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Modeling Female Contraceptive Recommendation Using Hybrid Analytical Hierarchy Process and Profile Matching

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Abstract

Multi-criteria decision-making (MCDM) methodologies have been extensively employed across various domains within healthcare. They can be utilized for disease prediagnosis, aiding clinical decision-making (e.g., surgery), conducting health technology assessments, as well as establishing healthcare priorities. This research presents the outcomes of a hybrid MCDM strategy, integrating the AHP and Profile Matching to facilitate clinical recommendations related to female contraception. Many cases in Indonesia show acceptors' inappropriateness in using available contraceptives, causing side effects resulting in negative effects. The challenges in the Keluarga Berencana or Planned Parenthood program in Indonesia are increasing, based on the decline in the number of new acceptors and the high unmet needs for contraception. Failure to meet the need for contraception has the potential to increase birth rates and maternal mortality rates, which requires serious attention and the development of appropriate strategies. Based on the problem, this study aims to create a decision support model in selecting suitable contraceptives for acceptors. The criteria used in this study consisted of age, medical history, weight (BMI), breastfeeding or not, history of childbirth, period of use, and income. The seven criteria are implemented in AHP with a consistency test result value of 2.2%. Based on the target value of contraceptives obtained from the results of Profile Matching, compatibility was determined with a sample of three acceptor profiles. The results that have been achieved indicate a sample recommendation model for acceptors of IUD-type contraception that can assist midwives or medical personnel in providing recommendations for selecting appropriate contraceptive methods. Future studies can integrate the results of recommendations for health service providers (e.g., hospitals, Public Health Center or Puskesmas) in procuring contraceptives.

Keywords: Multi-Criteria Decision-Making, AHP, Profile Matching, Healthcare, Contraceptives

1. Introduction

One of the 17 SDGs established by the Indonesian government is to provide a healthy life and promote well-being for all people, regardless of age [1]. This includes the following goals: lowering the Maternal Mortality Rate (MMR); decreasing preventable infant and under-five deaths by lowering the Neonatal Mortality Rate and the Under-five Mortality Rate; putting an end to the AIDS epidemic and other infectious diseases; and ensuring universal access to sexual and reproductive health services [2]. This goal is in line with efforts to improve the quality of human resources related to Population and Prosperous Family Development. Achieving these targets requires comprehensive strategies, including strengthening healthcare infrastructure, enhancing access to planned parenthood education, and implementing evidence-based policies. In particular, it emphasizes the importance of collaborative efforts among government entities, healthcare practitioners, and community organizations to deliver effective, accessible reproductive health services tailored to diverse population needs.

Keluarga Berencana (KB) or Planned Parenthood is an attempt to plan or limit the number and interval of pregnancies by using contraception [3]. Windarti [4] states that a good understanding of planned parenthood will influence the proper use of contraception based on knowledge of the benefits of contraception so that the mother (acceptor) herself can decide which contraception is suitable for use. However, this information remains unfinished business in order to

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enable the achievement of the intended goals. Despite efforts to raise awareness, many acceptors continue to lack adequate information on current contraceptive alternatives and their long-term health effects. This research gap highlights the need for more targeted educational initiatives and decision-support tools that assist healthcare providers in guiding women toward informed choices, tailored to individual health profiles and lifestyle preferences.

To address these ongoing challenges, innovative approaches are needed to bridge the gap between contraceptive availability and informed decision-making among potential users. The integration of technology into healthcare particularly through decision support systems offers promising potential to enhance the quality of counseling, improve the personalization of contraceptive recommendations, and increase user satisfaction. By leveraging data-driven methodologies such as Multi-Criteria Decision-Making (MCDM), healthcare providers can systematically evaluate various factors influencing contraceptive choices. This study proposes the development of a hybrid decision support model using the Analytical Hierarchy Process (AHP) and Profile Matching to assist in selecting the most suitable contraception for female acceptors. It is expected that this approach will support more effective planned parenthood strategies and contribute significantly to achieving national health targets related to reproductive well-being.

2. Literature Review

Indonesia's efforts to improve the quality of reproductive health have become a central agenda in public health and development programs. As part of the broader Sustainable Development Goals (SDGs), Planned Parenthood (Keluarga Berencana/KB) has been a major strategy in regulating birth rates, ensuring maternal health, and promoting family welfare. However, the effectiveness of this program is heavily influenced by the public's access to reliable contraceptive information, the availability of health services, and the consistency of policy implementation. Monitoring program participation and service delivery outcomes is essential to evaluate the program's reach and to identify gaps in access or service quality. Quantitative indicators, such as the number of new participants and the achievement of coverage targets, help measure the performance of the KB initiative over time and reveal key areas for intervention.

Figure 1 depicts the trend of new participants entering the KB, or Planned Parenthood program in Indonesia over a five-year period from 2015 to 2019 [5]. Between 2015 and 2016, the number of new participants increased from 6.41 million in 2015 to a peak of 6.66 million. However, after this high, the number of new participants continued to fall annually. By 2017, the figure had reduced to 6.39 million, and it had further decreased to 6.03 million in 2018. By 2019, the number of new KB participants had dropped even lower to 5.68 million. Counselling is a crucial part of implementing the Planned Parenthood program since it optimizes contraceptive use.

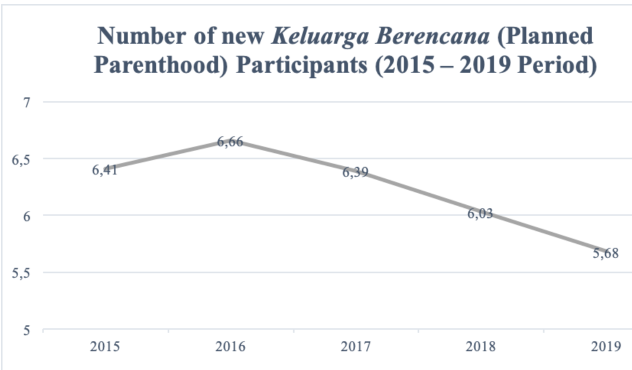

Figure 1. Trend of new Planned Parenthood Participants in Indonesia from 2015 – 2019.

The figure 2 below depicts the target, realization, and achievement percentages for Keluarga Berencana (Planned parenthood) requirements in Indonesia from 2019 to 2021 [6]. The dark bars indicate the annual targets, whereas the light gray bars show the actual implementation of planned parenthood activities. The blue line shows the achievement percentage, which is declining from 81.9% in 2019 to 46.1% in 2021.

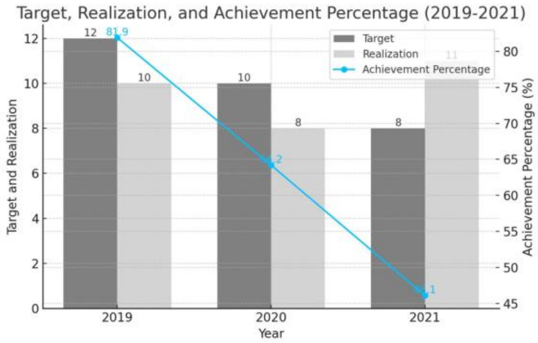

Figure 2. Unmet Need of Planned Parenthood Requirement.

This achievement rate can be connected with the unmet need in the context of planned parenthood. Unmet need denotes the proportion of individuals seeking planned parenthood services who are not presently utilizing them [7]. A lower achievement percentage suggests a higher unmet need, indicating that more people are unable to access necessary planned parenthood services. A decreasing achievement percentage over these years, as illustrated in figure 2, suggests a widening discrepancy between the intended targets and the actual delivery of services, as unmet need is a performance indicator that is negatively correlated. Ideally, a higher achievement percentage would be associated with a lower unmet need, which would indicate enhanced access and service delivery in planned parenthood. Despite the fact that the unmet need rate is decreasing, Indonesia has yet to achieve its objective of reducing it to 8.3%. This target reflects the government's ambition to ensure broader access to planned parenthood services; however, current achievements remain below these expectations, suggesting that further efforts in public health and planned parenthood services are required [8].

Goueth et al. [9] discovered that contraceptive use, adherence, knowledge, and self-efficacy were all positively impacted by technology-based contraceptive decision support tools. In order to optimize clinical decision-making for contraceptive users following these advantageous outcomes, this paper implements a computer science methodology. The Multi-Criteria Decision-Making (MCDM) method was employed in this study to formulate recommendations regarding female contraception [10]. The Analytical Hierarchy Process (AHP) and Profile Matching [11] were integrated. The positive impact of contraceptive use is anticipated to be enhanced, particularly in Indonesia, as a result of the implementation of MCDM.

Compared to MCDM, the Decision Making (DM) [12] approach was originally used to solve problems optimally by applying statistical techniques or quantitative surveys. MCDM is an approach or method for making decisions based on alternative/solution options from multiple criteria [13]. MCDM emphasizes decision-making that is likely to be implemented by several stakeholders, considering the problem's structure and all relevant features (according to a priority scale) that are influential and occasionally inversely related to each criterion in the decision-making process. The decision-making criteria included in this study were derived from primary data obtained from cases in lower and middle-income countries (LMICs) [14]. Indonesia, exemplifying a low- and middle-income country, has distinct problems in female contraceptive decision-making attributable to its heterogeneous population and disparate access to healthcare services. Health facilities in Indonesia, such as Public Health Centers (Puskesmas) and local clinics, are essential in delivering planned parenthood services, frequently requiring the management of constrained resources while striving to fulfill the contraceptive needs of individuals and the community. The criteria were derived from the data collection findings disseminated to participants at the Puskesmas in Pandeglang Regency, West Java, Indonesia. These criteria are subsequently used as components for priority mapping and consistency evaluation in the AHP. The subsequent parts' outcomes are prioritized via the Profile Matching technique to facilitate recommendation modeling for acceptors based on the type of contraception.

The declining trend in new KB participants and the widening gap between targets and actual achievements highlight an urgent need for more targeted, efficient, and informed decision-making in contraceptive service delivery. In response to these challenges, various studies have begun integrating technological and computational methods to support contraceptive decision-making. Particularly, decision support systems (DSS) that utilize Multi-Criteria Decision-

Making (MCDM) frameworks, such as the Analytical Hierarchy Process (AHP) and Profile Matching, offer a structured and transparent approach to tailoring contraceptive recommendations. These methods consider various user-specific criteria, enhance service personalization, and provide strategic direction for improving the effectiveness of planned parenthood programs in Indonesia and other similar low- and middle-income countries.

3. Methodology

This section outlines a systematic methodology to developing a decision-support system that tailors contraceptive recommendations to the unique needs of each user. This study employs a hybrid approach combining the AHP and Profile Matching to systematically prioritize criteria and match profiles. With this hybrid approach, it is expected to obtain more comprehensive and accurate decision solutions, as well as provide deeper insights into the decision-making process on MCDM in healthcare, emphasizing the application of diverse MCDM methodologies to address complex challenges in this field.

2.1. Analytical Hierarchy Process

The AHP aids decision-makers in addressing complex problems that encompass several criteria, particularly when those criteria are conflicting or qualitative. It offers a systematic, quantitative approach for structuring and analyzing decision-making issues, rendering it especially beneficial across several domains including business, healthcare, engineering, and public policy. The AHP facilitates systematic and reasonable comparison of solutions by breaking an issue into a hierarchy of sub-problems [15].

AHP's key strength is its capacity to organize decision-making problems into a hierarchy, with the aim at the top, criteria at the middle, and choice options at the bottom. The decision maker employs pairwise comparisons to determine the relative relevance of criteria and the performance of alternatives in reference to each criterion. These comparisons are normally made on a scale of 1 (equal importance) to 9 (very important).

The paired comparisons yield a pairwise comparison matrix, which is used to calculate the criteria weights and alternative performance ratings. AHP uses eigenvalue decomposition to calculate the priority vector and the consistency ratio to assess judgment reliability. This decomposition aims to find the eigenvalue and eigenvector of the matrix. Eigenvalue provides information about the relative importance of each criterion, while eigenvector indicates the appropriate priority weight. In the context of AHP, the eigenvectors generated from the pairwise comparison matrix reflect the weights that can be used to rank alternatives based on the established criteria. One of the advantages of using eigenvalue decomposition is its ability to handle inconsistencies in judgments. AHP provides a method for calculating a consistency index, which allows decision makers to assess how consistent their preferences are in pairwise comparisons. If low consistency is detected, then the judgment can be reviewed to improve the accuracy of the results. This decomposition acts as a mechanism to ensure validity and reliability in the decision-making process using AHP. If the consistency ratio surpasses a specific level, the judgments are deemed inconsistent and more refinement is required.

AHP has found extensive application in strategic decision-making within businesses, especially in selecting the most appropriate course of action from multiple alternatives. For instance, Canco et al. [16] used AHP to assess strategic business decisions by considering the perspectives of consumers and managers.

In healthcare, AHP has been employed to evaluate medical treatment options, healthcare policies, and hospital performance. Byun et al. [17] implemented AHP to prioritize community-based intervention programs in order to enhance the compliance of patients with chronic diseases with their treatment regimens, taking into account factors such as efficacy, cost, and potential adverse effects. Similarly, AHP was also implemented to determine the most suitable healthcare policies, including the allocation of funding for various medical services, thereby guaranteeing that decisions were made in accordance with both clinical outcomes and societal benefits [18].

AHP was employed to prioritize key performance indicators (KPIs) such as patient satisfaction, operational efficiency, and clinical outcomes in hospital performance assessment, as demonstrated by [19]. This facilitated the enhancement of resource allocation and quality management in the hands of hospital management.

AHP has also been employed in public policy decision-making, where complex societal issues require a balancing of competing interests. Rivero Gutiérrez et al. [20] applied AHP to evaluate public transportation systems in urban areas, to assess public transportation systems in urban areas, with an emphasis on accessibility, environmental impact, cost, and convenience criteria. The hierarchical framework facilitated the comparison of alternative policies and the selection of the most suitable option in a transparent and objective manner.

2.2. Profile Matching

Profile Matching is a decision-making technique that contrasts an individual's profile with a set of predefined profiles to identify the most appropriate alternatives based on prescribed criteria [21]. Multi-Criteria Decision Analysis (MCDA) is a common application of the method, which aims to identify the alternative that most closely aligns with the decision-maker's preferences, requirements, or circumstances. Profile Matching is particularly advantageous when the alternatives can be described in terms of multiple criteria and the objective is to align the alternatives with a user's unique profile or requirements, in contrast to other MCDA techniques [22].

The fundamental concept of Profile Matching is to assess a collection of alternatives by assessing their compatibility with the criteria, preferences, or requirements of an individual or organization. The procedure typically entails the subsequent steps: 1) Profile Definition: A profile is constructed based on the decision maker's requirements. This may include qualitative and quantitative criteria such as preferences, needs, or constraints. 2) Alternative Profiling: Each alternative is described using the same criteria as the profile, often in the form of a score or rating. 3) Matching Process: A comparison is made between the decision-maker's profile and the alternative profiles. The degree of compatibility or "match" is assessed, with a higher degree indicating a better fit.

In most cases, the profiles are described using multiple criteria, which can be weighted to reflect their relative importance. The degree of match can be determined using a variety of methods, such as weighted scoring, straightforward distance measures, or similarity indices. Profile Matching is particularly advantageous in the healthcare sector for the purpose of recommending treatments, selecting medications, or selecting medical devices based on patient profiles. For example, in personalized medicine Profile Matching was applied to determine optimal drug developed a model to evaluate drug suitability for hypertension patients [23]. The model evaluates the patient's health status using parameters that have been established by experts and suggests suitable medication varieties.

2.3. Hybrid AHP-Profile Matching

The method commences with data acquisition via interviews and questionnaires administered to contraceptive users, collecting vital information regarding demographic, medical, and lifestyle variables. The data are subsequently evaluated to ascertain the requirements and preferences of each acceptor. A hierarchy structure is established using AHP to identify and evaluate essential characteristics affecting contraceptive selection, including age, medical history, and breastfeeding status. The Profile Matching approach is then utilized to align the weighted criteria with each acceptor's profile, discovering discrepancies and assessing suitability. The final outcome is a ranked recommendation list that provides personalized contraceptive options, designed to enhance acceptors' satisfaction and alignment with clinical guidelines.

By using a pairwise comparison matrix, AHP helps in systematically assessing the weight of each criterion, thus minimizing subjective bias. On the other hand, Profile Matching functions to match alternatives with predetermined criteria, based on the suitability between the alternative profile and the desired needs or preferences. This method allows for a more in-depth evaluation of existing alternatives, considering how each alternative meets the predetermined criteria. By combining these two methods, decision makers can take advantage of the advantages of AHP in determining the priority of criteria and the strength of Profile Matching in evaluating the suitability of alternatives. This synergy not only improves accuracy in decision making by only using traditional methods but also provides transparency and stronger justification for the choices made, resulting in solutions that are more effective and relevant to existing needs.

Figure 3 delineates a systematic procedure for creating a decision-support system that recommends appropriate contraception techniques for users. The approach commences with Problem Identification, wherein the challenges associated with contraceptive utilization and selection criteria are delineated. This is succeeded by Data Collection, when information is obtained from acceptors via interviews and questionnaires to acquire pertinent data on criteria affecting contraceptive selection. The data collection process began with interviews conducted with midwives at the Pandeglang District Health Center, West Java. Midwives play a significant role as decision makers regarding the criteria for selecting contraception. This interview aims to determine the criteria and scale of importance in providing planned parenthood services to acceptors. Furthermore, to obtain quantitative data, a questionnaire was distributed to 100 female contraceptive acceptors aged between 20 and 40 years. This questionnaire was designed to collect information about the acceptor profile and contraceptive use. Random sampling was carried out to ensure the representativeness of the data obtained. However, acceptor demographic information cannot be published due to an agreement in the ethical clearance obtained before the study was conducted, in order to protect the privacy and confidentiality of respondents.

After data collection through questionnaires, additional interviews were conducted with several samples of acceptors to validate the questionnaire contents. This process is important to ensure the accuracy and consistency of the data collected. Interviews with acceptors aim to further explore their experiences in using contraception and ensure the accuracy of the information they provide. Subsequently, an analysis of the acceptors' requirements is performed to examine their profiles and ascertain their individual demands.

Data obtained from interviews and questionnaires will be analyzed using qualitative and quantitative analysis methods. Qualitative analysis was conducted on the interview transcripts to identify key themes and patterns emerging from the midwives' experiences and acceptor profile information. Meanwhile, quantitative data from the questionnaires and the importance scale values from decision makers will be further analyzed using the hybrid AHP and Profile Matching methods. The development of decision support via the AHP entails establishing a hierarchical framework to prioritize criteria, including age, health status, and lifestyle factors, which will impact the recommendation system.

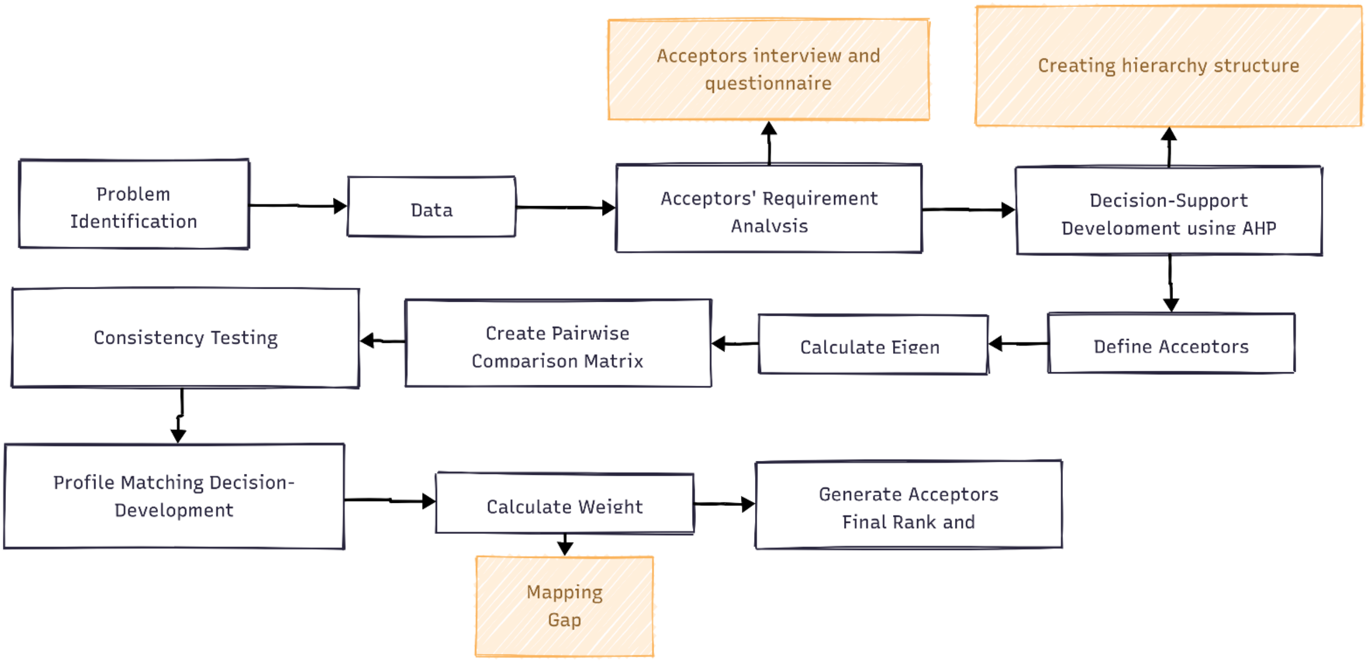

Figure 3. Research Flow of Hybrid AHP-Profile Matching

The subsequent steps concentrate on constructing and validating the AHP model. Defining Acceptors' Criteria delineates the precise elements for assessing contraceptive alternatives. Calculating the Eigen Vector and constructing a Pairwise Comparison Matrix are mathematical procedures employed to provide weights to each criterion, indicating their relative significance. Consistency Testing guarantees the reliability of these assessments. The process then advances to Profile Matching Decision-Development, where Mapping Gap assists in identifying disparities between the optimal and real acceptor profiles. Ultimately, Calculate Weight and Gap enhances the decision model, culminating in the final phase, Generate Acceptors' Final Rank and Recommendation, wherein the optimal contraceptive technique for each acceptor is identified based on their distinct profile and the model's computed recommendations. The main procedure for AHP and Profile Matching model creation mainly consist of:

Eigen Vector Calculation: Calculates the primary eigenvector of the pairwise comparison matrix, which signifies the priority or weight of each criterion.

Consistency Test: Employs the biggest eigenvalue to compute the Consistency Index (CI) and Consistency Ratio (CR) to assess the consistency of the matrix.

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

λ_{max} = the largest eigenvalue of the pairwise comparison matrix; n = the number of criteria or alternatives being compared

$$CR = \frac{CI}{RI} \quad (2)$$

CI = Consistency Index, and RI = Random Index; Gap Mapping: Maps the disparity between acceptor profiles and optimal profiles for each criterion, subsequently utilized for Profile Matching; Weighted Gaps: Computes the weighted discrepancies for each criterion, utilized to evaluate alternatives according to their adherence to the criteria; Final Recommendation: Employs weighted gaps to evaluate contraceptive techniques and propose the most appropriate alternative.

4. Results and Discussion

3.1. Creating AHP Hierarchy

The model for advising female contraception employs a hybrid AHP and Profile Matching to effectively incorporate user-specific criteria or factors in identifying the most appropriate contraceptive options. The Analytic Hierarchy Process (AHP) is employed to assess the relative significance of primary criteria (age, medical history, and breastfeeding) and secondary one's (body weight, maternity history, duration of use, and income) by allocating weighted scores to each criterion based on expert evaluations. These weights facilitate the prioritization of criteria vital for tailored contraceptive recommendations. Profile Matching thereafter evaluates individual profiles against the prioritized criteria to align each user with the most suitable contraceptive technique.

Criteria or factors are typically classified into Core Factors (CF) and Secondary Factors (SF) according to their importance and impact on the outcome. Core Factors (CF) are those that exert a principal influence and are considered vital in the decision-making process. When selecting a female contraceptive technique, considerations include age, medical history, and nursing status. Age is considered as a significant criterion, as certain contraceptives may be more suitable or safer for various age demographics, particularly in relation to hormonal fluctuations and fertility management over time. Medical history is also important, as various health issues (such as hypertension or clotting disorders) may limit the use of hormonal contraceptives, necessitating safer alternatives. Breastfeeding status is another core factor, as it directly influences the choice of contraception due to potential impacts on milk supply and the baby's health. Together, these core factors form the primary criteria, as they heavily influence which contraceptive options are safe, effective, and appropriate for a woman.

Secondary criteria, also known as secondary factors (SF), are supplemental variables that, while significant, have a smaller direct impact on the major decision than core factors. In contraceptive decision-making, SF includes body weight (BMI), maternity history, period of use, and wage. Body weight (BMI) is important since it can alter the efficiency of various contraceptives, such as hormonal pills, as well as which techniques are recommended. Maternity history, or the number and kind of previous births (e.g., caesarean or vaginal), is important because various treatments may be more appropriate based on prior delivery experience. The period of use, whether short or long term, is also taken into account when determining the most appropriate method for a woman's planned parenthood goals. Finally, wage or income level influences access to different contraceptives, as certain methods may be more affordable than others. Although these secondary criteria influence the decision, they serve as supplemental parameters to strengthen the selection based on the key factors.

The AHP hierarchy, which is organized as a tree, is based on seven key criteria that help select the best contraceptive technique for a woman based on her specific features and circumstances. The use of the seven criteria and their respective sub-criteria in this study is based on information obtained from midwives as decision makers as explained in Section 2. Figure 4 presents each branch of the hierarchy for selecting female contraception.

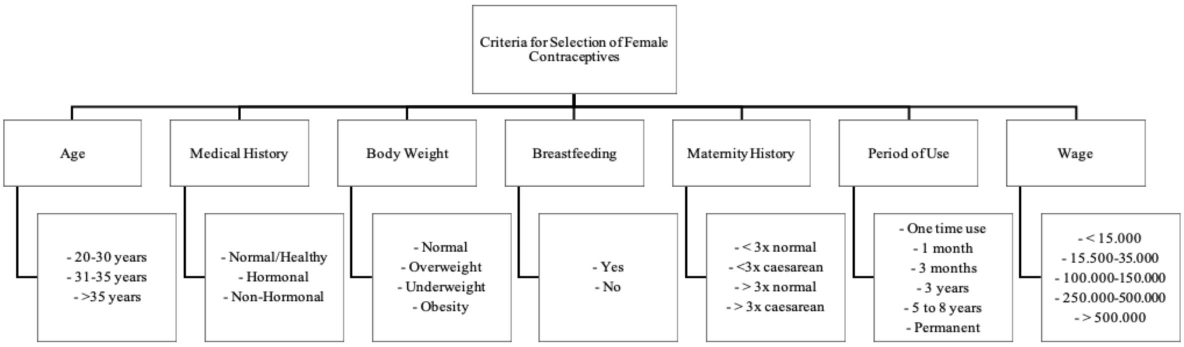

Figure 4. AHP Hierarchy Structure

3.2. Comparison Matrix and Consistency Testing

Following the assessment of all criteria based on their level of importance by the decision maker, the next step is to compose a Pairwise Comparison Matrix, which is an important element in the AHP method to support the decision-making process involving multiple criteria. This process involves comparing multi-criteria at one time to determine which is more important or preferred, and how much difference in importance there is between the criteria. Table 1 depicts pairwise comparisons of various criteria or factors used to assess the suitability of contraceptive techniques, as part of the AHP prioritizing stage. In AHP, each criterion is compared to all other criterion on a scale to determine its relative relevance. For example, a number greater than one suggests that the row criterion is more important than the column criterion, and a value less than one implies that it is less important. A number of 1.00 indicates equal importance.

Table 1. Pairwise Comparison Matrix

Criteria	Age	Medical History	Body Weight	Breastfeeding	Maternity History	Period of Use	Wage
Age	1.00	0.67	2.00	1.50	2.50	2.00	2.50
Medical History	1.50	1.00	2.00	1.50	3.00	2.00	3.00
Body Weight	0.50	0.50	1.00	0.67	1.50	1.25	1.50
Breastfeeding	0.67	0.67	1.50	1.00	2.00	1.25	1.80
Maternity History	0.40	0.33	0.67	0.50	1.00	0.67	1.00
Period of Use	0.50	1.00	0.80	0.80	1.50	1.00	1.50
Wage	0.40	0.33	0.67	0.56	1.00	0.67	1.00
Sum	4.97	4.50	8.63	6.52	12.50	8.83	12.30

In this table, criteria such as Medical History and Maternity History have greater comparison values across many cells, indicating that they are more important during the review process. The values in each cell indicate how much more essential one criterion is than another. For example, a comparative value of 1.5 for Medical History relative to Age indicates that Medical History is valued 1.5 times more than Age in establishing IUD appropriateness.

The Sum row at the bottom adds up the comparison results for each criterion, which is used to normalize the matrix and compute the priority vector (as shown in table 2). These totals contribute to determining each criterion's weight in the final result, allowing the AHP process to rank the criteria based on their relative relevance on contraceptive appropriateness. This structured comparison guarantees that the most significant criteria are properly weighted in the profile matching algorithm.

Table 2. Priority Vector

Criteria	Score of Priority Vector
Age	0.205828679
Medical History	0.242313768
Body Weight	0.116183953
Breastfeeding	0.151042055
Maternity History	0.077894938
Period of Use	0.127624829
Wage	0.079111779

Table 2 shows the computed weights for each criterion in the decision-making process. In AHP, a priority vector shows the relative relevance of each criterion in evaluating alternatives—in this example, the suitability of contraceptive techniques such as IUD/Spiral. Each criterion is awarded a priority value based on pairwise comparisons, with higher scores denoting greater importance in the decision framework.

The table reveals that Medical History has the highest priority weight (0.242313768), indicating that it is the most important element when determining eligibility. Age and breastfeeding both have substantial weights of 0.205828679 and 0.151042055, showing their importance. Criteria such as Maternity History and Wage have lower priority scores of 0.077894938 and 0.079111779, respectively, indicating that they play a less substantial impact in the final selection.

These priority scores are critical for the profile matching process since they indicate how much each criterion effects a candidate's overall compatibility score. By weighting variables according to their importance, the AHP model guarantees that recommendations are based on a fair and methodical assessment of each acceptor's profile versus the optimum qualities for IUD/Spiral contraception.

Table 3 shows the results of the consistency analysis carried out to confirm the reliability of the pairwise comparisons employed in the AHP model. Consistency testing is necessary in AHP to ensure that the decisions made between criteria are logically coherent. The table shows three key evaluation metrics: Principal Eigen Value (λmax), Consistency Index (CI), and Consistency Ratio (CR).

Table 3. Result of Consistency Testing

Evaluation Measurement	Score
Principle Eigen Value (λmax)	7.17499329
Consistency Index (CI) → (λmax-n)/(n-1)	0.029165548
Consistency Ratio (CR) → CI/RI	2.2%

The Principal Eigen Value (λmax) is computed as 7.17499329, which is utilized to determine the consistency index. This score signifies the extent to which the assessments correspond with a coherent matrix. The Consistency Index (CI) is 0.029165548, indicating a minimal degree of inconsistency. The Consistency Ratio (CR), determined by the formula CI/RI, is 2.2%. As this value is beneath the normal criterion of 10%, the assessments are deemed acceptably consistent. The low CR signifies that the pairwise comparisons employed to evaluate criteria in this study are dependable, facilitating confidence implementation in the profile matching method to suggest appropriate contraceptives.

Upon establishing the AHP criteria (as delineated in table 4 combined based on data collection stages), the subsequent stage involves ascertaining the target value for each contraceptive device. This study examines a case sample to assess the appropriateness of IUD/spiral contraception by evaluating its goal scores for each pertinent criterion.

Table 4. Scoring of Sub-Criteria

Criteria	Sub-criteria	AHP Weight	Sub-criteria's Score
Age	20-30 years	0.205828679	5
	31-35 years		4
	>35 years		3
Medical History	Normal/Health	0.242313768	5
	Hormonal		4

	Non-Hormonal		3
Body Weight (BMI)	Normal Overweight Underweight Obesity	0.116183953	3 2 1 0
Breastfeeding	Yes No	0.151042055	4 5
Maternity History	< 3x normal <3x caesarean > 3x normal > 3x caesarean	0.077894938	5 4 3 2
Period of Use	One time use 1 month 3 months 3 years 5 to 8 years Permanent	0.127624829	1 2 3 4 5 6
Wage	< 15.000 15.500-35.000 100.000-150.000 250.000-500.000 > 500.000	0.079111779	5 4 3 2 1

3.3. Contraceptive Scoring and Acceptors' Profile

To understand and evaluate the effectiveness of various contraceptives, scoring becomes an important method to assess the performance of each device based on a number of relevant criteria. This scoring process not only considers the technical and medical criteria of the contraceptive device, but also social or economic factors, and individual preferences that may influence the choice of the acceptor. Thus, scoring provides a more comprehensive picture of how each contraceptive device can meet the needs of the user. Next, to clarify the results of the scoring process, we will present a sample of the acceptor profile. By analyzing the acceptor profile in detail, it is hoped that better insight can be obtained into the suitability of the contraceptive device to the specific needs of the user.

Table 5 shows the goal scores for each parameter affecting the suitability of IUD/Spiral contraception. Each criterion—age, medical history, body weight, breastfeeding status, maternity history, period of usage, and wage—has been assigned a target score that shows its priority or importance in evaluating IUD/Spiral candidates. A target score of 5 denotes high priority, implying that these parameters are critical for establishing IUD appropriateness. For example, age, medical history, nursing, and maternity history all have a target score of 5, indicating that these variables are carefully considered when considering IUD as a contraceptive option.

Table 5. Result of Target Score

Criteria	Target Score IUD/Spiral
Age	5
Medical History	5
Body Weight	3
Breastfeeding	5
Maternity History	5
Period of Use	2
Wage	4

Lower scores, such as 3 for body weight, 2 for length of usage, and 4 for wage, show that, while these criteria are still included in the evaluation, they have a lower impact when compared to the more important elements. This prioritization directs the weighing process in the profile matching approach, ensuring that each acceptor's profile is evaluated in relation to the target profile for IUD compatibility. By using this target score, the study focuses on the most important elements in contraceptive advice, resulting in a tailored evaluation framework to provide more informed and personalized recommendations for IUD/Spiral contraception use.

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Table 6 summarizes the major characteristics of three acceptors (A1, A2, and A3) that will be utilized for the profile matching approach to assess the suitability of IUD/Spiral contraception. The table includes information about each acceptor's age, maternity history, and body weight (as evaluated by the BMI index), all of which are essential criteria in determining compatibility with IUD use. Acceptor 1 (A1) is 28 years old, with a normal pregnancy history and a normal BMI. Acceptor 2 (A2) is 32 years old, has a history of cesarean birth, and is classified as overweight. Acceptor 3 (A3) is 36 years old, with a normal pregnancy history and a normal BMI.

Table 6. Sample Acceptors' Profile

ID	Age (yrs)	Maternity History	Body Weight (BMI Index)
Acceptor 1 (A1)	28	Normal	Normal
Acceptor 2 (A2)	32	Caesarean	Overweight
Acceptor 3 (A3)	36	Normal	Normal

These profiles serve as a foundation for evaluating each acceptor's attributes with relation to the goal profile for IUD appropriateness. By correlating these properties with the specified profile criteria, the profile matching method may evaluate the degree of alignment of each acceptor with the optimal parameters for IUD/Spiral contraception, facilitating a tailored suggestion based on compatibility. This integrated technique facilitates a more comprehensive study by merging the systematic prioritizing of AHP with the individualized evaluation features of profile matching, culminating in a ranked list of suggestions for IUD compatibility.

3.4. Gap Weighting and Selection

Analyzing the gap weighting results during this decision-making process and selecting acceptors that have a suitable profile is a crucial step in achieving optimal decisions. Gap weighting aims to identify the difference between the expected criteria and the actual performance of the available alternatives. By using a predetermined AHP model combined with target score, we can measure the extent to which each alternative meets the established criteria, and determine priorities based on the resulting weights.

The calculation steps for gap mapping in the Profile Matching method begin by determining the relevant variables for analysis, followed by setting the minimum or standard value that must be achieved for each variable. Then, the gap or discrepancies is calculated as the difference between the actual acceptors' profile (acquired data) and the minimum profile standard set. The results of this gap calculation indicate how far the actual profile deviates from the expected standard. Furthermore, each gap value is weighted based on the level of importance of each variable, which is divided into Core Criteria (CF) and Secondary Criteria (SF). After weighting, the average value for each category is calculated, and the total value is obtained by combining the contributions of CF and SF according to the predetermined weights. The final step is to determine the ranking based on the total calculated value, providing an overview of which alternative best meets the predetermined criteria.

Figure 5 and table 7 depict essential stages in the profile matching methodology employed to assess the compatibility between each acceptor's profile and the criteria for contraceptive recommendations. The heat map in figure 5 illustrates the discrepancies between the ideal profile and each acceptor's actual profile across many criteria: age, medical history, body weight, breastfeeding, maternity history, period of use, and wage. A score of "0" signifies the absence of a gap, indicating that the acceptor's profile is in complete accordance with the minimum standards for that feature. Positive or negative numbers denote deviations, with negative values implying suboptimal alignment and positive ones signifying optimal alignment.

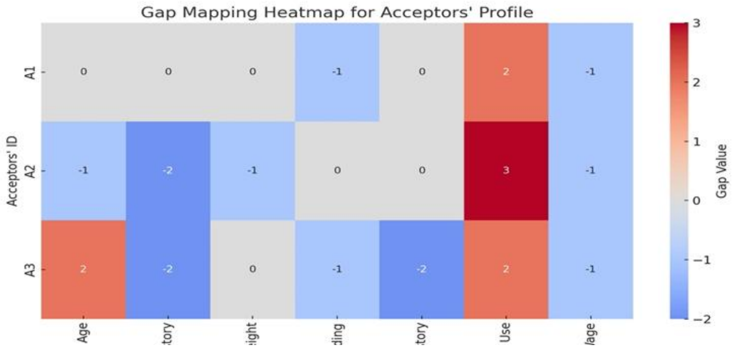

Figure 5. Result of Gap Mapping

Table 7 displays the weighted scores assigned to each gap based on its degree of deviation. Higher scores indicate greater alignment with the ideal profile, mitigating the impact of each gap. This weighting technique improves the initial gap analysis by measuring how each acceptor's attributes match the desired profile, ultimately contributing to the overall profile matching score used to generate contraceptive recommendations. Together, these tables help translate qualitative profile differences into quantifiable measures that support a systematic ranking of acceptors. After the gap weighting stage, the next step is to select acceptors. This process involves matching the alternative profiles with the previously analyzed criteria, so that only the most suitable alternatives will be selected as acceptors. Through this approach, we can not only ensure that the choices made meet the desired standards, but also provide a clear picture of the suitability of each alternative to the final goal.

Table 7. Result of Gap Weighting

Acceptors' ID	Age	Medical History	Body Weight	Breastfeeding	Maternity History	Period of Use	Wage
A1	5	5	5	4	5	3	4
A2	4	3	4	5	4	2	4
A3	3	3	5	4	3	3	4

Table 8 shows the final (total) scores for three different acceptor profiles (A1, A2, and A3). These ratings are derived using profile matching scoring, and they most likely reflect the degree of compatibility between each acceptor's profile and specific criteria for choosing a contraceptive technique. The scores reflect how well each acceptor meets the requirements for a good contraceptive option, with higher values suggesting greater alignment or compatibility. To rank the acceptors for compatibility with an IUD/Spiral contraception recommendation, we can order them from the highest to the lowest score: A1 – Total Score: 4.374852993 (Highest compatibility), A2 – Total Score: 3.98743249, A3 – Total Score: 3.855517193 (Lowest compatibility)

Table 8. Final Profile Matching Score

Acceptors' Profile	Total Score
A1	4.37485299
A2	3.98743249
A3	3.85551719

According to the findings, the model indicates that A1, possessing the greatest (top-rank) compatibility score, is the most appropriate candidate, succeeded by A2 and A3, so highlighting the efficacy of AHP and profile matching in providing customized, evidence-based contraceptive guidance. The modeling results obtained from this study show significant potential in increasing the compatibility of other contraceptive acceptors. By applying the methods that have been developed, decision makers can more easily identify and choose the contraceptive method that best suits the needs and profiles of individuals. The satisfaction resulting from choosing the right contraceptive method is expected to encourage an increase in the number of participants in the planned parenthood program which is known to have decreased from 2016-2019 (as seen in figure 1). When acceptors feel that their choice is in accordance with their needs and expectations, they tend to be more satisfied and motivated to continue using the method. This is very important in the context of achieving the target of fulfilling unmet needs based on the BKKBN report until 2021 (presented in figure 2), which is often caused by the lack of knowledge and trust of female acceptors in the planned parenthood program.

By increasing understanding of various contraceptive methods and providing clear information and adequate support, it is hoped that the stigma and uncertainty that often hinder participation can be reduced. In addition, this approach can also help educate the public about the benefits of planned parenthood, thereby changing negative perceptions into more positive views. Overall, the results of this modeling have broad implications for the development of planned parenthood programs in Indonesia. By focusing on the needs and preferences of acceptors, and increasing their knowledge and confidence, the program will not only increase the number of participants but also contribute to achieving larger public health goals. This is critical to ensuring maternal and child well-being and supporting sustainable development in Indonesia.

The study that produced a hybrid model between AHP and Profile Matching has several limitations that need to be considered. One of the main limitations is that the data collection process was limited to only Puskesmas in Pandeglang Regency, West Java. This results in the results obtained may not be fully representative of the entire population of contraceptive acceptors in Indonesia. By only covering one geographic location, it is possible that the demographic, cultural, and socio-economic characteristics of the respondents do not reflect the diversity that exists in other areas. In addition, the decision makers in this study were also limited to midwives as expert who provide health services in the area. Although midwives have relevant knowledge and experience, their views may not include other perspectives from health workers or the acceptors themselves. This limitation can affect the final results of the model and its relevance in a broader context.

To improve the validity of the study and the ability of the model to be applied to various contexts of contraceptive selection in Indonesia, further studies are needed. Further research should involve a larger and more diverse number of respondents, as well as different geographic locations to obtain a more comprehensive picture of the preferences and needs of contraceptive acceptors. By expanding the scope of the study, this hybrid model can be adapted to different local contexts, making it more effective in assisting decision-making regarding contraceptive choices. Collecting data from multiple sources and perspectives will enrich the available information and improve the accuracy of the model. Thus, the research results are not only valid for Puskesmas in a region but can also be applied more widely to support family planning programs throughout Indonesia. This is important to achieve public health goals and meet unmet needs in the use of contraceptives, so that it can contribute to improving the welfare of families and society as a whole.

5. Conclusion

Based on the study, a systematic approach using the hybrid AHP and Profile Matching was successfully adopted to recommend appropriate contraceptive options, with a focus on IUD/Spiral compatibility. The AHP process allowed for organized prioritizing of essential criteria—such as age, body weight, medical history, breastfeeding status, and maternity history, period of use and wage—via pairwise comparisons, ensuring that the most relevant elements were given adequate weight. The Consistency Testing proved the trustworthiness of these weightings, with a low Consistency Ratio (CR) reflecting consistent judgments in the criteria ranking.

Using these weighted criteria, the Profile Matching approach compared each acceptor's profile to the optimal qualities for IUD/Spiral contraception. This method gave a quantitative assessment of compatibility, yielding a ranked recommendation tailored to individual profiles. Based on the final compatibility scores, acceptors were ranked as follows: A1 had the highest score, followed by A2 and A3. This ranking indicates that A1 is the most suitable candidate for an IUD suggestion, with A2 and A3 slightly less matched with the desired profile.

Through this integrated model, the study demonstrates a reliable and personalized decision-support system that can aid healthcare providers in recommending contraceptive methods that align closely with each acceptor's unique needs. This proposed model gives essential guidance to health service providers, including as hospitals and Puskesmas, in obtaining contraceptives that meet the specific needs and preferences of their patient population, ensuring that supplies are in line with user demand and medical suitability. Overall, this strategy provides a viable framework for improving contraceptive counselling, fostering informed choices, and increasing user satisfaction with planned parenthood services. In addition, this study has limitations from the geographical distribution of participants and the limitation of decision makers only to midwives. Therefore, further studies are needed involving more respondents and different geographical locations to increase the representativeness and validity of the model in the context of contraceptive selection in Indonesia.

6. Declarations

6.1. Author Contributions

Conceptualization: A.Z., R.A., and I.N.I.; Methodology: R.A.; Software: A.Z.; Validation: A.Z., R.A., and I.N.I.; Formal Analysis: A.Z., R.A., and I.N.I.; Investigation: A.Z.; Resources: R.A.; Data Curation: R.A.; Writing Original Draft Preparation: A.Z., R.A., and I.N.I.; Writing Review and Editing: R.A., A.Z., and I.N.I.; Visualization: A.Z. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

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6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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