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Nurse Appointment Information System Using the Simple Additive Weighting Method (Study At One Of The Foundations In Bandung)

Nengsih[1], Asep Ririh Riswaya[2], Marjito[3], Solihin[4]
[1,2,3,4] *STMIK Mardira Indonesia, Bandung*
Email: nengsihh26@gmail.com[1], asep.ririh@stmik-mi.ac.id[2], marjito@stmik-mi.ac.id[3], solihin@stmik-mi.ac.id[4]

Abstract

Swift technological advancements have impacted multiple areas, including healthcare. The One Of The Foundations In Bandung, which provides home care services for the elderly and ailing, encounters difficulties with its nurse booking system, which remains manually operated via WhatsApp and phone calls. This method yields inefficiencies, substantial administrative overhead, and potential human errors. This study aims to develop a web-based information system utilizing the Simple Additive Weighting (SAW) method to enhance the efficiency of nurse booking and selection.

The SAW technique was selected for its capacity to manage multi-criteria decision-making, including factors such as healthcare tool utilisation, experience, age, and evaluations. The system includes online booking, criterion administration, evaluation weighting, and integrated reporting. This system enhances nurse booking and selection efficiency, alleviates administrative loads, and reduces potential errors, thereby significantly impacting healthcare service efficacy and advancing information technology in the healthcare sector.

Keywords: *Information System, SAW, Nurse Booking, Information Technology, Healthcare*

Introduction

Technological improvements have profoundly influenced numerous sectors, including healthcare. A significant advancement is the enhancement of efficiency in healthcare services, especially in information processing and patient service delivery. (Situmorang & Simarmata, 2024; Yarima et al., 2024) In the nursing profession, technology plays a crucial role in enhancing nurses' responsibilities, as nursing is among the most sought-after careers in healthcare.

The One Of The Foundations In Bandung provides nursing and caregiving services, particularly for patients who require ongoing care at home following hospital treatment. The practice of scheduling nurses at this foundation remains manual, relying on WhatsApp or phone conversations, which frequently results in inefficiency and susceptibility to errors. Patients face difficulties stemming from inadequate transparency regarding nurse availability and credentials, which hinders their ability to choose nurses based on characteristics such as experience or specialized abilities. This scenario generates challenges with booking efficiency and the frequently subjective evaluation of nursing performance. Consequently, an information system is essential to improve transparency, efficiency, and the quality of nursing appointment services.

System

Nurdin (2021) , as referenced by Tumini, defines a system as a collection of interrelated pieces that operate together to accomplish designated objectives.

Information

Santoni et al. (2023) as referenced defines information as a compilation of data or facts that have been processed and organised to enhance clarity and utility for the recipient.

Information Systems

Ramadaniah et al., (2023) and Farhanah (2023) define an information system as a system including a collection of information subsystems designed for data processing to generate information.

Booking

Pramudito et al., (2023) and Jebamani et al., (2022) define ordering as the process, method, or act of placing an order. The term booking is synonymous with ordering.

Nurse

Sivaram et al., (2020) a nurse as an individual possessing the knowledge, skills, and authority to deliver nursing care to others, grounded in their expertise and within the confines of their jurisdiction.

Simple Additive Weighting (SAW) Method

S. Kusumadewi and Purnomo, as cited by Melati and Triyono, assert that the fundamental principle of the SAW approach is to calculate the weighted sum of performance ratings for each alternative across all attributes. The SAW approach necessitates normalizing the decision matrix (x) to a scale suitable for comparison with all alternative ratings.

$$R_{ij} = \begin{cases} \dfrac{x_{ij}}{\max\ x_{ij}}, & \text{If } j \text{ is a benefit attribute} \\ \dfrac{\min\ x_{ij}}{x_{ij}}, & \text{if } j \text{ is the cost attribute} \end{cases}$$

Where:

R_ij = Normalized Performance Rating

max x_{ij} = Maximum Value of each row and column

min x_{ij} = Minimum Value of each row and column

x_{ij} = Rows and columns of a matrix

The aforementioned formula is employed to convert the original value into a scale suitable for comparison with other values in the decision matrix, hence streamlining the ranking of alternatives via the SAW approach.

There are several steps in completing the SAW method, including:

1. Determine the criteria that will be used as a reference in supporting decisions, namely C_i.
2. Determine the suitability rating of each alternative for each criterion.
3. Create a decision matrix based on the criteria C_i

4. Execute matrix normalisation according to equations tailored to the attribute type (profit attribute or cost attribute) to derive the normalised matrix value R.

The outcome is derived from the ranking procedure, specifically the sum of the normalised product of R and the weight vector, which yields a value.

Where R_{ij} is the normalized performance rating of alternative A_i on attribute C_j; i = 1,2,3,…, m dan j= 1,2,3,…,n. The preference value for each alternative C_i is given as follows:

$$V_i = \sum_{j=1}^{n} w_j r_{ij}$$

Where:

V_i = Final value of the alternative

w_j = Predetermined weight

r_ij = Matrix Normalization

A larger V_i value indicates that the alternative is more likely to be selected.

Research Method

This study utilises a mixed-methods approach to design and assess a web-based information system for nurse scheduling at the One Of The Foundations In Bandung. The study begins with an extensive literature review to identify optimal practices and deficiencies in current nurse booking systems and healthcare technologies. Surveys and interviews will be conducted with stakeholders, including nurses, caregivers, and patients, to gather insights into user needs and concerns. The system's architecture will have elements such as online booking, criterion administration, and assessment weighting, all linked with the Simple Additive Weighting (SAW) method to enhance multi-criteria decision-making.

Following the development phase, the system will undergo usability testing with a sample group to evaluate its interface and functionality. Furthermore, performance indicators will be evaluated to assess enhancements in booking efficiency and decreases in errors relative to the prior manual method. The results will undergo qualitative and quantitative analysis, providing significant insights into the system's effect on nurse scheduling efficiency and the overall quality of healthcare services. The research will culminate in a synthesis of principal findings and suggestions for additional improvements, emphasising the feasibility of expanding the system to other healthcare environments.

Result and Discussion

SYSTEM ANALYSIS

Analysis of the Simple Additive Weighting (SAW) Method

This study employed the SAW technique to identify the most exemplary nurse at the Sister One Of The Foundations In Bandung, based on various pertinent criteria.

a. Determining Criteria (Ci)

Criteria are elements utilised as benchmarks in the decision-making process. The employed criteria are:

Table 1. Criteria

Criteria (C)	Information	Attribute
C1	Use of Medical Devices	*Benefit*
C2	Work experience	*Benefit*
C3	Age	*Cost*
C4	Review	*Benefit*

b. Determine the Suitability Rating of Each Alternative for Each Criteria

The suitability rating is the assigned value for each alternative according to established criteria. Alternatives are the options that will be evaluated.

Nurse Data Alternatives

Table 2. Alternative Nurse Data

Alternative	Information
A1	Hery Hary Y
A2	Limah
A3	Neng Trysa M
A4	Ida
A5	Juju
A6	Rima Melati
A7	Puji Lestari
A8	Rizal Pebriana
A9	Allan M Sutara
A10	Rika Mawar

Creating a Decision Matrix Based on Criteria (Ci)

Criteria for Use of Medical Devices (C1)

Table 3. Criteria for Use of Medical Devices (C1)

Mark	Information
1	Mastering basic tools (Tensiometer, Glucometer, Oxygen Saturation Tool)
2	Master at least 2 of the medium tools (Nebulizer, Suction, Catheter)
3	Mastering at least 2 of the high-level tools (Nasogastric Tube, Insulin, Colostomy, Dialysis)
4	Master all basic, medium and advanced tools

Work Experience Criteria (C2)

Table 4. Work Experience Criteria (C2)

Mark	Information
1	< 1 Year
2	1 - 3 Year
3	2 - 5 Year
4	> 5 Year

Age Criteria (C3)

Table 5. Age Criteria (C3)

Mark	Information
1	18 - 25 Year
2	25 - 34 Year
3	35 - 44 Year
4	> 44 Year

Review Criteria (C4)

The appropriateness grade for the review criteria (C4) is calculated based on the average of the reviews provided by the bookers for the nurse. Table 3.7 following, delineates the categorisation of reviews (C4) according to the average review rating:

Table 6. Review Criteria (C4)

Mark	Information
1	Review rating 1: Less than satisfactory - The nurse only met basic expectations, but was still acceptable with a few minor notes from the customer.
2	Review rating 2: Moderately Satisfactory - The nurses perform their responsibilities adequately, although there is potential for improvement.
3	Review rating 3: Satisfactory - The nurse executed the duties competently and fulfilled the client's expectations without notable problems.

4	Rating: 4 Extremely Satisfied - The nurse delivered exemplary and professional service, fulfilling or surpassing the client's expectations.
5	Rating: 5 The nurse delivered outstanding service, surpassing all client expectations with professionalism and exemplary care.

c. Creating a Decision Matrix Based on Criteria (Ci)

A decision matrix is a tabular representation that displays the value of each alternative against each criterion.

Table 7. Decision Matrix

No	Nurse	C1 (Use of Medical Devices)	C2 (Work experience)	C3 (Age)	C4 (Review)
1	Hery Hary Y	2	4	2	4
2	Limah	3	4	3	3
3	Neng Trysa M	3	4	3	4
4	Ida	3	4	4	4
5	Juju	3	4	4	3
6	Rima Melati	4	4	2	5
7	Puji Lestari	3	3	3	3
8	Rizal Pebriana	3	2	1	3
9	Allan M Sutara	2	2	1	2
10	Rika Mawar	3	4	2	4
	Nilai Maksimum	4	4	4	5
	Nilai Minimum	2	2	1	2

Explanation:

C1 (Medical Device Utilisation): The score reflects the nurse's proficiency with medical equipment.

C2 (Work Experience): The score is determined by the nurse's professional experience.

C3 (Age): The score is determined by the nurse's age.

C4 (Reviews): The rating is determined by the average quantity of reviews obtained by the nurse.

d. Performing Decision Matrix Normalization

Normalisation is executed to transform the decision matrix data into standardised values, facilitating straightforward comparison. Normalisation is executed via a formula customised for the attribute type (benefit or cost).

Normalization Formula

Benefit

$$R_{ij} = \frac{x_{ij}}{x_{\max}}$$

Cost

Normalized Decision Matrix

$$R_{ij} = \frac{x_{\min}}{x_{ij}}$$

Table 8. Normalized Decision Matrix

No	Nurse	C1 (*Benefit*)	C2 (*Benefit*)	C3 (*Cost*)	C4 (*Benefit*)
1	Hery Hary Y	2/4 = 0.50	4/4 = 1.00	½ = 0.50	4/5 = 0.80
2	Limah	¾ = 0.75	4/4 = 1.00	1/3 = 0.33	3/5 = 0.60
3	Neng Trysa M	¾ = 0.75	4/4 = 1.00	1/3 = 0.33	4/5 = 0.80
4	Ida	¾ = 0.75	4/4 = 1.00	¼ = 0.25	4/5 = 0.80
5	Juju	¾ = 0.75	4/4 = 1.00	¼ = 0.25	3/5 = 0.60
6	Rima Melati	4/4 = 1.00	4/4 = 1.00	½ = 0.50	5/5 = 1.00
7	Puji Lestari	¾ = 0.75	¾ = 0.75	1/3 = 0.33	3/5 = 0.60
8	Rizal Pebriana	¾ = 0.75	2/4 = 0.50	1/1 = 1.00	3/5 = 0.60
9	Allan M Sutara	2/4 = 0.50	2/4 = 0.50	1/1 = 1.00	2/5 = 0.40
10	Rika Mawar	¾ = 0.75	4/4 = 1.00	½ = 0.50	4/5 = 0.80

e. Determining Preference Weights

Preference weights are numerical values that indicate the relative importance of each criterion in the decision-making process. The weights are established according to demands or priorities. The utilised preference weights are:

Table 9. Preference Weights

Criteria (C)	Information	Weight
C1	Use of Medical Devices	30% atau 0.3
C2	Work experience	30% atau 0.3
C3	Age	20% atau 0.2
C4	Review	20% atau 0.2

f. Calculating the Final Score for the Ranking

The final value is determined by summing the products of the normalised value and the preference weight.

Final Grade Calculation Formula

$$V_i = \sum_{j=1}^{n} w_j r_{ij}$$

6

Weighted Normalized Decision Matrix

Table 10. Weighted Normalized Decision Matrix

No	Nurse	C1*0.3 (Benefit)	C2*0.3 (Benefit)	C4*0.2 (Cost)	C3*0.2 (Benefit)	Final Score
1	Hery Hary Y	0.50*0.3 = 0.15	1.00*0.3 = 0.30	0.50*0.2 = 0.10	0.80*0.2 = 0.16	0.71
2	Limah	0.75*0.3 = 0.23	1.00*0.3 = 0.30	0.33*0.2 = 0.07	0.60*0.2 = 0.12	0.72
3	Neng Trysa M	0.75*0.3 = 0.23	1.00*0.3 = 0.30	0.33*0.2 = 0.07	0.80*0.2 = 0.16	0.76
4	Ida	0.75*0.3 = 0.23	1.00*0.3 = 0.30	0.25*0.2 = 0.05	0.80*0.2 = 0.16	0.74
5	Juju	0.75*0.3 = 0.23	1.00*0.3 = 0.30	0.25*0.2 = 0.05	0.60*0.2 = 0.12	0.70
6	Rima Melati	1.00*0.3 = 0.30	1.00*0.3 = 0.30	0.50*0.2 = 0.10	1.00*0.2 = 0.20	0.90
7	Puji Lestari	0.75*0.3 = 0.23	0.75*0.3 = 0.23	0.33*0.2 = 0.07	0.60*0.2 = 0.12	0.65
8	Rizal Pebriana	0.75*0.3 = 0.23	0.50*0.3 = 0.15	1.00*0.2 = 0.20	0.60*0.2 = 0.12	0.70
9	Allan M Sutara	0.50*0.3 = 0.15	0.50*0.3 = 0.15	1.00*0.2 = 0.20	0.40*0.2 = 0.08	0.58
10	Rika Mawar	0.75*0.3 = 0.23	1.00*0.3 = 0.30	0.50*0.2 = 0.10	0.80*0.2 = 0.16	0.79

Final Results and Rankings

Table 11. Final Results and Rankings

No	Nurse	Final Score	Ranking
6	Rima Melati	0.90	1
10	Rika Mawar	0.79	2
3	Neng Trysa M	0.76	3
4	Ida	0.74	4
2	Limah	0.72	5
1	Hery Hary Y	0.71	6
5	Juju	0.70	7
8	Rizal Pebriana	0.70	8
7	Puji Lestari	0.65	9
9	Allan M Sutara	0.58	10

Utilising the SAW approach, the scores for each category have been rounded to two decimal places to provide uniformity and streamline the findings. The ultimate score, derived from the aggregation of weights and criterion scores, is also rounded similarly.

The calculations indicate that Rima Melati attained the highest final score of 0.90, designating her as the most recommended nurse. The SAW technique provides a systematic approach to assessing and selecting the most suitable nurses based on multiple criteria. This method, utilising assigned preference weights and normalised criterion scores, can assist the Sister Ina Herlina Amanah Foundation in making more precise and objective decisions.



Figure 1. Use Case Diagram

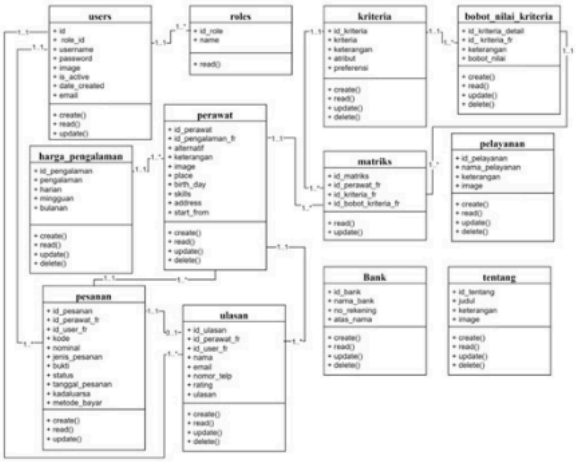

Figure 2. Diagram Class

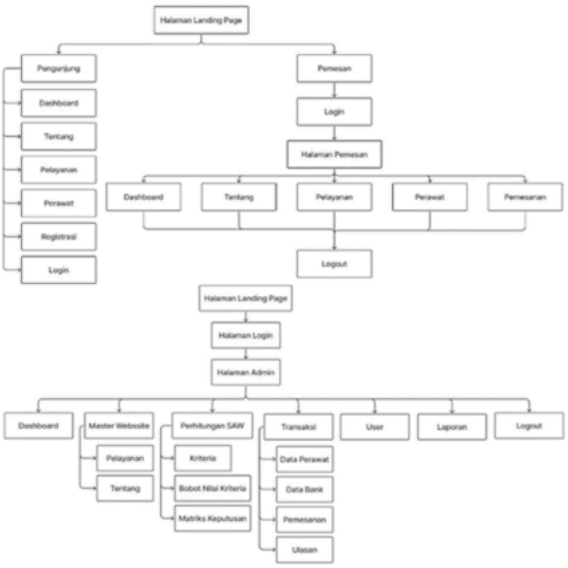

Figure 3. Menu Structure Design

SYSTEM IMPLEMENTATION AND TESTING

1. System Implementation

   System implementation is the process of executing a designed system to prepare it for operational use. The outcomes of executing the nurse booking information system are as follows:

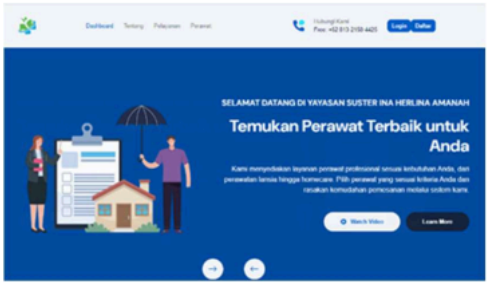

Figure 4. Web Home Page (frontend)

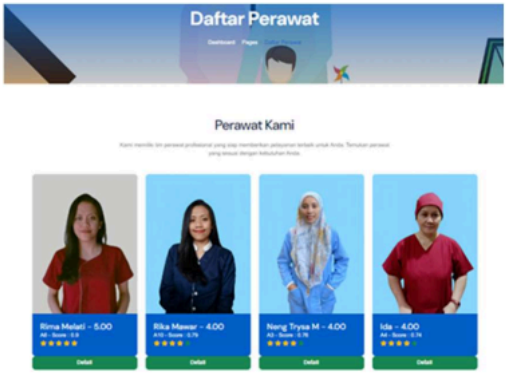

Figure 5. Nurse List Page



Figure 6. Nurse Details Page

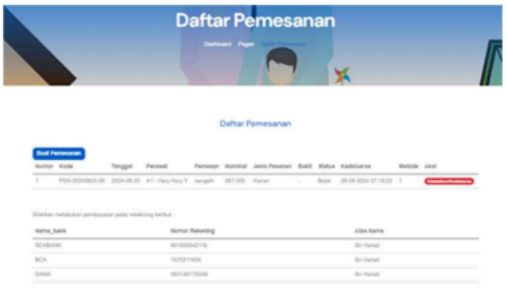

Figure 7. Create Order Page

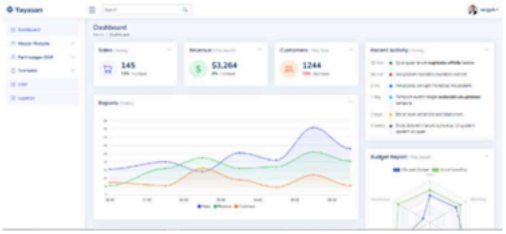

Figure 8. Admin Main Page (backend)



Figure 9. Normalized Decision Matrix Page

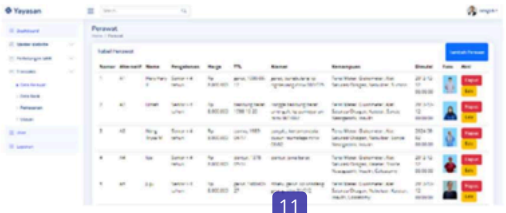

Figure 10. Nurse Data Management Page

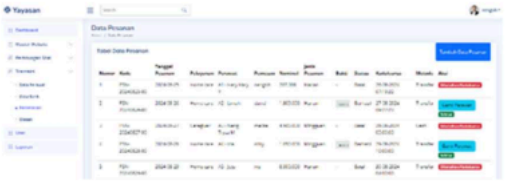

Figure 11. Order Data Management Page

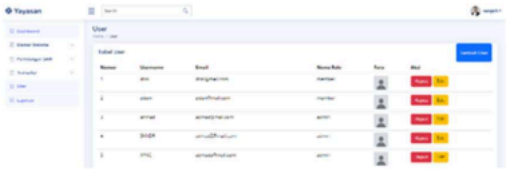

Figure 12. User Data Management Page

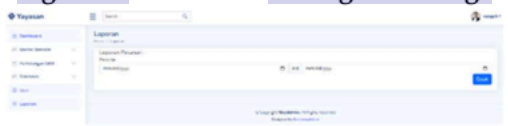

Figure 13. Order Report Page

2. System Testing

   This software testing utilises black box testing. Black box testing emphasises the functional requirements of the software while disregarding its design and programming. The following table presents the system testing conducted via the black box approach for the nurse booking system at the Ina Herlina Amanah Foundation.

Table 12. System Testing

No	Process Name	Actor Name	Action	Expected results	Results
1	Registration	Orderer	Register an account with your full name, email, and password.	The account is successfully registered in the system, allowing the customer to log in.	Success
2	Login	Admin and Orderer	Sign in with email and password	The user successfully logs into the system and	Success

				can access the available features.	
3	Service	Admin	Add, edit, and delete data	Service data can be added, edited, and deleted as needed.	Success
4	About	Admin	Input and save	Data about can be input and saved into the system.	Success
5	Criteria	Admin	View criteria data	Displays a list of predefined criteria	Success
6	Criteria Value Weight	Admin	View criteria value weight data	Displays a list of predefined criteria	Success
7	Decision Matrix	Admin	Selecting and saving data	The criteria data is successfully selected and stored for the SAW method calculation, including in the normalized decision matrix table, the weighted normalized decision matrix table, and generating	Success

				decision rankings..	
8	Nurse Data	Admin	Add, edit, and delete data	Nurse data can be added, edited, and deleted as needed.	Success
9	Bank Data	Admin	Add, edit, and delete data	Bank data can be added, edited and deleted as needed.	Success
10	Booking	Admin	Add and verify	Orders can be made and verified by the admin.	Success
11	Review	Admin	Deleting a review	Reviews can be deleted by admin.	Success
12	Users	Admin	Add, edit, and delete data	User data can be added, edited, and deleted as needed.	Success
13	Report	Admin	Print report	Reports can be printed based on the data in the system..	Success
14	Place an Order	Orderer	Select a service package and fill out the order form	The order was successfully created and recorded in the system.	Success
15	Upload Proof	Orderer	Upload proof of payment after receiving the invoice	Proof of payment was successfully	Success

				uploaded and accepted by the system for verification.	
16	Change Nurse	Orderer	Selecting new nurses and replacing nurses who have been booked	The nurse who had been booked was successfully replaced according to the customer's request.	Success
17	Cancel Order	Orderer	Cancel an order that has been made	The order is successfully cancelled and the order status is updated in the system.	Success
18	Give a Review	Orderer	Provide a review of the service received	Provide a review of the service received	Success

Coclusion

The research indicates that the deployment of a web-based nurse booking information system utilising the Simple Additive Weighting (SAW) method has markedly enhanced the efficiency of nurse bookings at the Ina Herlina Amanah Foundation. This advanced system enables users to select nurses based on specific characteristics, including proficiency with healthcare tools, experience, and age, thereby resolving difficulties that were previously challenging to address through manual methods. The SAW technique enhances transparency and precision in selecting the most

suitable nurses for users' requirements. The incorporation of booking records and user feedback enables the foundation to assess nurse performance, optimize administrative functions, and reduce errors, thereby enhancing the quality of healthcare services.

To enhance the system, numerous recommendations have been proposed. Incorporating automated notification functionalities for users and administrators may enhance communication and facilitate more efficient monitoring of the booking process. Enhancing system security via data encryption and two-factor authentication would safeguard sensitive health information. Systematic assessments of nursing performance and user satisfaction will yield critical insights for enhancing features that more effectively meet user requirements. Ultimately, developing a mobile application would enhance accessibility, allowing people to schedule and monitor nursing services on their smartphones conveniently.

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