



Design and User Evaluation of an Integrated Nurse Rostering Support System in an Indonesian Hospital

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Abstract

This study aims to design and evaluate an integrated nurse rostering support system embedded in a hospital Data Repository and Support System (DRSS) in Indonesia, with roster outputs that can be exported to the existing Human Resource Information System (HRIS) to avoid duplicate data entry. The system automates monthly nurse scheduling by enforcing unit-specific constraints, such as minimum staffing levels per shift, night-shift quotas, and team-based coverage, while providing a user-friendly interface for head nurses to

configure, generate, review, and adjust rosters. A system development approach was combined with a descriptive cross-sectional survey. After the module was implemented and used in an inpatient ward, a structured questionnaire was administered to nine key users (seven head nurses and two nurse managers) to assess perceived usefulness, ease of use, fairness and transparency of the generated schedules, and overall satisfaction and intention to use. Data were analyzed using descriptive statistics (frequency, mean, and standard deviation). The findings indicate that respondents generally agreed that the system reduces manual workload, helps satisfy staffing requirements, and supports more transparent distribution of shifts. Mean scores for ease of use show that users perceive the interface and workflow as easy to learn and integrate into existing practices. Perceptions of fairness and transparency were also positive, with respondents accepting the schedules produced and appreciating the possibility of manual adjustments before final approval. In conclusion, the integrated nurse rostering support system is feasible for routine use and is well accepted by key users in the ward, with potential for gradual extension to other units accompanied by further evaluation.

Keywords: Decision support system, Health information systems, Nurse rostering, Staff scheduling, User evaluation

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Introduction

Nurse rostering is a recurring and complex managerial task that directly affects patient safety, continuity of care, and nurse well-being. In many hospitals, including those in Indonesia, monthly nurse schedules are still prepared manually by head nurses using paper forms or spreadsheets. This manual process is time-consuming, cognitively demanding, and highly error-prone because it must satisfy numerous rules at once, such as minimum staffing per shift, fair distribution of night duties, and team-based coverage in each ward (Ceschia et al., 2023; den Hartog et al., 2023). When these rules are not followed consistently, the consequences may include understaffed shifts, unfair workload distribution, increased fatigue, and diminished job satisfaction, all of which can indirectly influence the quality and safety of patient care (Alaouchiche et al., 2024). For this reason, improving the way nurse schedules are generated has become an important issue for hospital management and health services research.

A substantial body of literature has framed the Nurse Rostering Problem (NRP) as a combinatorial optimization problem and proposed various solution methods, ranging from exact mathematical programming and constraint programming to metaheuristics and hybrid algorithms (Guo & Bard, 2022; Turhan & Bilgen, 2020). These studies typically focus on algorithmic performance, such as feasibility, constraint violations, fairness metrics, and computation time under controlled experimental conditions. While this line of work has significantly advanced our understanding of how to compute high-quality schedules, it often assumes that the resulting algorithms can be easily embedded in real information systems and adopted by nurse managers. In practice, however, the gap between algorithmic prototypes and everyday hospital workflows remains a major barrier to implementation (Amindoust et al., 2021).

At the same time, hospital information systems such as Human Resource Information Systems (HRIS) and in-house Data Repository and Support Systems (DRSS) are increasingly used to store detailed staff and scheduling data. Yet, in many institutions these systems function mainly as repositories, while the actual rostering is still done offline and manually by head nurses. As a result, the potential of existing digital data to support automated, consistent, and transparent rostering is not fully realized (O'Connell et al., 2024). There is relatively limited empirical evidence on how optimization-based rostering can be integrated into such systems and how end users, particularly head nurses and nurse managers, perceive and accept these tools in their daily practice, especially in the Indonesian context.

This article addresses these gaps by focusing not on proposing a new optimization algorithm, but on designing and evaluating an integrated nurse rostering support system that is



implemented within a hospital Data Repository and Support System (DRSS). The module uses data stored in the DRSS to generate monthly rosters, and its outputs can be transferred to the existing Human Resource Information System (HRIS) so that staff data do not have to be entered twice. The main objective of the study is to describe the architecture and workflow of the rostering module and to investigate how head nurses and senior nurses perceive its usefulness, ease of use, fairness and transparency of the generated schedules, and overall acceptability. This study makes two main contributions. First, it presents a concrete example of how optimization-based scheduling can be embedded in a user-friendly interface and linked to existing hospital data flows, helping to bridge the gap between theoretical NRP research and everyday operations. Second, it provides empirical evidence on user perceptions and acceptance, which is important for understanding whether such systems are likely to be adopted and sustained in practice, and complements previous work that focused mainly on algorithmic performance rather than user experience.

Methodology

Research Design / Setting

This study adopted a descriptive cross-sectional survey design combined with a system development approach. The nurse rostering module was implemented and deployed within the hospital's Data Repository and Support System (DRSS), which stores detailed staff and scheduling data. The resulting rosters can subsequently be imported into the hospital's Human Resource Information System (HRIS) so that staff assignments are updated without duplicate data entry. After a trial period in which head nurses used the system to generate monthly rosters, a structured questionnaire was administered to evaluate their perceptions of the system.

System Overview and Module Design

The nurse rostering support system was implemented as a web-based module embedded in the hospital's Data Repository and Support System (DRSS). The module reads master data on nurses, shift types, unit-specific staffing rules, and historical schedules from the DRSS database. It provides an interface for head nurses to configure the planning period, select the target ward, and review the list of available staff together with their contractual obligations and leave requests. Based on these inputs, an optimization engine automatically generates a monthly roster that satisfies minimum staffing levels per shift, night-shift quotas, and team-based coverage rules as far as possible.

From the user's perspective, the workflow is straightforward. First, the head nurse ensures that staff data and unit rules in the DRSS are up to date. Second, the head nurse initiates roster generation for the upcoming month and waits for the system to propose a set of assignments. Third, the proposed roster is reviewed on screen, and manual adjustments can be made to accommodate



specific preferences or last-minute changes. Finally, once the roster is approved, it is exported from the DRSS module and imported into the Human Resource Information System (HRIS) so that staff assignments are updated without duplicate data entry. This design ensures tight integration with existing hospital information systems while keeping the interaction steps for end users as simple as possible.

Population and Sample

The target population of the study consisted of head nurses and nurse managers involved in schedule preparation and validation in the inpatient ward where the system was deployed. The inclusion criteria were: (1) being formally responsible for or actively involved in nurse scheduling in the unit and (2) having used the rostering module at least once during the study period. Nurses who did not participate in the scheduling process or who were not available during data collection were excluded.

A total of nine respondents participated in the study, comprising seven head nurses and two nurse managers. A non-probability purposive sampling technique was used, focusing on staff who directly interact with the system in their scheduling tasks.

Instrument for Data Collection

Data were collected using a structured questionnaire titled “Perceived Usefulness and Acceptance of Nurse Rostering Support System”. The questionnaire consisted of three parts: (1) a short set of socio-demographic questions (e.g., age, position, years of experience, unit); (2) Section A, comprising eight items (A1–A8) on perceived schedule quality, fairness of workload and night-shift distribution, adequacy of staffing, and overall satisfaction with the roster generated by the system; and (3) Section B, comprising nine items (B1–B9) measuring perceptions of the rostering system itself, divided into several dimensions: perceived usefulness (e.g., “The system helps me complete scheduling faster”), perceived ease of use (e.g., “The system is easy to learn and operate”), perceived fairness and transparency of schedules, and overall satisfaction and intention to continue using the system. Items in Sections A and B were formatted on a five-point Likert scale ranging from 1 = Strongly Disagree to 5 = Strongly Agree. Higher scores indicate more positive perceptions.

Reliability of the Instrument

Internal consistency reliability for Section B was assessed using Cronbach’s alpha based on the responses from the main survey ($n = 9$). For the nine perception items in Section B, the overall Cronbach’s alpha was $\alpha = 0.96$, indicating excellent internal consistency of the scale.

Validity of the Instrument



Content validity was established through expert review. The draft questionnaire was examined by two experts in nursing management and health informatics to ensure that the items were relevant, clear, and appropriately represented the constructs of interest. Feedback from the experts was used to refine wording and remove ambiguous items. Face validity was further checked by asking several nurses who resembled the target respondents to review the questionnaire before formal data collection and to comment on any item that they found unclear or difficult to answer.

Data Collection Procedure

Permission to conduct the study was obtained from the hospital management and the head of the inpatient ward. After explaining the purpose of the study and assuring confidentiality, respondents were invited to complete the questionnaire at the ward during working hours. Participation was voluntary, and informed consent was obtained from all participants. Completed questionnaires were collected by the researcher and checked for completeness before data entry.

Method of Data Analysis

Data were entered and analyzed using Python with appropriate statistical libraries. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize responses for each item and each dimension. Cronbach's alpha was calculated to assess internal consistency reliability for Section B. For interpretation, mean scores closer to 5.0 were considered to reflect stronger agreement or more positive perceptions. The findings are reported in the Results section using descriptive summaries of the item responses.

Results

Characteristics of Respondents

A total of nine respondents participated in the study, consisting of seven head nurses and two nurse managers who were directly involved in nurse rostering in the inpatient ward. All respondents had prior experience preparing monthly rosters manually and had used the new rostering module at least once during the trial period.

Perceptions of Schedule Quality, Fairness, and Adequacy (Section A)

Section A of the questionnaire comprised eight items (A1–A8) that assessed respondents' perceptions of workload distribution, night-shift allocation, days off, adequacy of staffing on each shift, and overall satisfaction with the roster generated by the system.

Across all eight items, none of the respondents chose Strongly Disagree, Disagree, or Neutral. For every item, 100% of responses fell into the positive categories (Agree or Strongly Agree). More specifically:



- a. A1 (“The distribution of working hours among nurses in this roster is reasonably balanced”): 11.1% Agree, 88.9% Strongly Agree.
- b. A2 (“The number of night shifts received by each nurse is still within a reasonable range”): 22.2% Agree, 77.8% Strongly Agree.
- c. A3 (“The rotation pattern of P–S–M shifts does not change too often and is not too exhausting”): 22.2% Agree, 77.8% Strongly Agree.
- d. A4 (“The days off provided in this roster are sufficient for each nurse”): 33.3% Agree, 66.7% Strongly Agree.
- e. A5 (“For each shift, the number of nurses on duty feels adequate for the workload in the unit”): 33.3% Agree, 66.7% Strongly Agree.
- f. A6 (“For each shift, the availability of charge nurses (PJ) is adequate”): 44.4% Agree, 55.6% Strongly Agree.
- g. A7 (“In general, this roster can be used with little or no manual modification”): 33.3% Agree, 66.7% Strongly Agree.
- h. A8 (“Overall, I am satisfied with the roster produced by the system”): 33.3% Agree, 66.7% Strongly Agree.

Perceptions of Interface, Features, and Ease of Use (Section B)

Section B (B1–B9) evaluated the user interface, clarity of menus and buttons, readability of the schedule display, interpretability of violation indicators, perceived system speed, and overall usefulness and acceptance of the module.

For Section B, the pattern was similar. None of the respondents selected Strongly Disagree, Disagree, or Neutral; all responses were either Agree or Strongly Agree. In detail:

- a. B1 (“The scheduling module layout is easy to understand the first time it is used”): 22.2% Agree, 77.8% Strongly Agree.
- b. B2 (“Menus and control buttons are easy to find”): 22.2% Agree, 77.8% Strongly Agree.
- c. B3 (“The roster is displayed in a clear and easy-to-read format”): 11.1% Agree, 88.9% Strongly Agree.
- d. B4 (“Violation indicators (highlights/warnings) are easy to understand”): 11.1% Agree, 88.9% Strongly Agree.
- e. B5 (“The feature for comparing results between algorithms helps me choose the best roster”): 22.2% Agree, 77.8% Strongly Agree.
- f. B6 (“The time required by the system to produce a roster is still acceptable”): 11.1% Agree, 88.9% Strongly Agree.
- g. B7 (“Overall, this system makes it easier for me to prepare duty schedules”): 22.2% Agree, 77.8% Strongly Agree.



- h. B8 (“Overall, I am satisfied with the ease of use of this scheduling module”): 11.1% Agree, 88.9% Strongly Agree.
- i. B9 (“I am willing to use this system for schedule preparation in the next period”): 22.2% Agree, 77.8% Strongly Agree.

These responses show that users considered the module easy to learn and operate, with a clear layout and informative violation indicators. The comparison feature between algorithmic solutions and the perceived system speed were also viewed positively. High agreement with B7–B9 indicates strong satisfaction and behavioural intention to continue using the system.

Time Required for Manual versus System-Based Scheduling (Section C)

Section C compared the time required to prepare a one-month roster manually with the time required when using the system.

Time required for manual roster preparation (one month):

- a. < 30 minutes: 11.1% (1 respondent)
- b. 30 minutes – 1 hour: 0.0%
- c. 1 – 2 hours: 11.1% (1 respondent)
- d. 2 – 4 hours: 22.2% (2 respondents)
- e. > 4 hours: 55.6% (5 respondents)

Thus, 77.8% of respondents reported spending 2 hours or more on manual roster preparation, and more than half required over 4 hours to complete one monthly schedule.

Time required using the nurse rostering system:

- a. < 5 minutes: 77.8% (7 respondents)
- b. 5 – 15 minutes: 11.1% (1 respondent)
- c. 15 – 30 minutes: 0.0%
- d. 30 – 60 minutes: 11.1% (1 respondent)
- e. > 60 minutes: 0.0%

In practical terms, 88.9% of respondents were able to obtain a complete roster in less than 15 minutes, and the majority (77.8%) did so in under 5 minutes. No respondent reported needing more than one hour when using the system.

Likert-type items in Section C further reinforced these findings: all nine respondents strongly agreed that the system saves time compared with previous practice and that their workload feels lighter, while 88.9% strongly agreed and 11.1% agreed that the roster is now neater and easier to control.

Qualitative feedback

Open-ended comments from respondents were consistent with the quantitative findings. Users appreciated that the system automatically generates rosters according to predefined rules,



saves substantial time (one respondent reported completing a monthly roster in about 92 seconds), is simple to operate, and produces neat schedules that are easy to review. Suggestions for improvement mainly concerned refining the composition of staff competencies within each shift and enhancing the display of long scheduling horizons. Respondents also requested further integration with other hospital systems and calendar-style visualisation of duty requests. In summary, the comments confirmed that the system is highly beneficial, while users also suggested several areas for further improvement.

Discussion

This study designed and evaluated an integrated nurse rostering support system implemented within a hospital DRSS platform and explored how head nurses and nurse managers perceive its usefulness, ease of use, fairness, and overall acceptability. Responses from nine key users showed uniformly positive perceptions, with all items rated “agree” or “strongly agree”. Users also reported a substantial reduction in time needed to prepare monthly rosters, from several hours manually to only a few minutes with the system, indicating that the module can significantly reduce the administrative burden of scheduling.

The high scores for perceived usefulness and ease of use suggest that decision support systems can effectively support complex tasks such as nurse rostering when they are well integrated into existing workflows. Respondents felt that the system helps them complete schedules faster, reduces errors, and ensures that staffing requirements are met, while the interface and steps were regarded as easy to learn and operate. These findings are in line with previous work that highlights usability and system integration as key determinants of successful adoption, beyond algorithmic performance alone.

Perceptions of fairness and transparency were also favourable. Users considered the distribution of working hours and night shifts to be reasonable, days off and staffing levels to be adequate, and the resulting rosters acceptable for daily practice. This suggests that encoding explicit rules on night-shift quotas, team-based coverage, and minimum staffing into the system can promote more consistent and defensible rostering decisions. At the same time, qualitative feedback showed that users value the ability to make manual adjustments and requested refinements related to staff competency mix and visualisation of longer scheduling horizons, underscoring the need to balance automation with professional judgement.

Overall, the findings indicate that an integrated nurse rostering support system can be both technically feasible and acceptable to key users in an Indonesian hospital setting. By leveraging staff and scheduling data stored in the DRSS, and by exporting the resulting rosters to the HRIS



to keep personnel records up to date without duplicate entry, the system aligns well with current work practices and existing information flows.

Limitations and Future Research

This study has several limitations. The sample was small (nine respondents) and drawn from a single inpatient ward, so the results cannot be generalized to all nurses or hospitals and should be viewed as an initial user evaluation by key decision-makers. The data were self-reported and collected at one point in time, and the analysis was descriptive only, without assessing long-term effects on outcomes such as overtime or turnover. In addition, although the system uses optimization algorithms, this paper did not present a detailed comparison of algorithmic performance across scenarios.

Future research should involve larger and more diverse samples, include multiple units or hospitals, and use longitudinal designs to observe changes over time. Separate studies are also needed to report and analyse the performance of the different optimization approaches embedded in the system through comprehensive computational experiments and statistical comparisons.

Conclusion and Recommendation

This study presented the design and user evaluation of an integrated nurse rostering support system implemented as a module of a hospital Data Repository and Support System (DRSS) in Indonesia, with roster outputs that can be exported to the existing Human Resource Information System (HRIS). The system automates monthly schedule generation under unit-specific constraints and provides a user-friendly interface for configuration, generation, and review. Based on responses from nine head nurses and nurse managers, the system was perceived as useful, easy to use, fair, and transparent, and it was reported to markedly reduce the time and effort required to prepare rosters. These findings indicate that the system is feasible for routine use in the ward studied and has the potential to improve scheduling processes in similar hospital settings, while recognising that the present work represents an initial, small-scale evaluation.

In terms of practical implications, hospital management is encouraged to extend the use of the system gradually to other wards with complex scheduling needs, accompanied by local configuration of unit-specific rules. Regular training and technical support should be provided so that head nurses and nurse managers remain confident in operating the module and interpreting violation warnings. Further development of the system ought to prioritise features requested by users, particularly improved visualisation of longer scheduling horizons, more detailed control of staff mix per shift, and deeper integration with other hospital applications such as attendance or payroll systems.



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For future research, broader user evaluations involving larger samples, multiple units, and repeated measurements over several scheduling cycles are needed to better understand user acceptance and patterns of use over time. Comprehensive algorithmic studies should also be conducted to compare different optimisation approaches embedded in the system in terms of feasibility, constraint violations, workload fairness, demand fulfilment, and computation time. In addition, longitudinal studies are needed to examine whether the adoption of automated rostering contributes to wider clinical and organisational outcomes, such as nurse satisfaction, absenteeism, and overtime. Future work should also explore its indirect effects on patient safety and quality of care.



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