Workload Analysis and Improvement of the Nurses Duty in the Hospital

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Abstract. Nurse is someone who has a task as a medical assistant in the hospital. They work for eight hours per day in serving patients and helping out the doctors such as, wound cares, infusions, bathing patients, injecting medical substances, giving medications, moving patients, changing patient clothes, etc, creating a lot of work for them. According to survey of the Indonesian National Nurses Association there are 50.9% of nurses experiencing work stress, dizziness, and fatigue because of high workloads. Therefore, it is necessary to be improved. Objective of this study is to analyse the mental workload of nurses and develop few of recommendations to reduce the mental workload. National Aeronautical and Space Administration Task Load Index (NASA-TLX) is used to evaluate the mental workload based on six variables: mental demand, physical demand, temporal demand, own performance, effort, and frustration level. While the developed improvement uses the participatory ergonomic method which involve nurse, doctor, ergonomist, and designer as stakeholder by implementing a group discussion to determine criteria of enhancement. Statistical analysis is applied to verify the hypothesis. Result of this study shows that the score of NASA-TLX is 62.46, which means the task is overload. As for the result, participatory ergonomic is verified at 5% of significant levels that requires some improvements, including but not limited to administrative activities in the form of making action invoices, physical activity that causes spinal cord injuries was lifting the patients and bending while injecting the patient, and work shift system where morning and afternoon shift longer than night shift.

Keywords: Nurse, NASA-TLX, Participatory Ergonomic

1. Introduction  
Hospital is a public health service in the form of inpatient, outpatient and emergency. These services are carried out by medical personnels such as doctors, midwives, and nurses. They work in shift schedule for eight hours. The doctor is responsible for diagnosing the disease, giving medicine, performing surgery, etc. This task is assisted by nurses who have a task as a medical assistant in the hospital [1] that includes wounds care, infusion, injecting, giving medication, changing patient clothes, and transfer of patient to another location. The Indonesian National Nurses’ Association in 2006 found that 50.9% of nurses get stress, dizziness, fatigue, and are unable to rest. It because of the high workload and time consuming. The workload causes psychological distress and feeling of entrapment to escape from an aversive situation, which both are related to fatigue[2-3].
Based on the preliminary study it is identified that 47.8\% of nurses have complaints related to working hours, rest hours, work shifts, income, number of workers, and reward and punishment. This is encouraged by [4] who found 60.3\% of nurse experiencing the high workload in doing the task. Study of [5] shows that nurses experiencing work stress directly related to work is caused by low income, heavy workload, night shift and the lack of interaction. The excessive workload can increase the occurrence of failure of collaboration between nurses and doctors, poor communication between nurses with patients, discharge nurses and nurse job dissatisfaction [6]. In addition, the impact of nursing workload can cause decreasing quality of care and safety patient, as well as level of anxiety, stress, burnout, and attrition of nurses[7-8]. This condition is significant to be improved in order to avoid the excessive workload.

The objective is to investigate the nurse workload and to recommend some improvement of causes the negative effect on nurse subjectively. The workload will be identified based on mental demand, physical demand, temporal demand, own performance, effort, and frustration level. As for the recommendation is resulted from focus group discussion among the stakeholders. They are nurse, doctor, ergonomist, and designer.

2. Methods

2.1. NASA-TLX Questionnaire

National Aeronautical and Space Administration Task Load Index (NASA-TLX) is a method developed based on subjective measurement needs consisting of nine factor scales, namely task difficulty, time pressure, type of activity, physical effort, mental effort, performance, frustration, stress and fatigue. The nine existing factors are simplified into six indicator factors, namely mental demand, physical demand, temporal demand, own performance, effort, and frustration [9]. In this study, NASA-TLX questionnaires are distributed to 94 nurses from three hospital in Yogyakarta for assessing their mental workload.

The stages in measuring NASA-TLX are :

1. Weighting

Respondents were asked to selecting one of two indicators considered as the dominant cause of workload mental at work. The number of the calculation of calculated from each indicators are most influential. The number of these calculations will be weights to every indicator mental burden. The following are table comparison indicators NASA-TLX:

![Figure 1. Weighting NASA – TLX Indicators](source: [9])

2. Rating

Respondents are asked to rate the six indicators of mental load. Subjective rating given is dependent on the mental burden felt by the respondents. The following rating indicator of NASA-TLX:

...
3. Calculating the value of the product
   Represents the multiplication result of the indicator weight with the rating of each indicator:
   \[
   \text{Product} = \text{rating} \times \text{weighting factor}
   \]

4. Calculating Weighted Workload (WWL)
   WWL is obtained by summing the six products:
   \[
   \text{WWL} = \sum \text{product}
   \]

5. Calculate the average WWL
   WWL is obtained by dividing the total number of weights:
   \[
   \text{Score} = \frac{\sum \text{product}}{15}
   \]

6. Interpretation of score
   Classification of mental workload scores is explained by [9] as follows:

   | Workload Group | Score   |
   |----------------|---------|
   | Low            | 0 – 9   |
   | Moderate       | 10 – 29 |
   | Kinda High     | 30 – 49 |
   | High           | 50 – 79 |
   | Very High      | 80 – 100|

   In addition to research [10], the classification of mental workload is classified into:
### Table 2. Classification of Mental Workload

| Workload Group | Score |
|---------------|-------|
| Underload     | < 40  |
| Optimal Load  | 40 – 60 |
| Overload      | ≥ 60  |

2.2. Participatory Ergonomic

Participatory ergonomic is a process whereby employees participate together with management to strive to plan, implement, and evaluate processes with other resources to produce appropriate work design concepts so that systematically reduce workplace accidents [11-12]. In this study, participatory ergonomic is used to develop solution recommendations in reducing the mental workload experienced by nurses. Participatory ergonomics involve several stakeholders, namely nurses, doctors, ergonomist, and designer. There are three steps in applying participatory ergonomic according to [13]:

1. Participant selections
2. Conduct design and development based on the result of input provided by participants
3. Implementation of results for further evaluation by participants.

3. Result and Discussion

3.1 Result of NASA – TLX Questionnaire

The WWL average of 94 nurses is 62.46 where according to table 2 it is included in the overload category. The highest load category is at the medium level, namely effort with a value of 18.1704, then mental demand (MD) with a value of 10,737 and a physical demand (PD) indicator with a value of 10,133. The temporal demand (TD) indicator is 9.76, the frustration indicator (FR) 6.83 and the own performance (OP) indicator 6.82 which fall into the category of low workload.

Nurses have a high workload because they have a large responsibility in providing nursing services to patients [14]. In this study it is known that nurses need greater effort to handle patients because the number of nursing staff is not comparable with the large number of patients who enter. The tasks carried out require nurses to think, concentrate, and count, including giving drug doses, administering intravenous fluids and administering patient data. In administering doses of drugs and administering intravenous fluids, a thought process and proper calculation are needed from the nurse. In the patient administration process, the nurse carries out an action invoice that is the value of the services provided to the patient to be paid by the patient to the hospital. This activity becomes a problem for nurses because of the double job function.

Double functions occur because invoicing is an administrative task that can be done by admin workers without having to have nurse competencies. In research [15] even stated that indicators of mental needs become dominant factors in nurses because nurses are required to work quickly so that all patients can be served. Besides that, affecting the high mental needs are the number of patients and the unpredictable severity of the patient, the knowledge and skills possessed are not able to compensate for the difficulty of work, the pressure and demands to save the patient both the moral demands, the demands of the hospital leadership and the demands of the family. patients, are always faced with the right decision making and high responsibility in carrying out nursing care.

Nurse activities tend to be many and varied and involve physical involvement including encouraging beds, patient wheelchairs, transferring patients, and lifting patients on stretchers. Physical
activity carried out by nurses has been greatly assisted by the existence of adequate assistive devices and facilitates the appointment, transfer, and encouragement. For example in the activity of pushing, the bed of a patient who has been equipped with a wheel so that there is no need for excessive energy to encourage, in the use of wheelchairs it is now easier for patients and nurses with the automatic buttons inside. While in the process of appointment and transfer such as the use of a stretcher, the scoop stretcher tool helps nurses because of its human adjusting principle so that it is only necessary to insert a stretcher to the bottom of the patient's body without having to lift the patient's body first. Even so, there are still complaints of spinal cord injury experienced by nurses in the appointment process.

The amount of work that exceeds the capacity causes the physical condition of the nurse to be easily tired and easily tensed [16]. This is because nursing services require technical skills and sufficient knowledge. Nurse activities can be categorized as monotonous work because of its routine nature such as sitting too long which causes the muscles to become stiff, standing and bending too long when doing nursing activities can cause pain in the waist. The impact experienced by nurses is spinal cord injury due to wrong lifting, this is often the case for emergency nurses. The increased risk of spinal cord injury occurs as a result of repetitive activities [17].

The shift system requires the nurse to complete the work on the shift to complete. This results in shift changes cannot be done in a timely manner. In other cases, nurses can "order" their shift schedules to the head of the room. But this causes a shortage of nurses in certain shifts. The existence of this "ordering" system also causes fatigue for nurses when the shift schedule is close so that the rest time is reduced. This is evidenced by the existence of complaints where nurses complain about working hours, rest hours, and work shifts where there is a correlation with the lack of available nursing staff.

3.2 Result of Participatory Ergonomic
Participatory ergonomic with nurses finds several problems in nurse activities including administrative problems in the form of invoicing action, problems due to physical work such as removing patients in moving patients resulting in spinal injury in nurses, as well as problems in the work shift system where there are deficiencies number of nurses in certain shifts.

Problems in administrative activities actually do not require the competence of a nurse, which is the making of an action invoice. Action invoices are used to enter the value of services used by the patient for the actions given by the nurse. So in this case it is necessary to identify the tasks performed by the nurse, whether the task is the main duty of the nurse or not. In this problem, a job redesign is needed for nurses. So that it can be identified as the main tasks that must be done by nurses and tasks that can be done by other people without having to have competence as a nurse. Job redesign is a process to get as much information as possible about the facts that occur in order to complete the tasks that are in a position [18]. Job redesign is a procedure that must be passed to determine the responsibilities and characteristics of people working in a position [19].

Physical activities carried out by nurses include transferring patients to bed to be taken to the nursing room, sewing wound activities, infusion, and measuring urine. In the activity of moving the patient to the bed to be taken to the ward there is a process of lifting, removing, and pushing a load. While in the activity of sewing the wound, infusion, and measuring urine there are jobs with a bent posture. All of these activities have the potential to cause nurses to experience injury. In overcoming the odd position when the posture is bent, it can be technically controlled. Technical control is carried out to reduce the impact of spinal injuries that can be experienced by nurses. The opportunity for spinal cord injury in nurses is 43.1 - 87% [20]. A bent position can not be avoided by nurses when providing nursing services with the patient lying in bed. Bending is a position of deflecting the spine in a frontal direction that can overload the intervertebral disc, and increase ligament contraction and spinal support muscles [21]. So if the bending work is done for a long time and with frequent frequency, the ligaments and supporting muscles of the spine can weaken and put pressure on the intervertebral disc.

Technical control is carried out by providing adjustable facilities and infrastructure such as chairs and beds that can be adjusted in height. When performing treatment in a patient's condition, the height of the nurse influences the magnitude of the arch's back angle [21]. The greater the arch angle of the back, the muscle and ligament contraction will increase so there can be an emphasis on the intervertebral disc. Analysis in the study [21] states that the curved angle of more than or equal to 600 has the potential
11 times more often to cause spinal cord injury. Further explained, the dominant work equipment causing spinal injury is the use of beds and gurney. By providing equipment that can be set the height of the nurse will be free to adjust the height of the body when conducting checks. Besides providing training on patient lifting techniques also controls the risk of injury experienced by nurses. Nurses must be trained so that minimal patient lifting and moving work are carried out by two nurses who are competent in patient transfer techniques, untrained nurses are proven to be significant risk factors for spinal cord injury [22]. The right recommendation is to remove or transfer the patient with a shrug method that is by using one hand to do the lifting and the other hand rests on the bed or base. Lifting with a shrug method has been used internationally for many years because this method produces lower intra-abdominal pressure compared with two-handed removal at the same time [17].

Determination of the work shift schedule is carried out by the head of the room with a system of "ordering" for nurses who want to determine the schedule on the desired day. The "ordering" system is common because it is a form of right given to nurses to be able to determine their own schedule so that in working nurses can be happier. But it cannot be denied that this system will result in a shortage of nurses on certain shifts. For this reason, it is necessary to do shift shift management by making a work shift system. The nurse's work shift system is as follows:

1. Shift rotation follows the sun
   The purpose of shift rotation following the sun is setting the shift according to the rotation experienced by the sun that is morning - evening - night. This is related to the human nervous system which has repulsion when sudden changes occur, so that with the shift of the sun's rotation there is no significant change in the nervous system [17].

2. The shift system uses continental patterns (2 - 2 - 3) or metropolitan patterns (2 - 2 - 2)
   A good work shift system according to [23] is continental and metropolitan patterns. Both patterns have differences in weekend cycles obtained, in continental patterns Saturday and Sunday weekends will be found in the fourth week. While in the metropolitan pattern the new weekend will be found in the eighth week, so that the continental pattern will be preferred by workers.

3. Work shift planning includes weekends with 2 consecutive holidays.
4. Break time between shifts is at least 11 hours.
5. Night work 2 days in a row must immediately be followed by a break of at least 24 hours.

In designing work shift rotations, [17] explains two things that must be considered, namely the lack of rest or sleep should be kept as small as possible to reduce fatigue, and provide as much time as possible for family life and social contact. Therefore, giving of 2 holidays in a row can provide opportunities for personal life and social contact for nurses. Reducing fatigue can be done
by paying attention to giving a minimum of 11 hours of inter-shift time and resting at least 24 hours after night work for two consecutive days. In addition, the reduction in the number and quality of sleep of night shift workers will lead to reduced work performance [17].

6. Scheduling with a decentralized system. In carrying out the work shift scheduling system, it should be continued in a decentralized manner, which is given responsibility to each head of each room. Decentralized scheduling will make it easier for nurses to control the work environment and increase nurses’ autonomy in scheduling and flexibility [24].

The three solution recommendations obtained from each expert are verified by all stakeholders as validation of whether the three recommendations are appropriate and applicable.

Table 3. Validity Test Results

| Item | Scale Mean if Item Deleted | Scale Variance if Item Deleted | Corrected Item-Total Correlation | Cronbach's Alpha if Item Deleted |
|------|---------------------------|-------------------------------|-------------------------------|--------------------------------|
| 1    | 8.90                      | 1.358                         | .591                          | .775                           |
| 2    | 8.70                      | 1.379                         | .665                          | .702                           |
| 3    | 8.80                      | 1.221                         | .672                          | .690                           |

Validity test results are seen from the corrected item-total correlation which shows the value of 0.591 for recommendation 1, for recommendation 2 is 0.665, and for recommendation 3 shows the value of 0.672. All r counts ≥ r table is 0.4438, so the recommendation for the given solution is valid. In the reliability test, the value of cronbach's alpha is obtained at 0.797 where the consistency is included in the classification. Overall from the results of validity and reliability, the recommendations for the solutions provided can be applied to reduce the mental workload of nurses.

4. Conclusion

Based on the results of the processing and discussion carried out, it can be concluded as follows:

1. The mental workload of nurses experiences overload with an average value of weighted workload of 62.46. The highest indicator with medium workload is an effort of 18.17; mental demand of 10.737; physical demand of 10.133; and with a low workload namely 9.76 temporal demand; frustration level 6.83 and own performance 6.82.
2. Solution recommendations given for problems in administrative activities, spinal cord injury due to physical activity, and work shifts are as follows:
   a. Job redesign,
   b. Technical control
   c. Work shift system.
3. The recommended solution is valid with r count ≥ r table and reliable with a value of 0.797 so that recommendation solutions can be applied to reduce the nurse's mental workload.

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