# Application Model of Nurse Electronic Rostering Software (NERS) In Hospital Ward

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## Abstract

**Introduction:** Good scheduling arrangements are needed so that there is no physical, emotional and psychological fatigue to nurses, which will have a negative impact on the performance of nurses in providing services to patients. This study aims to develop an application model for the electronic rostering of nurses in the ward.

**Methods:** The design in this study was Research and Development (R&D). The population of this study was all nurses who worked in the inpatient room. The sampling technique used was simple random sampling. Data for the assessment of scheduling characteristics were collected using questionnaire based on formulation of the problem and Focus Group Discussion (FGD). Data analysis is in descriptive form.

**Results**: Most of the respondents considered that ward scheduling characteristics were sufficient (80.2%). The development of electronic rostering model emphasizes on optimizing the needs and distribution of nurses, equalizing shift and off, and reducing time for preparing schedules. The development of an electronic rostering model was also adjusted to the policies of the hospital regarding the nurses' work scheduling method so that it can be implemented appropriately in the ward.

**Conclusion:** The development of an electronic work scheduling model for nurses in the inpatient room includes: division based on the level of patient dependence, scheduling flexibility by proposing early holidays and leave, and reducing the duration of nurses' rostering preparation.

## INTRODUCTION

Employee scheduling problems are often found in the service industry, one of which is in hospitals. In general, scheduling nurses in Indonesia is classified into a shift system, namely morning, evening and night shifts. The uncontrolled number of patients, the seriousness of the patient's illness, organizational characteristics, absence and personal requests for holidays, as well as the qualifications and specialties of the nurses themselves are some of the factors why scheduling nurses is difficult, including scheduling each nurse into different working hours in the short term (Susandi and Milana, 2015).

Good preparation is required in scheduling arrangements for nurses. This is necessary so that there is no physical,

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emotional and psychological fatigue and exhaustion in nurses, which will have a negative impact on the performance of nurses in providing services to patients (Griffiths et al., 2014). Fatigue and physical exhaustion usually occur due to nurses' lack of sleep as the result of long hours of standby on consecutive morning, evening and night shift. Lack of sleep will increase the error rate in humans. To avoid this, the hospital needs to make clear rules to regulate the working hours of nurses so that they can work properly according to the existing rules and nurses have a pleasant experience in doing their work (Rhéaume and Mullen, 2018). Work schedules affect nurses in undertaking activities outside of work; 25% of respondents who worked on evening and night shifts found that shift work sometimes made it difficult for them to socialize with the environment outside their work. Night shift workers have a higher percentage of physical and mental symptoms at work than when they work in the morning or evening with complaints of mood swings and headaches (Jensen, Larsen and Thomsen, 2018). Strategies to maintain health and attitude of a good nurse and vigilance for the safety of patients should include a fatigue management plan and an optimal schedule (Haluza, Schmidt and Blasche, 2019)

The application of technology in the nursing managerial process is deemed sufficient to provide convenience in its implementation. The use of information technology can increase the effectiveness and efficiency of work for both managers and nurses. The scheduling program is based on four criteria: the level of satisfaction of nurses, demand for holidays, rotation schedules and maximum work periods on the night shift (Chen and Yeung, 1993). The electronic scheduling program is proven to save time for nurse managers, providing accurate and timely access to all nursing staff, fairness, equality of work shift patterns and easy leave management. It was felt able to grow a good sense of job satisfaction for nurses (Price, 2016).

Several studies indicate that good scheduling model can be considered as a solution to improve the level of satisfaction of nurses. This study is conducted to develop a model of the electronic work scheduling application based on the characteristics of scheduling nurses consisting of coverage, quality, stability, flexibility, fairness, and cost (Warner, 1976). Work scheduling is also adjusted to the hospital policy that includes the number of the need for nurses, nurses' competence classification, duty cycle, etc.

## MATERIALS AND METHODS

### Study Design

Design of this research is Research and Development (R & D).

### Population, Sample and Sampling

The population in this study is all nurses working in the ward unit (151 nurses). The sampling technique used was simple random sampling and it obtained 106 samples of nurse respondents.

### Instrument

Data for the assessment of scheduling characteristics were collected using questionnaires compiled based on Warner's (1976) theory of work scheduling characteristics consisting of coverage, quality, stability, flexibility, fairness, and cost consisting of 26 statements and problem formulations. Furthermore, data for the development of the nurse rostering software were collected through Focus Group Discussion (FDG).

### Data Analysis

Analysis of the data is in descriptive form, explaining the tables of tabulated results.

### Ethical Clearance

This study has obtained ethical clearance from the Committee of Ethical Approval in the Faculty of nursing Airlangga University, number: 2082-KEPK.

## RESULTS

Table 1 shows that most of the respondents are women (72.6%), the education level of the respondents is mostly diploma (75.5%), the employment status of respondents is mostly permanent (63.2%), the

positions of the respondents are mostly nurses (64.2%), and the length of work of the respondents was mostly more than 5 years (62.2%).

Table 2 shows that most respondents rated the characteristics of work scheduling currently applied in ward as moderate category (80.2%).

Table 3 shows the results of quantitative data on the characteristics of work scheduling in wards. The results indicate that 2 sub-variables', average, coverage (309) and quality (321), are less than the total average (322.08). Schedule consistency (320) on stability sub variable and time (317) on cost sub-variable are also less than the total average (322.08).

Table 4. shows the results of the FGD conducted with nursing manager respondents and the head of the room, which is a method of scheduling nurses' electronic work by increasing scheduling characteristics that are still below the average value, maintaining good characteristics and electronic work scheduling methods based on hospital policy. Recommendations that can be given to the hospital ward based on the FGD carried out are as follows: there is a need for an automatic computer-based scheduling program based on scheduling characteristics and hospital policies for a more effective and efficient schedule preparation process.

*Development of Nursing Electronic Rostering Methods (NERs)*

The development of electronic scheduling application models (NERs) emphasizes scheduling characteristics which consist of

Table 1. Respondent Characteristics (n=106)

| Characteristic | n | % |
|---|---|---|
| **Sex** | | |
| male | 29 | 27.4% |
| female | 77 | 72.6% |
| **Education** | | |
| D3 | 80 | 75.5% |
| D4 | 1 | 0.9% |
| S1 | 25 | 23.6% |
| **Job Status** | | |
| Non-permanent | 39 | 36.8% |
| Permanent | 67 | 63.2% |
| **Position** | | |
| Ward Chief | 5 | 4.7% |
| Shift Chief | 33 | 31.1% |
| Nurse | 68 | 64.2% |
| **Work length** | | |
| <1 Year | 4 | 3.8% |
| 1-5 years | 36 | 34.0% |
| >5 years | 66 | 62.2% |

Table 2. Work scheduling characteristics in patient wards

| Categories | n | (%) |
|---|---|---|
| Good | 21 | 19.8 |
| Moderate | 85 | 80.2 |
| Total | 106 | 100.0 |

Table 2. Assessment of sub-variable characteristics of work scheduling of nurses in the ward

| Sub-variable characteristics | Average (sub-variable) | Average (total) |
|---|---|---|
| Coverage | 309.1 | |
| Quality | 321 | |
| Stability | 323.7 | |
| Flexibility | 328.6 | 322.08 |
| Fairness | 324 | |
| Cost | 325.7 | |

Table 1. Results of the Focus Group Discussion (FGD)

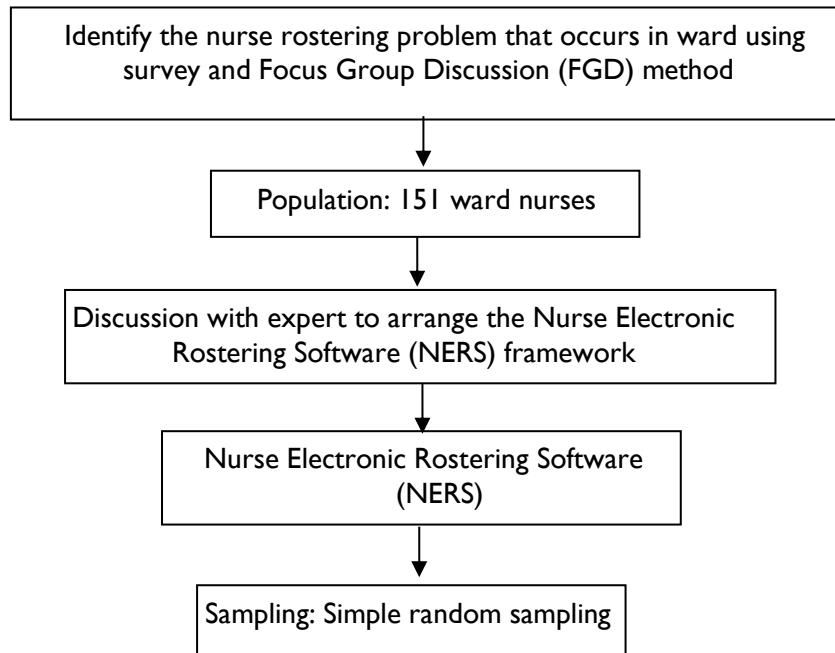| Strategic Issues | Cause | FGD Result | Research Study |
|---|---|---|---|
| Incompatibility of the number and competence of clinical nurses in the ward (coverage) | 1. Considered the number of nurses is not in accordance with the needs<br>2. The nurse's clinical competence in the room is not in accordance with the needs | 1. Being in a new nurse recruitment stage gradually<br>2. In the process of improving the competence of clinical nurse in the ward | The scheduling method should be made automatically based on hospital policies and maximizing the availability of staff in the room |
| Duty cycle division that is not appropriate and equitable (quality) | 1. High flexibility of service schedules<br>2. Holidays that are not appropriate | Duty cycle regulation is expected in accordance with hospital policy | Scheduling method is made automatically to maximize equalization of working hours and duty cycle. |
| There was a change in service schedule / schedule swap (stability) | 1. High flexibility of service schedules | It is expected to minimize the changes after the arranged schedule | The automatic scheduling method is based on the number of needs and requests for holidays at a certain time. |
| The time for preparing the work schedule is quite long (cost) | 1. Arrangement of service cycle for each nurse.<br>2. Request for a certain date of holiday | Expected scheduling method that requires a faster time in the preparation | Automatic scheduling method can save time and the estimated processing is less than 1 hour |
| Adjusting the scheduling method based on the scheduling policy applicable in the hospital | The scheduling method is based on the scheduling policies that apply in the hospital | 1. The average number of nurses in inpatient rooms is 20 people<br>2. The nurse's clinical authority consists of PK I-PK IV and PM with PK IV - PM as the head of the room, PK III-IV as the deputy head of the room and PK III or PK II with a minimum work of 10 years as team leader.<br>3. Nurses workload 40 hours / week with a holiday cycle after 2x night service.<br>4. The division of the shift work time, namely: 7 hours of morning service, 7 hours of evening service and 10 hours of night service (calculated overtime)<br>5. Head of room and deputy head of the morning office.<br>6. The number of holidays for each nurse adjusts the number of red dates / holidays (weeks and holidays) in one scheduling period. | Scheduling methods should be created automatically based on hospital policies |

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┌─────────────────────────────────────────────────────────────┐
│   Identify the nurse rostering problem that occurs in ward    │
│   using survey and Focus Group Discussion (FGD) method        │
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                              ▼
              ┌──────────────────────────────────┐
              │   Population: 151 ward nurses     │
              └──────────────────────────────────┘
                              │
                              ▼
    ┌──────────────────────────────────────────────────┐
    │  Discussion with expert to arrange the Nurse       │
    │  Electronic Rostering Software (NERS) framework     │
    └──────────────────────────────────────────────────┘
                              │
                              ▼
          ┌────────────────────────────────────┐
          │  Nurse Electronic Rostering Software │
          │              (NERS)                  │
          └────────────────────────────────────┘
                              │
                              ▼
            ┌──────────────────────────────────┐
            │  Sampling: Simple random sampling  │
            └──────────────────────────────────┘
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Figure 1. Research framework

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        ╱─────────────────────────────────────╲
       ╱  INPUT:                                 ╲
      ╱    • Number of nurses                      ╲
     ╱     • Nurses classification                  ╲
    ╱      • Work hours                              ╲
   ╱       • Level of patient need                    ╲
  ╱          (Douglass method)                          ╲
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                          │
                          ▼
              ╭──────────────────────╮
              │   Nurse electronic    │
              │   rostering software  │
              ╰──────────────────────╯
                          │
                          ▼
        ╱─────────────────────────────────────╲
       ╱  OUTPUT:                                ╲
      ╱    • Schedule distribution                 ╲
     ╱     • Nurse composition based                ╲
    ╱        on nurse classification                 ╲
   ╱       • Balancing the nurse work                 ╲
  ╱          hours in a period                          ╲
 ╱         • Nurse rostering database                    ╲
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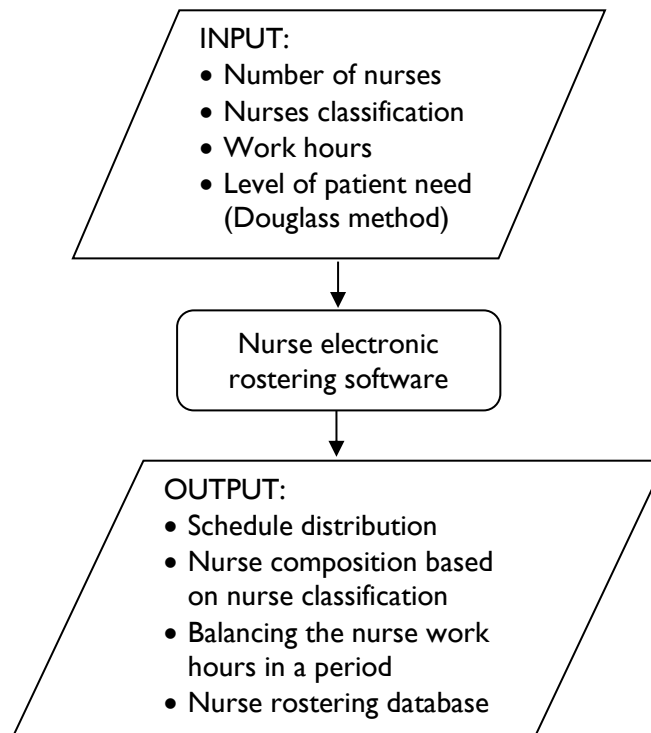
Figure 2. Nurse Electronic Rostering Software (NERS)

coverage, quality, stability, flexibility, fairness and cost.

Coverage is translated as optimization and maximizing the resources possessed by the inpatient room. The distribution is evenly distributed per shift according to the minimum clinical competence for each level of the organizational structure starting from the executive nurse to the head of the room. The quality of scheduling in this application adjusts for the service cycle by considering the appropriate number of holidays and the distribution of holidays on weekends or red dates. The stability of the schedule in this study is to minimize the exchange of official schedules after the schedule is compiled and distributed to nurses. The flexibility in scheduling in this application is to maintain what has been running, namely the application for leave and holidays on a certain date before the schedule is drawn up. Fairness in scheduling in this application is equalization of work hours load that must be met by each nurse. This can be seen from the difference in hours in the total working hours of each nurse. Cost in this study is defined as the effort and time needed to compile a schedule, so this application is designed to shorten the time of preparing the service schedule itself. In addition, the development of an electronic scheduling application model is also adjusted to the policies of the hospital regarding the nurse's work scheduling method so that it can be implemented appropriately in the ward.

## DISCUSSIONS

*Identification of Nurse Scheduling Problems on the Ward*

The problem of scheduling has received attention over the past few years because it is based on the concept of small action with a large effect that maximizes the profitability of the organization through exploiting the availability of workers and equipment in the best possible way (El Adoly, Gheith and Nashat Fors, 2018). The results of the assessment of the characteristics of work scheduling in ward are mostly "sufficient." The assessment of scheduling characteristics is based on the suitability of the number and needs of nurses in the ward (coverage). The manager who is responsible for making the service schedule

must pay attention to several things so that the implementation of the service schedule runs well, including: 1) flexible time; 2) staff should not be overly tired due to frequent or prolonged overtime requests; 3) patient care should not be disturbed; 4) decision-making in the official schedule must pay attention to the policies applicable in the organization; 5) strive for fairness in making service schedules; 6) cyclic personality, namely the next work schedule is known because the personality pattern repeats itself every four weeks; 7) utilization of additional personals; 8) nurse competence that has been determined by hospital policy; 9) scheduling by staff; 10) nurse mix skill (Kim and Windsor, 2015).

The insufficient number of nurses will cause the workload of nurses to increase so that nurses no longer carry out actions according to their competence (Moore and Waters, 2012). The insufficient number of personnel is not allowed to perform long services because it will have an impact on care and can increase the potential for errors by nurses. In addition, the composition of nurses in terms of competence must be diverse so that the head nurse must pay attention to the competence and skill mix of staff in the room (Rizany, Sri Hariyati and Purwaningsih, 2017). A higher concentration level of nurses has a positive impact on patient care outcomes and the mortality rate is shown to be lower, that is, patients are treated with optimal equal nursing levels. Competency-based work schedules are more effective and facilitate work within the official schedule. However, the lack of manpower both in terms of the number and equal distribution of competencies in the unit and the ego of the nurse are obstacles in compiling competency-based service schedules (Rizany, Sri Hariyati and Purwaningsih, 2017). Fatigue occurs because nurses should not be maintained on the morning shift, evening and night in a row, as that will lead to lack of sleep (Afandi, Setiawati and Mufti, 2012).

The quality point of the research results is also a problem that arises in the scheduling process on the ward. Included in quality are holidays on weekends, single or separate holidays, and certain patterns of work rotation as well as the demand for holidays at certain periods (Warner, 1976). Work scheduling that should have been determined can change due to the large number of patients admitted to a

hospital; this can affect the rotation of office scheduling which results in not optimal service (Juniar, Astuti and Iftadi, 2017). Management work schedule with shifts and days off allows the nurse to take a break to improve service quality. Changing the schedule of nurses that is not considered appropriate has the potential to have negative consequences if in an emergency, the patient deteriorates and the morale of staff decreases (Clark et al., 2015). Shift that has the highest level of fatigue based on the results of the questionnaire is the morning shift. From the level of speed, level of accuracy and level of constancy, it can be concluded that the highest level of fatigue is in the afternoon shift. Based on the calculation of energy consumption and oxygen consumption using work physiology methods, the highest is in the morning and evening shifts (Juniar, Astuti and Iftadi, 2017).

The time scheduling arrangement also emerged as one of the problems that arose in scheduling in the ward. Based on the research findings, Excel-based scheduling is a promising solution for reallocating nursing resources in a hospital setting. E-rostering can reduce the number of manager assignments and offer better support when recruiting replacement labor, with less labor costs and time savings. To ensure success and adoption, it is necessary to provide sufficient training during the implementation phase of a new electronic system (Tuominen et al., 2016).

*Nurse Electronic Rostering Software (NERS)*

Displacement of the scheduling has traditionally been the implementation of an electronic scheduling, otherwise known as e-rostering, throughout the hospital has been felt to help the nursing managers to make scheduling more effective by combining requesting flexible working staff while meeting the needs of the organization (Drake, 2014). The purpose of scheduling work for staff is a way of reconciling resources, care needs and work-life balance. The use of e-rostering is recommended as an efficient way of achieving this reconciliation (McIntyre, 2018). In addition, an effective and efficient e-roster is able to accommodate excess and deficient staff / employees, ensuring safety, efficiency and flexibility (Hasson et al., 2018).

Scheduling is the arrangement and allocation of available time for nurses to carry out planned tasks with the aim of minimizing costs and equalizing workloads (Lin et al., 2015). The "NERs" application can help nurse managers to maximize the existing nurse resources. This application divides nurses as needed based on the calculation of needs according to Douglass, which is applied by the hospital. The division of the number of personnel into different work shifts and the composition consisting of Katim and implementing nurses in accordance with hospital policies are also included as one of the components in the application. Service schedule management with proper shifts and holidays allows nurses to take breaks to improve the quality of care (Sagherian et al., 2017). The "NERs" application tries to improve the quality of the nurse's scheduling by optimizing each nurse to get a holiday allowance on weekends or red dates. The hospital needs to make clear rules to regulate the working hours of nurses so that they can work properly according to existing rules and nurses have a pleasant experience in doing their work (Rhéaume and Mullen, 2018).

The "NERs" application is able to maintain the stability of the service schedule by increasing other sub-variables such as quality and flexibility. The flexibility of the schedule in the application is supported by a menu for applying for leave and holidays on certain days before the schedule is arranged. A flexible work schedule will increase productivity, reduce absences, increase commitment and afford better hiring (O'Neal, 2012). Justice can mean "equality" (equality of results), "worthiness (individual freedom) or "need" (social justice). Fairness in work scheduling is defined as equality of results. For example, the need for a "fair" allocation of requests, annual leave, flexible work and study leave were all explicitly expressed (Drake, 2019). The "NERs" application divides the workload of each nurse by an average of 40 hours per week. The difference ranges from each nurse averaged 3-7 hours. The difference in workload from each shift can be one of the triggers for the appearance of fatigue in nurses (Clark et al., 2015). Nurse's electronic work scheduling application can significantly reduce the schedule time for one scheduling period. This application-based schedule arrangement is able

to compile a scheduling period in less than one hour. Computer-based work scheduling shows that the amount of time needed to compile the schedule, the nurse work schedule application "NURSE-Help" takes an average of less than 20 minutes, while manually the head of the room takes 2 to 4 hours.(Chen and Yeung, 1993). The electronic scheduling program is proven to save time for senior staff, provides accurate and timely access to all nursing staff, fairness, equality of work shift patterns and easy leave management (Price, 2016).

## CONCLUSION

Problems that arise in the scheduling of nurses in the inpatient room based on the theory of scheduling characteristics are the suitability of the number and distribution of nurses, the stability of the schedule, and the long time needed for preparing the schedule. The development of electronic work scheduling methods for nurses in the inpatient room, allows, among others: automation of distribution based on the level of patient dependence, fixed schedules in one period, flexibility in scheduling by proposing early holidays and leave, equal work hours load and reducing the duration of nursing work schedules. The electronic work scheduling model for nurses in the inpatient room was developed to be more effective and efficient so that it can improve the quality of service in nursing.

### *Conflict of Interest*

The authors declare that there is no conflict of interest in this study.

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