



# Investigation of Human Behavior in Emergent Evacuation from an Underground Retail Store

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## Abstract

Pedestrian evacuation from underground building in emergency situations could be influenced by the structure of buildings, characteristics of pedestrian movement and seriousness of emergency events. To understand the evacuation process of pedestrian in emergency, evacuation drills on an underground retail store and a questionnaire survey are conducted. The characteristics of human evacuation behaviour are discussed and the evacuation time and specific flow in each evacuation scenario are analyzed. The phenomenon of unbalance exit-selection is revealed, and more guidance devices are needed in the underground retail store. The results also indicate that obstacles nearby the emergency exits should be removed and the clustering places for evacuees should be far away from the emergency exits. It is concluded that the results could provide assessment of the accuracy of existing egress models, and ensure that building owners and managers have a sound basis for evacuation planning.

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## 1. Introduction

Human behaviors in fire have attracted researchers from all over the world to carry out research, especially ever since the “911” disaster. For the reason that more complexity of human behaviors in fires, the means of data collection, such as questionnaire survey, interviews with survivors of fire, evacuation drills and unannounced evacuations involving members of the public [1], have been used to explore human behaviors.

The evacuation process might be influenced by many factors, especially the human behaviors, such as recognition, response and motion characteristics of evacuees [2, 3]. Referring to the evacuation from retail stores, the complex building structures and evacuation routes should be taken into consideration. Shields et al. [4, 5] and Samochine et al. [6] had conducted unannounced evacuation drills in retail stores to obtain the original data of evacuation process and capture the characteristics of human behavior. In their studies, the participants had no prior knowledge of the evacuations, and the evacuation processes were recorded by digital cameras. Moreover, an announced evacuation drill from retail store [7] was also conducted in China. These researches mainly focus on the pre-movement time, exit choice during the evacuation process, as well as the influences of staff behaviors on evacuation process and so on. However, there are usually many fire

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compartments in the retail stores, and they will be closed in emergency situations except the fire doors between the fire compartments. The influences of taking fire doors of adjacent fire compartments as emergency exits on evacuation process have not been clearly identified, and more researches with respect to this issue are needed.

To explore the effect of useable fire doors of adjacent fire compartments and individual characteristics on the efficiency of retail store evacuation, in this paper, the evacuation drills in different scenarios from an underground retail store and a questionnaire survey are conducted to investigate the evacuation process. The evacuation processes are recorded by digital cameras placed beside the exits and the surveillance cameras in the retail store. In this way, the evacuation time, the ratio of exit selecting, as well as the influences of useable of fire doors of adjacent fire compartments and pedestrian distributions on evacuation efficiency can be obtained and discussed.

The rest of this paper is organized as follows. In section 2, evacuation drills in an underground retail store and a questionnaire survey are presented. The results and discussion are given in section 3 follows by a brief summary of the findings in the last section.

## 2. Evacuation drill

### 2.1. Design and implementation of the evacuation drill

The evacuation drill was conducted in a retail store, which had two floors above the ground floor and one floor under the ground floor. The retail store occupied 6000m<sup>2</sup> with 1100 staffs. The underground floor of the retail store was divided into four fire compartments, and the building area of fire compartments are shown in Fig 1. There were totally 14 emergency exits, in which 5 exits lead to fire-protection passageway (2, 3, 4, 5, 13), 3 exits lead to staircases (1, 6, 14), and 5 exits lead to the adjacent fire compartment (7, 8, 9, 10, 11).

For the efficiency and simplicity of the evacuation drill, we chose the fire compartment four as the original location, on which the participants were distributed. The participants were staffs who do not work in underground floor and the evacuation drill were conducted from 7 to 8 a.m. The participants in fire compartment four could reach fire-protection passageway by exits 3, 4, reach fire compartment two by exit 7, and reach fire compartment three by exit 8. Four different scenarios were set in the evacuation drill, and the detailed information could be found in Table 1. The homogeneous distribution can be defined that the participants were distributed uniformly in fire compartment four, and the inhomogeneous distribution means that the participants were distributed in the one side of fire compartment four, which is far away from the fire-protection passageway. Besides, eight digital cameras were placed on exits 1, 2, 3, 4, 5, 6, 7, 8 to record the evacuation processes.

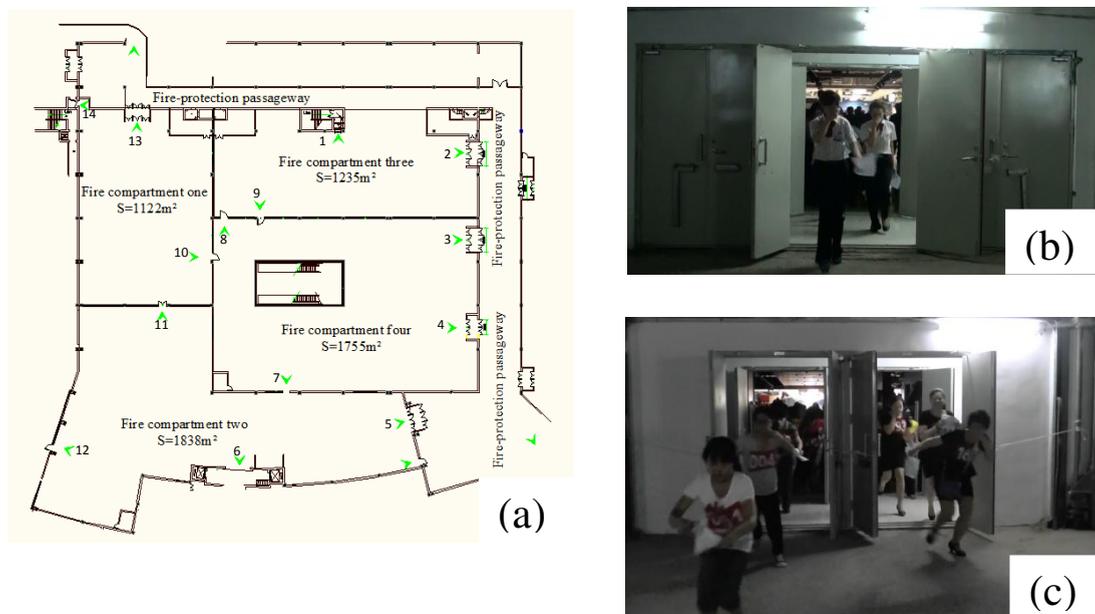


Fig. 1. Schematic of the underground floor of the retail store(a); Snapshots of the evacuation processes from cameras on (b)exit 3 and (c)exit 4.

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