitoring applications. *Ships and Offshore Structures*, 13(6), 649–656. <https://doi.org/10.1080/17445302.2018.1443694>