



## Factors Influencing Failure Emergency Evacuation in Work Environments during Fire

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### Dear Editor,

One of the necessary measures of saving human life in emergency situations, such as fires, is the safe and swift evacuation of people. The prerequisites for this are to anticipate, identify, and eliminate factors preventing people from leaving buildings in a timely and safe manner while moving them to a safe place [1]. The occurrence of errors caused by engineering, design, human, and psychological factors can aggravate unfavorable and unsafe situations in cases of emergency. Besides, upon the occurrence of accidents, they pave the way for irreparably severe human and financial damage. Therefore, the study of the failures or errors affecting performance and the management of emergency evacuations can be effective in identifying factors affecting human emergency evacuations and improving them in fire incidents.

Against this background, this article aims to draw the attention of researchers to effective errors in

emergency evacuations, which increase the potentials for adverse consequences of fire incidents. Identification of these factors can lead to the improvement and development of future studies, design and construction of buildings, and promotion of human health and safety. In the following sections, these errors are introduced and classified into three categories of design, human, and psychological errors.

Design errors are the errors rooted in environmental factors and infrastructure design. A study conducted at a public hospital in Indonesia showed that the lack of emergency lighting in corridors, stairs, ramps, as well as the low number of fire detectors in inpatient rooms disturbed the evacuation process and elongated the evacuation time [2]. Another study conducted on subway stations showed that structural design features, emergency evacuation facilities, as well as time and characteristics of emergencies, such as fires, were the most important environmental factors

affecting safe evacuation. Therefore, forecasting and paying attention to the number of users, width and length of routes, the number of exits, width of corridors, and bottlenecks are very effective in performing optimal evacuation [3].

In addition to the factors mentioned above, it is pretty important to design equipment and resources needed for emergency evacuation. To avoid physical collisions and falls among people, it is recommended to enlarge the size of emergency exit signs. Emergency exit signs play an important role in ensuring safety of buildings against fires. Besides, they help evacuees escape fire faster by following quickest and safest escape routes after a fire is detected. A study conducted on 138 subjects showed that environmental factors affected the speed of people evacuation. In addition, the speed of people evacuation increased with increasing brightness. However, the average evacuation speed improved more with increasing the exit sign size than when brightness increased, which decreased physical contact among people [4].

There are other challenges to the safe emergency evacuation process in high-rise buildings. Accordingly, human fatigue when moving to lower floors and some residents' inability to move are two of these challenges. In the 11 September accident, several people were rescued from the World Trade Center, who reported they had to stop and rest on several floors when descending stairs. Therefore, to improve the evacuation process in high-rise buildings, it is necessary to use evacuation elevators in addition to evacuation stairs, to be simulated in related studies. Traditionally, evacuation elevators have not been used as evacuation routes, and people have been instructed not to use elevators in case of fires. However, if people exit from high-rise buildings through stairs, it will lead to their fatigue and slowness of exit. On the other hand, with the increase in the breathing activity, the amount of smoke inhaled into the lungs increases, thereby causing people to get trapped between floors. Accordingly, the use of evacuation elevators with appropriate ventilation can be investigated in high-rise buildings. In addition, virtual reality simulation (the equipment used for human immersion in virtual reality to study human behavior) shows that the waiting time of less than 5 minutes is acceptable and safe for people evacuation. Moreover, this type of simulation that uses a simple navigation system with green flashing lights guides people in finding and choosing the elevator as an evacuation emergency route. However, the waiting time for the elevator to arrive and getting stuck in the elevator are the two main perceived risks posed to people [6].

Human errors are another category of errors affecting safe evacuation of humans in emergencies during a fire [5]. These errors are diverse, with the identification of which increasing reliability of the equipment effective in the emergency evacuation process. Some of these errors include not reacting to warnings quickly and correctly as well as displaying unsafe behaviors, such as staying in the danger zone and taking photos and videos at the time of the accident. It is worth noting that excessive fear as well as feeling despair about being rescued cause cognitive errors in people, being a type of human error effective in finding and choosing the correct evacuation route [5]. Recent studies show that a well-designed and relatively simple navigation system, such as placing a green flashing light next to an emergency exit sign, is significantly effective in correctly choosing exit routes in humans [6]. In this article, psychological errors are the third category of the factors affecting the safe evacuation of people. Psychological characteristics affect how information is processed, including recognizing, understanding, and evaluating warning messages. Psychological errors, under conditions of uncertainty, have a significant impact on people's decision-making, behavior, and reaction. Therefore, evaluating individual and social human behaviors at the times of crisis and emergency can be effective in the safe operation of emergency evacuation. A phenomenon named "population pursuit" is one of the most common psychological errors in some emergencies. This type of error usually occurs to people unfamiliar with the location. In such situations, people unfamiliar with the environment tend to follow the collective behavior of chasing the fleeing population; accordingly, they follow the fleeing population without recognizing and evaluating warning messages, which is always a successful evacuation method. In some research, it has been reported as an unsafe method [5]. Another common psychological error occurs to people unfamiliar with the scene. Due to the fact that emergencies affect people's decisions, behavior, and reactions, in emergencies such as fires, people unfamiliar with the location of the building cannot make complex decisions. Thus, they try to take the same exit, being the same psychological error that in some cases victimizes prisoners. Accordingly, it is necessary to raise people's awareness to reduce such errors and control adverse consequences [7].

This article enumerates common mistakes in the safe evacuation of people in fires. In addition, it mentions the successful and safe design and implementation of the emergency evacuation

process as part of the emergency response plan. It is recommended to conduct further studies on errors occurring in the emergency evacuation process.

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