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A Group Decision Support System for Retail Product Sales: A Case Study in Padang, Indonesia

Meri Azmi [a,*], Deni Satria [a], Yance Sonatha [a], Farhan Rinsky Mulya [a], Dwi Sudarno Putra [b]

[a] *Department of Information Technology, Politeknik Negeri Padang, Padang, Indonesia*
[b] *Department of Automotive Engineering, Universitas Negeri Padang, Padang, Indonesia*
Corresponding author: [*]meriazmi@pnp.ac.id

Abstract*— The expansion of the industrial sector has resulted in a rise in the abundance of industrial products that are now accessible in the marketplace. Nevertheless, the proliferation of possibilities has presented a significant dilemma for retail retailers, rendering the process of selecting merchandise considerably more arduous. The seller is required to meticulously evaluate a range of elements, including the type, quality, and likelihood of successfully selling the goods in order to generate a financial gain. The present study introduces a novel approach in the form of a group decision support system aimed at aiding retail sellers in the process of product selection. The system has been specifically created to efficiently process diverse sets of information pertaining to the comparison of retail products based on certain criteria. This functionality empowers sellers to make prompt and precise selections. In order to attain the most favorable outcomes, this study integrates three distinct approaches within the decision-making calculation process: Fuzzy Logic, EDAS, and Borda techniques. The utilization of the Fuzzy Logic approach is employed for the purpose of assigning a numerical value to a criterion that lacks clarity. This is subsequently followed by the application of the EDAS method to rank the criteria. The final step involves amalgamating the outcomes of the decision-making process through the utilization of the Borda method. The web-based group decision support system has demonstrated its efficacy in offering effective solutions for retail business players to enhance sales and mitigate losses. Through the utilization of this system, retail vendors are able to make well-informed judgments regarding their merchandise, hence facilitating the maximization of their financial gains and mitigation of potential hazards. In summary, the proliferation of industrial products has presented difficulties for retail merchants. However, this study suggests a potential remedy in the shape of a collective decision support system. The integration of Fuzzy Logic, EDAS, and Borda techniques yields a robust decision-making framework, enabling retail sellers to make well-informed choices and effectively attain their business objectives.

***Keywords*— Group decision support system; BORDA; EDAS; fuzzy logic; retail product sales.**

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I. INTRODUCTION

The act of purchasing and selling is a prevalent form of engagement that frequently arises in our day-to-day experiences [1]. This particular action is commonly observed in commercial establishments involved in the exchange of goods, such as shops, convenience stores, large-scale supermarkets, or several other types of retail outlets[2]. Retail or retail stores act as intermediaries between manufacturers and consumers, facilitating the sale of items or services on a smaller scale [3]. Hence, retail establishments hold significance within the supply chain as they serve as intermediaries, facilitating the connection between manufacturing facilities as producers and end consumers of products[4][5]. The decision-making process regarding product sales holds significant importance in sustaining the operations of a retail store [6]-[9]. The wide range of items manufactured and distributed by manufacturers on a daily basis is a challenge for retail businesses in identifying the optimal selection of products and services to offer for sale[10]. When formulating a sales plan, it is imperative for retail store operators to carefully evaluate the nature, caliber, and potential of their merchandise in order to achieve profitability [11]-[13]. The Datul Mart minimarket currently lacks a decision support system for retail product sales. The production of numerous products that experience poor sales performance can result in financial losses over an extended period. The proliferation of items within the market poses challenges in terms of comparing and selecting retail products for sale. In addition to the advancement of competition, industry, and technology, the necessity for Datul Mart

minimarkets to enhance their management practices arises. The author's intention to design a group decision support system for retail goods sales is driven by the significant potential for loss. To mitigate potential losses resulting from the excessive purchasing and selling of retail products, it is imperative to enhance the operating effectiveness of the minimarket.

Therefore, it is imperative to develop a system that can efficiently and accurately facilitate retail product sales decisions in accordance with the specific requirements of decision-makers [14][15]. The implementation of a decision support system is planned for the Datul Mart minimarket, which is currently facing challenges in making effective decisions on the sale of retail products. In order to identify an appropriate decision support system (DSS) for the specific requirements of Datul Mart, the author did an extensive literature review encompassing multiple articles that discussed various DSS methodologies.

First, the Double Exponential Smoothing technique, employed for sales forecasting in the context of goods, has been empirically demonstrated to assist firm managers in predicting sales volumes. This method facilitates the determination of stock levels, hence enhancing the decision-making process for users. The present method's implementation exhibits a user satisfaction level of 83% in relation to its visual aesthetics, 83% in terms of its ease of use, and 67% with regards to its transaction effectiveness [16][17].

Second, the use of the Analytic Hierarchy Process approach is utilized to develop an appropriate marketing strategy that enables businesses to effectively navigate and succeed in the competitive market landscape [18]. Consequently, the organization is able to make informed decisions aimed at mitigating manufacturing costs, thereby yielding a net profit that fosters sales growth and enhances market share [19]. Furthermore, the EDAS technique, which has been empirically validated, can facilitate alumni in gaining awareness of their capabilities and offer recommendations for potential career paths aligned with their skill sets [20][21].

Fourth, The implementation of the Simple Moving Average approach in the procurement forecasting system serves the purpose of streamlining and expediting the process. This approach has the potential to mitigate the occurrence of excessive orders for items, hence leading to financial losses incurred from the procurement expenses associated with these goods [22]. This study aims to compare the EDAS and ARAS approaches in the context of DSS housing selection in an Indonesian metropolis. Both strategies yield comparable ranking outcomes for the available alternatives [23]. In the realm of academic inquiry, there exists a body of study that seeks to integrate the Fuzzy and TOPSIS methodologies. The utilization of the fuzzy method has been discovered to enhance subjective assessment [24][25]. In the study conducted by the author, a hybrid approach involving the Topsis and Borda methodologies was employed to ascertain the optimal selection of personnel [26]-[28].

Furthermore, the utilization of a tripartite approach consisting of the Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW), and Borda technique has been proposed as a means to facilitate decision-making processes and serve as a tool for evaluating pertinent information in the context of selecting the optimal site for establishing a minimarket [29]. The implementation of the DSS approach in practical applications can be employed either independently or in conjunction with other methods. The integration of many approaches seeks to leverage the strengths of each method in effectively managing data or achieving the desired decision attributes [30][31]. The findings of these research indicate that employing a combination of strategies within a Decision Support System (DSS) yields superior outcomes. Consequently, the present study will employ a tripartite approach encompassing Fuzzy Logic, EDAS, and Borda as its chosen methodologies. Each approach is employed in distinct computational procedures. The initial approach, referred to as Fuzzy Logic, is employed to identify indeterminate values, subsequently followed by a ranking procedure utilizing the EDAS method, culminating in the aggregation of the ranking outcomes through the Borda method.

The decision support system was developed by incorporating the computations of specified procedures within a web-based framework [32]. In this particular scenario, the utilization of these three methodologies is intended to enhance the precision of decision-making. The criteria employed are systematically examined and evaluated in an impartial manner, ensuring that the resulting judgments are produced with precision and can be justified. It is anticipated that this method will offer convenience in the processing of data, particularly in cases where data is inadequate or limited. Another crucial objective is to enhance the efficacy and efficiency of business operations [33]. The article's organization is characterized by a systematic presentation, wherein the DSS contents are presented in section 2. Section three provides a comprehensive account of the methodology employed in the development of a Decision Support System (DSS) system. Section four of the document provides an account of the findings and subsequent analysis, while the concluding section encapsulates the final remarks..

II. Materials and Method

A. Fuzzy Logic

Fuzzy logic was initially identified by Lotfi A. Zadeh, a professor at the University of California, in June 1965 [34][35]. Fuzzy Logic is a logic system that extends classical logic, which is characterized by binary membership values of 0 and 1. In Fuzzy Logic, sets are endowed with two attributes, namely, namely:

1) Linguistics, namely naming a group that represents a certain state or condition using natural language, such as: good, enough, and less.

2) Numeric is a value (number) that indicates the size of a variable such as 0, 50, 100.

The membership function is a curve that shows the mapping of data input points into their membership values, also called membership degrees. Membership value can be obtained in one way, namely by using a functional approach. In this study, the membership function implemented is triangular. This function was chosen because it has a simple logic and form where the function combines 2 lines (linear) [36]. Figure 1 shows the triangular function representation of equation 1.

$$\mu[x] = \begin{cases} 0; & x \le a \text{ atau } x \ge c \\ (x-a)/(b-a); & a \le x \le b \\ (b-x)/(c-b); & b \le x \le c \end{cases} \quad (1)$$

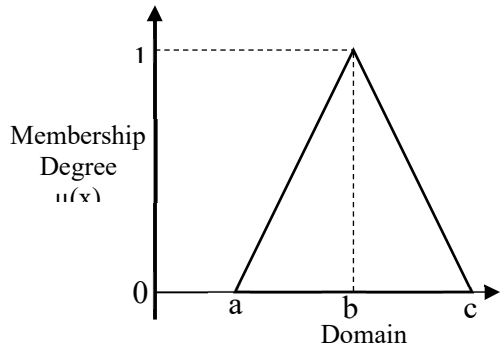

Fig. 1 Triangular fuzzy membership function

B. EDAS Method

Evaluation based on Distance from Average Solution (EDAS) is a decision-making method using an average solution to assess alternatives, considering the positive and negative distances from the average value [37]. The EDAS method has a simpler and faster calculation that does not affect the accuracy of the calculation [38]. The advantages of this method appear when conflicting criteria must be considered. The stable EDAS method was used with various weighting criteria and was consistent compared to other method [39]. Following are the calculation steps using the EDAS method:

1) Create a Decision Matrix (X), equation 2.

$$X = \begin{bmatrix} x_{01} & x_{0j} \dots & x_{0n} \\ x_{i1} & x_{ij} \dots & x_{in} \\ & \vdots & \\ x_{m1} & x_{m2} \dots & x_{mn} \end{bmatrix} \quad (2)$$

2) Determine the Average Solution (AV).

$$AV = \left[AV_j\right]_{1\times m} \quad (3)$$

Where the value of AV_j can be calculated by equation 4.

$$AV_j = \frac{\sum_{i=1}^{n} X_{ij}}{n} \quad (4)$$

3) Determine the Positive/Negative Distance from the Average (PDA/NDA). According to the type of criteria (benefit and cost).

$$PDA = \left[PDA_{ij}\right]_{n\times m} \quad (5)$$

$$NDA = \left[NDA_{ij}\right]_{n\times m} \quad (6)$$

For the j[th] criterion, which is a Benefit type criterion, the following equations are used:

$$PDA_{ij} = \frac{max\left(0,(X_{ij}-AV_j)\right)}{AV_j} \quad (7)$$

$$NDA_{ij} = \frac{max\left(0,(AV_j-X_{ij})\right)}{AV_j} \quad (8)$$

As for the j[th] criterion which is a criterion of type Cost then the following equations are applies:

$$PDA_{ij} = \frac{\max\left(0,(\mathrm{AV_j}-\mathrm{X_{ij}})\right)}{\mathrm{AV_j}} \quad (9)$$

$$\mathrm{NDA_{ij}} = \frac{\max\left(0,(\mathrm{X_{ij}}-\mathrm{AV_j})\right)}{\mathrm{AV_j}} \quad (10)$$

4) Determine the Weighted Amount of PDA/NDA (SP/SN).

$$SP_i = \sum_{j=1}^{m} w_j \times PDA_{ij} \quad (11)$$

$$SN_i = \sum_{j=1}^{m} w_j \times NDA_{ij} \quad (12)$$

5) Normalization of SP/SN (NSP/NSN) Values.

$$NSP_i = \frac{SP_i}{\max(SP_i)} \quad (13)$$

$$NSN_i = 1 - \frac{SN_i}{\max(SN_i)} \quad (14)$$

6) Calculating the Value of the Assessment Score (US).

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad (15)$$

where $0 \le AS_i \le 1$

C. Borda Method

In 1435 one of the writers and theologians who eventually became a cardinal, Nicholas Cusanus, first proposed calculations using the Borda method. At first, at the time of the election of the Holy Roman Emperor, he suggested using this calculation method, but unfortunately, his suggestion was rejected. Then in 1784, Jean Charles de Borda recommended this method of calculating voting for the I 'Academie des Sciences as the electoral system. The calculation method worked well until sixteen years later, a new member, known as Napoleon Bonaparte, did not like the electoral system using this calculation method. Napoleon prefers to choose a simple electoral system, where the majority vote is entitled to win the election [40].

The Borda method is one method used to determine the voting ranking preferentially [41]. In a pairwise comparison, the preferred alternative in the top-ranking position will be given a higher score than the candidate in the next-ranking position. Here is how to solve the case using the Borda Method:

- Determination of the ranking value in a sequence of alternative choices with the top order given a value of m where m is the total number of choices or alternatives.
- The value of m is used as a multiplier of the votes obtained at the position concerned.

Based on the calculation of the value of the Borda function from the alternative choices, the choice with the highest value is the choice that the decision maker most prefers. The system consists of three main components: the database, the model base, and the dialog interface. The database is a component in charge of storing and providing knowledge data for the system. The data will be processed based on the model to make decisions. The results are displayed by the interface dialog to the user's computer. Figure 2 shows the design of the group decision support system.

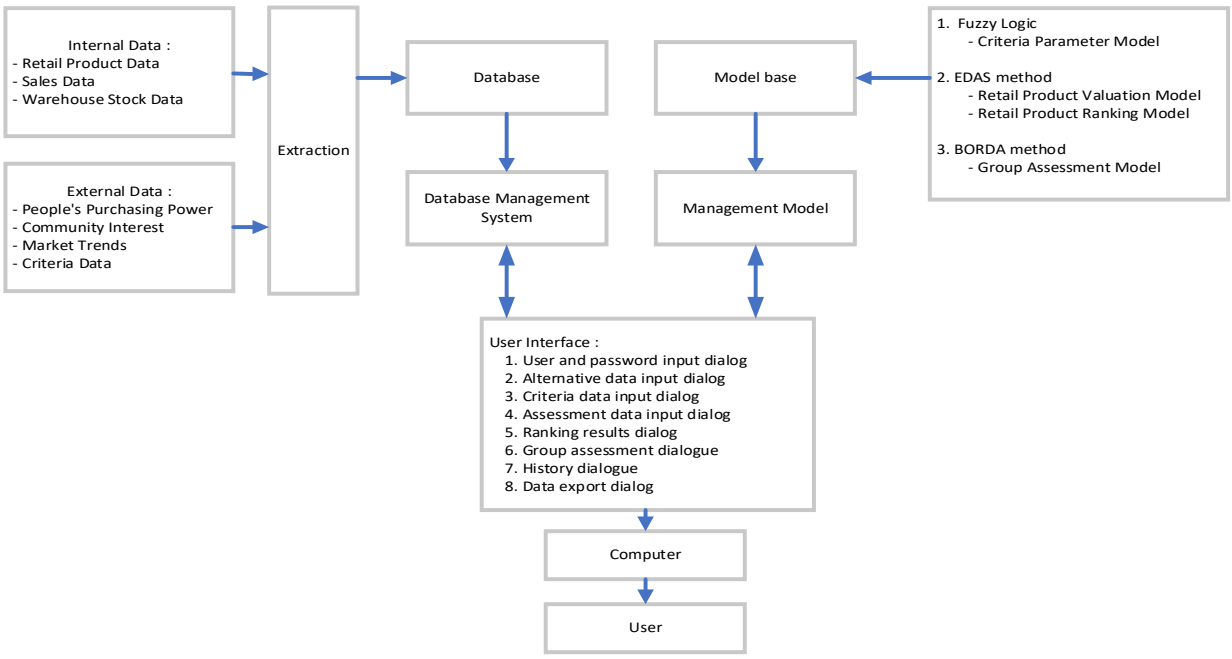

Fig. 2 Design of the group decision support system

D. Needs Analysis

System requirements analysis is needed to understand the system's needs to be developed. System requirements analysis consists of functional requirements and non-functional requirements. Functional requirements are requirements that contain the processes that the system will carry out. The functional requirements of this system are:

- Can make group decisions using Fuzzy Logic, EDAS, and Borda methods.
- Can do a comparison of retail products to be sold.
- Can manage alternative data, criteria, assessments, and user access.

E. Data Sources

The data used by the group decision support system can be generated by extracting data from various internal and external sources and from the personal data of one or more users. Here are some data sources from this system:

1) Internal data is data whose source comes from within the Datul Mart minimarket. Internal data can be in the form of monthly profit, maintenance schedule, amount of capital, production amount, sales data, warehouse stock, and others.

2) External Data is data that comes from outside the Datul Mart minimarket. For example, information about people's purchasing power, changes in people's habits, buyer interests, and so on. The data can come from government agencies, trade associations, and market research companies.

3) Extraction data results from a combination of data from internal and external sources. Data can be a summary or a combination of several data.

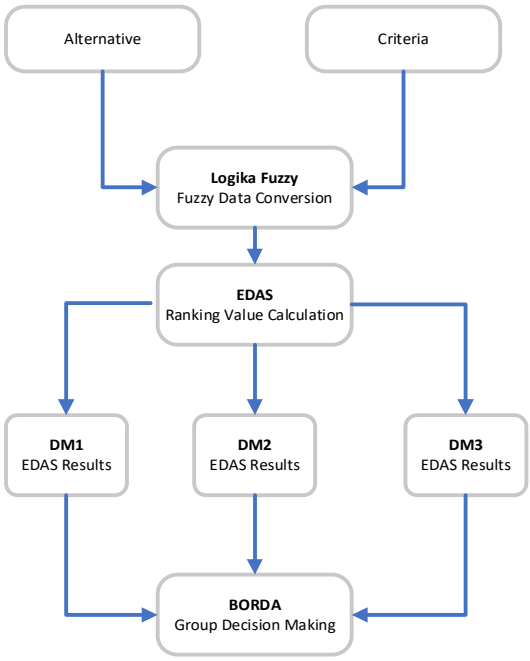

Fig. 3 Group Decision Support System Modeling

A. Group Decision Support System Modeling

Some indicators or criteria must be considered in a retail product, such as capital, price, quality, opportunities, and profits. This indicator is very important for business actors in determining their retail product sales decisions. Then it can be formulated into the system as criteria and alternatives, namely retail products. Then each alternative is assessed with their respective criteria. The data will be converted first using Fuzzy Logic if it has criteria with unclear values. Furthermore, the ranking process for each alternative is carried out using the EDAS method. The results obtained may vary depending on the person's ranking, such as the owner and manager. So, with that, the ranking results are grouped using the Borda method to produce a winner. The process diagram is shown in Figure 3.

III. Result and Discussion

Table I shows the result of the manual calculation of group decision-making based on sales data of 2 liters of cooking oil using Microsoft Excel.

TABLE I
MANUAL CALCULATION

Alternative	Price	Profit	Stock	Popularity
Sania	48500	11500	90	High
Sunco	51500	13500	60	Middle
Fortune	50000	14000	85	High
Tropical	51000	12000	100	Low

There are four retail products of 2-liter cooking oil for which a decision will be made based on price, profit, stock, and popularity criteria.

TABLE III
CRITERIA'S TYPE AND WEIGHTING VALUE

Criteria	Type	Weight
Price	Cost	0.35
Profit	Benefit	0.30
Stock	Benefit	0.20
Popularity	Benefit	0.15

The criteria used are weighted based on their level of importance. The total of the criteria weights must be 1; otherwise, the criteria weights are normalized.

A. Fuzzy Logic Method Calculation Procedure

TABLE IIIII
CRITERIA'S TYPE AND WEIGHTING VALUE

Popularity	Range
Low	0-50
Middle	0-100
High	50-100

Then convert the unclear value into a fuzzy value using the fuzzy membership function formula.

$$Tinggi(70) = \left\{\frac{70-50}{100-50} = 0{,}4 \right. \quad (16)$$

TABLE IV
FUZZY VALUE CALCULATION

Alternative	Fuzzy Value
Sania	0.4
Sunco	0.8
Fortune	0.6
Tropical	0.4

B. EDAS Method Calculation Procedure

From the data that has been fuzzy, then a decision is made using the EDAS method. The average solution according to the criteria (AV) is calculated by equation 4.

TABLE V
AV CALCULATION RESULT

Criteria	AV
Price	50250
Profit	12750
Stock	83,75
Popularity	0,55

After obtaining the AV results, the calculation continues with steps 3-6. The results from steps 3 to step 6 can be seen in Tables VI and VII.

TABLE VI
EDAS STEP 3-6 CALCULATION

Alternative	SP	SN	NSP	NSN
Sania	0.03	0.07	0.32	0.00
Sunco	0.09	0.07	1.00	0.07
Fortune	0.05	0.00	0.56	1.00
Tropical	0.04	0.06	0.45	0.09

TABLE VII
EDAS CALCULATION

Alternative	AS	Rank
Sania	0.16	4
Sunco	0.53	2
Fortune	0.78	1
Tropical	0.27	3

C. Borda Method Calculation Procedure

Calculations with the Borda method are used to perform group decision-making based on previous decision-making results, in the example of the calculation data. It is done three times decision using the previous method. The results are shown in Table VIII and Table IX. The results will be made a group decision.

TABLE VIIVI
DM VALUE

Rank	DM 1	DM 2	DM 3
1	Fortune	Fortune	Fortune
2	Sania	Sunco	Sunco
3	Sunco	Sania	Tropical
4	Tropical	Tropical	Sania

$$Poin_{fortune} = (3 * 4) + (0 * 3) + (0 * 2) + (0 * 1) = 12 \quad (17)$$

$$Nilai_{fortune} = \frac{12}{(6+8+12+4)} = 0.40 \quad (18)$$

TABLE IX
BORDA VALUE CALCULATION

Alternative	Borda point	Borda Value	Rank
Sania	6	0.20	3
Sunco	8	0.27	2
Fortune	12	0.40	1
Tropical	4	0.13	4

In the table X is a comparison of the results of system calculations and manual calculations.

TABLE X
RESULT COMPARATION

Alternative	Proposed Method	Manual Method	Error
Sania	0.20	0.20	0
Sunco	0.27	0.27	0
Fortune	0.40	0.40	0
Tropical	0.13	0.13	0

IV. Conclusion

Based on the analysis conducted at the Datul Mart Minimarket, problems were found in making retail product sales decisions. So, we need a system to help make retail product sales decisions. In order to avoid losses in managing excessive buying and selling of retail products, decisions can be made quickly and precisely according to the needs of decision-makers. The system can run and function according to the needs of design analysis. System implementation using Fuzzy Logic, EDAS, and Borda methods has been

successfully developed. The results of this study are in the form of a group decision support system for determining retail product sales. The results of comparing system calculations with manual calculations using Fuzzy Logic, EDAS, and Borda methods are 100% accurate.

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