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Self-reported likely behaviour of rail passengers during an emergency evacuation-A case study of Kuala Lumpur, Malaysia

Muhammad Abrar Iman Mohamed [a], Noorhazlinda Abd Rahman [a,*], Charitha Dias [b]

[a] School of Civil Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang, Malaysia
[b] Qatar Transportation and Traffic Safety Center, College of Engineering, Qatar University, P.O. Box 2713, Doha, Qatar

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ABSTRACT

Prior knowledge on how passengers behave during a potential emergency evacuation could be advantageous in designing efficient crowd management and emergency procedures. This study examines the likely behaviours of Malaysian passengers during a potential future emergency evacuation situation. Four key behaviours, i.e., reactive, proactive, cooperative and competitive behaviours, were considered. A questionnaire survey was conducted at one major rail transit terminal in Kuala Lumpur, Malaysia to collect the data. All 301 questionnaire responses displayed non-uniformity in their likely behaviour. Results explained that the passengers are more likely to be proactive (e.g., move to exit immediately as soon as the warning siren is sounded) than reactive (e.g., go to assembly point after being instructed) during the pre-evacuation. Further, people are more likely to be cooperative (e.g., help other people who may have difficulties in getting out) than competitive (e.g., push or shove other peoples to get out quickly) during the evacuation. In terms of demographic influences on behaviours, results demonstrated that there could be significant differences in certain behaviours between males and females and between different age groups. The findings of this study provide valuable information for developing models for simulating passengers' evacuation at rail transit terminals. Further, the managers of emergency response could utilize such data and outcomes in devising effective crowd management strategies and developing appropriate training and educational campaigns.

1. Introduction

The development of rail-based transport systems, like KTM Komuter (Commuter), the STAR Light Rail Transit (LRT), the PUTRA LRT, the Express Rail Link (ERL), and the Mass Rapid Transit (MRT) during the past two decades in Malaysia has shown that the rail transit is becoming a popular mode of transportation in busy cities like Kuala Lumpur, Malaysia. Rail passenger volumes in Kuala Lumpur have been increasing exponentially, and it is expected to further increase in the near future [1]. With current circumstances, improving pedestrian facilities and enhancing crowd safety in transit terminals have gained attention among authorities (National Transport Policy 2019–2030) [2]. Numerous researches on crowd safety strategies in rail transit terminal (RTT) have been triggered, and one of the safety strategies that need to be researched immediately is evacuation strategies at rail transit terminals during an emergency in relation to passengers' behaviour. According to Ahola et al. [3] and Glen et al. [4], to manage a crowd in an emergency, the passengers' behaviour must be comprehensively understood in advance. By understanding passenger's behaviour during an emergency evacuation, the emergency response teams could forecast how people behave during an emergency and prepare in advance to avoid major injuries, fatalities, and evacuation delays.

During the past decade, major incidents have been reported at train stations in several countries that caused mass passenger evacuations. For example, a fire broke out in a red line station of the Moscow metro station in June 2013, causing 4500 commuters to be evacuated and 45 people injured [5]. Another example is the suicide bombings that occurred in a three-carriage train at the Maelbeek metro station in central Brussels on March 22, 2016 (British Broadcasting Corporation [BBC], 2016) [6]. In that incident, 14 were killed, 219 injured, and many commuters (unrecorded) were forced to evacuate. However, in Malaysia, train stations have never experienced any tragic incidents (like bombing or terrorist attacks, floods, train accidents, or fire) that require mass evacuation. Nonetheless, it is worth it if every train station and transit system in Malaysia is prepared to face such situations since the consequences could be catastrophic during an emergency. According to Zanariah et al. [7], there is a lack of research on the detailed consideration of passengers' behaviour in the area of RTT in Malaysia. There

* Corresponding author.
E-mail address: celindarahman@usm.my (N.A. Rahman).
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is a necessity to integrate transportation engineering and passengers' behaviour to quantify the performance of evacuation strategies in rail transit stations.

Several previous studies have examined the likely behaviour of passengers while evacuating from buildings, airports, and ships [8–14]. There are culture-driven elements in human behaviour and decision-making during emergencies [15,16] that make the outcomes of such previous studies may not be directly applicable to other countries. For example, Malaysia is a multi-ethnic and multi-lingual society. Although many ethnic groups in Malaysia share similar values (e.g., honesty, responsibility, willingness to help, and taking risk), but their priorities differ [17]. In addition, studies conducted in the past decades had concluded that the Malaysian community has a lack of knowledge and understanding in response to emergencies and natural disasters [18,19].

Thus, an exploratory study to examine the likely behaviour of passengers during a potential evacuation was conducted at the busiest rail transit terminal in Kuala Lumpur, Malaysia, to explore four critical elements of evacuation behaviours, i.e., reactive, proactive, competitive, and cooperative behaviours. This study is expected to provide valuable insights to expand human behaviour knowledge during emergencies and to develop efficient evacuation strategies.

This paper is organized as follows. The next section summarizes the relevant previous studies on the likely behaviours of passengers during emergency evacuations. This is followed by the descriptions of questionnaire design, data collection, and data analysis. Then results are presented. Finally, the discussion and conclusions are offered.

2. Related works

The safe evacuation of people from different types of public buildings, e.g., metro stations, airports, and shopping complexes during emergencies, is a global concern. In developing safe and efficient evacuation strategies, it is crucial to understand the passengers' likely behaviour during potential emergencies. Shiwakoti et al. [8] identified four crucial categories of likely behaviours of people under emergency conditions, namely 'reactive', 'proactive', 'cooperative', and 'competitive' behaviours. The theoretical backgrounds of these four key underlying behaviours during emergencies have been studied by sociologists over many years.

2.1. Reactive and proactive behaviours

According to Covey [20], reactive people are often influenced by their physical environment, while proactive people carry their own withstands. That is, proactive people are usually firm with their decisions and not easily affected by the surrounding circumstances. In relation to human responses to an emergency situation, reactive behaviours are associated with the instruction from the emergency personnel, e.g., on what to do, where to go. On the other hand, proactive people tend to take action once they were aware of the emergency situation rather than waiting for instructions [19,23]. Bateman and Crant [21] stated that most people are reactive; i.e., during a situation that requires a decision to be made, most people will wait for others to communicate and seek help. Through a survey conducted at an underground rail station inside a shopping centre in Melbourne, Shiwakoti et al. [10] reported that passengers are more likely to wait for the instructions from the staff rather than evacuating by themselves from the building. Consequently, passengers were more likely to display reactive behaviour (e.g., wait for staff instructions) than proactive behaviour (e.g., move to exit). This agrees with the role-rule model, where the response of any person to an emergency depends on his role, whether he/she is a passenger or a staff member [22]. Passengers who are not familiar with the emergency procedure would be reactive, i.e., they will wait for instructions from the staff members [13]. The study by Stedmon et al. [23] that was conducted to compare the behaviours between the aviation and rail passengers reported that the aviation passengers are more controlled and more reactive, as they expect to have instructions on what to do. However, during an emergency, rail passengers are expected to be more proactive with more self-reliance under emergency evacuation.

A comprehensive literature review of reported case studies on the actual evacuation of underground transport systems revealed that people can take a proactive or reactive approach in different emergency situations [22]. For instance, in some cases, such as the King's Cross fire in London in 1987, people showed reactive behaviour after the emergency siren went off. Even though they received cues from the fire, they did not respond and evacuate until they were instructed by the public address (PA) system and authorities, or guided by the station staff. In other cases, such as the Burnley tunnel accident in Melbourne in 2007, people showed proactive behaviour and did not wait for instructions. Instead, they took quick actions and moved toward the exit when they receive cues of emergency. Similar proactive behaviour was reported in the China Airlines CI-120 aircraft evacuation accident [24].

According to Kangedal and Nilsson [25], people tend to react slowly when they do not feel the danger. In general, people underestimate the capability of other individuals during an urgent disaster, or they may underestimate the likelihood of encountering an emergency as it is a rare event [12]. Therefore, they tend to be reactive and follow the instructions from the emergency personnel to evacuate safely rather than being proactive and navigate themselves to find a safe location or evacuation route. In a different study, Shiwakoti et al. [26] conducted a survey on 796 train passengers with an open-ended question of what they would do in an emergency evacuation. They reported that passengers showed reactive behaviour as they waited for the staff instructions and announcements instead of direct evacuating or reporting to the emergency personnel. In terms of gender, male passengers showed more proactive behaviour compared to females. Males are risk-takers, while females try to avoid the risk and seek additional information instead of evacuating [26–28]. In terms of age, during an emergency, elderly people tend to wait for instructions, which means that they are more reactive compared to young people [28].

Overall, the likelihood of displaying a proactive or reactive behaviour depends on a few factors which include demographic (e.g., gender and age), the physical environment and surrounding conditions.

2.2. Competitive and cooperative behaviours

Sociologists have focused primarily on the psychological aspects of crowd behaviour, such as cooperative or competitive behaviour under emergency conditions. Cooperative behaviour in this context can be related to the interactions between two or more people during an emergency toward a mutual goal, e.g., to reach an exit or assembly area, while helping and waiting for others [19,23]. On the contrary, competitive behaviour is related to the tendency of people to take certain actions (like pushing) in order to save themselves first [19,23]. During the World Trade Centre towers disaster in September 2011, the evacuating people cooperated and tried to assist each other despite the existing danger and life risk [29–31]. Similarly, Cocking et al. [32] stated that over 99.2% of people showed altruistic and cooperative behaviours during the World Trade Centre evacuation in September 2011. Shiwakoti et al. [8] conducted a site survey on 1134 passengers at Melbourne train station and reported that people are more likely to be cooperative (e.g., helping other passengers) than competitive (e.g., shoving other people). Among gender, competitive behaviour was more obvious in the males than the females. In another study, some male passengers showed competitive behaviour during the "Costa Concordia" ship incident in 2012. To enter lifeboats, they pushed the crowd and caused injuries to other passengers [33,34].

According to Stedmon et al. [23], people experience cooperative behaviour in aviation and rail emergency evacuations. In rail emergencies, there is a threshold where people often help each other and tend to be rational and cooperative [35]. Above that threshold, people tend to be competitive and less collaborative. This can be attributed to the immediate life threat or danger perception. According to Muir [36], people tend to save themselves or their family members during a life-threatening incident rather than trying to help each other. They tend to show competitive behaviour (e.g., compete to survive) rather than cooperative behaviour (e.g., working collaboratively to help others) when they are driven by their primary survival instinct. This kind of survival competitive behaviour was observed during the fire accident at the Bradford City football stadium in London in 1985. Consequently, 56 individuals died, and over 250 spectators were injured in that accident [37].

According to several studies on emergency evacuations, people are more likely to show cooperative behaviour such as going to the exit and helping others [38,39]. Similarly, interviews with survivors and witnesses of massive emergency accidents revealed that the competitive behaviour was rare as the cooperative behaviour dominated in life-threatening emergencies [32,40]. On the other hand, others reported that people tend to show competitive behaviour (e.g., pushing and trampling) under emergency situations such as crowd crushes (e.g., looking for a safe place in an accident) at entries and exits [41]. The competitive behaviour increases the evacuation time and lessens the individual's outflow, and can lead to deadly consequences [42]. There is a debate on whether people are more likely to show cooperative or competitive behaviour in emergency situations [10].

All these previous studies highlight that the differences in human behaviour between different geographic locations or facilities could be attributed to the passengers' safety awareness as well as the complexity of the location and the available safety evacuation tools. Gleaning insights from the previous studies, a questionnaire was designed and disseminated to collect data to explore passengers' likely behaviour when evacuating from a busy rail transit terminal in Kuala Lumpur, Malaysia. Details of the questionnaire survey are described in the next section.

3. Methods

This section is comprised of three parts. The first part describes the questionnaire design. In the second part, the data collection procedures for the online and site surveys are presented. The analysis methods of the survey data are presented in the last part.

3.1. Survey design

A questionnaire survey was designed to explore four underlying human behaviours, i.e., reactive, proactive, competitive, and cooperative behaviours, during emergency evacuations. The questionnaire consisted of two sections: (1) questions on socio-demographic characteristics, and (2) statements on behaviours. The socio-demographic section included questions on gender, age group, the purpose of travel, and familiarity with the rail transit terminal. The behavioural statements consisted of questions on the passenger's likely behaviours during an emergency evacuation.

Each underlying behaviour, i.e., reactive, proactive, competitive and cooperative, was measured by three behavioural statements. Twelve closed-ended behavioural statements were developed to represent the likely behaviour of the passengers in an emergency evacuation. All these behavioural statements were adapted and rephrased accordingly from Shiwakoti et al. [8] to suit the Malaysian culture. The statements corresponding to key underlying behaviours are listed in Table 1. As shown in Table 1, the 12 behavioural statements could further be divided into two specific phases: (1) the “pre-evacuation” phase and (2) the “evacuation” phase. Behavioural statements for the “pre-evacuation” phase indicate the likely behaviour of the passengers after the warning siren until they begin the purposive evacuation movement to a place of safety. On the other hand, behavioural statements for “evacuation” indicate the possible behaviours during the evacuation phase, i.e., while moving to a safe place by the passengers.

The participants' responses were recorded using a 5-point Likert scale, ranging from 1 for “Strongly Disagree” to 5 for “Strongly Agree”. In this survey, the participants are constricted in the range of options he or she has to choose from as an answer.

3.2. Data collection

The rail transit terminal (RTT) in Kuala Lumpur was selected as the study site as it is the Malaysia's busiest transportation hub and, as of March 2016, the commuters at the selected RTT have reached 160,000 per day [43]. The hub has six rail networks; the KLIA Express Rail Link, KLIA Transit, Rapid KL (Putra), KTM Komuter, KTM Intercity, and KL Monorail Services in addition to taxi and bus services.

Two surveys, i.e., online survey and site survey, were conducted in this study. The site survey was conducted at the selected rail transit terminal on 9th and 10th November 2018, outside peak hours, i.e., during 10 am and 3 pm, to avoid the effect of congestion and delays during the peak hours. Three graduate students were dispatched for the survey. Participants or respondents involved in this survey are among Malaysian passengers who have experience using any public transports at the RTT. The questionnaire survey was conducted in accordance with the guidelines by the School of Civil Engineering, Universiti Sains Malaysia. Participation in the survey was voluntary and non-coercive. Before the respondent answers the questionnaire, the potential respondent was approached courteously and consent from the respondent was obtained first. Besides, no personally identifiable details, e.g., name, address, were collected. The questionnaire took between 2 and 3 min to be completed.

In addition to the site survey, an online survey was also conducted to obtain more data. The online questionnaire was designed using Google forms, and the questions in the site survey and the online survey were exactly the same. The online questionnaire was distributed in January

Table 1
Categorization of behavioural statements.

	Behavioural statements	Corresponding underlying behaviour	Phase
1.	Move to exit immediately as soon as the warning siren sounded.	Proactive	Pre-evacuation
2.	Use emergency button when witness an accident.		
3.	Go to assembly area quickly when hear the warning siren.		
4.	Wait for instruction of the PA (public address) system.	Reactive	
5.	Wait for direction from the station staff.		
6.	Go to assembly point after being instructed.		
7.	Push or shove other passengers if necessary, to get out quickly.	Competitive	Evacuation
8.	Rush toward exit route to save yourself first without paying attention to others people.		
9.	Find own exit route without staff permission.		
10.	Help other people who may have difficulties getting out.	Cooperative	
11.	Give priority to disable passengers while evacuating.		
12.	Stay calm and rational during emergency evacuation.		

2019, through emails, via social media platforms (i.e., Facebook, Instagram, and Twitter) and WhatsApp. Target respondents were those who live in Selangor and Kuala Lumpur areas since the RTT is situated in Kuala Lumpur. The data collected via the online survey was only meant for the respondents who had or have experience using the facilities at the selected RTT. Respondents with no experience using facilities in the selected RTT would click the "NO" button and will be terminated from participating in the survey.

3.3. Analysis methods

To compare the effects of independent observations, e.g., the effect of age, gender, and familiarity of the station on likely behaviours, non-parametric tests such as Mann Whitney *U* test and the Kruskal-Wallis test were used. Non-parametric tests do not require the assumption of Normality. Further, they can be used for ordinal data, and they are easier to interpret. In addition, Spearman Correlation was used to investigate the association between likely behaviour and ordinal variables.

To explore the relationship between likely behaviour responses and the demographic variables, i.e., age and gender, ordinal regression models were developed. In the regression models, average scores for each behavioural statement that are corresponding to the underlying likely behaviour were set as the dependent outcome, and demographic variables were entered as predictors. In addition to the above analysis, Exploratory Factor Analysis (EFA) was performed on the responses obtained for the 12 statements to identify meaningful patterns in the behavioural statements. Results obtained through these analyses are presented in the next section.

4. Results

As mentioned before, 12 behavioural statements were considered, and their internal reliability was tested via the Cronbach Alpha coefficient. The 12-item scale showed acceptable internal reliability with a Cronbach's coefficient (alpha) of 0.779, which is above the acceptable limit value of 0.7.

4.1. Demographics of the respondents

From both surveys (site and online surveys), 301 complete responses were collected. Out of 301 responses, 101 responses were collected from the site survey, while 200 responses were collected from the online survey. Demographic characteristics of the respondents of the questionnaire survey are summarized in Table 2.

Table 2
Characteristics of the survey respondents.

Items	Category	Frequency	Percentage
Gender	Male	144	47.8
	Female	157	52.2
Age	≤ 15	10	3.3
	16–25	80	26.6
	26–35	60	19.9
	36–45	74	24.6
	46–55	60	19.9
	≥ 56	17	5.6
Purpose of the trip	Work	67	22.3
	College	25	8.3
	Leisure	137	45.5
	Business	31	10.3
	Travel	41	13.6
Familiarity with the building	Familiar	113	37.5
	Neither familiar nor unfamiliar	73	24.3
	Unfamiliar	115	38.5

Out of all respondents, 144 (47.8%) were males, and the rest of 157 (52.2%) were females. In addition, most of the respondents were in the age group 2 (16–25 years old) with 26.6% followed by 24.6% in group 4 (36–45 years old), 19.9% in groups 3 (26–35 years old) and 5 (46–55 years old), respectively and 5.6% in group 6 (over 55 years old). The skewness of the age distribution reflects that young and middle-aged passengers are the group of people who frequently travel and use public rail services. The age distribution in this study is in line with Shiwakoti et al. [26].

With regard to the familiarity of the respondents with the rail transit terminal, out of 301 responses, 115 (38.5%) were not familiar with the terminal, 113 (37.5%) of them stated that they are familiar with the terminal, while 73 (24.3%) of them were "not sure" which is in between familiar and unfamiliar.

4.2. Likely behaviour of passengers

The percentages of the responses for each behavioural statement are summarized in Fig. 1. It can be noted that the respondents are likely to be more proactive and cooperative rather than reactive and competitive. The lowest ratings were recorded for "Push other passengers if necessary, to get out quickly", "Rush toward the exit route to save yourself first without paying attention to disabled people" and "Find your own exit route without the staff permission". That is, the respondents are likely to avoid being competitive during an evacuation situation.

Shiwakoti et al. [8,9] revealed that Australian passengers were more likely to display cooperative than competitive behaviour during emergency evacuations. This finding is consistent with the result of our study for Malaysian passengers. However, Malaysian passengers are more likely to adopt proactive behaviours than reactive behaviours, which contradicts the findings in Shiwakoti et al. [8,9].

Figs. 2 and 3 show the box plots for "proactive and reactive" behaviours and "competitive and cooperative" behaviours, respectively. Even though respondents are split into proactive and reactive behaviours, they are more likely to be proactive during the pre-evacuation. Mann-Whitney *U* test was conducted to compare the average scores for proactive and reactive behaviours. It was confirmed that difference in average scores were statistically significant (z-score = 10.177, *p*-value is <0.00001). Meanwhile, between cooperative and competitive behaviours, respondents are more likely to be cooperative during the evacuation. As shown in these figures, the range of responses for both proactive and cooperative behaviours is between 4 and 5, which is between "agree" and "strongly agree", and short in size, indicating that all passengers hold the same opinion during an emergency evacuation. As confirmed with Mann-Whitney *U* test difference in average scores for competitive and corporative behaviours were statistically significant (z-score = 19.44621, *p*-value is <0.00001).

However, passengers might have different opinions in reactive and competitive behaviours, which can be observed from the difference in sizes of the boxplots for the two crucial elements. The findings of this study are consistent with the results of Stedmon et al. [23], who reported that during emergencies, people are more likely to be cooperative and proactive with more self-reliance.

4.3. Influence of gender on likely behaviour of passengers

The differences in likely behaviours during an emergency evacuation by gender were analysed using the Mann Whitney *U* test. Table 3 shows the result of the Mann Whitney U test for each behavioural statement. From the result, it can be seen that, compared to females, male respondents are more likely to adopt competitive behaviour but less likely to display reactive behaviour. This result is logical as males are more active during an emergency and tend to take more risks than females [26–28]. This finding also agrees with the outcomes of Venkatesh and Morris [44] who stated that males are less likely to ask for directions compared to females. During the evacuation, female respondents are more likely to

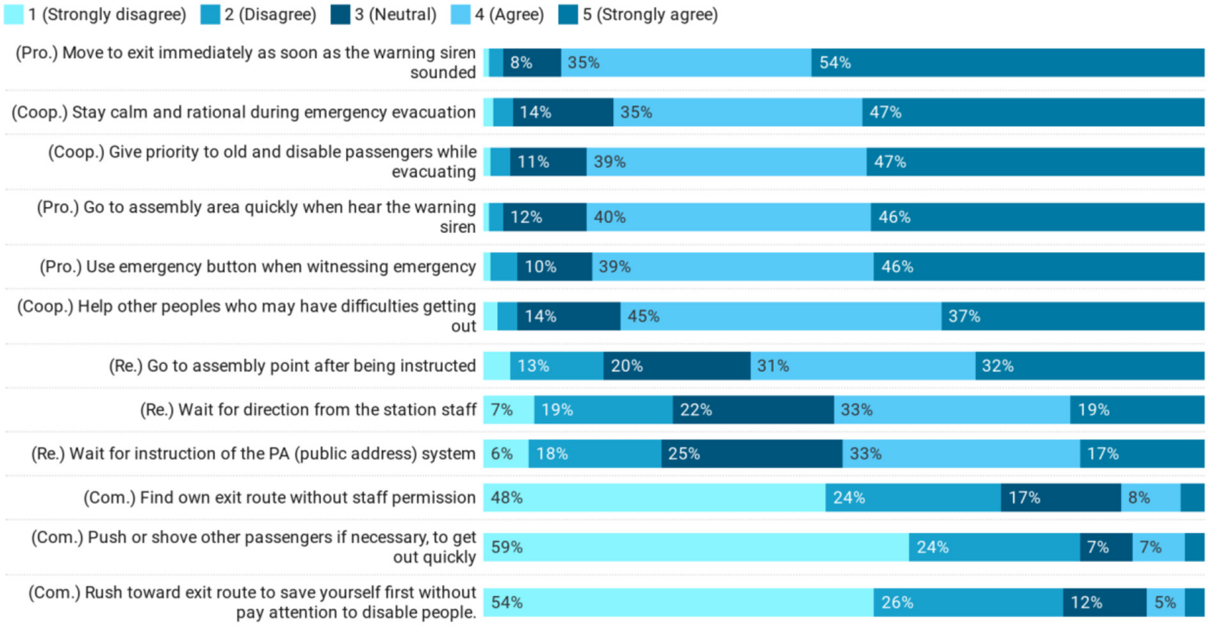

Fig. 1. Distribution of responses for behavioural statements.

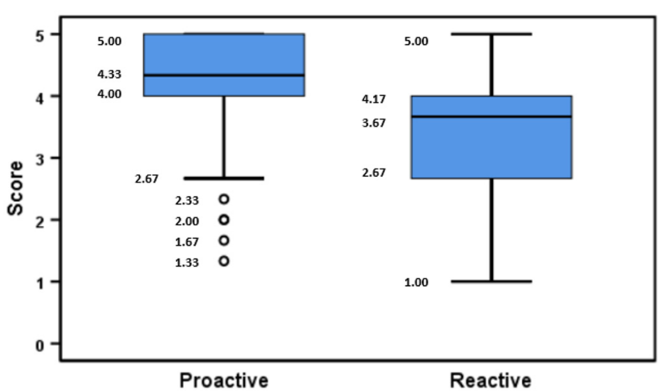

Fig. 2. The boxplots for Proactive and Reactive behaviours.

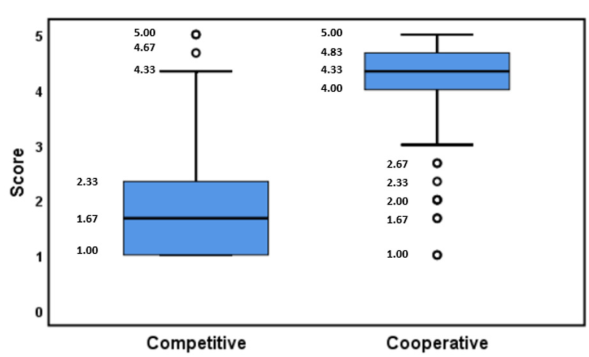

Fig. 3. The boxplots for Competitive and Cooperative behaviours.

adopt cooperative behaviour such as helping other people, giving priority to old and disabled people, or staying calm and rational. This supports the results of Shiwakoti et al. [8] on rail transit passengers where males showed a more obvious competitive behaviour than females.

Table 3
Mean and standard deviation of the likely behaviours based on gender.

Likely behaviour	Category	Male Mean (± SD)	Female Mean (± SD)	Mann-Whitney *U* test (z-score, *p*-value)
1	Pro	4.42 (±0.84)	4.39 (±0.71)	(0.892, 0.373)
2		4.18 (±0.92)	4.32 (±0.79)	(1.075, 0.280)
3		4.22 (±0.85)	4.34 (±0.75)	(1.054, 0.294)
4	Re.	3.07 (±1.22)	3.63 (±1.02)	(3.891, 0.0001) **
5		3.17 (±1.28)	3.55 (±1.06)	(2.335, 0.019) *
6		3.64 (±1.24)	2.84 (±1.04)	(1.020, 0.308)
7	Com.	1.76 (±1.11)	1.66 (±0.99)	(0.422, 0.674)
8		1.87 (±1.15)	1.66 (±0.88)	(0.890, 0.373)
9		2.20 (±1.21)	1.73 (±1.00)	(3.313, 0.001) **
10	Coop.	4.08 (±0.91)	4.13 (±0.86)	(0.369, 0.711)
11		4.24 (±0.90)	4.31 (±0.77)	(0.276, 0.779)
12		4.18 (±0.95)	4.30 (±0.82)	(0.784, 0.435)

* Significant at 0.05 level.
** Significant at 0.01 level.

4.4. Influence of age on likely behaviours of passengers

The age groups were divided into six independent groups and the mean (± standard deviation) of scores for each behavioural statement is shown in Table 4. Kruskal-Wallis test was conducted to compare each behaviour, i.e., reactive, proactive, competitive, and cooperative, between different age groups. For this analysis, the average score was considered for each category. Results indicated that for reactive behaviours, there is a statistically significant difference between different age groups (H statistic = 11.1058, *p*-value = 0.0254). For other categories, i.e., proactive, competitive, and cooperative behaviours, statistically significant differences were not found between different age groups. Correlations between the scores for each behavioural statement and age groups were explored using Spearman correlation coefficient (r_s) and the outcomes are presented in Table 5. For these calculations, the sample sizes were low for two age groups, i.e., age ≤ 15 and age ≥ 56. Therefore, the samples for (age ≤ 15) and (age ≥ 56) groups were combined with (16 ≤ age ≤ 25) and (46 ≤ age ≤ 55) groups, respectively. Results indicate that scores for the statements corresponding to reactive behaviours are negatively correlated with age.

Table 4
Mean and standard deviation of the likely behaviours based on age groups.

Likely behaviour and category		≤15	16–25	26–35	36–45	46–55	≥ 56
		Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)
1	Pro.	4.8 (±0.42)	4.27 (±0.76)	4.45 (±0.83)	4.51 (±0.69)	4.28 (±0.88)	4.58 (±0.62)
2		4.7 (±0.48)	4.01 (±0.97)	4.35 (±0.73)	4.32 (±0.79)	4.23 (±0.91)	4.53 (±0.71)
3		4.7 (±0.48)	4.15 (±0.87)	4.26 (±0.071)	4.39 (±0.69)	4.28 (±0.9)	4.29 (±0.85)
4	Re.	4.1 (±1.28)	3.55 (±1.02)	3.55 (±1.15)	3.16 (±1.23)	3.11 (±1.15)	3.17 (±1.01)
5		4.4 (±0.84)	3.53 (±1.09)	3.55 (±1.22)	3.13 (±1.25)	3.13 (±1.15)	3.17 (±1.07)
6		4.6 (±0.69)	3.87 (±1.05)	3.9 (±1.05)	3.66 (±1.1)	3.62 (±1.26)	2.94 (±1.39)
7	Com.	1.3 (±0.67)	1.73 (±1.03)	1.75 (±0.98)	1.62 (±1.05)	1.8 (±1.24)	1.7 (±0.92)
8		1.3 (±0.67)	1.82 (±1.13)	1.75 (±1.02)	1.73 (±0.91)	1.8 (±1.1)	1.76 (±0.97)
9		2.5 (±1.08)	2.02 (±1.13)	1.8 (±1.00)	1.75 (±1.08)	2.16 (±1.23)	2 (±1.22)
10	Coop.	4.4 (±1.35)	4.07 (±0.72)	4.08 (±0.96)	4.23 (±0.78)	4 (±0.94)	4.05 (±1.19)
11		4.7 (±0.67)	4.25 (±0.75)	4.3 (±0.86)	4.38 (±0.71)	4.11 (±0.97)	4.23 (±1.03)
12		4.3 (±0.67)	4.22 (±0.78)	4.32 (±0.87)	4.38 (±0.85)	4.06 (±1.07)	4.05 (±0.89)

Table 5
Correlations between age and likely behaviours.

Likely behaviour and category		Spearman correlation	
		Coefficient (r_s)	p-value (2-tailed)
1	Pro.	0.036	0.529
2		0.093	0.107
3		0.063	0.276
4	Re.	−0.184	0.001**
5		−0.186	0.001**
6		−0.152	0.008**
7	Com.	−0.021	0.711
8		0.022	0.700
9		−0.015	0.791
10	Coop.	−0.002	0.978
11		−0.032	0.580
12		−0.017	0.773

** Significant at 0.01 level.

Table 6
Correlations between familiarity and likely behaviours.

Likely behaviour and category		Spearman correlation	
		Coefficient (r_s)	p-value (2-tailed)
1	Pro.	0.0506	0.38233
2		0.0987	0.08786
3		0.0755	0.19198
4	Re.	0.0338	0.55966
5		−0.0406	0.48361
6		−0.0305	0.59891
7	Com.	−0.0987	0.08806
8		−0.0237	0.68311
9		−0.2015	0.00045**
10	Coop.	0.10066	0.08173
11		0.05804	0.31634
12		−0.0271	0.64006

** Significant at 0.01 level.

This finding disagrees with the findings of Kanno et al. [28] where elderly people were found to be more reactive than the young. In our study for Malaysian passengers, young passengers were more reactive than elderly passengers. During the evacuation, cooperative behaviour dominated regardless of age groups where the mean was above 4 for all groups.

4.5. Familiarity of the place and likely behaviours of passengers

Familiarity with a building also affects human behaviour and decision-making during evacuations [45]. The effects of familiarity on the likely behaviour of rail's passengers were examined using Spearman's correlation. It was found that, there were no statistical significant between familiarity and proactive behaviours (average of the scores for statement 1, 2 and 3) (r_s = 0.08749, p (2-tailed) = 0.13055), familiarity and reactive behaviours (average of the scores for statement 4, 5 and 6) (r_s = −0.00802, p (2-tailed) = 0.89003), and familiarity and cooperative (average of the scores for statement 10, 11, and 12) (r_s = 0.06164, p (2-tailed) = 0.28725). However, the correlation between familiarity and competitiveness (average of the scores for statements 7, 8, and 9) was statistically significant by normal standard (r_s = −0.13755, p (2-tailed) = 0.01713). This finding explains that the passengers' competitive behaviour increases as the familiarity increases. It should be noted that scores for familiarity vary from 1 (= familiar) to 3 (= unfamiliar) and scores for competitiveness vary from 1 (= Strongly Disagree) to 5 (= Strongly Agree). Spearman correlations between familiarity and the scores for the individual statements are shown in Table 6, and it can be observed that people are more likely to find their own exit route when familiarity increases. This observation is logical, because passengers, who are familiar with the premises, know where the exits are located, and they tend to move toward exits by themselves.

4.6. Outcomes of factor analysis

To identify meaningful patterns in the behavioural statements, Exploratory Factor Analysis (EFA) was performed on the responses obtained for the 12 statements using IBM SPSS Statistics 26 software. Based on the eigenvalues, which are greater than 1, a solution was obtained with four factors. These four factors explained 72.68% of the total variance. For factor loadings, a cut-off value of 0.5 was set, and the loadings below this value were removed. Outcomes of the EFA are summarized in Table 7. Cronbach's alpha (internal reliability) was good (> 0.8) for the second factor and acceptable (> 0.7) for the first, third, and fourth factors. Further, according to the Kaiser-Meyer-Olkin (KMO) measure, the sampling adequacy was satisfactory, i.e., larger than the recommended value of 0.6. Further, Bartlett's test of sphericity was significant (0.000).

Closely observing the loadings for each factor in Table 7, it can be identified that the obtained factors exactly represent the behavioural categories. That is, factors 1, 2, 3, and 4 (Table 7) represent proactive, reactive, competitive, and cooperative behaviours, respectively. This finding means that the original categorization of behavioural statements is valid and internally consistent.

Table 7
Factor loadings for the behavioural statements.

Behavioural statement	Factor			
	1	2	3	4
Move to exit immediately as soon as the warning siren sounded.	0.790			
Use emergency button when witness an accident.	0.836			
Go to assembly area quickly when hear the warning siren.	0.782			
Wait for instruction of the PA (public address) system.		0.902		
Wait for direction from the station staff.		0.932		
Go to assembly point after being instructed.		0.815		
Push or shove other passengers if necessary, to get out quickly.			0.812	
Rush toward exit route to save yourself first without paying attention to other people.			0.821	
Find own exit route without staff permission.			0.785	
Help other people who may have difficulties getting out.				0.842
Give priority to disable passengers while evacuating.				0.842
Stay calm and rational during emergency evacuation.				0.682
% variance explained	19.356	31.960	12.561	8.800
Cronbach alpha	0.774	0.865	0.771	0.793
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.759			
Bartlett's Test of Sphericity	0.000			

4.7. Outcomes of ordinal logistic regression models

Ordinal logistic regression models were developed using IBM SPSS Statistics 26 software for each behaviour category to identify which demographic variables significantly affect likely behaviours. As confirmed with power analysis that was conducted using GPower 3.1 software, the sample size (301) was adequate for logistic regressions with 2 predictors with medium effect [46]. As the sample sizes were low for the age groups that are less than 15 and more than 56, these samples were combined with (16-25) and (46-55) age groups, respectively. Models for reactive and competitive behaviours were significant, whereas the models for the other two behaviours, i.e., proactive and cooperative, were insignificant. Outcomes (only for significant models) are summarized in Tables 8 and 9. As can be understood from the table, the effect of both gender and age are significant on reactive behaviours, and only the effect of gender is significant on competitive behaviour. In particular, males are less likely to behave reactively. However, they are more likely to display competitive behaviours compared to females. In addition, age was also a significant predictor for the reactive behaviour. That is, people who are younger than 35 years are more likely to behave reactively as compared to people who are older than 46 years. However, displaying a reactive behaviour was statistically similar for the commuters who are within the age range of 36 and 45 and who are over 46 years.

5. Discussion and conclusions

In the event of an emergency evacuation in a rail transit terminal, understanding how passengers respond and behave could undoubtedly be beneficial in designing efficient emergency procedures. Further, such understanding could aid in improving emergency communication systems and developing the calculation tools to assess the safety levels of the rail transit system. In this contribution, we have conducted a self-reported survey to examine the likely behaviour of passengers during an emergency evacuation in a rail transit hub by focusing on four crucial behaviours, i.e., reactive, proactive, competitive, and cooperative behaviours.

Outcomes of this study disclosed that passengers were more likely to adopt proactive behaviour during the pre-evacuation phase and cooperative behaviour during the evacuation phase. Approximately 54% of the participants responded that they will move to an exit as soon as the warning siren sounded (proactive behaviour), and 47% of the participants responded that they will stay calm and rational during an emergency evacuation and give priority to old and disable passengers while evacuating (cooperative behaviour). Our finding that passengers move to exit immediately is consistent with the finding obtained by Shiwakoti et al. [47]. It is also worth mentioning that, when the investigation was made on the survivors of the 1980 MGM Grand Hotel fire, "went to an exit" was one of the most frequent behavioural responses by the survivors [48]. Meanwhile, our finding that passengers are likely to be cooperative (i.e., "stay calm and rational" and "give priority") during evacuation is analogous with the findings by Cocking et al. [32], who stated that the passengers behave orderly and calm during the emergency incident and they do not display selfish and uncooperative behaviours. That is, it can be suggested here that the combination of proactive and cooperative behaviours should be considered in planning an emergency response strategy to ensure the smoothness of the evacuation process in any emergency.

Table 8
Outcomes of the ordinal logit model for the effect of gender and age on reactive behaviour.

		Estimate	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Reactive behaviour	Gender = Male [a]	−0.564	0.204	0.006	−0.964	−0.164
	Age ≤ 25 [b]	0.804	0.275	0.003	0.266	1.343
	26 ≤ Age ≤ 35 [b]	0.803	0.304	0.008	0.207	1.399
	36 ≤ Age ≤ 45 [b]	0.119	0.284	0.675	−0.438	0.676

a. The reference category is Female
b. The reference category is Age ≥ 46

Model fitting information

Model	−2 Log likelihood	Chi-square	df	Sig.
Intercept only	322.054			
Final	300.376	21.678	4	0.000

Table 9
Outcomes of the ordinal logit model for the effect of gender on competitive behaviour.

		Estimate	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Competitive behaviour	Gender = Male [a]	0.539	0.206	0.009	0.135	0.943
a. The reference category is Female						

Model fitting information

Model	−2 Log Likelihood	Chi-Square	df	Sig.
Intercept only	337.130			
Final	330.229	6.901	2	0.032

Further, our findings indicated that males are more likely to adopt competitive behaviour during an evacuation, in which they prefer to find their own exit route without staff permission, compared to females, who prefer to wait for instructions or directions from the station staff (reactive behaviour). Several past case studies on emergency evacuations explained that males are known to be risk-takers, while females prefer to avoid the risks [49]. Moreover, the results indicated that there was a correlation between the familiarity of the building and finding the exit routes (i.e., one of the competitive behaviours). That is, when passengers are familiar with the transit terminal, in any emergency occurrence, people tend to adopt competitive behaviour by finding their own exits. These findings indicate some important points that need to be considered in planning effective evacuation strategies in rail transit systems where the emphasis needs to be put on gender mainstreaming and familiarity of the building.

It is also interesting to note that young passengers were more reactive compared to the elderly. That is, the elderly passengers are less likely to adopt behaviours such as "wait for instruction of the PA system", "wait for direction from the station staff", and "go to assembly point after being instructed". This finding contradicts with Kanno et al. [28], who stated that elderly people are more reactive than young people. Another previous study revealed that people below 30 years are less likely to evacuate than people in other age groups when a natural disaster occurs [50]. The difference in findings could be attributed to the difference in types of threats posed to the respondents and their awareness of emergency responses. In this study, the respondents were asked in general about their likely behaviour in case of an emergency. Nevertheless, these findings provide some important implications for emergency preparedness and devising crowd management strategies in emergency evacuations.

The outcomes of the ordinal regression analysis further confirmed the effects of gender and age on reactive behaviour and the effect of gender on competitive behaviour. Further investigations are required to look into the impact of socio-demographic parameters, including gender, age, education, etc. in relation to the cultural differences and types of threats in decision-making during emergency evacuations.

This study was based on 301 responses collected through a questionnaire survey. Although the sample sizes seem limited, they were adequate for (non-parametric) statistical tests conducted in this study. Further, only two demographic variables, i.e., age and gender, were used in ordinal regression models, and the sample size was adequate. In addition, the outcomes of the EFA indicated that the sampling adequacy was satisfactory. Nevertheless, as the sample sizes were low for some categories, e.g., age, such categories were combined with other categories. Thus, larger sample sizes might be preferred for further studies to obtain a more representative cross section in terms of socio-demographic characteristics. In addition, under future studies, other behaviours, e.g., symmetry breaking and route choice behaviours, that were identified as critical behaviours in previous studies should also be examined.

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Declaration of Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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