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Decision Support System in Smartwatch Selection Using the Weighted Product (WP) Method

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Abstract

The advancement of information technology has significantly impacted daily life, including the development of smart devices such as smartwatches. Smartwatches are multifunctional devices capable of connecting to the internet and interacting with various electronic devices. However, the vast number of available options makes it difficult for consumers to choose the right smartwatch. This research proposes a web-based Decision Support System (DSS) utilizing the Weighted Product (WP) method to assist consumers in selecting the most suitable smartwatch. The WP method employs a weighted multiplication of ratings for each attribute to generate objective recommendations. Data collection was carried out through literature studies, questionnaires, and interviews. System analysis and design were followed by system testing using expert judgment, black-box testing, and the System Usability Scale (SUS). The evaluation results indicated that the WP DSS achieved a 100% success rate in black-box testing, a SUS score of 75.25 (categorized as good), and expert judgment scores of 3.25, 3.5, and 3.75 (valid category). These results confirm that the proposed DSS is feasible for smartwatch selection.

Keywords: Smartwatch; Weighted Product; Decision Support System; SUS; Web-based

Introduction

The rapid advancement of technology has led to the proliferation of wearable smart devices, with smartwatches being one of the most widely adopted. Smartwatches offer various functionalities, including fitness tracking, health monitoring, communication, and smartphone integration(Lorinsa, 2020). Due to the increasing number of smartwatch brands and models available, consumers often face difficulty selecting the most suitable smartwatch based on their preferences and needs(Lorinsa, 2020).

Decision Support Systems (DSS) (Umar et al., 2022) are widely used to assist users in making informed decisions by systematically evaluating multiple criteria. In this study, we propose a web-based DSS that applies the Weighted Product (WP) method to help consumers select the best smartwatch. The WP method is a multi-criteria decision-making (MCDM) approach that assigns weighted scores to alternatives based on user-defined criteria, enabling a more structured and objective evaluation(Siddik et al., 2023).

This paper discusses the development and implementation of the DSS, including the methodology used, system design, and evaluation. This research aims to provide consumers with a practical tool to simplify the smartwatch selection process and enhance decision accuracy by integrating a systematic decision-making framework.

Methods

This section outlines the methodology for developing the Decision Support System (DSS) for smartwatch selection. The methodology consists of several stages, including data collection, system design, and applying the Weighted Product (WP) method for decision-making.

Decision Support System (DSS)

A Decision Support System (DSS) (Yudhana et al., 2022) is a computerized system that assists users in making informed and structured decisions by analyzing multiple criteria. DSS integrates data, computational models, and user inputs to generate optimal recommendations tailored to specific needs. Its primary function is to help users process complex decision-making tasks by systematically evaluating different alternatives and ranking them based on predetermined criteria(Vujovic et al., 2018).

DSS is commonly used in various domains, such as healthcare, business management, finance, and technology. In this study, a DSS is developed to support users in selecting the most suitable smartwatch by considering multiple factors such as compatibility, battery life, screen size, durability, price, and additional features. By leveraging a structured decision-making framework, the DSS ensures that the selection process is efficient, objective, and tailored to the user's preferences(Soares et al., 2024).

The proposed DSS follows a client-server architecture, where the front-end user interface allows users to input their preferences, and the back-end system processes these inputs using the Weighted Product (WP) method. The system dynamically adjusts rankings based on user-defined criteria weights, ensuring the recommendations align with individual user priorities. Additionally, the system is designed to be scalable, allowing future integration of more smartwatch models and decision criteria to enhance its effectiveness(Ramezani et al., 2023).

By integrating DSS into smartwatch selection, users benefit from a data-driven approach that eliminates guesswork and streamlines decision-making (Sunardi et al., 2022). Implementing a DSS not only improves accuracy in selecting an optimal smartwatch but also enhances user experience by providing clear and well-structured recommendations(Goodings et al., 2024).

A Decision Support System (DSS) is a computer-based system that assists users in making informed decisions by systematically analyzing multiple criteria. DSS combines data, models, and user inputs to tailor recommendations to specific needs(Köhler et al., 2024). In this study, a web-based DSS was developed to help consumers select the most suitable smartwatch based on predefined criteria.

Weighted Product (WP) Method

The Weighted Product (WP) method is a multi-criteria decision-making approach that applies a weighted multiplication of attribute ratings(Humairoh et al., 2022). WP does not require matrix normalization, unlike the Simple Additive Weighting (SAW) method. Instead, each attribute rating is raised to the power of its assigned weight. The WP method ensures that alternatives with higher benefit attributes and lower cost attributes receive a higher ranking score(Berhitu et al., 2024).

The WP method is widely used in decision-making scenarios where multiple criteria must be considered simultaneously(Nur Rofiq & Puji Raja Bagus Kausar, 2024). This method is particularly effective in evaluating alternatives by accounting for both beneficial and cost-based attributes, with cost attributes assigned negative exponents. By assigning appropriate weights to each criterion, WP ensures that each factor contributes proportionally to the final decision(Humairoh et al., 2022). The method is robust in handling subjective decision-making, making it suitable for selecting products like smartwatches, where various features must be compared objectively.

One of WP's main advantages is its ability to differentiate the significance of criteria while preserving the integrity of the evaluation process(Kadim, 2022). Higher-weighted criteria have a stronger influence on the ranking, ensuring that the most relevant attributes impact the final selection. This makes WP particularly suitable for applications where users may prioritize different features, such as battery life, screen size, or fitness tracking capabilities.

The mathematical formulas used in the WP method are as shown in Equations (1)–(3) (Riki & Yanti, 2020):

Weight Normalization:

$$W = \frac{w_j}{\Sigma w_j} \tag{1}$$

where:

- W_j normalised weight of criterion j
- $\sum W_j$, total sum of all criteria weights

Vector S Calculation:

$$S_i = \prod_{j=1}^{n} (X_{ij})^{wj} \tag{2}$$

where:

- S_i, preference value for alternative i
- X_{ij}, performance rating of alternative i on criterion j
- W_j, weight of criterion j
- n, total number of criteria

Vector V Calculation:

$$V_i = \frac{S_i}{\prod_{i=1}^{n}(S_i)}; i = 1,2,\ldots,m \tag{3}$$

where:

- V_i, final ranking score for alternative iii
- S_i, preference value for alternative iii
- m, total number of alternatives

Equations (1)–(3), the WP method systematically evaluates and ranks smartwatch options based on predefined criteria, ensuring an optimal decision-making process. The application of WP in this research allows users to objectively compare different smartwatches and select the best alternative according to their preferences.

Data Collection

Data collection for this study was conducted through literature reviews, user surveys, and expert interviews. The literature review provided insights into the key criteria consumers consider when selecting a smartwatch. Surveys were distributed to potential smartwatch users to gather data on their preferences, while expert interviews helped validate the importance of various decision criteria.

The alternative smartwatches used in this study were selected based on market popularity and user demand. Table 1 presents the smartwatch alternatives considered in this study:

Table 1. The Alternative

No	Smartwatch Model
1	Samsung Galaxy Watch 4 40mm
2	Garmin Venu SQ Music
3	Garmin Vivomove Sport
4	Garmin Edge 130 Plus
5	Garmin Venu SQ
6	Garmin Forerunner 55
7	Honor Magic Watch 2 46mm
8	Huawei GT 3
9	Amazfit Bip 3
10	Amazfit Bip 3 Pro
11	Amazfit GTS 4 Mini
12	Amazfit GTS 2 Mini
13	Amazfit GTR 3
14	Amazfit GTR 3 Pro
15	Amazfit GTR 4
16	Amazfit T-Rex 2
17	Samsung Galaxy Watch Active 2
18	Xiaomi Watch S1 Active
19	BOZLUN Smart Watch C22
20	Redmi Watch 3

In addition to the smartwatch alternatives, the study identified six key decision criteria used for evaluation. Table 2 summarizes these criteria:

Table 2. The Criteria

Criteria	Weight
Compatibility	1
Battery Capacity	2
Screen Size	1
Durability	2
Price	−3
Features	1

These criteria were selected based on consumer expectations and expert recommendations. Compatibility refers to the smartwatch's ability to integrate with various smartphone operating systems. Battery capacity determines how long the smartwatch can operate on a full charge. Screen size affects readability and usability, while durability considers the smartwatch's resistance to environmental factors. Price is a crucial consideration for consumers with budget constraints, and features include additional functionalities such as GPS, heart rate monitoring, and NFC capabilities.

The collected data was then processed using the Weighted Product (WP) method to generate objective and structured recommendations for smartwatch selection. Data was collected through literature reviews, user surveys, and expert interviews. The literature review helped identify key decision criteria relevant to smartwatch selection. User surveys gathered consumer preferences on smartwatch attributes, while expert interviews validated each criterion's relevance and weight distribution.

The selected decision criteria include:

- **Compatibility:** Compatibility with different smartphone operating systems.
- **Battery Capacity:** The duration for which a smartwatch can operate at a full charge.
- **Screen Size:** Display dimensions affecting readability and usability.
- **Durability:** Resistance to environmental factors such as water and dust.
- **Price:** The cost of the smartwatch in the market.
- **Features include** GPS, heart rate monitoring, and NFC capabilities.

System Design

The Decision Support System (DSS) for smartwatch selection was designed as a web-based, structured, user-friendly interface application. The system architecture follows a **client-server model**, where the front end allows users to input preferences, and the back end processes data using the **Weighted Product (WP) method** to generate ranked recommendations.

The DSS consists of three main components:

1. **User Input Module**
   - This module lets users specify their preferences for various smartwatch criteria, such as battery life, screen size, compatibility, durability, price, and additional features.
   - The system allows users to assign weights to each criterion, ensuring that recommendations align with their priorities.
2. **Processing Module**
   - The system's core is the **WP method**, which calculates the rankings of smartwatches based on user-defined preferences.
   - The system retrieves data from a pre-stored database containing smartwatch specifications and applies the WP formula to compute preference scores.
3. **Output Module**
   - This module displays the **ranked list of recommended smartwatches** and the calculated scores for each model.
   - The results are visualized through tables, providing users with an easy-to-understand comparison of different smartwatches.

Security and Scalability

- The DSS incorporates **user authentication** to ensure secure access and prevent unauthorized modifications to the selection criteria.
- The system is designed to be **scalable**, allowing the integration of additional smartwatch models, new decision criteria, and real-time market data updates.

By implementing this structured DSS, users can make objective and informed decisions, simplifying the smartwatch selection process while ensuring that their chosen device meets their specific needs.

Results

Implementation of Weighted Product Method

Implementing the Weighted Product (WP) method in the Decision Support System (DSS) follows a structured approach to ranking smartwatch alternatives. The steps in the manual calculation process are as follows:

1. **Defining Decision Criteria and Alternatives**
   - The study considers six criteria: compatibility, battery capacity, screen size, durability, price, and features.

- The system evaluates 20 smartwatch models as alternatives.

2. **Weight Normalization**
   - Each criterion is assigned a weight based on its importance. The normalized weight is calculated using the above formula
   - The weights are then categorized as benefit or cost attributes, with cost attributes assigned negative exponents.
3. **Calculation of Vector S**

   The vector S for each alternative is computed using the above formula. Table 3. presents the calculated vector S values for selected smartwatch models:

Table 3. Calculated Vector S

No	Smartwatch Model	S Value
1	Samsung Galaxy Watch 4 40mm	1.374
2	Garmin Venu SQ Music	1.059
3	Garmin Vivomove Sport	0.885
4	Garmin Edge 130 Plus	1.196
5	Garmin Venu SQ	1.267
6	Garmin Forerunner 55	1.231
7	Honor Magic Watch 2 46mm	1.029
8	Huawei GT 3	1.335
9	Amazfit Bip 3	1.374
10	Amazfit Bip 3 Pro	1.762
11	Amazfit GTS 4 Mini	1.246
12	Amazfit GTS 2 Mini	1.246
13	Amazfit GTR 3	1.431
14	Amazfit GTR 3 Pro	1.390
15	Amazfit GTR 4	1.335
16	Amazfit T-Rex 2	1.282
17	Samsung Galaxy Watch Active 2	1.041
18	Xiaomi Watch S1 Active	1.390
19	BOZLUN Smart Watch C22	1.231
20	Redmi Watch 3	1.012

Calculation of Vector V

The final ranking score is determined by normalizing vector S, called vector V. Table 4. presents the final ranking based on the computed V values:

Table 4. Calculated Vector V

No	Smartwatch Model	V Value
1	Amazfit Bip 3 Pro	0.070
2	Amazfit GTR 3	0.057
3	Samsung Galaxy Watch 4 40mm	0.055
4	Amazfit Bip 3	0.055
5	Amazfit GTR 3 Pro	0.055
6	Xiaomi Watch S1 Active	0.055
7	Huawei GT 3	0.053
8	Amazfit GTR 4	0.053
9	Amazfit T-Rex 2	0.051
10	Garmin Venu SQ	0.050
11	Amazfit GTS 4 Mini	0.050
12	Amazfit GTS 2 Mini	0.050
13	Garmin Forerunner 55	0.049
14	BOZLUN Smart Watch C22	0.049
15	Garmin Edge 130 Plus	0.048
16	Garmin Venu SQ Music	0.042
17	Honor Magic Watch 2 46mm	0.041
18	Samsung Galaxy Watch Active 2	0.041
19	Redmi Watch 3	0.040
20	Garmin Vivomove Sport	0.035

Ranking Results

The ranking results obtained through the Weighted Product (WP) method highlight the top-performing smartwatches based on user-defined criteria. The smartwatch models were evaluated on compatibility, battery life, screen size, durability, price, and additional features. The final ranking reflects the best alternatives suited to consumer needs.

The results indicate that the **Amazfit Bip 3 Pro** ranked highest with a score of **0.070**, followed by the **Amazfit GTR 3** and **Samsung Galaxy Watch 4 40mm**, scoring **0.057** and **0.055,** respectively. The lowest-ranked smartwatch in this study was the **Garmin Vivomove Sport**, with a score of **0.035**.

The ranking process effectively demonstrates the usefulness of the WP method in making structured and objective decisions. The results validate the system's capability to provide reliable recommendations by considering multiple decision-making criteria. Users can leverage the ranking output to make informed purchasing decisions based on their preferences and needs.

The Decision Support System (DSS) was evaluated using three primary methods: **expert judgment, black-box testing, and the System Usability Scale (SUS) test**. These evaluation techniques aimed to assess the system's accuracy, functionality, and usability.

1. Expert Judgment Evaluation

Three domain experts specializing in decision support systems and wearable technology reviewed the system. The evaluation focused on four key aspects: **data completeness, selection criteria accuracy, ranking suitability, and decision accuracy**. The results are summarized in Table 5.

Table 5. Expert Judgment

No	Evaluation Component	Expert 1	Expert 2	Expert 3	Average Score
1	Data Completeness	3	4	3	3.25
2	Selection Criteria Accuracy	3	3	4	3.50
3	Ranking Suitability	3	3	4	3.75
4	Decision Accuracy	4	4	4	4.00

The results indicate that the system performs well in **ranking smartwatch alternatives** and provides valid recommendations.

2. Black-Box Testing

A black-box test was conducted to verify the correctness of system functionalities, including user input handling, WP calculations, and output generation. The system passed 100% of the test cases, confirming that all features operated as expected.

3. System Usability Scale (SUS) Test

Usability testing was conducted with 10 respondents using the SUS framework. Each question was rated on a Likert scale (1 to 5). The system received an average SUS score of 75.25, categorizing it as "Good" usability.

The evaluation results confirm that the DSS is **accurate, functional, and user-friendly**, making it a reliable tool for selecting a smartwatch.

Conclusion and Future Work

Conclusion

This study successfully developed a Decision Support System (DSS) for smartwatch selection using the Weighted Product (WP) method. The system was designed to assist users in making informed decisions based on predefined criteria, such as compatibility, battery life, screen size, durability, price, and features. The implementation of the WP method allowed for a structured and objective evaluation of smartwatch alternatives, ensuring accurate and data-driven recommendations.

The evaluation process, including expert judgment, black-box testing, and usability testing, confirmed that the DSS functions effectively and meets user expectations. The system achieved a 100% success rate in black-box testing, an SUS score of 75.25, and positive expert evaluations. These results validate the system's reliability and usability in real-world applications.

Future Work

Despite the promising results, several areas of improvement remain for future research and development:

1. Expansion of Smartwatch Alternatives – The current dataset includes 20 smartwatch models. Future versions can incorporate a broader range of devices to improve recommendation accuracy.
2. Integration of Machine Learning – Implementing machine learning algorithms can enhance the system's decision-making by learning from user preferences and refining recommendations.
3. Addition of More Criteria – Additional decision criteria, such as user reviews, software updates, and connectivity options, can be integrated to provide more comprehensive recommendations.
4. Mobile Application Development – Developing a mobile application version of the DSS would increase accessibility and usability for a wider range of users.
5. Multi-User and Cloud-Based Features – Implementing a cloud-based system with multi-user functionality allows users to share and compare smartwatch recommendations.

Future research can address these enhancements to further improve the DSS, making it a more effective and adaptive tool for smartwatch selection.

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