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Analytical Hierarchy Process Method of Prosthetic and Orthotic Materials for Patient Needs

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Abstract

This study highlights the importance of optimising assistive devices for people with disability, as the law says in Law No. 8 of 2016. Ligar Mandiri Prosthetics and Orthopaedics Clinic offer related services, where choosing the right materials is getting more complicated because of fast tech advances and lots of options like carbon fibre, plastic, and titanium. This study aims to develop a Decision Support System (DSS) to assist practitioners in selecting materials based on quality, cost, and production time criteria. The alternatives evaluated include local, semi-imported, and imported materials. Using the Analytic Hierarchy Process (AHP) method, the analysis shows that imported materials received the highest ranking (0.54708), followed by local materials (0.24157) and semi-imported materials (0.21155). The DSS developed in this study has enhanced the accuracy, efficiency, and transparency of decision-making, thereby supporting practitioners in providing effective and reliable prosthetic and orthotic solutions.
Keyword: *Prosthetic; Orhtotic; Analytic Hierarcy Process (AHP); Disability.*

1. Introduction

A gratitude-based intervention is highly beneficial in improving self-confidence when facing the future, particularly for individuals with disabilities [1]. As people with disabilities represent a vulnerable group, they should have equal standing with non-disabled groups in society [2]. This statement aligns with government efforts to support the empowerment and protection of disability rights through Law No. 8 of 2016, which classifies disabilities into four categories physical, intellectual, mental, and/or sensory and promotes the optimization of assistive devices based on medical recommendations to support daily activities. Accordingly, the government, through the Ministry of Social Affairs of the Republic of Indonesia (Kemensos), encourages the fulfillment of the rights of persons with disabilities, particularly access to information through digital technology [3]. This situation highlights the need for designing a decision-support system to assist practitioners in determining the optimal materials and more transparent access to information for patients. Moreover, this initiative aligns with the Indonesian government's commitment and the Ministry of Social Affairs' efforts to enhance information accessibility through digital technology for individuals with disabilities.

Ligar Mandiri Prosthetic & Orthotic is a healthcare clinic offering services and products for the creation of assistive medical devices. The clinic has served patients with physical disabilities from diverse backgrounds. The prosthetic devices available include artificial hands, legs, fingers, and noses, while the orthotic devices offered include corrective shoes, chair back braces, AFOs (ankle-foot orthoses), arch supports, and hand splint polio braces. Additionally, they also provide mobility aids such as wheelchairs, crutches, commodes, and walkers. These prosthetic and orthotic devices are specially designed to assist patients with physical limitations [9]. Understanding and managing the care of these devices is crucial, which presents a challenge for patients who are unfamiliar with proper usage [10]. A study by Magnusson and Ahlström [11] conducted in two countries found that patient satisfaction levels with assistive devices ranged between 3.7 and 3.9 out of 5. However, devices are not the sole priority for patients; effective communication and continuous service are equally significant [10]. On a deeper level, effective communication and recognition of individuals—whether patients or employees—play a critical role. Appreciation for employees, in particular, enhances productivity and fosters innovation, strengthening the company's competitive edge [12].

For individuals with physical disabilities post-amputation, it is recommended to use mobility aids to improve body image and physiological functions [4]. Prosthetic devices enable optimal daily activities by concealing the missing body part [5], while orthotic devices are specifically designed to support limb movement, prevent deformities, and protect injuries [6]. Beyond the role of assistive devices and policy support in enhancing the quality of life for individuals with disabilities, it is crucial to consider psychological aspects such as coping styles, which help individuals manage emotional challenges arising from physical or social limitations [7]. A study conducted by Bancroft et al. [8] revealed that assistive devices tailored to the patient's health condition are highly beneficial for mobility and for preventing damage to vulnerable body parts. In the context of healthcare decision-making, Adiputra and Wasino [18] implemented a web based system for recording community health program reports similar to AHP. This system demonstrates how structured digital tools can improve transparency in decision-making and reduce human error in healthcare management. Afandi [19] applied AHP to supplier selection, showing that it can effectively quantify subjective preferences and rank alternatives. The study revealed practical, measurable challenges, such as inconsistent supplier reliability and varying material quality, underscoring the importance of structured decision support in supplier's selection.

The selection of appropriate materials for prosthetic and orthotic devices is crucial to ensuring both comfort and functionality. With a wide range of materials available, such as titanium, plastic, and carbon fiber, patients often face significant challenges in choosing the most suitable option [6]. Technology integration has the potential to improve efficiency, accuracy and comfort in the manufacture of prosthetic and orthotic health assistive devices, with the adoption of technology the design is made more ergonomic, high-quality with faster and more economical production processes [9], [13]. The objective of this study is to develop a web-based decision support system that utilizes the Analytic Hierarchy Process (AHP) to assist clinics in selecting the most appropriate prosthetic and orthotic materials for patients. By systematically evaluating various criteria, this system aims to provide an objective and measurable framework for decision making. The expected benefits include increased patient satisfaction and functional outcomes, as well as improved patient experience in prosthetic and orthotic services

2. Literature Review

People with disabilities are a protected group, psychosocial research highlights how well-being and adaptive adjustment mechanisms (for instance, gratitude interventions, adjustment styles) influence adjustment and quality of life in people with disabilities, informing patient-centred prosthetic/orthotic care pathways [1], [7]. In orthotics, it is positioned as a core intervention to support function and prevent complications [8]. These aspects drive a decision-making framework that considers not only technical performance but also patient-reported outcomes and service delivery quality.

A clinical study shows that prostheses can help restore body image and function after amputation [4], and that patient satisfaction with lower limb prosthetic and orthotic devices depends on device attributes and service delivery processes [11]. Communication and health literacy emerge as critical factors in device use and satisfaction, suggesting that transparency in selection criteria can strengthen trust and compliance [10], [11], [5]. Rapid advancements in materials such as titanium, carbon fibre, engineered polymers and digital fabrication have transformed prosthetic and orthotic manufacturing, enabling lighter, stronger, and more ergonomic devices, as reviewed in recent technology surveys [9], [6]. Research on bio-based composites reveals the potential for cost-effective ankle and foot orthoses while maintaining structural performance, expanding material options for context-appropriate solutions [13]. These developments expand the design space—and thus complexity—in material selection in routine clinical practice.

Given the trade-off between quality, cost, and production time, multi-criteria decision-making (MCDM) is an appropriate approach. The Analytic Hierarchy Process (AHP) provides a structured approach to breaking down objectives, weighting criteria, and prioritising alternatives using pairwise comparisons with consistency checks [14], [17]. AHP has been widely applied to procurement and material issues, including supplier selection where price often dominates but quality and availability remain important [15], [19]. In the context of material/machine selection, AHP can rank candidate materials based on technical and economic criteria, although findings also caution that inconsistencies (high CR) can threaten validity if assessments are unstable [20]. In determining retail sizes and other decision support system (DSS) examples, alternative algorithmic approaches (e.g., Naïve Bayes, SAW) demonstrate the diversity of decision analysis tools available beyond AHP [12], [16]. Overall, this collection demonstrates the suitability of AHP for selecting prosthetic and orthotic materials while highlighting methodological rigour (e.g., CR < 0.1) and transparency. For prosthetics and orthotics, clear and principle-based presentations of multi-criteria trade-offs may enhance patient understanding and perceptions of choice fairness, complementing health literacy objectives [10], [11].

This study updates the latest developments by implementing an AHP-based decision support system (DSS) specifically for the selection of prosthetic and orthotic materials in a real clinical environment (Ligar Mandiri), by implementing a three-criteria model—material quality, material cost, and production time—aligned with practitioners' workflows, and integrating explainable and consistency-checked weighting to support transparent and patient-centred communication, in line with considerations of human rights and literacy [2], [3], [10], [11], [14], [17]. Conceptually, this differs from previous material/manufacturing surveys [6], [9], [13] by shifting from descriptive technology mapping to data-driven normative choices, and from general AHP procurement examples [15], [19], [20] to clinic-specific prosthetic and orthotic decisions where patient trust and service quality are central. Methodologically, the main contribution is a validated AHP pipeline (CR < 0.1) with clear global priorities over local/semi-imported/imported alternatives, yielding reproducible rankings that can be communicated to stakeholders and audited for quality improvement. The integration of decision analysis with patient-oriented transparency represents the main uniqueness of this study and its practical significance for prosthetic and orthotic services.

Afandi [19] analyzed supplier selection using AHP in the context of manufacturing/procurement. The parameters/criteria analyzed were price, quality, availability, and distance. Results: price dominates (priority ≈ 0.504), followed by quality, availability, and distance, indicating cost-driven selection in this context and showing how criterion weights can dominate the final ranking when economic pressures are high. Adiputra & Wasino [18] discuss web-based public health reporting applications, but their contribution is relevant here as it documents mixed data collection practices and system design applicable to clinical DSS development. Although not a study of AHP, this research describes rigorous field data collection, stakeholder interview techniques, and clinically oriented workflow integration, providing insights into how AHP-based DSS should be validated and integrated in real clinical settings [18].

This study centers on the application of decision-making technology in the selection of prosthetic and orthotic materials using the Analytic Hierarchy Process (AHP). However, the increasing diversity of materials also makes clinical decision-making more complex. Although previous studies have applied AHP to the selection of suppliers or materials in general manufacturing, there are few to adapt it specifically to the clinical context of prosthetics and orthotics, which requires a balance between material quality, cost, and production time while ensuring transparency and patient trust. This study expands this field by developing an AHP-based Decision Support System (DSS) tailored to the real clinical environment.

3. Methods

This study applies the decision-making system developed by Thomas L. Saaty in 1980, known as the Analytical Hierarchy Process (AHP). This method involves data collection and processing using mixed methods, presented in a simplified form [14]. AHP facilitates solving complex decision-making problems by structuring them into a hierarchy of goals, criteria, subcriteria, and alternatives [15]. Furthermore, the implementation of AHP in this research helps minimize errors for prospective buyers [16]. The determination of criteria simplifies the prioritization process among them, as this technique converts qualitative judgments into quantitative estimates [17].

3.1 AHP Algorithm

1) Define Goals

in determining the desired solution, the Analytical Hierarchy Process (AHP) begins by defining the decision elements consisting of the goal, criteria, subcriteria, and alternatives. Through this hierarchical structure, AHP enables a systematic evaluation of each alternative based on its performance across all defined criteria and subcriteria, ultimately leading to the selection of the most suitable material for prosthetic and orthotic applications.

2) Establishing a Hierarchy

AHP breaks the problem into a hierarchical model consisting of three levels. Goal is the main objective of decision; Criteria are the factors that influence the decision; while Alternatives give the options to be evaluated.

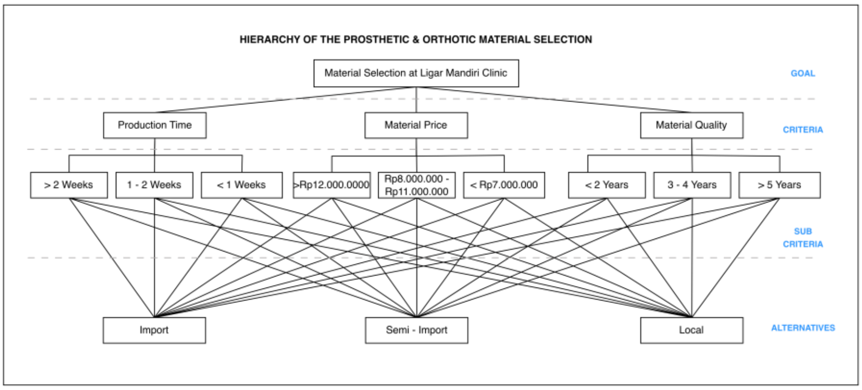

Figure 1. Material Selection Hierarchy (Source: Personal Documentation)

3) Pariwise Comparison Matrix

A matrix for pairwise comparison is developed, involving a comparison of each criterion and option in pairs using Saaty's scale from 1 to 9 to ascertain their corresponding significance. The comparison matrix is represented as $A = [a_{ij}]$, with a_{ij} signifying the comparative significance of element i to element $i$to j.

4) Eigen Vector and Weight Calculation

The results of these comparisons are then processed to obtain the eigen vector and weight calculation, which represent the priority or contribution of each element in the hierarchy. Each column of the matrix is normalized, and the principal eigenvector is calculated as the formula:

$$w_i = \frac{\sum_{j=1}^{n} \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}}{n} \quad \text{......................... (1)}$$

5) Consistency Calculation

Consistency calculation is performed using the Consistency Index (CI) and Consistency Ratio (CR), with CR values below 0.1 indicating acceptable consistency.

$$\lambda_{\max} = \sum_{i=1}^{n} (Aw)_i / w_i \quad \text{.......................... (2)}$$

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad \text{.......................... (3)}$$

$$CR = \frac{CI}{RI} \quad \text{.......................... (4)}$$

6) Score Calculation

Score calculation stage combines the weights of criteria and alternatives to compute a global priority value for each option, where the highest score indicates the best and most suitable material for clinical use.

$$P_i = \sum_{j=1}^{m} (w_j \times a_{ij}) \quad \text{……………………. (5)}$$

3.2 Data and Research Variable

The data collection techniques used in this study encompass three main methods: observation, interviews, and literature review. Observation was conducted to collect data directly [18] and address the requirements of AHP regarding the phenomena occurring in the clinic. Subsequently, interviews were carried out directly with two clinic practitioners. Meanwhile, the literature review served as the theoretical foundation and reference for the research. Furthermore, a pairwise comparison of the criteria was conducted to determine their weight-of-importance, where values were assigned based on an importance scale from 1 to 9. Afterwards, alternatives, namely import, semi-import, and local, were evaluated based on each criterion using eigenvector normalisation to determine global priorities. To improve the reliability of the method, this study conducted a consistency test by calculating the Consistency Index (CI) and Consistency Ratio (CR) to ensure that pairwise comparisons are not inconsistent; provided CR < 0.1, the decision is considered valid.

3.3 Blackbox Testing

A clear distinction must be drawn between algorithm performance validation and software functional validation. The Analytic Hierarchy Process (AHP) algorithm in this study is a mathematically defined multi-criteria decision-making method, whose validity is evaluated through consistency measures, such as the Consistency Index (CI) and Consistency Ratio (CR), as detailed in section **4.4**.

Black-box testing is applied strictly in accordance with its standardized. Focusing on what the system does. Specifically, the testing verifies that all functional modules such as user authentication, criteria and alternative data input, pairwise comparison entry, data storage, and result visualization operate correctly under valid and invalid input conditions. Test cases are designed based on functional requirements and user scenarios involving clinic practitioners. Black-box testing in this research serves to validate system reliability, correctness of input–output behavior, and usability.

4. Results and Discussion

4.1. Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) is highly flexible and can be applied to various decision-making problems, enabling decisions to involve multiple criteria simultaneously. This makes it effective for addressing complex issues such as material selection. This study aims to identify the best prosthetic and orthotic material based on the criteria of material quality, material cost, and production time. The alternatives considered are import, semi-import, and locally sourced materials. Once the elements are defined, the researcher conducts pairwise comparisons for the criteria and compares the alternatives against each criterion. Following this, the eigenvector normalization and consistency calculations are performed. The final step in material selection involves calculating the overall score to determine the optimal choice.

Table 1. Level of Importance

Scale	Level of Interest	Description
1	Equally Important	Both elements have the same level of importance.
3	Slightly more important	One element is slightly more important than the other.
5	More important	One element is more important than the other.
7	Very important	One element is significantly more important than the other.
9	Extremely important	One element is vastly more important than the other.
2, 4, 6, 8	Uncertain	The importance of one element relative to the other is greater than "equally important" but less than "slightly more important."

4.2. Pairwise Comparison

Based on the statements provided by the practitioners through an interview, these statements will be translated into a rating. The first pairwise comparison is done for each criterion, followed by the pairwise comparison of alternatives for each criterion. The statement "material quality is more important than price" is assigned an importance level of 5, "material quality is much more important than time" is assigned a level of 7, and "price is more important than time" is assigned an importance level of 5.

Based on the calculations obtained through Table 2, the pairwise comparison for each criterion derived from the interview assessment, shows that the price of material is compared with quality, yielding a value of $\frac{1}{5}$ = 0,2. The production time is compared with quality, giving a value of $\frac{1}{7}$ = 0,14. Meanwhile, production time is compared with material price, yielding a value of $\frac{1}{5}$ = 0,2.

Table 2. Pairwise Comparison of Criteria

	Material Quality	Material Price	Production Time
Material Quality	1	5	7
Material Price	0,2	1	5
Production Time	0,14	0,2	1
Total	1,34	6,2	13

Based on Table 3, which outlines the pairwise comparison of alternatives against the quality criterion, the following importance levels were assigned: the statement "import quality is much better than local" received an importance level of 7, while "import quality is better than semi-import" was given a level of 5. Additionally, "semi-import quality is better than local" also had an importance level of 5. From these assessments, the corresponding values for the pairwise comparisons were calculated: the comparison between semi-import quality and import quality yielded a value of 0.2, while the comparison between local quality and import quality resulted in a value of 0.14. Finally, the comparison between local quality and semi-import quality gave a value of 0.2.

Table 3. Comparison of Each Alternative Towards Material Quality Criteria

Material Quality	Import	Semi import	Local
Import	1	5	7
Semi import	0,2	1	5
Local	0,14	0,2	1
Total	1,34	6,2	13

In Table 4, the pairwise comparison for the material price criterion showed the following importance levels: the statement "local price is better than semi-import" was assigned an importance level of 5, "local price is much better than import" received an importance level of 7, and "semi-import price is better than import" was given an importance level of 5. Based on these assessments, the pairwise comparison values were calculated as follows: the comparison between import price and semi-import price yielded a value of 0.2, the comparison between import price and local price resulted in a value of 0.14, and the comparison between semi-import price and local price gave a value of 0.2. These values will help determine the relative importance of each alternative based on material price in the decision-making process.

Table 4. Comparison of Each Alternative Towards Material Price Criteria

Material Price	Import	Semi import	Local
Import	1	0,2	0,14
Semi import	5	1	0,2
Local	7	5	1
Total	13	6,2	1,34

In the pairwise comparison presented in Table 5, the practitioners provided the following assessments: "semi-import production time is better than import" was assigned an importance level of 5, "local production time is much better than import" received an importance level of 7, and "local production time is better than semi-import" was given an importance level of 5. Based on these evaluations, the following results were obtained: the comparison between material quality and material price yielded a value of 0.2, the comparison between material quality and production time resulted in a value of 0.14, and the comparison between material price and production time gave a value of 0.2.

Table 5. Comparison Of Each Alternative Towards Production Time Criteria

Production Time	Import	Semi import	Local
Import	1	0,2	0,14
Semi import	5	1	0,2

Production Time	Import	Semi import	Local
Local	7	5	1
Total	13	6,2	1,34

4.3. Eigen Vector Normalisasi (EVN)

The eigenvector (EVN) is obtained by multiplying each row by the corresponding column in Table 2. After performing the multiplications, the results are summed up, and the total value for each criterion is divided by the overall sum of 73.28, as shown in Table 6.

Table 6. Eigen Vector Normalisation Towards Criteria

	Material Quality	Material Price	Production Time	Total	EVN
Material Quality	2,98	11,4	39	53,38	0,7284389
Material Price	1,1	3	11,4	15,5	0,2115175
Production Time	0,32	1,1	2,98	4,4	0,0600437
		Total		73,28	

Table 7 examines the criteria specifically related to Material Quality by multiplying each row and column in Table 3. After normalization, the total value for each criterion is calculated, and the eigenvector (EVN) is determined in the same manner as in the previous table. The results indicate that import material quality has the most significant influence, with an EVN of 0.7284.

Table 7. Eigen Vector Normalisation Towards Material Quality Criteria

Material Quality	Import	Semi import	Local	Total	EVN
Import	2,98	11,4	39	53,38	0,7284389
Semi import	1,1	3	11,4	15,5	0,2115175
Local	0,32	1,1	2,98	4,4	0,0600437
		Total		73,28	

Table 8 analyzes the criteria based on material price by multiplying each row and column in Table 4. The normalization process follows the same steps as outlined in Tables 6 and 7. The results show that local material price is a significant factor in material selection compared to import and semi-import materials.

Table 8. Eigen Vector Normalisation Towards Material Price Criteria

Material Price	Import	Semi import	Local	Total	EVN
Import	3	1,11	0,33	4,44	0,0605895
Semi import	11,4	3	1,11	15,51	0,2116539
Local	39	11,4	2,98	53,38	0,7284389
		Total		73,28	

The first step involves multiplying each row and column in Table 5, followed by summing the results. Next, the total value is divided by the overall sum of 73.28. Table 9 presents the normalization process for production time. The highest eigenvector (EVN) value is 0.7287, indicating that production time is the most critical factor. In this context, local materials outperform others due to their shorter production times.

Table 9. Eigen Vector Normalisation Towards Production Time Criteria

Production Time	Import	Semi import	Local	Total	EVN
Import	3	1,11	0,33	4,44	0,0605895
Semi import	11,4	3	1,11	15,51	0,2116539
Local	39	11,4	3	53,4	0,7287118
		Total		73,28	

4.4. Consistency Ratio & Final Score

The calculation of λmax is used to measure the consistency of the pairwise comparison matrix. This value is determined by multiplying each eigenvector (EVN) by the corresponding criterion weight.

$$\lambda_{max\ criterion} = (1{,}34 \times 0{,}7284389) + (6{,}2 \times 0{,}2115175) + (13 \times 0{,}060037) = 3{,}0680841$$

$$\lambda_{max\ quality} = (1{,}34 \times 0{,}7284389) + (6{,}2 \times 0{,}2115175) + (13 \times 0{,}060037) = 3{,}\ 0680841$$

$$\lambda_{max\ price} = (13 \times 0{,}605895) + (6{,}2 \times 0{,}2116539) + (1{,}34 \times 0{,}728439) = 3{,}0760262$$

$\lambda_{max\ time}$ = (13 x 0, 605895) + (6,2 x 0, 2116539) + (1,34 x 0, 7287118) = 3,0763919

After calculating λmax the next step is determining the Consistency Index (CI), which measures the degree of consistency in the pairwise comparisons. λmax is the average eigenvalue, and n represents the number of criteria.

$$CI = \frac{\lambda max^{-n}}{n-1} = \frac{3{,}0680841^{-3}}{3-1} = 0{,}034042$$
$$CI = \frac{\lambda max^{-n}}{n-1} = \frac{3{,}0680841^{-3}}{3-1} = 0{,}034042$$
$$CI = \frac{\lambda max^{-n}}{n-1} = \frac{3{,}0760262^{-3}}{3-1} = 0{,}0380131$$
$$CI = \frac{\lambda max^{-n}}{n-1} = \frac{3{,}0763919^{-3}}{3-1} = 0{,}038196$$

The next step is calculating the Consistency Ratio (CR), which evaluates whether the consistency of the pairwise comparison matrix is acceptable. IR is the Random Index, obtained from a standard table of Random Index values based on the number of criteria (n).
Table 10. Random Index Value (IR).
(Source: (15))

N	1	2	3	4	5	6	7	8	9	10
IR	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49

Therefore, n=3 and the IR value is 0.58. If the CR is less than 0.1 (10%), the matrix can be considered consistent. CR for criteria shows 0.0586932, CR for alternatives against material quality is 0.0586932, CR for alternatives against material price is 0.0655398, and CR for alternatives against production time is 0.0658551. All CR values are below 0.1.

$$CR = \frac{CI}{IR} = \frac{0{,}034042}{0{,}58} = 0{,}0586932$$
$$CR = \frac{CI}{IR} = \frac{0{,}034042}{0{,}58} = 0{,}0586932$$
$$CR = \frac{CI}{IR} = \frac{0{,}0380131}{0{,}58} = 0{,}0655398$$
$$CR = \frac{CI}{IR} = \frac{0{,}038196}{0{,}58} = 0{,}0658551$$

The final score, or global priority, for each alternative is calculated by multiplying each criterion's EVN value by the corresponding weight of each alternative and then summing the results.

Import $= (0{,}7284389\, x\, 0{,}7284389) + (0{,}0605895\, x\, 0{,}2115175) + (0{,}0605895\, x\, 0{,}0600437) = 0{,}54708$
Semi import $= (0{,}2115175\, x\, 0{,}7284389) + (0{,}2116539\, x\, 0{,}2115175) + (0{,}2116539\, x\, 0{,}0600437) = 0{,}21155$
Local $= (0{,}0600437\, x\, 0{,}7284389) + (0{,}7284389\, x\, 0{,}2115175) + (0{,}7287118\, x\, 0{,}0600437) = 0{,}24157$

Based on the calculations outlined, the AHP method proves to be an effective approach for data-driven decision-making. The import material holds the highest ranking with a value of 0.54708. Although it is more expensive, the overall evaluation shows that import materials are superior in terms of comfort and long-term durability for patients with disabilities. The second-best material is local, with a score of 0.24157, followed by semi-import material in third place with a score of 0.21155. This suggests that while local and semi-import materials are viable options, import materials provide the best overall benefit for the users. The discussion of these results highlights the importance of balancing quality and cost. The clinic practitioners provided feedback indicating that although the price of import materials is high, patients tend to be more satisfied with the quality of medical devices made from a combination of import materials such as titanium, rubber, carbon fiber, and others. This suggests that, to enhance patient satisfaction, the quality factor should be prioritized in the decision-making process, even though it may involve higher costs.

A similar study was conducted by Afandi [19], this result applied the AHP method to supplier selection, identifying the best supplier based on price, distance, quality, and availability. The dominant criterion was price (0.504), followed by quality (0.230), availability (0.217), and distance (0.049). This study highlights the importance of cost considerations in decision-making.
Another related study was conducted by Sianipar et al. [20], which examined material selection for machining based on tool wear, cutting speed, surface quality, and cost. The alternatives included Aluminum, Brass, and Copper. Data was collected through observation, literature

review, and interviews. The study found that the best material was Aluminum (0.570), despite a consistency ratio (CR) of 0.44, exceeding the acceptable threshold of <0.1, indicating inconsistencies in comparisons. In addition, a study by Rizky Ahadian et al. [15] found that the Price criterion had the highest weight/priority, accounting for 26.77% of the five criteria used in selecting cement materials supplier.

Within the clinical context, this method can be applied to improve the accuracy and efficiency of orthotic and prosthetic material selection, enabling practitioners to make more informed, data-driven decisions to meet patient needs. However, the current model has its limits, such as the reliance on the subjectivity of practitioner judgement and the lack of patient psychosocial factors in the material selection process. For in-future research, the model can be refined by integrating broader multi-criteria analysis, including ergonomic factors, patient preferences, to improve validity and overall patient-satisfaction.

4.5. Program Testing

Before the testing phase, the Decision Support System (DSS) website using the Analytic Hierarchy Process (AHP) method was configured to connect to a local server (localhost) with a MySQL database. The system was tested by the programmer to ensure successful implementation and to verify that all modules and features, such as CRUD functionality, operated correctly. The User Acceptance Test involved the clinical practitioner and the clinic owner to evaluate the system's reliability, accuracy, and efficiency. Additionally, user training was conducted to enhance understanding of the system's features and workflow, ensuring optimal implementation in supporting decision-making processes within the clinic.

No	Fitur	Skenario	Input/Aksi	Output	Hasil	Tampilan	Status
1	Login	User memasukkan username dan password yang telah didaftarkan di database	admin 12345	Login berhasil user diarahkan ke halaman dashboard	Login berhasil		LULUS
	Login	User memasukkan username dan password yang salah	admin 11111	User tidak dapat login	Sistem memberikan alert		LULUS
	Login	User login menggunakan akun yang memiliki hak akses owner	owner 12345	1. Login berhasil user diarahkan ke halaman dashboard 2. user dapat melakukan proses CRUD	Login berhasil		LULUS

Figure 2. Blackbox Testing Examples (Source: Personal Documentation)

4.6 Discussion

This study demonstrates that an AHP-based decision support system (DSS) can effectively structure and justify prosthetic and orthotic material selection in a real clinical setting. The results show that imported materials ranked first (global priority = 0.547), outperforming local (0.242) and semi-import (0.212) alternatives. This ranking is consistent with the quantitative results reported in Section 4 and directly supports the conclusion that quality-driven decisions yield the most optimal clinical outcomes.

From a theoretical perspective, these findings extend prior prosthetic and orthotic studies that emphasize functional performance, durability, and patient comfort as key determinants of satisfaction [4], [5], [11]. The dominance of material quality aligns with clinical evidence that high-performance materials such as titanium and carbon fiber improve long-term usability and body function, despite higher costs [6], [9], [13]. Thus, the present study strengthens earlier work by translating descriptive material advantages into a formal, quantitative decision hierarchy that can be audited and replicated.

Compared with previous AHP-based studies in manufacturing and procurement contexts, this study reveals both convergence and divergence. Afandi [19] and Ahadian et al. [15] reported that price was the dominant criterion in supplier and material selection, reflecting cost-sensitive industrial environments. The integration of a web-based DSS further contributes to the literature by operationalizing AHP within clinical workflows. Prior studies have highlighted the importance of transparency, communication, and health literacy in prosthetic and orthotic services [10], [11]. By providing explicit criteria weights and explainable rankings, the proposed DSS supports clearer practitioner–patient communication and aligns with rights-based and accessibility-oriented healthcare policies [2], [3]. This practical contribution moves beyond theoretical AHP models toward patient-centered, technology-enabled care.

Nevertheless, the findings should be interpreted in light of several limitations. The model relies primarily on practitioner judgments, which have been shown to influence well-being and device acceptance [1], [7]. This AHP-based DSS provides a valid, transparent, and high-impact approach for prosthetic and orthotic material selection. By empirically confirming the primacy of material quality and demonstrating methodological rigor, this study both strengthens and refines prior research, contributing to the advancement of decision-support practices in prosthetic and orthotic services.

5. Conclusion

This research aimed to develop a Decision Support System (DSS) using the Analytic Hierarchy Process (AHP) to assist in selecting the most suitable prosthetic and orthotic materials based on quality, cost, and production time criteria The implementation of AHP effectively structured the decision-making process and provided transparent, data-driven recommendations for clinical use. Based on the AHP calculations from stages one to six, the imported material ranked first with a value of 0.5, followed by the semi-imported material with 0.2, and the local material with 0.1. These results indicate that imported materials are the most optimal choice, offering superior quality and durability despite higher costs. Overall, the system proved reliable and accurate in supporting clinical decision-making, aligning with the study's main objective to enhance efficiency and objectivity in material selection. One recommendation that should be considered is providing further education to patients about the long-term benefits of material selection and the care of their devices. Future research should integrate ergonomic measures, patient preferences, and broader psychosocial indicators into the AHP hierarchy to enhance external validity and clinical relevance

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