The Effect of Perceived Safety on User Behaviour in the Holy Mosque

Kassim Gidado and Mohammed Alkhadim

Abstract The Holy Mosque in Makkah is claimed to be the largest and most used crowded open space building in the world. It is used by very large crowd reaching maximum capacity of up to 2 million users at a time especially during the Hajj period. In practice, facilities managers of such buildings always give a lot of emphasis to objective safety (normative and substantive), but researches have shown that subjective safety (perceived) is equally important and cannot be overlooked. This research theorised that a decline in perceived safety (PS) will have an influence on user behaviour (UB) that could result in a crowd disaster. Previous researchers have established that there are 10 key factors that could affect perceived safety in large space buildings, but no empirical study has yet been carried out to identify how significant is the effect of each of these factors on perceived safety and the consequent effect of perceived safety on user behaviour. This paper therefore presents the findings of an empirical study carried out by using the Holy Mosque as a case study. Data was collected using iPad devices via a group-administered questionnaire to 1940 pilgrims from 62 different nationalities during the Hajj period. The results were analysed using SPSS for descriptive analysis and AMOS 22 for Confirmatory Factor Analysis (CFA) and Structural Equation Modelling (SEM) to test the relationships between the factors and PS and between PS and UB by setting up a number of hypotheses. The findings revealed 7 out of the 10 factors have a significant influence on perceived safety and also established that perceived safety has a significant influence on the behaviour of the pilgrims as users.

Keywords Large space buildings · Perceived safety · Subjective safety · User behaviour

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1 Introduction

Miller (2015) has reported several incidents during the Hajj that caused loss of thousands of lives. Still (2000) has established that the safety limit for crowd density is 40 people in 10 m^2 for a moving crowd and 47 for standing areas, but Alnabulsi and Drury (2014) confirmed that the crowd density in the Holy Mosque is often 6–8 people per m^2. This clearly exceeds the safety limit with an extremely high risk or potential of occurrence of a crowd disaster. Such peak capacities are often reached during the Hajj (annual pilgrimage to the city of Makkah by Muslims lasting 4–6 days that involves rituals in four holy places: Holy Mosque, Arafat, Muzdalifah and Mina) especially during the Tawaf (anticlockwise circumvallating movement of pilgrims in the Holy Mosque around the Kaaba repeated seven times) that is done on the 2nd day immediately after the first visit to Jamarat (ritual site situated at Mina). This type of crowd is classified by Berlonghi (1995) as "a dense or suffocating crowd" that could sweep people along with movement and compression, which could result in injuries and fatalities.

Sagun et al. (2008) states that the fundamental principle of safety in the built environment is ensuring the safety of occupants during both normal and emergency events. The Hajj Authorities have therefore invested heavily and are using strategies and systems to help mitigate the Health and Safety risks using objective safety considerations based on globally recognized best practices. Every effort is continuously made to expand the mosque, currently at 356,800 m^2, to help the situation, but there is also an annual increase in the number of pilgrims attending the Hajj from across the world. Although the emphasis on objective safety is appropriate, but research has shown that subjective safety (perceived) is equally important and cannot be overlooked. Dickie (1995) have reviewed some major past crowd disasters that occurred in Sunderland (1883, deaths 183), London (1943, 173 deaths), Bolton (1946, 33 deaths), Glasgow (1971, 66 deaths) and Sheffield (1989, 96 deaths) and concluded that a flaw of hazard and poor risk management during the event was one of the main reasons for these disasters, but issues associated with perception of the crowd and their actions or behaviour could not be eliminated from the reasons leading to the disastrous outcomes. Miller (2015) and Challenger et al. (2009) have reported notable stampedes and other failures during the Hajj of 2015, 2006, 2004, 2001, 1998, 1994 and 1990 resulting in thousands of lives lost and many more injured. Although none of these notable disasters have occurred in the Holy Mosque, but having these established facts, the potentiality of a crowd disaster is extremely high. This reveals the urgency to have a better understanding of the relationship between perceived safety and behaviour of pilgrims in the Holy Mosque.

Alkhadim et al. (2018) have adapted two theoretical frameworks, namely: FIST model developed by Fruin (1993); and the Six Dimensions and Loci model developed by Chukwuma and Kingsley (2014), to identify 10 critical factors of perceived safety in crowded large space buildings, namely: Perceived Force (PF), Perceived Poor Information (PPI), Perceived Insufficient Space (PIS), Perceived Poor Real Time Management (PPRTM), Perceived risk of Stampede (PRS), Perceived risk of Riot

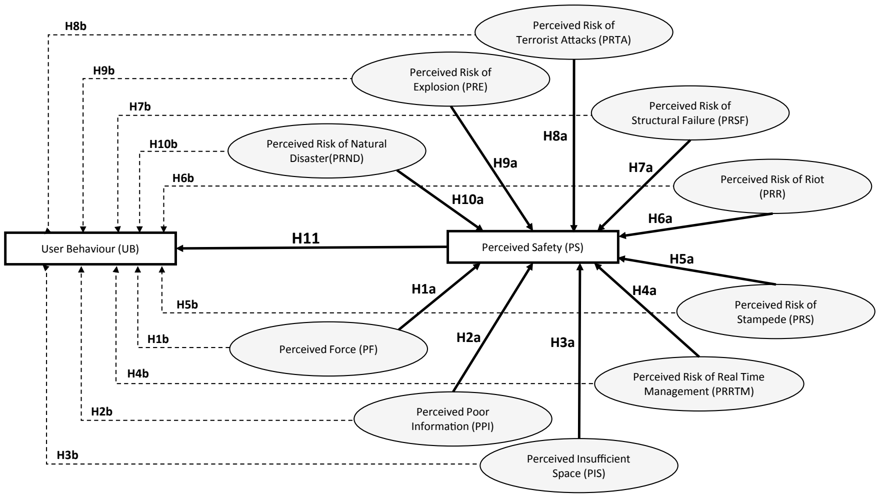

Fig. 1 The Subjective Crowd Safety Model (SCSM)

(PRR), Perceived risk of Structural Failure (PRSF), Perceived risk of Terrorist Attack (PRTA), Perceived risk of Explosion (PRE) and Perceived risk of Natural Disaster (PRND). They carried out a detailed confirmatory analysis of the 10 factors together with perceived safety and user behaviour to test the theoretical pattern of the variables loading on a developed construct to show how well they match reality. Based on these studies, a conceptual Subjective Crowd Safety Model (SCSM) is therefore developed to study the interrelationships between the variables. The SCSM model is illustrated in Fig. 1, which shows that there are 10 hypothesis (H1a to H10a) set to test the direct effect of each critical factor on perceived safety (PS) respectively; one hypothesis (H11) to test the direct effect of PS on user behaviour (UB); and 10 other hypothesis (H1b to H10b) to test the in-direct effect of each critical factor on UB respectively. The purpose of this paper therefore is to establish these direct and indirect effects by testing the 21 hypotheses depicted in the conceptual model.

2 Research Methodology

Primary data was collected using iPad devices via a group-administered questionnaire distributed to 1940 pilgrims of 62 different nationalities during the Hajj period using stratified sampling technique. The results were analysed using SPSS for descriptive analysis and AMOS 22 for Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). Initially, secondary data was used to establish the items for each variable to guide the development of the questionnaire. The CFA analyses have established the 12 latent constructs, and the assessment of the model shows solid evidence of unidimensionality, convergent validity, discriminant validity, and reliability and therefore warrants the continuation to further analysis. 38 items were found with acceptable factor loading greater than 0.60. The descriptive and CFA analyses have been reported in Alkhadim et al. (2018).

SEM was chosen as a statistical technique for two main reasons: Firstly, the study aims to establish the interrelationship between the perceived safety and user behaviour in which latent variables are encountered that cannot be measured directly. Secondly, SEM is a powerful tool that can test the model fit to the data by taking into account any measurement error (unreliability) for each latent variable of the constructs being estimated.

3 Structural Equation Modeling (SEM)

The structural model as shown in Fig. 2 presents the interrelationship among the variables. It consists of 10 unobserved exogenous constructs (Perceived Force, Perceived Poor Information, Perceived Insufficient Space, Perceived Poor Real Time Management, Perceived risk of Stampede, Perceived risk of Riot, Perceived risk of

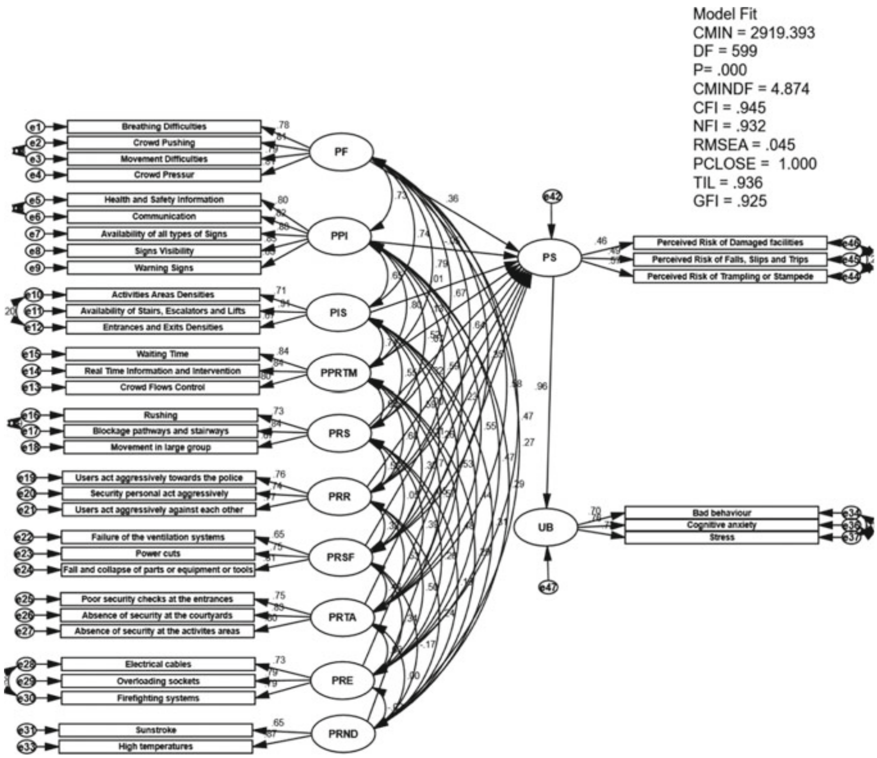

Fig. 2 The proposed structural model

Structural Failure, Perceived risk of Terrorist Attack, Perceived risk of Explosion and Perceived risk of Natural Disaster) and two unobserved endogenous constructs (Perceived Safety & Users Behaviour).

According to Awang (2015), a model that achieves fit indexes values of comparative fit index CFI ≥ 0.90, standardised root mean square residual SRMR ≤ 0.08, and the root mean square error of approximation RMSEA ≤ 0.06 should be considered an acceptable model fit. Based on these fit indexes, the model illustrated in Fig. 2 is therefore a good fit because the CFI = 0.979, SRMR = 0.032, and RMSEA = 0.043. Consequently, the model became accepted for further analysis in testing the 21 different hypotheses identified in Fig. 1.

4 Testing Direct Effects

The results of the analyses are summarised in Table 1 that shows each path and its estimate for path coefficient weight, standard errors, coefficient regression composite reliability and p-value as well as the significance for that particular path. It presents the effect of each exogenous construct on the respective endogenous construct.

The results reveal that all the independent variables have a significant effect on perceived safety except three: PPI perceived poor information ($p = 0.207$), PIS perceived insufficient space ($p = 0.882$), and PRSF perceived risk of structural failure ($p = 0.925$). It means hypotheses H2a, H3a and H7a are **rejected**.

Making reference to Table 1, the hypothesis **H2a** (*Perceived Poor Information* (*PPI*) *has a significant direct influence on Perceived Safety* (*PS*)), the results showed that the path coefficient of PPI on PS is at −0.026 with a $p < 0.207$, which is not significant. This value indicates that for every one-unit increase in the PPI, its effect on PS would even decrease by 0.207 units. It means that PPI does not have a significant

Table 1 The significant effect among the constructs

	Constructs		Estimate β	S.E.	C.R.	p	Result
PS	←	PF	0.229	0.031	7.507	***	Significant
PS	←	PPI	−0.026	0.021	−1.263	0.207	Not Significant
PS	←	PIS	0.003	0.019	0.148	0.882	Not Significant
PS	←	PPRTM	0.076	0.03	2.543	0.011	Significant
PS	←	PRS	0.035	0.017	2.068	0.039	Significant
PS	←	PRR	0.19	0.021	8.976	***	Significant
PS	←	PRSF	−0.002	0.019	−0.095	0.925	Not Significant
PS	←	PRTA	0.073	0.021	3.442	***	Significant
PS	←	PRE	0.116	0.02	5.847	***	Significant
PS	←	PRND	0.048	0.022	2.161	0.031	Significant
UB	←	PS	1.259	0.059	21.489	***	Significant

direct influence on perceived safety. Although Challenger et al. (2009) confirmed that communicating with crowd is essential in maintaining order and crowd behaviour, it is not surprising that PPI is not significant in this case because pilgrims are spiritually deep in their individual thoughts and ritual deeds that they do not pay any attention to announcements or even signs.

For hypothesis **H3a** (*Perceived Insufficient Space* (*PIS*) *has a significant direct influence on Perceived Safety* (*PS*)), the established path coefficient of PIS to PS is 0.003 ($p < 0.882$). Again, this is not statistically significant and therefore conclude that PIS does not have a significant direct influence on perceived safety. This is a surprising outcome because one would expect that the excessive congestion that clearly exceeds the recommended crowd limits per metre square PIS should be significant. Although these results differ from published studies such as Westover (1981), there are other studies that agreed with the findings, such as Alnabulsi and Drury (2014) that went further to argue that the pilgrims were high in what they term 'social identification' as Muslims. It means that the persons in a crowd act as one because they share a common social identity which increases cohesion within the crowd and in-turn increases socialising and positive feelings.

To test hypothesis **H7a** (*Perceived Risk of Structural Failure* (*PRSF*) *has a significant influence on Perceived Safety* (*PS*)), the results show $\beta = -0.002$ and $p < 0.925$. It means it does not support the hypothesis. Therefore PRSF has no significant direct influence on perceived safety. Although there was an incidence of crane on a construction site collapsing on pilgrims in 2015, this outcome is expected because pilgrims consider the building to be structurally sound especially having all elements fully cladded with concrete-like material and they do not feel any structural movement as they conduct their rituals in the mosque.

However, by again making reference to the values on Table 1, each of the following hypotheses is **supported** and discussed below:

To test the hypothesis **H1a** (*Perceived Force* (*PF*) *has a direct significant influence on Perceived Safety* (*PS*)), the path coefficient between PF and PS is significant at 0.229 ($p < 0.001$). This suggests that for every one-unit increase in the PF, its effect on PS would increase by 0.229 units. It is therefore concluded that PF has a significant direct influence on PS. This is often produced by either hearing, sensing or seeing the force as pilgrims move and perform their rituals in and around the Holy Mosque. Berlonghi (1995) has confirmed that such forces are created when density exceeds a certain level and may lead to a disaster.

Testing hypothesis **H4a** (*Perceived Poor Real-Time Management* (*PPRTM*) *has a significant influence on Perceived Safety* (*PS*)), the results show $\beta = 0.076$ and $p < 0.011$. It means that PPRTM has a significant direct influence on perceived safety. Similarly for hypothesis **H5a** (*Perceived Risk of Stampede (PRS) has a significant influence on Perceived Safety (PS)*), $\beta = 0.035$ and $p < 0.039$. It means PRS has a significant direct influence on perceived safety. Again, for hypothesis **H6a** (*Perceived Risk of Riot* (*PRR*) *has a significant influence on Perceived Safety* (*PS*)), the values of $\beta = 0.19$ and $p < 0.001$ were obtained. It also confirms that PRR has a significant direct influence on perceived safety. These results have confirmed the importance of avoiding occurrence (or near-miss occurrence) of riot and the need to ensure real-time management. Interestingly, both PPRTM and PRR are found to be more important than the risk of stampede. It means that where there is evidence of timely crowd management (crowd stop & start, re-directions & diversions, entry & exit controls) and orderliness of procession, the pilgrims tend to feel safer even if it takes longer.

For hypothesis **H8a** (*Perceived Risk of Terrorist Attack* (*PRTA*) *has a significant influence on Perceived Safety* (*PS*)), $\beta = 0.073$ and p value <0.001. This outcome supports the hypothesis that PRTA has a significant direct influence on perceived safety. The same outcome is for hypothesis **H9a** (*Perceived Risk of Explosion* (*PRE*) *has a significant effect on Perceived Safety* (*PS*)) having $\beta = 0.116$ and $p < 0.001$. Also for hypothesis **H10a** (*Perceived Risk of Natural Disaster* (*PRND*) *has a significant influence on Perceived Safety (PS)*) with $\beta = 0.048$ and value of $p < 0.031$. Although terrorist attack or explosion has never occurred in the Holy Mosque, the pilgrims clearly perceived the threat of terrorism or an explosion. Three key items made the pilgrims to feel unsafe including poor security checks at the entrances, absence of security at the courtyards, and absence of security at the major points of ritual activities. The results are supported by the work of Arana and Leon (2008), which indicated that perceive threat of terrorism directly influence the decision that persons make and the action they take. With the 2016 Hajj occurring during the hot season, it is also expected that the effect of natural disaster on PS should be significant because the factor includes sunstroke, lack of shaded areas, and lack of alternatives to reduce high temperatures. Many experts have already confirmed that high temperatures may increase aggressive behaviour, cramps, exhaustion, dehydration and heat stroke.

For the key hypothesis **H11** (*Perceived Safety* (*PS*) *has a significant direct influence on User Behaviour* (*UB*)), the value of $\beta = 1.259$ and the p value <0.001. This confirms that perceived safety has a very high impact on the behaviour of the pilgrims and the relationship is statistically highly significant. Challenger et al. (2009) agrees with this finding when they said that the sense of safety has an influence on the behaviour of people in a space.

In summary, 7 hypotheses have been supported (H1a, H4a, H5a, H6a, H8a, H9a, H10a and H11). Three have been rejected: H2a is ***rejected*** ($P = 0.207$), which means that the information provided to pilgrims during Hajj is sufficient such that it has no significant effect on the pilgrims to feel unsafe. H3a is also ***rejected*** ($P = 0.882$), which means that the space provided in the Holy Mosque or the resulting high crowd density does not affect the feeling of unsafe. H7a is also ***rejected*** ($P = 0.925$), which means that the possibility of structural and mechanical collapse does not have an effect on their perception of feeling unsafe.

5 Testing Indirect Effect (Mediation)

The study went further to examine the mediation effect (indirect effect) on the relationship between the independent and its dependent variables in the model. According to Gaskin and Lam (2016), mediation means that the effect of one variable on another is transmitted (at least in part) via a third or intervening variable. Computationally, it is the product of at least two paths that can be traced from one variable to another. It implies that to analyse the mediation effect both the direct and indirect effects must be recognised. The direct effect refers to the effect from an independent variable that goes directly to the dependent variable while the indirect effect is the effect that goes indirectly from independent to the dependent variable through the mediator variable which can either be a partial or full mediator.

To assess the existence of mediation effects, the study employed resampling producer "Bootstrapping". Awang (2015) has recognised that this test is required by researchers to confirm the effects of mediation, and it is especially used for testing the indirect effect. The mediation effects were tested using the Maximum Likelihood Bootstrapping resamples procedure in AMOS 22 with bootstrap samples of 2000, and 95% bias-corrected confidence intervals. The results, shown on Table 2 contains the parameter estimate for the regression weight, upper and lower limit of the confidence intervals, P-value, standard errors (SE), standard error estimate for the standard error (SE-SE), mean parameter estimate (Mean), bias for the parameter estimate (Bias), the standard error (SE-Bias), and type of the mediation for Perceived Safety (PS) mediating the relationship between each of the 10 critical risk factors and User Behaviour (UB). The results of all the studied paths showed that the Bootstrap estimate for the mediation effect was not biased.

To interpret the results, if the figure zero (the null) falls outside the lower and upper limit of the confidence intervals, there is significant evidence to reject the null and infer that the indirect effect is significant. If zero (the null) falls within the interval, it fails to reject the null which infer that the effect is not significant. Also, where the direct and indirect effect are both significant, the mediation type is considered to be 'partial mediation'.

From the results in Table 2, the following hypotheses were therefore **supported** because 'zero' falls outside the lower and upper limits of the confidence intervals for the respective parameters, and that there is partial mediation because the direct and indirect effects are both significant (which means PS mediates the relationship between the risk factor and UB):

- **H1b** (*PS mediates the relationship between PF and UB*)—the indirect effect of PF on UB was statistically significant ($\beta = 0.289$, $p = 0.001$) and 'zero' falls outside the lower and upper limit of the confidence intervals (0.204, 0.386).
- **H4b** (*PS mediates the relationship between PPRTM and UB*)—the indirect effect of PPRTM on UB was statistically significant ($\beta = 0.096$, $p = 0.027$) and zero falls outside the lower and upper limit of the confidence intervals (0.012, 0.192).
- **H6b** (*PS mediates the relationship between PRR and UB*)—the indirect effect of PRR on UB was statistically significant ($\beta = 0.239$, $p = 0.001$) and zero falls outside the lower and upper limit of the confidence intervals (0.183, 0.304).
- **H8b** (*PS mediate the relationship between PRTA and UB*)—the indirect effect of PRTA on UB was statistically significant ($\beta = 0.092$, $p = 0.005$), and zero falls outside the lower and upper limit of the confidence intervals (0.030, 0.150).

Table 2 The mediation effect between critical factors and UB

Parameter	β	Maximum likelihood			Bootstrap					Type of mediation
		Lower	Upper	p	SE	SE-SE	Mean	Bias	SE-Bias	
PF → PS → UB	0.289	0.204	0.386	0.001	0.046	0.001	0.289	0.001	0.001	Partial mediation
PPI → PS → UB	−0.033	−0.098	0.028	0.301	0.032	0.000	−0.034	−0.001	0.001	No mediation
PIS → PS → UB	0.004	−0.057	0.061	0.910	0.030	0.000	0.003	−0.001	0.001	No mediation
PPRTM → PS → UB	0.096	0.012	0.192	0.027	0.046	0.001	0.096	0.001	0.001	Partial mediation
PRS → PS → UB	0.044	−0.003	0.091	0.065	0.024	0.000	0.043	0.000	0.001	No mediation
PRR → PS → UB	0.239	0.183	0.304	0.001	0.030	0.000	0.240	0.001	0.001	Partial mediation
PRSF → PS → UB	−0.002	−0.049	0.047	0.947	0.025	0.000	−0.003	−0.001	0.001	No mediation
PRTA → PS → UB	0.092	0.030	0.150	0.005	0.030	0.000	0.092	0.000	0.001	Partial mediation
PRE → PS → UB	0.146	0.094	0.200	0.001	0.027	0.000	0.146	0.000	0.001	Partial mediation
PRND → PS → UB	0.060	0.001	0.124	0.048	0.032	0.000	0.061	0.000	0.001	Partial mediation

- **H9b** (*PS mediate the relationship between PRE and UB*)—the indirect effect of PRE on UB was statistically significant (β = 0.146, $p = 0.001$) and zero falls outside the lower and upper limit of the confidence intervals (0.094, 0.200).
- **H10b** (*PS mediate the relationship between PRND and UB*)—the indirect effect of PRND on UB was statistically significant (β = 0.060, $p = 0.048$), and zero falls outside the lower and upper limit of the confidence intervals (0.001, 0.124).

However, the following 4 hypotheses were **rejected** because the indirect effect is statistically not significant and 'zero' falls within the lower and upper limit of the confidence intervals. Evidently, both the direct and indirect effects are not significant which confirms 'no mediation'. It therefore concludes that Perceived Safety (PS) **does not mediate** the relationship between the respective safety factor and User Behaviour (UB):

- **H2b** (*PS mediates the relationship between PPI and UB*)—the results indicate that the indirect effect of PPI on UB was statistically not significant (β = −0.033, $p = 0.301$), zero falls within the lower and upper limit of the confidence intervals (−0.098, 0.028).
- **H3b** (*PS mediates the relationship between PIS and UB*)—the results indicate that the indirect effect of PIS on UB was statistically not significant (β = −0.004, $p = 0.910$) and zero falls within the lower and upper limit of the confidence intervals (−0.057, 0.061).
- **H5b** (*PS mediates the relationship between PRS and UB*)—this indicates that the indirect effect of PRS on UB was statistically not significant (β = −0.044, $p = 0.065$), clearly zero falls within the values of the lower and upper limit of the confidence intervals (−0.003, 0.091).
- **H7b** (*PS mediates the relationship between PRSF and UB*)—the results show that the indirect effect of PRSF on UB was statistically not significant (β = −0.002, $p = 0.947$), and that zero falls within the lower and upper limit of the confidence intervals (−0.049, 0.047).

To summarise the outcomes, the rejected hypotheses could be interpreted as follows: H2b is rejected which means that the information provided to the pilgrims during Hajj event could be adequate; H3b is also rejected which means that the space provided in the Holy Mosque or the resulting high crowd density does not affect the pilgrims such that they become stressed or anxious; H5b is also rejected which means that although the risk of stampede influence the pilgrims perception of safety, the perception does not mediate its influence on the behaviour of the pilgrim in the Holy Mosque; and H7a is also rejected which means that pilgrims' perception of the possibility of structural and mechanical collapse does not have an effect on their behaviour.

6 Conclusion

The paper discussed the direct and indirect effect among the variables. It tested the proposed Structural Equation Model (SEM) and presented the interrelationships among the variables including twelve constructs (Perceived Force, Perceived Poor Information, Perceived Insufficient Space, Perceived Poor Real Time Management, Perceived risk of Stampede, Perceived risk of Riot, Perceived risk of Structural Failure, Perceived risk of Terrorist Attack, Perceived risk of Explosion and Perceived risk of Natural Disaster, Perceived Safety and User Behaviour). The overall findings have established that there is a direct influence of perceived safety (PS) on the pilgrims' behaviour (UB) in the Holy Mosque. The research provides convincing evidence that perceived safety should never be overlooked when determining the level of safety (safe condition) of a crowded large space building. It has established that seven (7) major factors have a direct influence on perceived safety, namely (in the order of significance): perceived force, perceived risk of riot, perceived risk of explosion, perceived poor real time management, perceived risk of terrorist attack, perceived risk of natural disaster, and perceived risk of stampede. With the exception of the perceived risk of stampede, these factors also have an indirect effect on user behaviour. Raineri (2015) has already established that crowd behaviour is a major factor in crowd disaster, it is therefore plausible to conclude that anything that significantly influences crowd behaviour could result in an unsafe situation that could lead to a disaster.

The analysis of the direct effects revealed that 9 hypotheses were supported, but 3 variables do not have a significant effect on perceived safety, namely: Perceived Poor Information ($p = 0.207$), Perceived Insufficient Space ($p = 0.882$), and Perceived risk of Structural Failure ($p = 0.882$). This paper also discussed the results of the mediation effect (indirect effect) on the relationship between the independent and its dependent variables in the model. The results found that there were significant indirect relationships between 6 safety factors (namely: perceived force, perceived poor real time management, perceived risk of a riot, perceived risk of terrorist attack, perceived risk of explosion, perceived risk of natural disaster) and user behaviour.

The paper suggests that the emphasis on expansion of the Holy Mosque as a mitigating strategy helps in objective safety provision, but it is not sufficient to provide a safe condition. It also suggests that Space (PIS), Information (PPI) and Structural failure (PRSF) are not the most critical subjective safety factors for Facilities Managers to worry about. The important items are: an orderly procession of pilgrims to prevent perceived force (PF) or risk of riots (PRR); provision of better and reliable hard services to mitigate the risk of explosion (PRE); and better security screening to decrease risk of terrorist attack (PRTA).

The following recommendations are made to enhance safety at the Holy Mosque:

- It is recommended that risk assessment should include an additional section to address subjective safety;
- To enhance the confidence of pilgrims as they go into the Holy Mosque, it is recommended to deploy an effective use of modern technology to control the

inflow and outflow of the crowd by counting the actual numbers of people that enter and exit the Holy Mosque to effectively control the capacity and to avoid extreme high density in the Holy Mosque at all times. The information could also be used to effectively plan the rate of arrivals of pilgrims to the Holy Mosque at peak times during Hajj to help avoid large gatherings at the entrances and exits as the pilgrims queue to enter the Mosque;

- Provide effective maintenance of all M&E hard services in the facility to avoid likelihood of failure or explosion;
- Provide a form of security screening system at entrances that can reliably reduce the risk of terrorist attack and improve the confidence of pilgrims;
- Deploy appropriate strategies to mitigate unnecessary occurrence of perceived force e.g. to stop pilgrims from moving in the opposite direction of Tawaf; to stop 'large groups' from performing the Tawaf at the ground floor level.

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