

# Developing risk profiling for firefighters: Enhancing safety and performance



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## ABSTRACT

Firefighters encounter numerous complex and ever-changing hazards when carrying out emergency response activities, necessitating the development of effective risk profiling methods to enhance both their safety and operational efficiency. This study outlines a comprehensive approach to constructing risk profiles tailored specifically for firefighters, integrating various methodologies to create a robust and adaptable framework. The methods used incorporating historical incident data, environmental variables, and individual firefighter characteristics to identify and assess potential risks. Additionally, the risk profiling framework include Psychosocial risk factors are also considered, allowing for a holistic understanding of the human element in firefighting risk assessment. By developing risk profiles to the specific needs and characteristics of firefighters, this method aims to significantly improve their safety, ability to make decisions, and overall operational efficiency in the demanding and ever-changing setting of emergency response situations. This article discussed methods

- To identify safety cultures using questionnaires
- To analyse risk from incident reports using content analysis
- To verify and validate risk using thematic analysis from Focus Group Discussion

## Specifications table

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## Method details

### Introduction

Emergency response involves personnel from various agencies which expose them to a range of occupational hazards. These hazards include physical and psychological hazards such as exposure to chemicals, biological agents, traumatic incidents, acts of aggression, vehicle collisions and handling of heavy loads that are unique to their roles [1]. Responding to emergencies in unfamiliar locations and situations further increases the risk of accidents and injuries [2]. According to Lori [3], the highest reported occupational accidents were from the fire and rescue sector. In Malaysia, the Fire and Rescue Department Malaysia (FRDM) is one of the core agencies dealing with threats from fire, water rescue, road traffic accidents, forest fires, emergency medical rescue services, hazardous chemical spills, as well as search and rescue. The extensive range of responsibilities in this position exposes their personnel to diverse occupational dangers, resulting in a significant level of potential risk [4]. Considering the nature of hazards FRDM personnel are exposed to, as well as the statistics on accidents involving FRDM available, the management of risks for this agency is profoundly necessary. Thus, the main objective of this study is to identify the spectrum of risks, critical issues, and challenges, as well as occupational safety and health culture practiced by FRDM and its personnel in developing risk profiling. The methods used is achieved through the adoption of a multi-strategy research approach both quantitative and qualitative were employed in this study which includes conducting document analysis of FRDM accident, safety culture survey, focus group discussion and nominal group technique.

### Theories related to the studies

The study of firefighters risk profile is falls under the domain of Occupational Safety and Health. Due to the multitude of risks encountered by firefighters, they must remain vigilant and the measures they take to mitigate these risks have significant ramifications for their lives. Firefighters are consistently instructed to prioritize personal safety when doing operations, and the management has implemented a safety culture across all levels of workers. Nevertheless, there are still occurrences that result in the demise, harm, and incapacitation of firefighters while carrying out their duties. This occurs due to the firefighters' safety climate being at a low level, as their risk perceptions and risk assessments are mostly influenced by their own experiences and opinions. The following is the theory related to this study.

#### Theory of planned behaviour

This theory is frequently applied in situations involving risk-taking, such as in this study where the actions of firefighters are influenced by their beliefs. These ideas were formed based on their knowledge and experience and are reflected in the behavior of the firefighters. Their behavior will be reflected in the actions they choose, taking into account the potential repercussions based on the range of risks and the risks they may encounter. Here, they will determine whether to participate or abstain from the precarious situation.

#### Theory of causation accident

This theory offers preventive strategies designed to mitigate unsafe actions. Although accidents are unavoidable, they can be prevented by using appropriate control mechanisms. The organization has the responsibility to foster a safety culture among firefighters by promoting safety awareness, supplying personal protective equipment (PPE), enforcing safety regulations, and conducting training sessions.

Several theories can be utilized in the study of firefighters' risk profiling, nevertheless, the most important factor is in comprehending and implementing the theory in the firefighters' day-to-day tasks. This approach can effectively mitigate risk and assist in decision-making, particularly in situations where firefighters encounter dynamic risk.

### Study protocol

This study protocol described how a study of developing risk profiling for firefighters being conducted. It contains information on research objectives, methodology and ethics in conducting a research. The study protocol for this research as stated below.

#### Introduction

This study methodology provides a structure for developing a risk assessment with the aim of improving understanding of and mitigating the hazards encountered by firefighters. It described the process of developing risk profile for firefighters and used as a map to guide the entire process. Fig. 1 illustrates the method stages.

#### Objectives

This study protocol as a guiding reference for the development of a risk profile for firefighters by comprehending existing, future, and predicted risks. This protocol is facilitating:

1. Assessing the range of occupational safety and health (OSH) hazards encountered by FRDM staff.
2. Investigate the occupational safety and health culture among FRDM staff.
3. Identify critical issues and challenges in FRDM profession

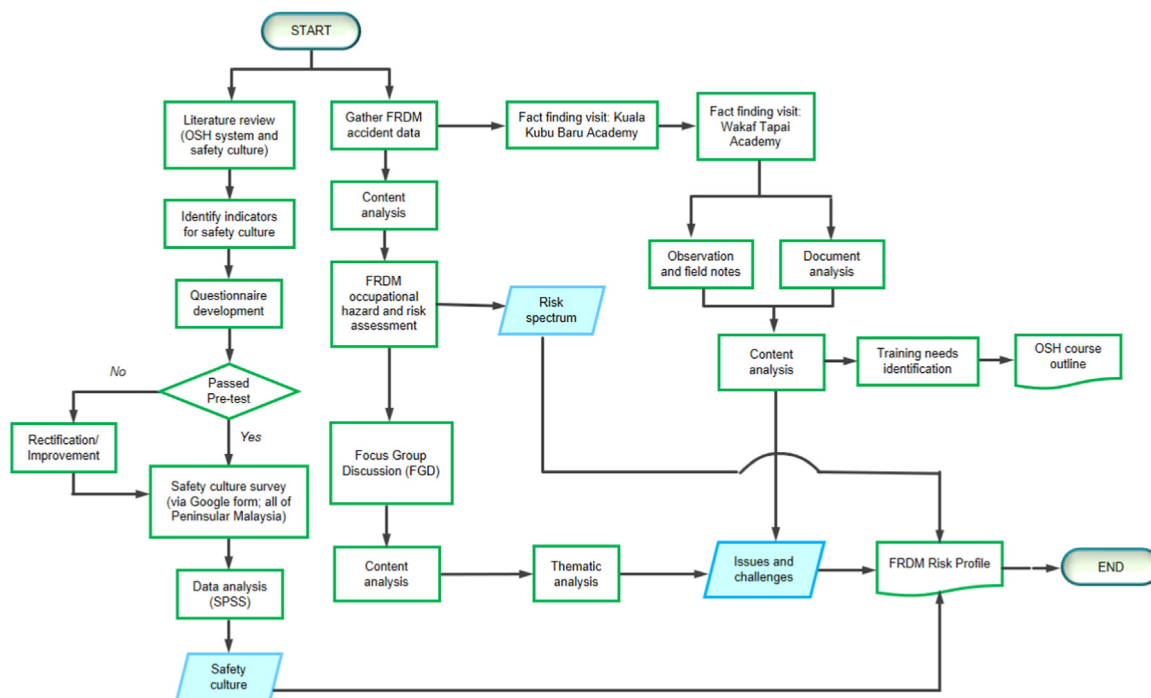


Fig. 1. Methods used in developing FRDM risk profile.

Table 1  
Methodology used.

Research Objectives	Methods Used	Output
Assessing the range of occupational safety and health (OSH) hazards encountered by FRDM staff.	Focus Group Discussion Observation Document Analysis	Risk Spectrum • occupational and hazard risk spectrum
Investigate the occupational safety and health culture among FRDM staff	Questionnaire	Safety Culture • perception on safety climate • safety culture in the workplace • safety behaviour and maintenance of equipment.
Identifying critical issues and challenges in FRDM profession	Focus Group Discussion Observation Document Analysis	Issues and challenges • equipment and PPE status • response time • physical fitness

Methodology

This study utilised multi research methodology in order to get the accurate findings aligned with the research objectives. The methodology used is indicated in Table 1

Ethics approval

Prior to conducting this study, ethical approval from the university’s ethical committee to conduct the survey and the focus group discussion were obtained. Participant rights, privacy, and general well-being are all protected, and ethical considerations ensure responsible and confidential use of data. Researchers uphold tight confidentiality when participants disclose private information. Only authorised individuals have access to data, which should be securely kept. Upon receiving the certificate of permission, a consent form was developed and issued alongside the survey form prior to the data collection. A letter granting approval was dispatched to the FRDM.

The survey and the focus group discussion were conducted in their respective fire stations, using Malay language, which is the participants’ native language. Prior to answering the questionnaire and participating in the FGD, participants were required to provide their approval to the content of the consent form.

The researchers are required to assure that they will participate voluntarily and make informed decisions. The consent form ensures anonymity and confidentiality of the information disclosed.

## Analysis

### Safety cultures

The Occupational Safety and Health (OSH) system is widely used as a framework for implementing a methodical approach to enhance and sustain performance, safety, and health in the workplace [5]. Approaches that might be formulated in accordance with this standard focus on safeguarding personnel against potential dangers, hazardous situations, illnesses, and any other conditions that may result in injury or fatality. The organization's Occupational Safety and Health (OSH) policy serves as the fundamental framework for establishing structures and practices that promote the active engagement of personnel in OSH activities.

In relation to the policies and structures established, the roles and responsibilities, accountabilities, training, competencies, documentation and communication are all part of the organization. Every type of work and activities conducted within the organization must consistently adhere to regulations and be evaluated. Evaluation is conducted using investigative procedures, auditing techniques, and review protocols [5]. The evaluation action for improvement entails implementing corrective and preventive measures to ensure continual enhancement of the organization's OSH practices.

In order to ensure that the OSH system is followed by every personnel, a safety culture needs to be applied. Therefore, organization's members' need to be committed to adapting safety behaviors in their work [6]. To determine how to evaluate an individual's adaptation to safety culture, a psychometric technique can be employed. This technique specifically examines an organization's safety climate and utilizes quantitative methods, such as a safety climate questionnaire. This questionnaire provides a comprehensive assessment of the current safety climate within the organization [6,7]. Through a comprehensive analysis of existing literature, this study has effectively generated indicators that are appropriate for assessing safety culture. The literature review identified various indicators that measure different aspects related to fire fighters' safety. These include Risk Perceptions [8,9], safety climate at the organizational and group level [7,10,11], safety culture in the workplace specific to fire fighters [11], safety behavior [9,12], and equipment maintenance [13]. Toolkit developed by the United Kingdom Health and Safety Executive (HSE) was adapted and used as a research survey instrument in assessing safety culture. Once the measurements were finalised based on the objectives of the study, the questionnaire was then translated into Bahasa Malaysia and validated by the Language Centre which ensured the precise translations of the measurements. The questionnaire was then tested in a pre-test to verify the questions in the survey and ensure that the target respondents are able to answer and comprehend the questions [14]. The data was then analysed using Statistical Package for Social Sciences (SPSS) Version 22 to tests for collinearity, outliers, normality and missing data were done to ensure that the accuracy of the data obtained prior to analysis. Subsequently, SPSS was also used to determine the reliability of the data through the Cronbach Alpha test which measures the internal consistency of the items used in the questionnaire. Items that fall within the acceptable range of 0.75 to 0.96 were retained as it indicates a reliable measurement [15].

### Risk spectrum

Risk spectrum analysis is utilized to identify potential risks and provide input for risk evaluation and control [16]. It is also crucial for quantitatively understanding the intensity of hazards and incidents, as well as the potential contributing factors for personnel. Reports on incidents was analysed using content analysis. The analysis on the incident report was conducted deductive and inductively in text basis by analysing types of words and how does it being used in different contexts.

Four types of risk are then analysed as follows:

- a. Risk of incidents during operations.
- b. Risk of health impacts for accidents.
- c. Risk of incidents during operations based on hazard type.
- d. Risk of incidents during commute from/to work based on time ranges.

The reports contain information that leads to the identification of occurrence trends, which are then categorized.

- a. Type of accident
- b. Type of hazard
- c. Impact of incident
- d. Locations of incidents
- e. Time interval
- f. Magnitude of consequent influence

The incident was analyzed to find the key factors that contribute to the risk spectrum in this study. This analysis helps to justify the actual occupational hazards experienced by the firefighters. This data was subsequently utilized to identify operational issues and challenges that contributed to the firefighters involvement in incidents. This suggests the need for specific questions during interviews or focus group discussions, as well as the observation of certain situations as part of the study. Goldstein & Reiboldt (2015) [3] conducted similar research, with the latter employing document analysis to generate new interview questions.

### Issues and challenges

Based on the data collected from the FRDM accident report, the team has conducted two activities; a focus group discussion (FGD) with FRDM personnel and observation during the visit to the FRDM training center. Analyzed utilizing the content analysis method, the FRDM accident data from 2016 to 2022 was examined. A risk analysis report has been generated for occurrences involving FRDM

personnel as stated below:

- a. Categorization of incidents based on their nature (operations, training, maintenance, commuting, and other).
- b. Distribution according to the sorts of hazards, which include physical, biological, chemical, ergonomic, and psychosocial hazards.
- c. Distribution based on the impact of incidents (injuries, illnesses).
- d. Classification of injuries and illnesses (such as fractures, dislocations, sprains, concussions, superficial wounds, burns, amputations, and others).
- e. The risk rating for accidents occurring during operations is determined based on the severity of their impact, which can be classified as fatal, serious, minor, or inconsequential.

Subsequently, researchers employ the risk analysis data to carry out a Focus Group Discussion (FGD) in order to verify and validate the risk. The FGDs took place in four primary areas in Peninsular Malaysia: Penang in the North Zone, Selangor in the Central Zone, Johor in the South Zone, and Terengganu in the South Zone. There were a total of 8 sessions involving a total of 56 FRDM personnel. The researchers then conducted fact-finding visits to the Kuala Kubu Academy and Wakaf Tapai Academy, which serve as the training centers for the FRDM program. This academy serves as the training facility for FRDM personnel, including both officers and personnel. This is a technique used to verify the risk analysis [17] obtained from FRDM accident reports. An observation was conducted at this training academy. An assessment was conducted on the trainees' proficiency in equipment handling, physical training, safety and health protocols, and fire simulation exercises and the training syllabus [18,19]. The act of observing and recording information was conducted in the form of field notes [20]. Both field notes and document analysis were utilized to examine the content and determine the effectiveness of the training in preventing hazards and occupational risks for FRDM personnel.

Based on both FGD and observation, the team has transcribed the conversation/interview from FGD sessions and field notes from the observation and coded the information. The information has to go through coding, categorizing and theming process. Using Atlas Ti version 22, researchers created codes and described it and explained its relationship in the memo function. The overwhelming amount of codes are frequently collected and systematically analysed which bring into emerging themes. The FGD and observation from data risk analysis session has effectively identified and emphasised three key themes: safety, health, and management. These themes occur more frequently than others. These themes pose as concerns and challenges for FRDM staff during their operations.

#### *Risk profile*

After having all data collected, the results from the analysis of safety culture, risk spectrum, and identified difficulties and challenges were obtained [21–23]. The researchers aim to gather a panel of experts in the field to discuss the findings and achieve a consensus. The Delphi method is a research technique that allows researchers to collect consensus from the subject matter experts. It provides a venue for participants to voice their opinion [24]. A panel of three subject matter experts, with backgrounds in Occupational Safety and Health, academia, and former high-level personnel from FRDM, were invited to discuss the results and findings. The panelists are selected for their competence based on their extensive understanding of the subject area of interest [25]. A consensus was obtained from a panel of experts regarding the structural and strategic factors. Subsequently, a risk profile was developed which offers a thorough summary of the risks that FRDM personnel are exposed to. It encompasses information regarding the FRDM personnel's capacity to tolerate risk, the necessary level of risk, and the FRDM's ability to manage risk.

#### **Conclusion**

The methods used for developing risk profiling for FRDM personnel represents a crucial step toward enhancing the safety, performance, and overall effectiveness of firefighters during emergency response operations.

By leveraging historical incident data and real-time environmental variables, the framework facilitates the identification and prediction of potential hazards, enabling firefighters to make informed decisions based on dynamically evolving risk maps. By including the specific physiological and psychological traits of each FRDM personnel, the risk profiles gain a human-centered perspective that recognizes the influence on overall performance. The findings of this study will also lead to a more effective management of safety and health risks for the agency.

In conclusion, it can be seen that the FRDM personnel directly involved in operations exposed to highly hazard and risk working environment. The developed risk profiling aligns with evolving landscapes of firefighting, recognizing the importance of adaptability and precision in risk assessment. By addressing the unique challenges posed by the dynamic nature of emergency incidents, these risk profiles aim to significantly mitigate risks, improve overall situational awareness, and empower firefighters to execute their duties with heightened the level of safety and efficiency. This risk profile can also be applied to other emergency response organization.

#### **Ethics statements**

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the National Defence University of Malaysia (NDUM) Research Ethics Committee (protocol code NDUM 06/2019) and approved on 19 November 2019.

#### **Declaration of competing interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## CRedit authorship contribution statement

**Haliza Mohd Zahari:** Conceptualization, Methodology, Writing – original draft. **Mohd Muhaimin Ridwan Wong:** Visualization, Investigation. **Noor Diyana Fazan Ahmad:** Validation, Data curation. **Fuad Abas:** Writing – review & editing.

## Data availability

Data will be made available on request.

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