

Safe Scale: A Fire Risk Assessment Mobile

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Abstract--- *Fire Risk Assessment is a systematic procedure done to evaluate and determine potential hazards in the case of a fire and the consequences of it. Methods that are done to carry out this procedure can be qualitative, quantitative or a mixture of both. Fire Risk Assessment are done to ensure fire prevention systems in buildings. During Fire Risk Assessments, only a visual inspection is done and through testing is done only if necessary. These assessments are also a legal requirement in most countries which ensure safety of the building's occupants. Legislations give high priorities to Fire Risk Assessment as they help prevent the risk of fire and minimise the damage cause from a fire by enforcing law to complete Fire Risk Assessment regularly. Currently, the Fire Risk Assessments are done manually by filling up forms, guides and surveys, Guidelines are provided by the respective authorities in each country which is not standardised. Therefore, this research aims to propose a mobile application to conduct and assist the Fire Risk Assessment procedures.*

Keywords--- *Fire Risk Assessment, Risk Management, Fire Protection Systems.*

I. INTRODUCTION

The Fire Risk Assessment (FRA) systems in Malaysia are not as advanced or digitalized as other countries such as Singapore or the United Kingdom. As there are more technological advancements today, and the availability of the internet is wider than ever, the aim of implementing such a system in Malaysia would be feasible. Although regulations and standards related to fire safety have been reinforced to ensure the Fire Protection Systems (FPSs) are designed and installed properly, the constant maintenance of this system is a vital part in ensuring its safety. However, the FPS usually lies dormant and the hidden failures can only be detected through periodic inspection or in the case of a real fire incident which might be hazardous [1]. Almost one-third of fire safety systems are faulty when facing a fire due to lack of inspection, track records of tests and maintenance. The researcher also states that 49% of fire extinguishing systems installed are usually fault and cause huge property damage. There are rules and regulations to curb this issue, such as The Regulatory Reform (Fire Safety) Order in England and Wales, the Fire (Scotland) Act 2005, which is to carry out a FRA in any building or occupied space [2]. However, FRAs contain stacks of forms and reports that needs to be filled and read. This makes the Fire Risk Assessment complicated and runs the risk of being unlikely to be read carefully. As a result, certain important points in the assessment can be missed. This problem then causes the real risks not being addressed and increase the chances of a fire incident happening. Besides that, the manual FRA process also makes it harder to retrieve information when needed regarding recent inspections and repairs needed on faulty fire protection systems. Other concerns include, property owners who unaware about how to carry out FRA for their property. This will result in adhering to recommendation

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and suggestion made verbally and not documented. On the other hand, security concerns include the confidentiality of the images taken by building surveyor, and reports written during the assessment. This private information should be secured so it does not fall into the hands of unwanted parties. Therefore, the objectives of creating this application is to allow management of building to conduct fire risk assessment, record fire protection system inspections, fire hazards that are present in the building and allow to store images of the fire hazards. The application looks to move the paper-based fire risk assessing system to a more digitalised platform.

II. FIRE HAZARDS

Fire incidents can bring high cost of damage to a business or a building and worse a human life and fire safety is often neglected in buildings that were built in the past three decades as there was less awareness about the negative effects of having a poor fire safety mechanism [3]. Fire is one of the most dangerous threats that could harm the occupants of buildings, as well as all the assets in it such as fabrics or furniture. In some countries where high-rise buildings and skyscrapers are emerging fast like Hong Kong and China, fire safety is the major concern of the legislations especially after recent fire tragedies [4]. The main reason of the Garley Building Fire and Luoyang Dongdu Commercial Building Fire is the misuse of the buildings and inadequate maintenance [4]. Some of incidents that occurred in Malaysia is the People's Museum, Melaka in 2001, Rumah Pak Ali, Gombak in 2003 and the Sarawak Club in 2006. These buildings are heritage buildings that were not built considering fire safety measures [3]. Most of the buildings nowadays are multiple storey. However, if all 'sub-standard' or inadequate buildings are required to be improved at the same time it might be a huge cost burden. Therefore, effective ways are needed to curb this issue such as having a suitable auditing system to assess the safety level of multi storey buildings which can be done by the property or business owners themselves without the need to wait for a government official or other authority.

III. FIRE RISK ASSESSMENTS

Fire risk assessments (FRAs) is an assessment of the risks to people and property in the case of an unwanted fire incident [3]. Current safety legislations focus on individual premises and facilities to make the process simpler [5]. FRA is a systematic procedure done to evaluate and determine potential hazards in the case of a fire and the consequences of it. Methods that are done to carry out this procedure can be qualitative, quantitative or a mixture of both. The FRA is done on a physical building to ensure the quality of existing fire precaution systems and measures in place and determining if additional measures are needed. During the assessment, complete testing of the fire safety equipment is not done but rather only a visual inspection is done, the testing of the system is only done when necessary. FRA is also a legal requirement according to legislation of most countries around the world in which the main objective is to protect the safety of the occupants of a building. The procedure of a FRA is usually done by a competent person which can be the business owner or an appointed professional risk assessor. According to the United Kingdom policies stated in [6], a record of Fire Risk Assessment must be kept if the business has 5 or more people. Furthermore, the Civil Defence Force of Singapore has also stated that the owner or occupier of any public building such as offices, hospitals, shopping complex and condominiums should obtain a Fire Certificate (FC) which is given after the FRA in article [7]. Therefore, it is evident that legislations give high priorities to FRAs as they help

prevent the risk of fire and minimise the damage cause from a fire by enforcing law to complete the assessments regularly.

Currently, FRAs are mostly done manually or a traditional based systems by filling up forms, guides and surveys. A lot of guidelines are also given by the respective authorities as each country follows a type of methodology for FRAs.

For example, the United States of America uses a guideline called NFPA 551 which is prepared by the National Fire Protection Association and the United Kingdom follows PAS 79 or 7 methodology. PAS 7 methodologies presents the requirements for fire protection management systems which can be applied in businesses that operate on multiple sites or individual premises. PAS 7 is a very effective methodology because it effectively adopts the best practices of reconnected methodologies to counter the fire risk issues on new and existing buildings [5].

IV. FIRE RISK RANKING SYSTEMS

Fire Risk Ranking Systems (FRRS) are models of fire safety which originated from the insurance rating systems deployed in certain applications. Some FRRS such as the Fire Safety Evaluation System (FSES) are developed using arithmetical evaluations. These FRRS contains various process of analysing fire hazards and other risk potentials to produce a simple estimate of the fire safety level.

The calculations done can be given in the form values and the operated on a set of arithmetical function to give a safety index reading. The safety index can then be used as a scale to measure the safeness of a building. The identification of fire safety attributes should be performed by a systematic survey [4].

To enhance the efficacy of the FRA, a ranking system was proposed. The FRRS had several ways to address the gaps and enhance the assessment methods. Firstly, to rank based on fire codes decided by the local regulatory bodies. Secondly, based on fire and science engineering, where the ranking is done by referring to assessments from other building designs and method [8]. A scheme for the FRA was developed that had the following criteria.

a) Passive building construction:

- Building height
- Evacuation route
- Width of staircase
- Smoke doors
- Fire resistance construction

b) Fire services installation:

- Fire hydrant/hose
- Fire alarm
- Fire detection system
- Sprinkler system
- Fire extinguisher
- Smoke control

- Emergency lighting
- Exit sign

c) Software management for keeping fire risks low:

- Fire load density

The main objectives of having the FRA is to ensure all fire safety measures are available always, occupants will be able to use the fire safety measures and occupants will be assisted to escape to a safe place [8].

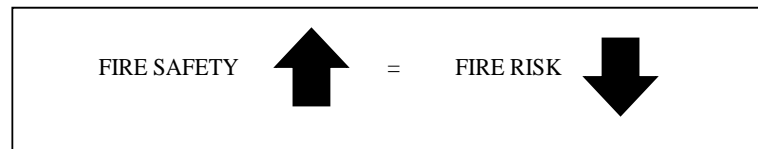


Figure 1: Relationship between Fire Safety and Risk

As shown in Figure 1, the higher the fire safety, the lower the fire risk in a building. As risk is a direct opposite of safety, the risk index will be measured by measuring safety and converting it to the opposite score.

Based on weightage, a checklist will be created that will be graded by the assessor from scale 1 to 10. The results of the checklist will be calculated by multiplying the weightage with the grades.

Finally, the final score for the criteria will be calculated by multiplying the total attributes score for the criteria and the criteria weightage [9]. The weightage points calculated will be in the decision making of the FRA report.

V. SAFE SCALE MOBILE APPLICATION

The Safe Scale Fire Risk Assessment mobile application will be developed using several concepts that will help enhance its functionalities. The first is using the Bring-Your-Own-Device (BYOD) concept. The BYOD concept poses many opportunities such as diminishing the boundaries between private and work life and reducing business expenditure.

As for mobile applications, mostly the devices used privately will be better than what the company provides with. Furthermore, as the FRAs will be done by the property owner themselves, using their own device for the process will be much easier.

The contractors who want to view the report of the fire safety system can also use their own devices which makes the process simpler. The threat of BYOD concept is that when own devices are brought into the working environment; it possesses more security issues related to malware or virus.

To mitigate this issue, a concept called encryption will be implemented in the source codes of the application. Encryption is the method of making a data or information unreadable by a human and is done by having an encryption key.

For this application, the Advanced Encryption Standard will be used as it one of the fastest and safest methods of encrypting data.

As smartphones are becoming increasingly available, the demand for mobile application is also on the rise. However, the senior citizens face some difficulties in navigation through mobile applications as they are not familiar with the trending smartphone technology.

However, they will be able to navigate better via this mobile application when there are less keyboard use, more icons and buttons. This is an important design criteria that is given importance during the design phase.

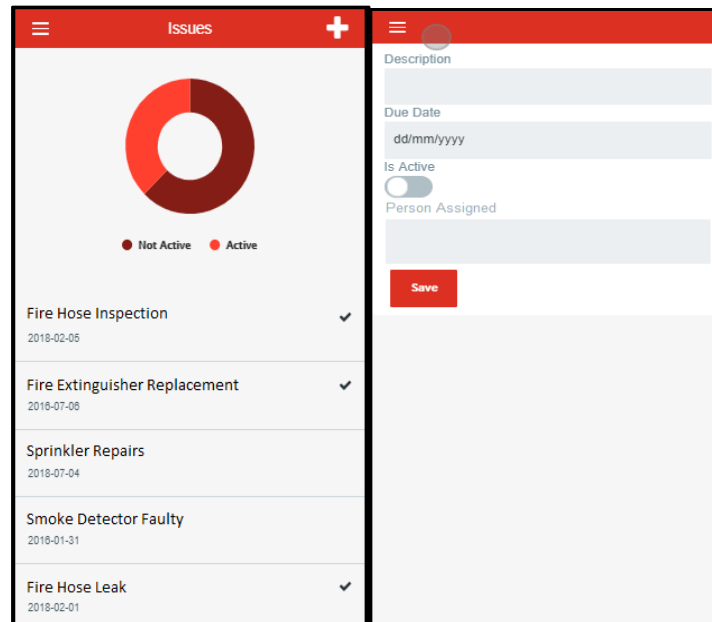


Figure 2: Proposed Safe Scale FRA Application Design

Figure 2 shows the proposed interface for the application. The main page is shown where the issue summary and the interface to input issues detected in the fire protection system is shown.

VI. RESEARCH METHODOLOGY

To design the Safe Scale Fire Risk Assessment Mobile Application, Rapid Application Development (RAD) is adapted. It is proven that the RAD methodology would fit the requirements for developing this project according to the time and resources constraints and nature of this project. RAD methodology is less structured and strict compared to its predecessors like the Waterfall model which makes it more flexible and smooth approach for development. Rapid Application Development will be used which means the application will be developed rapidly and to assist this the project will be broken into smaller sections which is called modular coding. Modular coding can be done by completing each deliverable one at a time which will be coded and compiled separately. Some portions of the projects need to be combined prior to testing due to the dependencies, therefore the required parts will be combined as needed. RAD is also a suitable methodology for this project as mobile application heavily rely on user feedback and response. As RAD constantly seeks for user feedback, an application that comfortably suits the needs of the user can be created according to the requirement adjustments obtained from time to time. The developer is also given the flexibility to incorporate new ideas, innovations or suggestions into the application development without much difficulty. Therefore, it is evident that RAD methodology as shown in Figure 3 would be the best methodology for developing the Safe Scale mobile application.

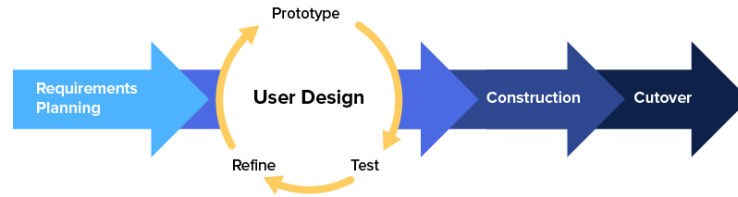


Figure 3: RAD Methodology (CodeIT, 2019)

The RAD methodology uses an iterative framework which allows development of a high-quality product within a limited budget and time. RAD has its own set of phases to follow through which are requirement planning, user design, system development and cutover. Every stage has its own objectives that needs to be met to ensure the progress of the project.

- **Requirements Planning Stage**

This is also called the Concept Definition Stage and the business functions, requirements, data subject areas and the scope of the system is determined. According to the chosen methodology, the researcher first gathers evidence for issues regarding FRAs and safety and observation of the previous systems including processes involved in FRAs. The researcher will take note of these points to prepare a list of functionalities that will be needed for the application. After concluding the requirements with the stakeholders, the researcher will plan a schedule for the project using a Gantt Chart. Figure 4 depicts a questionnaire prepared and distributed to 30 suitable respondents.

No.	Questions
Q1	What is your age group?
Q2	What type of property do you own?
Q3	What is the number of employees in your company?
Q4	How do you conduct fire risk assessment at your property?
Q5	How regular are inspections done on fire protection systems?
Q6	The time taken to complete a fire risk assessment is too long.
Q7	Too many forms are involved in fire risk assessments.
Q8	The reports produced from fire risk assessments are hard to read/retrieve.
Q9	Will the Safe Scale application reduce paper consumption?
Q10	Will the Safe Scale application simplify the process of conducting fire risk assessments?
Q11	Will the Safe Scale application reduce the cost of maintaining your property' fire systems?
Q12	Will the Safe Scale application reduce the manpower needed to conduct fire risk assessments?
Q13	What are the functionalities that can be added to the Safe Scale application?

Figure 4: Research Questionnaire

- **User Design Stage**

In the next phase, which is user design, also known as the Functional Design Stage is an iterative process of developing the prototype and critical system components, presenting to the stakeholders, taking note of their feedback and implementing the required changes. During this phase, the researcher or developer will have several meetings with the client/supervisor for the feedback regarding the application prototype.

- **Construction Stage**

During the construction phase, the development team will be heavily involved in coding and building the application to create a real working application. The construction will be done considering all previous feedbacks on the prototype and additional requirements can be addressed in this stage.

- ***Cutover Stage***

The last phase in RAD is the cutover where the complete product or system is delivered to the client. However, as this is an assignment-based project, the cutover phase will be used to document the progress of the project and possible ways of deployment. Future updates for the application will also be discussed during this phase. Finally, the presentation of this project will also be done in this phase.

VII. RESULTS AND DISCUSSION

The results from the questionnaire was then analysed to determine the feasibility of developing the application. The age group of 30 to 50 years old make up 50% of the total number and should be heavily considered in the process of developing the application. But this application will be created to cater all ages of users, even above 50 therefore, the application will be designed in the simplest way but prioritising the majority. Secondly, Warehouse and high-rise building account for 20% each, the multi-storey lot accounts for 23.3% and shop lots accounts for 36.7% which is the highest. Therefore, the application will be made to suit the needs for all four types of building and premises. According to the UK Law, FRAs are not required for business that run with 4 or less employees and this question will let the developer know the need for developing such an application for conducting Fire Risk Assessments (FRAs). Only 10% of the business has less than 4 employees which means this application would be helpful for at least 90% of the potential users. The survey also shows a large portion of the users, around 53.3% are still using paper-based systems to conduct FRAs which involved lots of forms and reports. Knowing this, the objective of developing the Safe Scale application become stronger and more relevant. Furthermore, there are also 16.7% of users who store their document locally which means it is not as secured as putting the information into an encrypted database, therefore the application will also help them to secure their digital copies of FRAs. Although some laws suggest that the FRAs are only needed to be once a year, it is always better to do a regular check to ensure the reliability of the fire protection systems, therefore this question was asked to the targeted users. It is observed that there is a variety of frequencies in conducting FRAs which shows the business owners are much aware of fire safety in their building. One of the main objectives of creating a mobile application is to save the consumption of paper thus reducing cost and increasing profits. So, question 9 was asked to know the opinion of the participants regarding paper consumption. The was very favourable with 96.7% of participants who agree that paper consumption will reduce by the implementation of this application. The opinion by respondents has showed that 76.7% agree that the application would simplify the process of conducting FRAs, 70% agree to having their costs of maintaining their fire protection systems lowered and 73.3% agree that the manpower needed to conduct the FRAs will reduce. The final question was asked to investigate the preferences of the users and additional functionalities that they would like to have in the application it was implemented. The highest requested functionality was to have a tutorial section for FRA procedures, this functionality was high probably due the confusion of the users on how this application would exactly work in the real world. The second most requested functionality was to have a fire protection system records or management system built into the application, this feature would make it easier for the owners to monitor their condition of fire protection system easily and maintain them efficiently. The third most requested feature was to have a function where the reports could be sent to the fire protection system contractors

directly. This would help the contractors assess the condition of the system without the need to wait for the owner's arrival on site. The other two features that were included are chat services with a certified fire risk assessor and tips and tricks to avoid fire hazards.

VIII. CONCLUSION

To conclude, the Safe Scale FRA application is necessary and a feasible application where the features are relevant to customers by reducing redundancy, which is drawback from the existing systems [8]. Past reviews [4] and [5] supports that this contribution is significant and has provided a detailed insight on the possible implementation techniques such as database security or Bring-Your-Own-Device (BYOD) concept that enhances the existing system [1]. Besides that, the appropriate methodology which is RAD was also determined and this ensures the feasibility of this project. Finally, the questionnaire was found to be the best method because of the ability to obtain a large amount of data in a short period of time. However, due to time constraints, some additional features of Safe Scale FRA mobile application such as uploading floor plans and chat services with fire risk assessors and contractors could be included in the future research to enhance the efficacy of the proposed application.

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