Identification of fire protection system availability in faculty of engineering, University of Teuku Umar

I Y Salena¹, M Safriani¹ and M A R Amin¹

¹Civil Engineering Department, Engineering Faculty, Universitas Teuku Umar, Meulaboh, Aceh Barat, Indonesia

Corresponding e-mail: inseunsalena@utu.ac.id

Abstract. The objective of this study is to identify the availability and implementation of fire protection systems in the Engineering Faculty of Teuku Umar University. The fire protection components identified were the access and water supply component, the mean of egress, passive and active fire protection systems, by conducting direct observations to the field using a checklist form. The building identification refers to the Minister of Public Works Regulation No. 26/PRT/M/2008, and the collected data was analyzed using the Likert scale method, which shows the level of conformity to the regulations based on the generated data. The result shows that the access and water supply components obtain 2.75 of the Likert scale; the mean of egress obtains an average value of 2.24 of the Likert scale. The values mean these facilities do not fulfill the regulation. The passive protection system obtains 2.48 of the Likert scale; it means the facilities do not fulfill the regulation. Active protection systems get an average value of 1.4 of the Likert scale; it means the facilities do not fulfill the regulation. The results of the study show that the fire protection system in the Faculty Of Engineering Building did not meet regulation No. 26/PRT/M/2008 overall so that further improvement is needed to fulfill the requirement of fire protection systems to overcome the danger of fire.

1. Introduction

The Southwest Aceh Regency area often experiences fire disasters. Throughout 2018, cases of fires have engulfed several buildings, including residential houses, Islamic Boarding Schools, and the West Aceh Government Office. The fire, which broke out in Sawang Teube Village, Kaway XVI Subdistrict, Aceh Barat District, burned three houses and one car. Based on information from the West Aceh BPBD (2017), material losses reached 370 million rupiahs. A massive fire also occurred at the Nur Yaqdhah Islamic Boarding School in Labuhan Haji Barat District, South Aceh Regency. Fifty-four units of the students’ rooms burned. The warehouse fire also occurred at the location of the West Aceh Government Office Complex.

Based on the background that put forward, the identification of the availability of fire protection systems based on regulations needs to be implemented. The number of fire cases shows the fire protection system and the readiness to deal with fire has not optimally applied. The potential fire hazard is large, can not be considered easy. Government regulations regarding the implementation of fire protection for buildings already exist, but supervision and control of the application of the fire protection system do not perform optimally.

Teuku Umar University (UTU) was the first state university in the South West Aceh region; the university was inaugurated on April 2, 2014. UTU consists of 6 faculties, one of those is the Faculty of...
Engineering. The Faculty of Engineering consists of a 2-level building that has a building area of 720 m² containing 8 rooms, which are separated by brick walls. The other parts of the building are equipped with room partitions. The appearance of the Faculty of Engineering Building is shown in figure 1.

![Figure 1. Engineering faculty.](image)

Based on the background above, it is essential to know the current conditions of the availability and application of fire safety systems in the UTU Faculty of Engineering Building. The purpose of this study is to identify the availability of fire protection systems at the Faculty of Engineering of Teuku Umar University.

2. Methodology

Field observation and inspection of protection components were performed to identify the availability and implementation of the fire protection system. According to [1], the fire protection system was divided into four components, each of those was divided into sub-components, as shown in table 1.

| No | Components                              | Subcomponent                                |
|----|-----------------------------------------|---------------------------------------------|
| 1  | Access and water supply                 | Water sources                               |
|    |                                          | Access road                                 |
|    |                                          | Distance between buildings                  |
|    |                                          | Private hydrant                             |
| 2  | Means of egress                         | Exits                                       |
|    |                                          | Means of egress reliability                |
|    |                                          | Doors                                       |
|    |                                          | Enclosure and protected stairs             |
|    |                                          | Number of means of egress                  |
|    |                                          | Arrangement of means of egress             |
|    |                                          | Discharge from exit                        |
|    |                                          | Illumination of means of egress            |
|    |                                          | Emergency lighting                         |
|    |                                          | Marking of means of egress                 |
| 3  | Passive protection system               | Fire resistive or noncombustible construction |
|    |                                          | Availability of fire windows and fire doors |
| 4  | Active protection system                | Interior finish materials                  |
|    |                                          | Fire barriers                              |
|    |                                          | Smoke barrier partitions                   |
|    |                                          | Smoke barriers                             |
|    |                                          | Automatic sprinkler systems                |
2.1. Data collection
Data collection is carried out by conducting direct observations in the field using the checklist form shown in table 2. The checklist form consists of components and sub-components of fire protection systems, the availability of the subcomponent based on the direct observation, and description of the information data collected from the existing building.

| No. | Component                          | Condition            | Information available |
|-----|------------------------------------|----------------------|-----------------------|
|     | Fire pumps                          |                      |                       |
|     | Water supplies                      |                      |                       |
|     | Fire extinguisher                   |                      |                       |
|     | Detection, alarm, and communications systems | |                       |

2.2. Data analysis
Data collection result was analyzed using the Likert Scale. Likert scale is a tool to measure or collect data by measuring and weighing the questions [5]. The rating on the Likert scale is shown in table 3, which consists of the suitability of the available fire protection system with the applicable regulations accordance with Ministry regulation No. 26/PRT/M/2008. The rating starts from 1, as the lowest rate which does not fulfill the regulation, and 5, as the highest rating which fulfills the regulation.

| No. | Description                          | Likert Scale |
|-----|--------------------------------------|--------------|
| 1   | Very accordance with regulation      | 5            |
| 2   | Accordance with regulation           | 4            |
| 3   | Enough accordance with regulation    | 3            |
| 4   | Less accordance with regulation      | 2            |
| 5   | Not accordance with regulation       | 1            |

The results of the assessment of the system components will be classified under certain criteria. To get the final results of each component, the below formula was used:

\[
Average = \frac{Amount \, of \, Values}{Data \, Collect \, X}
\]

\[
X = \frac{x_1 + x_2 + ... + x_n}{n}
\]

(1)

The higher the value, the closer it is to the maximum value of a set of numerical values. The relationship can be formulated as a percentage value [5].

3. Results and discussion
After the survey was conducted, the results of observations are set in a descriptive form. Then, they were analyzed using the Likert scale method. The following conditions show the fire safety component that observed. Table 4 shows the results of the identification of access and supply of water.
Table 4. Assessment of access and water supply.

| No | Fire safety component | Criteria accordance to PerMen PU No:26/PRT/M/2008 | Existing condition | Likert scale |
|----|-----------------------|--------------------------------------------------|--------------------|-------------|
| 1  | Water sources         | Available with a capacity that meets the minimal requirements to the function of the building | The only available water sources are the drill well. There is no fire well and water reservoir | 2           |
| 2  | Access road           | Fire department access road must have a width of not less than 6 m, and a minimum length of 15 m. The road must be paved and has the minimum width of the entrance of 4 m. The road must not be obstructed | Paving block pavement. Width is 12 m, and the length is 49 m. The entrance width is 4 m | 3           |
| 3  | Distance between buildings | The Minimum distance from the nearest building (m) based on the height of the building. 1) < 8 m, distance 3 m 2) > 8 -14 m, distance > 3 - 6 m 3) >14-40 m, distance > 6 - 8 m 4) > 40 m, distance > 8 m | The height of the Faculty of Engineering Building is about 12 m. The distance between the buildings next to it is 23 m | 5           |
| 4  | Private hydrant       | 1) Private hydrants must be installed at an accessible area | Not available | 1           |
|    |                       | 2) Completely functioning and complete | Not available | 1           |
|    |                       | 3) Water supply is 38 l/sec; 35 Bar for pressure | Not available | 1           |

Identification for Component of Means of Egress can be seen in Table 5 below.

Table 5. Assessment for means of egress.

| No | Fire safety component | Criteria accordance to PerMen PU No:26/PRT/M/2008 | Existing condition | Likert scale |
|----|-----------------------|--------------------------------------------------|--------------------|-------------|
| 1  | Exit access corridor/exit | 1) Exit corridor and exits must be separated from other parts of the building | On the 1st floor, the exits are separated from the corridor. However, on the 2nd floor, the exits are not separated from the corridor. | 2           |
|    |                       | 2) Construction of the separator must have a fire-resistance level of at least 1 hour in case the exits connect three floors or less | - On the 1st floor: construction of the separator is a partition of glass and aluminum - On the 2nd floor: there is no dividing construction. The available construction is a corridor that directly leads to the exit, which consists of plywood partitions and brick walls | 2           |
| 2 | Means of egress reliability |
|---|-----------------------------|
| 1) Furniture, decoration, or other objects should not be placed carelessly that they could disturb the exits, the access to it, the way to get out of there, or could disturb the view. | - On the 1st floor: exits access corridor is blocked by a banner located on the right side of the corridor |
| - On the 2nd floor: there are no obstacles | 3 |
| 2) There must be no disturbances due to railing, barriers, or doors of the track lane | - On the 1st floor: there are doors at both ends of the corridor before heading exits |
| - On the 2nd floor: corridor goes directly to exits | 2 |
| 3) Mirrors should not be installed inside or near any exits | There is no mirror attached on the 1st and the 2nd floors | 5 |
| 4) Every door and the main entrance to the exits must be visible and directly from the road to the exits | - On the 1st floor: the door and entrance go directly to the path for an exit |
| - On the 2nd floor: the door and entrance go directly to the exit stairs that lead to the exit lane | 4 |

| 3 | Doors |
|---|-------|
| 1) Every door on the outlet must be of the type of side hinges or swing doors | At 1st and 2nd floors: exit doors are made from the type of side hinges |
| 2) The door must open towards the outside lane | At 1st and 2nd floors: the door opens inward | 1 |

| 4 | Enclosure and protected stairs |
|---|-----------------------------|
| 1) All stairs inside a building, which serves an exit or component, must be enclosed | The stairs are on the outside corridor connecting between 1st and 2nd floors. The stairs lead to the exit. | 4 |
| 2) Spaces used in protected exits are prohibited, including under stairs that have the potential to interfere with the road to the outside | Under the stairs, there are tables and the waiting chairs that are used by students. The things block the way out | 2 |
| 3) Stairs must be provided with special identification; the marking must indicate the level of the floor, the top, and the bottom end of the staircase. | There is no identification and marking of the stairway | 1 |
| 4) The marking must be in a protected room placed close to 1.5 m above the landing and must be easily visible | There is no marking of the stairway | 1 |
| 5) Markings must be painted or written on the wall | There is no marking of the stairway | 1 |

| 5 | Number of means of egress |
|---|---------------------------|
| The minimum number of facilities to escape from each balcony, mezzanine, the floor, is two | The exit is difficult to achieve | 3 |

| 6 | Arrangement of means of egress |
|---|-----------------------------|
| Minimum number of facilities to escape from each balcony, mezzanine, and floor is two | The exit is difficult to achieve | 3 |
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Identification result for Component of Passive Protection Systems shown in table 6 below:

Table 6. Assessment result for passive protection systems.

| No | Fire safety component | Criteria accordance to PerMen PU No:26/PRT/M/2008 | Existing condition | Likert scale |
|----|-----------------------|-------------------------------------------------|--------------------|--------------|
| 1  | Fire resistive or noncombustible construction | The construction that meets the fire resistance requirements based on the type of construction (firewall, fire barrier, fire resistant ceiling, fire retardant partition, roof cover) | Type II construction, in which structural elements are non-flammable. The partitions are made of glass and aluminum. Ceilings are made of PVC | 2 |
| 2  | Availability of fire windows and fire doors | Fireproof doors and windows to protect openings in walls, floors, and ceilings against the spread of fire and smoke inside, inside and outside buildings | Doors are made of wood; glass for partition doors and windows are made of glass | 2 |
|   | Interior finish materials | Fire barriers | Smoke barrier partitions | Smoke barriers |
|---|----------------------------|----------------|--------------------------|---------------|
| 3 | Interior coatings are fire-resistant | 1) Walls, doors/windows, floors, floor/ceiling mounting constructions, that are constructed as fire barriers, constructed using fire-resistant materials that meet the testing requirements. | Brick walls, wooden doors/windows from wooden and glass frames, PVC ceilings. It is an existing structure that already exists and is not constructed as a fire barrier. |  |
|   |   | 2) Equipment or fire stopper systems for cables, cable racks, conduits, piping, tubes, smoke vents and exhaust vents, maintenance and similar equipment to accommodate electrical, mechanical, plumbing and communication systems that pass walls, floors, or floor/ceiling construction partners that are constructed as a fire barrier. | There is a portion of fire-stopping equipment, but there is also a part that is exposed. |  |
| 4 |   | 3) Openings in fire barriers for air conditioning ducts or air movement must be protected. | There are no openings specifically for air conditioning ducts, there is the air ventilation |  |
| 5 | Smoke barrier partitions | 1) The partition must be installed stretching from the floor to the bottom of the roof or the roof deck above, passing through hidden spaces such as above the suspended ceiling, and passing through the intermediate spaces for structure and mechanics. | Some partitions on the 1st floor did not reach the bottom of the roof, partitions attached to the ceiling for 2nd floor. |  |
|   |   | 2) The door must not have air grilles | The door does not have a grille |  |
|   |   | 3) The door must close alone or close automatically | There are two doors which are broken and cannot close automatically, exit door on L1 can close automatically |  |
| 6 | Smoke barriers | 1) The doors in the smoke barrier must completely cover the door openings, leaving only a minimum gap for the smooth operation of the door and there should be no openings on the door leaf, air cavities or door grille or grille. | There is no special smoke barrier door, there is a wooden door covering the door opening, there is no gap in the door but it still has a large gap. |  |
|   |   | 2) The doors on the smoke barrier must be of a type that can close itself or close itself automatically | The door cannot close by itself |  |

Identification result for Component of Active Protection Systems shown in table 7 below.
Table 7. Assessment result for active protection systems.

| No | Fire safety component                  | Criteria accordance to PerMen PU No:26/PRT/M/2008                  | Existing condition                  | Likert scale |
|----|--------------------------------------|------------------------------------------------------------------|------------------------------------|-------------|
| 1  | Automatic sprinkler systems           | Automatic sprinklers must be installed and fully ready to operate in the type of dwelling within the technical requirements/standards referred to. | Not available                      | 1           |
| 2  | Fire pumps                           | Fire pump available                                              | Not available                      | 1           |
| 3  | Water supplies                       | The main pipelines of private fire services must be installed under SNI 03-3989-2000 standards | No main pipe available             | 1           |
| 4  | Fire extinguisher                    | The installation, maintenance, selection and distribution of APAR must comply with SNI 03-3987-1995 | 1 APAR available for the whole building | 3           |
| 5  | Detection, alarm, and communications systems | Refer to SNI 03-3985-2000 or the latest edition "Procedures for Planning and Installing Fire Detection and Alarm Systems for the Prevention of Fire Dangers in Buildings and Houses". | Not available                      | 1           |

The evaluation results of fire safety components based on observations in the field and conformity assessment of regulations using the Likert scale is presented in the table below. Table 8 shows the value of the Likert Scale for Water Access and supply, which is 2.75. This value indicates that the requirements for access and water supply for fire safety in the Faculty of Engineering building is not following the regulations. Sub-components identified for the access road, and the distance between buildings meets the requirements, but for water supply and fire wells, reservoir water and hydrant is not available.

Table 8. Assessment result of access and water supply.

| No | Components            | Likert Scale |
|----|-----------------------|--------------|
| 1  | Water sources         | 2            |
| 2  | Access road           | 3            |
| 3  | Distance between buildings | 5            |
| 4  | Private hydrant       | 1            |

| The Average result of access and water supply component | 2.75 |

The identification component of the means of egress is shown in table 9. The average value obtained is 2.24 on the Likert scale. From the ten subcomponents observed, three subcomponents meet compliance with regulations namely Means of Egress Reliability, Number of Means of Egress, and Arrangement of Means of Egress. Seven other subcomponents do not meet the regulation.

Table 9. Assessment result for the means of egress.

| No | Components                  | Likert scale |
|----|-----------------------------|--------------|
| 1  | Exit access corridor/exit   | 2            |
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2 Means of egress reliability 3.5
3 Doors 2
4 Enclosure and protected stairs 1.8
5 Number of means of egress 3
6 Arrangement of means of egress 3
7 Discharge from exit 2.6
8 Illumination means of egress 2.5
9 Emergency lighting 1
10 Marking of means of egress 1

The average result of means of egress 2.24

The result for the passive protection system in table 10 shows the value of the Likert scale of 2.48 which indicates that the requirements for the passive protection system do not meet the regulation. The subcomponent of interior-finishing material is following the regulation but the other subcomponents are not following the regulations.

| No. | Components                                      | Likert scale |
|-----|-------------------------------------------------|--------------|
| 1   | Fire resistive or noncombustible construction   | 2            |
| 2   | Availability of fire windows and fire doors     | 2            |
| 3   | Interior finish materials                       | 4            |
| 4   | Fire barriers                                   | 2.3          |
| 5   | Smoke barrier partitions                        | 2.6          |
| 6   | Smoke barriers                                  | 2            |
|     | The average result of passive protection systems | 2.48         |

Table 10. Assessment result for passive protection systems.

Table 11 below shows the average result of the Likert scale for active protection systems, which is 1.4. This value indicates that the requirements for this component in the Faculty of Engineering Building are not following the regulations. The sub-components that fulfill the regulation are fire extinguishers. For the other component, they do not meet the regulation.

| No. | Components                                      | Likert scale |
|-----|-------------------------------------------------|--------------|
| 1   | Automatic sprinkler systems                     | 1            |
| 2   | Fire pumps                                      | 1            |
| 3   | Water supplies                                  | 1            |
| 4   | Fire extinguisher                               | 3            |
| 5   | Detection, alarm, and communications systems    | 1            |
|     | The average result for active protection systems| 1.4          |

Table 11. Assessment result for active protection systems.

4. Conclusion

Based on the research results that have been obtained from observations and the analysis according to Likert scale, it is concluded that the access and water supply component obtains the value of 2.75 in Likert scale, the means of egress obtains 2.24 in Likert scale, the passive protection system obtains 2.48 in the average value of Likert scale, and active protection system obtains 1.4 averagely in Likert scale. As a result, all fire safety system components that have been assessed do not meet the requirement of
the regulation. The components of access and water supply, means of egress, passive and active protection systems show a low value that does not fulfill the applicable regulations. Observations indicate the availability and implementation of building safety system components are still minimal at the Building of Faculty of Engineering of Teuku Umar University. Improvement is needed for fire safety protection systems in the environment of Teuku Umar University Campus to prepare and overcome the danger of fire.

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