Hospital fire safety improvement effort (study case Rumah Sakit Ibu dan Anak, Banda Aceh)

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Abstract. Rumah Sakit Ibu dan Anak (RSIA) Aceh Province is a public service agency that equipped well and also becomes a reference hospital. As a reference hospital, RSIA has many patients with a severe and critical condition which are difficult to be evacuated in a fire case. Therefore, the building of RSIA should have good fire safety to minimize risk for patients, hospital personnel, and equipment. The objective of this research is to appraise the safety building of RSIA with Fire Risk Index method. The appraisal was done for 23 hospital rooms by scoring 17 index parameters. Each parameter score then multiplied with respective weight and sum up to get a Fire Risk Index. Moreover, this research also assessed the hospital fire management with deep interview approach for several key persons. Next, the knowledge of hospital personnel and patients were also revealed with the questionnaire survey. The result found that RSIA has an intermediate level of building fire safety with an average index of 3.2. For fire management, it can be concluded that there is a system of fire management already available which is managed and commanded by Health and Safety unit. In addition, the equipment related to fire protection has been maintained regularly with support from the Disaster Mitigation Agency of Banda Aceh municipality. Related to the knowledge of hospital personnel, it revealed that some items need to be improved such as emergency code, the use of fire extinguisher, and emergency signal. For patients, the knowledge of using electrical equipment which has the potential to create fire should be improved. Lastly, patients also need to be informed about fire mitigation and evacuation.

1. Introduction

Fire safety is an important aspect of a Hospital day to day operation. Therefore, there are a few regulations that were issued to mitigate and prevent fire danger, such as Minister of Health decree No. 66/2016, which states that a hospital must carry on fire safety management to minimize risk on hospital resources, patients, visitors, and neighborhood environment [1].

Based on data that was issued by the Indonesian National Disaster Mitigation Agency [2], there were 2,048 fire cases from 2008 until 2018 and caused a loss of up to 43 billion Rupiah. On the other hand, Fire Fighting and Rescue Department of Banda Aceh Municipality recorded 287 fire cases from 2014 until 2017. Moreover, the Disaster Mitigation Agency of Aceh Province recorded 237 disaster events in range January until May 2019, which is dominated by the fire with 105 cases. These figures made fire is the most non-natural disaster which happens more frequently than others. Based on the facts [2], [3],
and [4], fire mitigation and prevention actions are required and must be implemented in particular for public service buildings like the hospital.

Hospital is a high risk from fire case due to many people are inside the building and could cause live loss. A high number of people could be patients with various conditions and caused evacuation efforts are difficult to be done. In addition, damage and property loss are also taking into account due to the availability of costly medical and non-medical equipment.

*Rumah Sakit Ibu dan Anak* (RSIA) Banda Aceh is a public service agency and become a reference hospital for another hospital within Aceh Province. RSIA is equipped with good medical equipment and has been qualified as a B category for minimum standard medical service. As a reference hospital, the condition of patients could be in severe or even in a critical stage which is difficult to be evacuated in a fire case. Therefore RSIA must have a good fire safety, reliable management system and personnel ability to keep patients safe from fire. Although RSIA never gets a fire incident, the frequent use of mechanical and electrical devices has a high probability of a fire accident. A fire accident can be ignited from many activities among those: the use of equipment with high power consumption (i.e. radiology device), electrical generator for power backup, short circuit, gas stove in the kitchen, pressure tube, chemical material usage in laboratory or pharmacy, and so forth.

From preliminary observation, it was found that RSIA already has some active and passive fire protection tools such as fire extinguisher, smoke detector, hydrant, etc. However, it is not known how those tools affect the safety of RSIA building from fire. The existence of those tools, of course, must be enhanced by management and resources to gain an optimum safety level. But, from previous research that was conducted by [5] about analysis of policy implementation towards hospital disaster plan on earthquake and tsunami at RSIA, it found that several aspects of disaster management had not been accomplished, namely: disaster mitigation team was not ready, no standard operating procedure available and the lack of hospital personnel awareness priority for rescuing patients.

Based on those facts and problems, this research aimed to appraise the safety building of RSIA in a fire case and also looking for a strategy to get the right approach in improving building fire safety to minimize loss and saving lives of people in RSIA.

### 2. Methodology

This research is a combination of qualitative and quantitative methods (mixed methods). The quantitative method was used to appraise the fire risk index of RSIA building and to measure the knowledge of hospital personnel and patients about fire safety. The qualitative method took part in the key person deep interview activity which explores strategy to improve fire safety.

Fire Risk Index (FRI) is a method to appraise the safety level of a building for a fire case. This method was developed by the Fire Safety Department of Lund University Sweden in the year 2000. This method can be applied to all building types such as residential, commercial, government, public service, etc. The result of this method at the end is a score index within range 0-5. The higher score index shows the higher fire safety of a building and vice versa the lower index indicates less fire safety [6].

The fire safety appraisal using FRI method is carried out by assessing 17 parameters, there are: building wall material, fire suppression, fire service, building compartment, structure separation, doors, windows, facade, attic, adjacent building, smoke control system, detection system, signal system, escape routes, structure load-bearing, maintenance and information, and ventilation. Each parameter has a respective weight as in table 1.

| No. | Parameter (P)       | Weight (w) |
|-----|---------------------|------------|
| 1   | Building wall material | 0.0576     |
| 2   | Fire suppression    | 0.0668     |
| 3   | Fire service       | 0.0681     |
| No. | Parameter (P)                     | Weight (w) |
|-----|----------------------------------|------------|
| 4   | Compartment                      | 0.0666     |
| 5   | Structure separation             | 0.0675     |
| 6   | Doors                            | 0.0698     |
| 7   | Windows                          | 0.0473     |
| 8   | Facade                           | 0.0492     |
| 9   | Attic                            | 0.0515     |
| 10  | Adjacent building                | 0.0396     |
| 11  | Smoke control system             | 0.0609     |
| 12  | Detection system                 | 0.063      |
| 13  | Signal system                    | 0.0512     |
| 14  | Escape routes                    | 0.062      |
| 15  | Structure load-bearing           | 0.063      |
| 16  | Maintenance and information      | 0.0601     |
| 17  | Ventilation                      | 0.0558     |

Each parameter is rated from 0 to 5 and multiplied by the respective weight. The final index is a summation of those multiplication results and can be formulated with equation 1.

\[ S = \sum_{i=1}^{17} w_i x_i \]  

(1)

Where \( S = \) FRI index, \( w_i = \) weight of \( i \)th parameter, \( x_i = \) Score of \( i \)th parameter.

To measure the knowledge of fire safety for hospital staff and patients, the questionnaire instrument was used. The questionnaire for both groups is different. The knowledge level of correspondent was determined by a total true answer in percent. Instrument validity and reliability were tested in the current site at RSIA because there are specific questions in the instrument which cannot be applied for other hospitals due to the discrepancy of facilities and equipment. Bivariate Pearson correlation was used in the instrument validity testing. This validity method correlates each item score to the total score. In the process it will filter each question which has a significant correlation with the total score, it means the corresponding question is important to support the result validity.

The population number of hospital staff is 473 which is the total number of RSIA employees. Meanwhile, the population number of patients is 137, which was determined from the daily average number of patients. The sampling number was determined using Slovin formula as seen in equation 2. Using a 10\% error margin for both groups, gave 83 hospital staff and 58 patients as sampling correspondent.

\[ n = \frac{N}{1 + Ne^2} \]  

(2)

Where \( n = \) Sampling number, \( N = \) Population number, \( e = \) Margin error.

The key person-deep interview approach was carried out to explore more detail about hospital management and equipment related to fire safety. The find out from FRI and questionnaire will be consulted with the key person in order to formulate the strategy to improve fire safety at RSIA.

3. Results and discussion

The appraisal of fire safety was done for 23 rooms in RSIA. Each parameter was assessed and rated with the help of a local building consultant. The result shows that some parameters already have maximum
score such as building wall material, structure separation, signal system, load-bearing capacity. On the other hand, the lower score can be found mostly in parameter fire suppression, attic and smoke control systems. Other parameters score varies from low to high. The spread of the score for each room can be seen in figure 1.

![Figure 1. Score value for 23 rooms in RSIA.](image)

After scoring each room, then each score was multiplied by the corresponding weight. Table 2 is the final result of FRI for each room. The FRI mean value is 3.2. It can be concluded that RSIA has an intermediate level of fire safety. Mushalla/Prayer room has the highest score with 3.41 and PICU got the lowest one at 2.78.

**Table 2. Fire Risk Index for 23 rooms in RSIA.**

| Room                               | Fire Risk Index |
|------------------------------------|-----------------|
| Administration office in RSIA      | 3.05            |
| First-floor nutrition installation |                 |
| Third-floor polyclinic             | 3.05            |
| First-floor laundry                |                 |
| Third-floor laboratory             | 3.30            |
| Operation room                     |                 |
| Room                                      | Fire Risk Index | Room                          | Fire Risk Index |
|-------------------------------------------|----------------|-------------------------------|----------------|
| VIP room and third-floor first-class room | 2.84           | Birthing room                 | 3.24           |
| Hall                                      | 3.28           | NICU                          | 3.00           |
| Meeting room                              | 3.30           | First-floor physiotherapy room | 3.08           |
| Second-floor adult room                   | 3.05           | First-floor radiology         | 3.29           |
| Adult ICU                                 | 3.15           | Pharmacy                      | 3.30           |
| Second-floor children room                | 3.13           | First-floor card room         | 3.33           |
| Prayer room                               | 3.41           | Emergency room                | 3.31           |
| Obstetry and gynecology                   | 3.25           | PICU                          | 2.78           |
| First-floor poly                          | 3.25           |                               |                |

For fire management, it can be concluded that there is a system of fire management already available which is managed and commanded by Health and Safety unit. In addition, the equipment related to fire protection has been maintained regularly with support from the Disaster Mitigation Agency of Banda Aceh municipality.

Related to the knowledge of hospital personnel, it revealed that both hospital staff and patients mostly have an intermediate level of fire safety knowledge with a percentage of 74.7% and 61.4%. Only 12.5% of hospital staff have good knowledge of fire safety and the rest 13.25% is bad. On the other hand, 17.54% of patients have a good knowledge of fire safety and 21.05% is bad. From the analysis of the survey result, some items need to be improved such as emergency code, the use of fire extinguisher, and emergency signal. For patients, the knowledge of using electrical equipment which has the potential to cause a fire should be improved. Lastly, patients also need to be informed about fire mitigation and evacuation.

4. Conclusion
RSIA has intermediate fire safety with a mean index of 3.2. The highest index is 3.41, which belongs to the prayer room; the lowest one is 2.8, which belongs to the Pediatric Intensive Care Unit (PICU). There are some parameters which are rated as the lowest score and considered to be improved. Those parameters are fire suppression, attic, and smoke control system. The knowledge level of hospital personnel regarding fire safety needs to be improved because the knowledge of 74.7% of the hospital staff was categorized at the intermediate level, 12.5% was categorized as good and 13.25% was categorized as bad. On the other hand, for the knowledge of patients for fire safety, 61.4% is at an intermediate level, 17.54% is good and 21.05% is bad. Some aspects required to be improved for hospital staff are emergency code, the use of fire extinguisher, and emergency signal. For patients, the knowledge of using electrical equipment that could cause a fire should be improved. Also, the patients need to be informed about fire mitigation and evacuation. For fire management, it can be concluded that the system of fire management at RSIA is already available and managed by the health and safety unit. In addition, the equipment related to fire protection is maintained regularly.
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