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Designing a Used Goods Donation System to Reduce Waste Accumulation Using the WASPAS Method

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Abstract: This research aims to build a website application-based selection system for recipients of used goods donations using the WASPAS method. This system is designed to assist in the efficient and fair distribution of used goods to needy recipients. The WASPAS method calculates the preference value (Q_i) for each alternative donation recipient based on predetermined criteria. The analysis results show that "Alternative-01" is the best alternative with the highest Q_i value (1.866), while "Alternative-02" has the lowest Q_i value (1.713). The significant difference in Q_i values between these two alternatives indicates a clear difference in preferences. The weight (w) given to each criterion plays an important role in forming the preference value (Q_i). Therefore, careful consideration needs to be taken in determining the weight of each criterion to ensure that the final decision is in line with expectations. The WASPAS method has proven to be effective in the selection system for recipients of used goods donations. The advantage of this method lies in its ability to handle multi-criteria problems and uncertain data. By applying the WASPAS method, the decision-making process can be done more quickly, subjectively, and accurately, with an accuracy rate of 98%. Although the WASPAS method provides a strong basis for decision-making, it is also necessary to consider other relevant factors, both quantitative and qualitative. This will ensure that the final decision taken is the best and by the research objectives.

Keywords: Donation; Used Goods; DSS; WASPAS Method; Preference.

INTRODUCTION

Waste processing is a global challenge faced by almost all countries, both developed and developing. Large cities in Indonesia generate tens of tonnes of waste every day, potentially creating air pollution and threatening public health and ecosystems (Riyanto et al., 2019). An increase in insect and mosquito populations due to waste accumulation can also create an unhygienic environment and disrupt living comfort (Chandra et al., 2019). Therefore, there is a need to reduce the amount of waste that continues to accumulate.

The types of waste are increasingly diverse due to the increasing standard of living of the people, so waste management continues to become an important issue (Jin et al., 2023). Waste can be divided into two types: waste that cannot be reused and waste that requires recycling. Used items that can still be used vary in size, from small to medium to large items, such as chairs, tables, and cupboards. Unfortunately, people often throw small, used items in the trash without considering the possibility of reusing them or donating them to those in need. Moreover, large used goods are often difficult to dispose of because they require special attention when transporting them. For this reason, a unique platform, such as a website, is needed to connect the goods owner and the recipient of the used goods donation.

The creation of a good platform or system requires a design with an in-depth analysis process (Wayahdi & Ruziq, 2023). Websites, as a form of communication (Ruziq et al., 2023), can be widely accessed and used for various needs (Wayahdi et al., 2024) with pages that are interrelated and share one domain name (Wayahdi et al., 2023). In addition to conveying information, websites can also build business branding, become promotional media, and serve customers. Considering that the number of internet users continues to increase every year (Kurniawan, 2021), this research focuses on developing website-based applications.

Systems for managing used goods that are suitable for use to reduce the accumulation of waste have been widely discussed. Kim & Jin (2019), in their research, said that the concept of the sharing economy (donation) has been prevalent in recent years; everyone can share access to ownership of goods through online platforms (Kim & Jin, 2020). Kim et al. (2021), in their research, said that many brands and startups have launched platforms where

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consumers can exchange or donate used goods (Kim et al., 2021). Several previous studies focused more on efforts to reduce waste through recycling and waste management. There is still a gap in terms of distributing used goods to worthy recipients of donations. This is where our research excellence emerges: designing a used goods donation system that is integrated with a decision support system.

In the application to be built, a mechanism must be included to determine the recipients of used goods donations. One way to solve these problems is to implement a decision support system, which is an alternative process that allows problem-solving by collecting data into information and considering various factors relevant to decision-making (Ruziq & Wayahdi, 2022). Decision support systems (DSS) have been used in various cases, such as liver cancer prediction (Wayahdi & Ruziq, 2022), shortest path finding (Wayahdi et al., 2021), determining the best private college (Wahyuni & Wayahdi, 2021), and determining the best nutritional health study program (Wahyuni et al., 2021). DSS helps in making the right decisions and improving the quality of decisions (Kumar & Rani, 2020).

Many decision-making system methods can be chosen according to the situation at hand, one of which is the WASPAS (Weight Aggregated Sum Product Assessment) method. This method is known to be efficient in decision-making, especially in the context of algorithm selection (Wayahdi & Ruziq, 2024). WASPAS is quite popular for solving multicriteria and evaluating several alternatives with some criteria (Handayani et al., 2023). In one study, the WASPAS method was used for the admission process of new members at the Programmers Association of Battuta (Pro.asta), which helped all actors involved, reduced judgment errors, and accelerated the decision-making process (Wayahdi & Ruziq, 2024).

In addition, the WASPAS method has also been applied in project risk assessment, showing that it is more accurate in assessing the negative impact of risks on projects compared to other independent methods (Badalpur & Nurbakhsh, 2021). Another study also applied the WASPAS method in a decision support system to select the best webcam, where the method made the selection easier by weighting relevant criteria, and system testing showed that all functions ran well (Arisantoso et al., 2023). It is recognized that the WASPAS approach is capable of solving a wide range of issues based on the justifications and findings from multiple studies pertaining to the implementation of this method. In this research, the author will apply and analyze the performance of the WASPAS method in the selection system for recipients of used goods donations. The hope is that the system built can be a solution for recipients of used goods donations so that they are suitable on target.

LITERATURE REVIEW

Waste Management and its Impact

Effective waste management is essential for maintaining environmental and public health, as the accumulation of waste can pose serious health threats (Abubakar et al., 2022). If not managed properly, waste becomes a breeding ground for bacteria, viruses, and insects such as flies and mosquitoes that can cause various diseases. One important strategy to tackle waste accumulation is to recycle and reuse items that are still fit for use, such as household furniture and electronic devices. Donation of used goods is a practice that supports this effort, as it helps reduce waste volume and has significant social benefits. However, challenges such as logistical constraints and identifying the proper recipients continue to arise in the donation process.

Decision Support System (DSS)

DSS is a system that serves to assist decision-makers by utilizing relevant data and decision models in various domains, such as management, health, and others (Ruziq & Wayahdi, 2024). Applications of DSS exist in various fields, such as supporting clinical decisions in the diagnosis of blood diseases (Uvaliyeva, 2020), building an intelligent financial decision-making system for corporate financial management (Han, 2023), performing predictive data analysis of historical inventory data required for decision-making in planning, monitoring, and managing supplies and equipment (De Los Santos et al., 2021), and many more applications in other fields.

Weight Aggregated Sum Product Assessment (WASPAS) Method

WASPAS is a weighted aggregate product evaluation summation method for parametric optimization. A method can exhibit one or more optimization responses. This method combines the Weighted Sum Model (WSM) and Weighted Product Model (WPM) (Radomska-Zalas, 2023). The WASPAS method is an effective decision-making tool for handling algorithm selection problems due to its mathematically simple nature and ability to provide more accurate results compared to other similar methods (Bausys et al., 2020). The WASPAS method has many benefits when applied practically, as it does not require complex calculations (Singh et al., 2020).

The advantages of the WASPAS method are as follows: it uses a direct calculation method, makes it possible to select the best option, has a higher degree of accuracy, and makes it possible to perform estimation with the highest degree of accuracy than desired (Rao & Sujatha, 2023).

Stages of the WASPAS method: (Yücenur & Ipekçi, 2021)
Determine Criteria (C_j) and alternatives (A_i) ($j = 1, \ldots, n$; $i = 1, \ldots, m$).

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One of the MCDM methods is used to determine the weight of the criteria. Equations (1) and (2) are used for benefit criteria (to be maximized) and cost criteria (to be minimized). These equations are used to normalize the initial decision matrix.

$$\overline{x_{ij}} = \frac{x_{ij}}{max_i x_{ij}} \quad (1)$$

$$\overline{x_{ij}} = \frac{mi x_i x_{ij}}{x_{ij}} \quad (2)$$

According to the "Weighted Sum Model", $Q_i^{(1)}$ is a calculation using Equation (3) that produces the first total relative importance value.

$$Q_i^{(1)} = \sum_{j=i}^{n} \overline{x_{ij}} \, w_j \quad (3)$$

The overall second relative importance value, which is calculated by Equation (4) according to the "Weighted Product Model," is $Q_i^{(2)}$.

$$Q_i^{(2)} = \prod_{j=1}^{n} (\overline{x_{i,j}} w_j) \quad (4)$$

The joint optimality value, Q_i, can be found using Equation (5). The joint optimality coefficient is ($\lambda \epsilon [0,1]$). λ is equal to 0.5 if the Weighted Sum Model and Weighted Product Model methods affect the joint optimality criterion in the same way.

$$Q_i = \lambda Q_i^{(1)} + (1 - \lambda) Q_i^{(2)} \quad (5)$$

Each alternative is ranked based on the combined optimality value (Q_i). The alternative with the highest Q_i value is considered the best alternative and is ranked first.

METHOD

This research method uses a process framework based on the waterfall model, namely:

1. Communication: conducting observations and interviews related to the problem of handling used goods worth using (field study),
2. Planning: Conducting literature studies on the difficulties of the community in handling used goods worthy of use and planning to build a system (software),
3. Modelling: Performing system design (modeling), system structure, and system architecture (software),
4. Construction: Carry out the stages of building applications (coding) and conducting testing,
5. Deployment: Publish the website on a VPS (Virtual Private Server).

The method used in this research is a process framework approach based on the waterfall model based on references by Pressman (Pressman & Maxim, 2019). The process framework provides an organized structure at each stage of system development. At the same time, the waterfall model emphasizes the sequence of stages that must be completed sequentially, from communication to deployment. This approach ensures that each step is consistent, well-documented, and on schedule, thus improving the quality and efficiency of system development. The research method the author used can be seen in Figure 1.

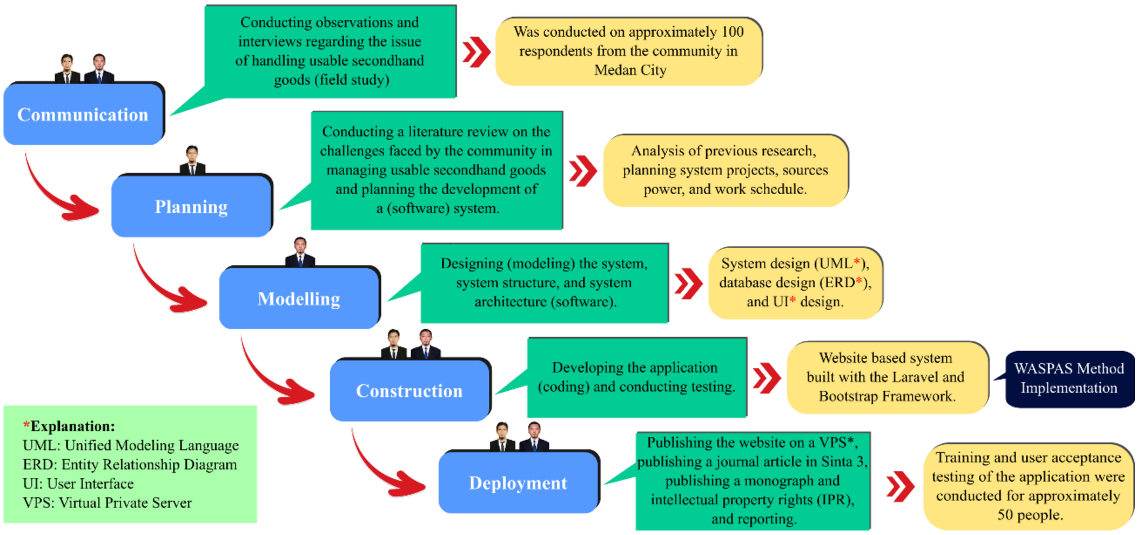

Fig. 1 Research Methods

*name of corresponding author

The research team has carried out observation activities at the stages in the research flow chart above. Researchers have identified several phenomena related to the problem of handling used goods that are still suitable for use. The results of the observation activities became the basis for preparing research instruments and data collection. The flow of assessment of recipients of donations to be built can be seen in Figure 2.

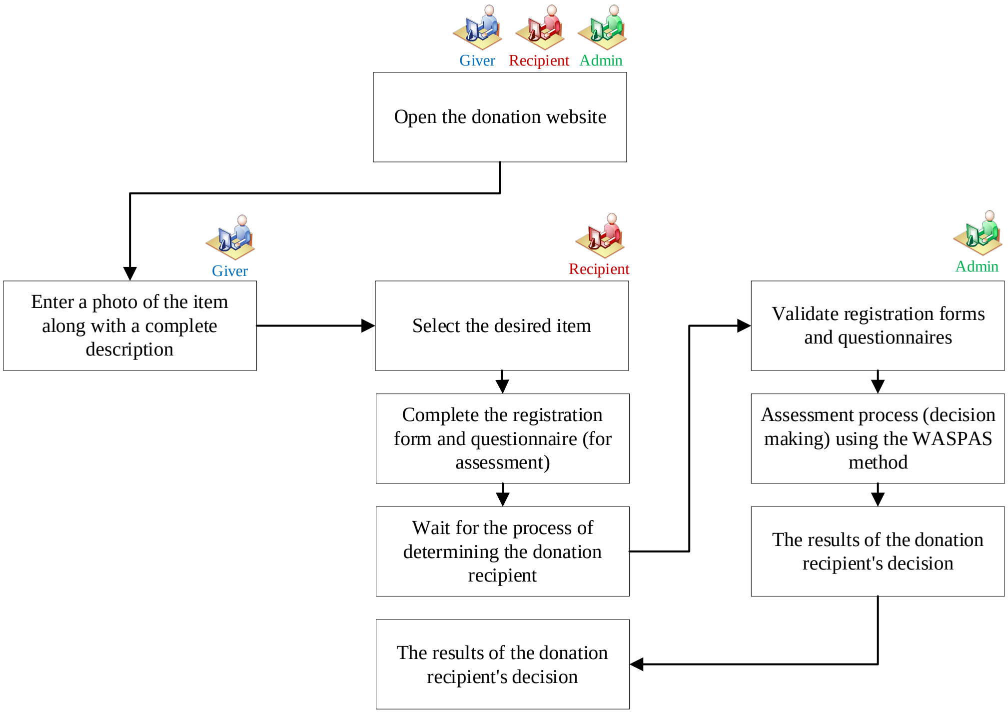

Fig. 2 Flow of Donations Recipients Assessment

In Figure 2, the general flow of the system can be seen, such as giving donations, applying for donation recipients, assessing potential donation recipients, and so on. In the used goods donation system that is designed, there is a relationship between the system and the system users, namely the system and the donor, the system and the recipient of the donation, and the system and the admin. This relationship can be seen more clearly if it is described using a use-case diagram. A use case diagram is like a road map that shows how the system should work according to user needs. (Wayahdi & Ruziq, 2023). The use case diagram for the system being designed can be seen in Figure 3.

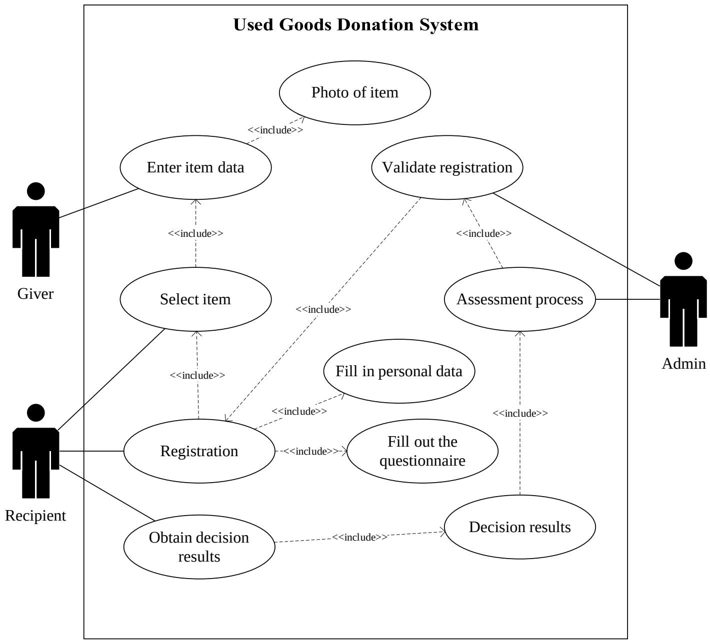

Fig. 3 Use Case Diagram

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After the system flow is described with a use case diagram, the next step is implementing the WASPAS method to determine who is the most eligible recipient of used goods donations. The implementation of the method is explained in several stages, namely:

1. Assessment criteria
   In this research, the author proposes 6 criteria, namely: monthly income, assets owned, number of dependent family members, need for goods, members of vulnerable groups, and the completeness of the document. The proposed criteria are determined by considering several aspects, such as data limitations and simplicity (so as not to make it difficult for potential donation recipients to complete the data), and the proposed criteria are pretty relevant to the case studied. Each criterion must have a weight that indicates the level of relevance or importance. An explanation of each criterion and its weight can be seen in Table 1.

Table 1. Assessment Criteria

Code	Criteria Name	Weight (w)	Sub Criteria	Value
C1	**Monthly income** Explanation: This criterion is quite pertinent in assessing the degree of financial necessity.	20%	<= 500,000	100
			> 500,000 and <= 1,000,000	90
			> 1,000,000 and <= 3,000,000	75
			> 3,000,000 and <= 5,000,000	60
			> 5,000,000	50
C2	**Assets owned** Explanation: This criterion can give a general idea of someone's financial capacity.	15%	There is not any	100
			Property (house/land)	-10
			Vehicle (car/motorbike)	-10
			Valuables (gold/silver/diamonds)	-10
			Finance (bank savings/ deposits/ investments)	-10
			Pension funds/social security	-10
C3	**Number of dependent family members** Explanation: This criterion considers the financial load that the family must carry.	20%	> 5 people	100
			>= 4 and <= 5	90
			>= 2 and <= 3	75
			1 people	60
			There is not any	50
C4	**Need for goods** Explanation: This is an important factor to make sure the given goods fit the recipient's needs.	15%	Very urgent (urgent)	100
			Urge	90
			Important	75
			Desirable	60
			No need	50
C5	**Members of vulnerable groups** Explanation: This criterion gives priority to vulnerable populations.	20%	People with disabilities	100
			Poor elderly/orphans	90
			Victims of natural disasters/conflicts	75
			Poor people/street children	60
			No	50
C6	**The completeness of the document (KTP & KK)** Explanation: For data transparency and verification, these requirements are crucial.	10%	Complete	100
			Incomplete	50

2. Alternative
   The alternative, in this case, is data on potential donation recipients. In this research, the author provides a sample of 5 alternatives that will be used in the process of assessing potential donation recipients using the WASPAS method. Table 2 shows the criteria value data for each alternative.

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Table 2. Alternative Data

Code	Alternative	Criteria					
		C1	C2	C3	C4	C5	C6
A1	Alternative-01	100	70	80	75	60	100
A2	Alternative-02	90	80	75	90	50	50
A3	Alternative-03	75	80	90	80	50	100
A4	Alternative-04	100	70	80	75	60	50
A5	Alternative-05	90	80	75	80	50	100
Maximum Value		**100**	**80**	**90**	**90**	**60**	**100**

3. Decision matrix

$$x = \begin{bmatrix} 100 & 70 & 80 & 75 & 60 & 100 \\ 90 & 80 & 75 & 90 & 50 & 50 \\ 75 & 80 & 90 & 80 & 50 & 100 \\ 100 & 70 & 80 & 75 & 60 & 50 \\ 90 & 80 & 75 & 80 & 50 & 100 \end{bmatrix}$$

Decision matrix normalization

$$x_{ij} = \begin{bmatrix} 100/100 & 70/80 & 80/90 & 75/90 & 60/60 & 100/100 \\ 90/100 & 80/80 & 75/90 & 90/90 & 50/60 & 50/100 \\ 75/100 & 80/80 & 90/90 & 80/90 & 50/60 & 100/100 \\ 100/100 & 70/80 & 80/90 & 75/90 & 60/60 & 50/100 \\ 90/100 & 80/80 & 75/90 & 80/90 & 50/60 & 100/100 \end{bmatrix}$$

$$x_{ij} = \begin{bmatrix} 1 & 0.875 & 0.889 & 0.833 & 1 & 1 \\ 0.9 & 1 & 0.833 & 1 & 0.833 & 0.5 \\ 0.75 & 1 & 1 & 0.889 & 0.833 & 1 \\ 1 & 0.875 & 0.889 & 0.833 & 1 & 0.5 \\ 0.9 & 1 & 0.833 & 0.889 & 0.833 & 1 \end{bmatrix}$$

4. Preference Q_i

$$Q_1^{(1)} = (1 * 0.2) + (0.875 * 0.15) + (0.889 * 0.2) + (0.833 * 0.15) + (1 * 0.2) + (1 * 0.1) = 0.934$$
$$Q_1^{(2)} = (1)^{0.2} * (0.875)^{0.15} * (0.889)^{0.2} * (0.833)^{0.15} * (1)^{0.2} * (1)^{0.1} = 0.932$$
$$Q_1 = 0.934 + 0.932 = 1.866$$

$$Q_2^{(1)} = (0.9 * 0.2) + (1 * 0.15) + (0.833 * 0.2) + (1 * 0.15) + (0.833 * 0.2) + (0.5 * 0.1) = 0.863$$
$$Q_2^{(2)} = (0.9)^{0.2} * (1)^{0.15} * (0.833)^{0.2} * (1)^{0.15} * (0.833)^{0.2} * (0.5)^{0.1} = 0.849$$
$$Q_2 = 0.863 + 0.849 = 1.713$$

$$Q_3^{(1)} = (0.75 * 0.2) + (1 * 0.15) + (1 * 0.2) + (0.889 * 0.15) + (0.833 * 0.2) + (1 * 0.1) = 0.9$$
$$Q_3^{(2)} = (0.75)^{0.2} * (1)^{0.15} * (1)^{0.2} * (0.889)^{0.15} * (0.833)^{0.2} * (1)^{0.1} = 0.894$$
$$Q_3 = 0.9 + 0.894 = 1.794$$

$$Q_4^{(1)} = (1 * 0.2) + (0.875 * 0.15) + (0.889 * 0.2) + (0.833 * 0.15) + (1 * 0.2) + (0.5 * 0.1) = 0.884$$
$$Q_4^{(2)} = (1)^{0.2} * (0.875)^{0.15} * (0.889)^{0.2} * (0.833)^{0.15} * (1)^{0.2} * (0.5)^{0.1} = 0.869$$
$$Q_4 = 0.884 + 0.869 = 1.753$$

$$Q_5^{(1)} = (0.9 * 0.2) + (1 * 0.15) + (0.833 * 0.2) + (0.889 * 0.15) + (0.833 * 0.2) + (1 * 0.1) = 0.897$$
$$Q_5^{(2)} = (0.9)^{0.2} * (1)^{0.15} * (0.833)^{0.2} * (0.889)^{0.15} * (0.833)^{0.2} * (1)^{0.1} = 0.894$$
$$Q_5 = 0.897 + 0.894 = 1.791$$

RESULT

The preference value Q_i has been calculated, marking the end of the WASPAS method decision-making procedure. This Q_i value functions as the primary reference for establishing the ranking of alternatives after completing the computation phases that include weight determination and normalization. To facilitate the analysis

*name of corresponding author

and comparison of the performance of all possible alternatives, the entire results of the Q_i value computations for the instance under investigation are reported in Table 3

Table 3. Results of the WASPAS Method Calculation

Code	Alternative	$Q_i^{(1)}$	$Q_i^{(2)}$	Q_i
A1	Alternative-01	0.934	0.932	1.866
A2	Alternative-02	0.863	0.849	1.713
A3	Alternative-03	0.900	0.894	1.794
A4	Alternative-04	0.884	0.869	1.753
A5	Alternative-05	0.897	0.894	1.791

Table 3 demonstrates that alternative "Alternative-01" with a value of 1.866, has the greatest Q_i value. Option "Alternative-02", with a value of 1.713, has the lowest Q_i value. The visualization of Table 3 can be seen in Figure 4 below.

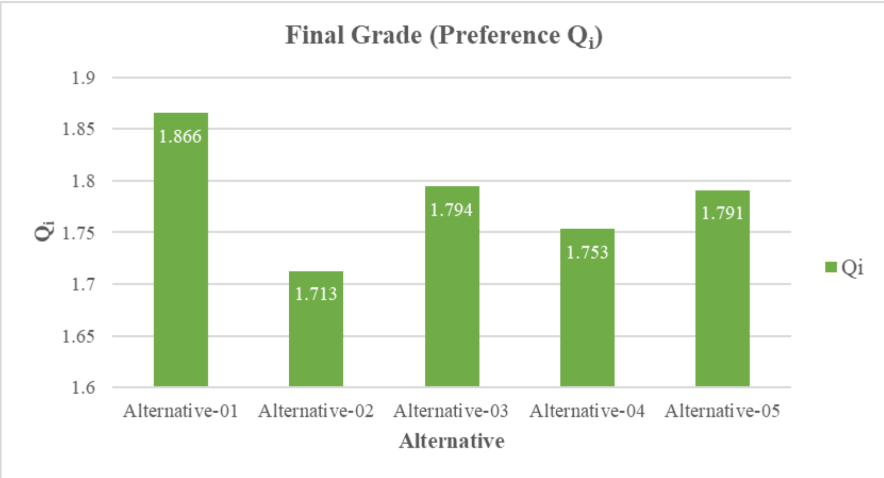

Fig 4. Final Grade Visualization (Preference Q_i)

Figure 4 above shows the final results of the calculations using the WASPAS method, presented in the form of preference values (Q_i) for each alternative, similar to Table 3. Table 4 displays the results of rating the candidates based on their final scores, going from highest to lowest.

Table 4. Ranking Result

Code	Alternative	$Q_i^{(1)}$	$Q_i^{(2)}$	Q_i	Ranking
A1	Alternative-01	0.934	0.932	1.866	1
A3	Alternative-03	0.900	0.894	1.794	2
A5	Alternative-05	0.897	0.894	1.791	3
A4	Alternative-04	0.884	0.869	1.753	4
A2	Alternative-02	0.863	0.849	1.713	5

The author carried out 100 tests on the system built by comparing manual calculations and system calculations. Testing includes accuracy, precision, and recall values. Accuracy is used to measure the proportion of correct decision results overall, precision is used to measure the proportion of correct positive decision results, and recall is used to measure the actual proportion of positive decisions that were successfully decided. Following are the evaluation results of the proposed method:

	Decision positive	Decision negative
Actual positive	99	1
Actual negative	2	98

Accuracy = 0.985, Precision = 0.980, and Recall = 0.990

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DISCUSSIONS

Based on the established criteria, "Alternatif-01" is the greatest option for receiving donations because it has the highest Q_i value (1.866). Based on the criteria, "Alternative-02" is deemed less acceptable since it has the lowest Q_i value (1.713). While the Q_i values of "Alternatives-03, 04, and 05" are reasonably similar to one another, "Alternative-03" has a marginally greater value than the other two. The greatest Q_i value (Alternative-01) and the lowest (Alternative-02) differ significantly, demonstrating a significant difference in preferences between these two options. Comparatively speaking, the differences in Q_i values amongst the other options are less, indicating that certain options function very similarly.

Based on the values entered into the predefined criteria, the WASPAS method can produce decisions. The outcome is significantly influenced by the weighting (w) that is assigned to each criterion. The weight of each criterion and the alternative values for each criterion have a significant impact on the combined preference value/optimality value (Q_i) that is obtained. To ensure that the final choice meets expectations, significant thought must be given to how each factor is weighted. The preferences for each alternative, as determined by WASPAS technique computations, are clearly illustrated in the preceding statement. From the results of the system testing carried out, the accuracy level was quite good, 98%. Less than 2% to achieve 100% accuracy because there is a slight difference between manual calculations and the system; this is because it uses decimal numbers. The author believes that this is still within reasonable limits. These findings can be used as a starting point for reaching the ultimate decision while accounting for other pertinent elements. Figure 4 shows the appearance of the main page of the designed donation website.

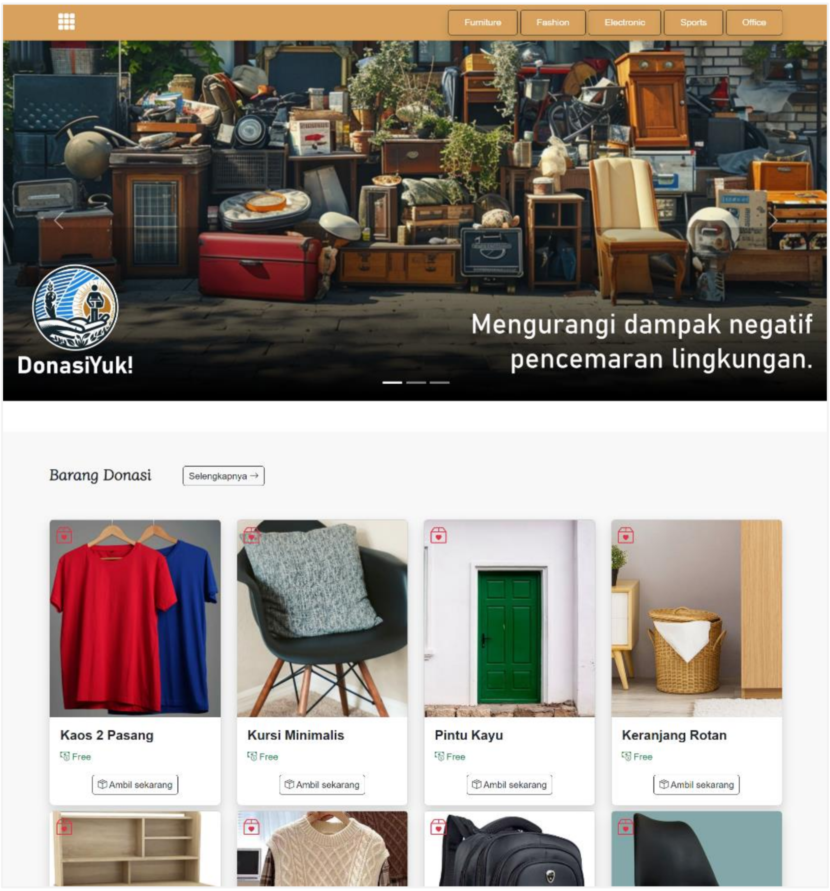

Fig 4. Main Page of the Designed Donation Website

CONCLUSION

The decision-making system for selecting beneficiaries of donated used goods can use the WASPAS technique. Due to its benefits, the WASPAS technique is a helpful tool for multi-criteria decision-making, especially when dealing with unclear data. Every actor involved in selecting donation recipients will get great help from this strategy. When an alternative has a high Qi value, it means that it meets the specified requirements more effectively. Making decisions like this will speed up the evaluation process and reduce assessment errors with an accuracy rate of 98%. While these techniques provide a helpful basis for decision-making, the WASPAS technique should not be the only consideration. Careful examination of several variables, both quantitative and qualitative, must be carried out before final selection. The weighting of the criteria used must also be considered because it will significantly influence the resulting decisions.

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