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Fire safety protection motivation and preparedness in Irish apartments: A Post-Grenfell analysis

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- Responsibility
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- Apartment Fire

Abstract

This study used an extended version of Protection Motivation Theory (PMT) to identify the variables that influence fire safety preparedness in apartment buildings. PMT was extended to include an individual's perceived responsibility for fire safety within their building.

A survey of 455 respondents living in apartments in Dublin, Ireland, was undertaken to ascertain the level of fire safety awareness and preparedness among residents. Data analysis included correlations, ordinary least squares regressions and probit analysis.

The findings reveal a worrying lack of preparedness and that fire safety preparedness motivation is complex, sometimes producing counterintuitive results. For example, a high level of worry about a fire increased the probability that a respondent tested their smoke detector(s) by 27.4 pp, yet was associated with a 33.3 pp reduction in the probability that a respondent acted in line with the building evacuation policy. The factors which influenced preparedness motivation also varied depending on the specific safety measure. For instance, assuming a personal responsibility for fire safety in the building was positively associated with perceived preparedness and having an extinguisher or fire blanket. Conversely, no relationship was observed between personal responsibility for fire safety and the presence of household fire plans, appropriate fire alarm response behaviour, or smoke detector testing.

The critical contribution of this study is the identification of factors that act as barriers to, or facilitators of, fire safety in residential apartments. Understanding what drives fire safety can be used to enhance the effectiveness of preparedness messaging to inform public fire safety campaigns.

Abbreviations: PMT, Protection Motivation Theory; PCI, Public, Commercial and Industrial.

1. Introduction

1.1. Background and context

The risks associated with fires in residential accommodation are complex due to factors such as occupancy density, building type, the behaviour of residents, the level of fire risk awareness and preparedness, and the influence of a wide range of socio-demographic characteristics (Canter, 1990; Kobes et al., 2010; Glauberman and Qureshi, 2018). These risks are heightened in high-rise, multi-unit apartments, making the need for fire safety and risk mitigation measures within these buildings even more critical. In their review of human behaviour in fires, Thompson et al. (2018) made the distinction between residential and PCI (public, commercial and industrial) fires and, within residential fires, distinguished between those in single occupancy homes and high-rise multi-occupancy buildings. They suggested high-rise dwellings incorporated features of both PCI and single occupancy homes, i.e., they have both communal areas and private spaces and, while less formal than in PCIs, apartment buildings also tend to have some form of building management, all of which influence fire safety management.

The Grenfell Tower fire in London, June 2017, brought the risk of fire within residential apartments to the forefront of government and public attention. In the aftermath of this tragedy and out of concern for the safety of residents living in similar circumstances, the Irish Government instigated a national review of fire safety, including an audit of multi-storey, multi-unit apartment buildings (Murphy, 2017). Completed in May 2018, the review called for further research to determine "the extent to which fire safety measures are in place in peoples' homes and the public's understanding of risk in the domestic setting with a view to informing further fire safety campaigns" (NDFEM, 2018, p.24). In response to the call, this study explored the factors influencing fire safety preparedness within Irish residential apartments in order to provide critical insight into fire safety preparedness and make a theoretical and practical contribution to fire safety research.

Previous research has shown that fire preparedness actions taken by residents were influenced by knowledge and experience, perceived responsibility, and risk awareness (Kobes et al., 2010; McLennan et al., 2013). However, risk awareness alone has been shown to have only a weak correlation with positive fire safety behaviour (McCaffrey, 2008). While fire safety campaigns are used to promote good practice in the home, influence attitudes, and raise public awareness of the preparedness measures that should be implemented (Department of Housing, Planning and Local Government, 2019), risk communication and fire safety campaigns must be built upon sound research and a greater understanding of the specific factors which promote good fire safety behaviour if they are to influence protection motivation.

2. Research objectives

The objectives of this study were twofold: firstly, to examine the level of fire safety awareness and preparedness within residential apartments, and secondly to determine the factors that motivate or deter apartment residents from adopting fire safety measures in their homes by applying an extended Protection Motivation Theory (PMT) model (see Section 2.1 for an overview of PMT).

A range of models have been developed to explain and predict behaviour intentions and actual behaviours (Jansen and van Schaik, 2017) when faced with perceived risks or hazardous situations. The most prominent of these models include PMT (Rogers 1975; Maddux and Rogers, 1983), the Protective Action Decision Model (Lindell and Perry, 2000), the Health Belief Model (Rosenstock et al., 1988) and the Reasoned Action Approach (Fishbein and Ajzen, 2010). The key strengths of PMT, as outlined by Jansen and van Schaik (2017, p.167), include its applicability to a range of scenarios, the fact it has "evolved over time towards a powerful explanatory theory for precautionary behaviour", and unlike some adoption theories, PMT includes the concept of risk. PMT focuses on the

"cognitive processes that individuals apply in order to evaluate threats and coping measures" (Jansen and van Schaik, 2017, p.167), where theories such as the Health Belief Model consist of a set of variables that have an effect on behaviour. Finally, a key strength of PMT is its value as a framework on which interventions and communication campaigns may be developed and evaluated (Norman et al., 2005).

While PMT has been used to examine emergency preparedness behaviours in several risk contexts: earthquakes (Mulilis and Lippa, 1990), flooding (Grothmann and Reusswig, 2006; Poussin et al., 2014; Bubeck et al., 2018), and wildfires (Martin et al., 2007; Westcott et al., 2017) it has not been applied to apartment fires. Given the limited research focused on apartment fires (Glauberman and Qureshi, 2018), it is unknown whether the same factors that influence protection motivation apply. For example, individuals may feel a greater sense of control over residential fires than over risks such as floods, hurricanes, and earthquakes (Stumpf et al., 2017).

2.1. Protection motivation theory

Rogers first proposed PMT as a model which described a person's motivation to protect themselves within the context of health-related risks (Rogers, 1975; Maddux and Rogers, 1983). At the centre of PMT are two key determinants of preparedness behaviours. The first is threat appraisal which is described as the process used to evaluate risk (Rogers and Prentice-Dunn, 1997). Sometimes likened to risk perception (Grothmann and Reusswig, 2006), it is the "subjective judgment[s] that people make about the characteristics and severity of a risk" (Darker, 2013, p.110), threat appraisal can be described as an individual's assessment of their vulnerability (perceived likelihood of a risk occurring) and the risk severity (perceived impact should a risk occur) (Rogers and Prentice-Dunn, 1997). Connected with threat appraisal are factors such as fear and worry (Babcicky and Seebauer, 2019; Rogers, 1975), which play a secondary role in the threat appraisal process (Rogers and Prentice-Dunn, 1997). Fear and worry influence how an individual assesses risk and their decision to take protective action (Miceli et al., 2008; Reynaud et al., 2013).

According to PMT, the second key determinant of preparedness behaviour is coping appraisal, an individual's assessment of their perceived ability to cope and mitigate risk (Rogers and Prentice-Dunn, 1997). Three variables inform the coping appraisals (Rogers and Prentice-Dunn, 1997; Grothmann and Reusswig, 2006): 1) response efficacy: the perceived effectiveness of the protective action; 2) self-efficacy: an individual's perceived capability to carry out the protective action; 3) cost-efficacy: the perceived costs (time and financial costs) associated with adopting the protective action. PMT suggests a person will be motivated to take preparedness action if they think that the risk posed is high (a high threat appraisal), and if they perceive that the protective action(s) available are effective, feasible to implement, and not too costly (a high coping appraisal) (Rogers and Prentice-Dunn, 1997; Grothmann and Reusswig, 2006; Poussin et al., 2014). Furthermore, the intention to prepare for an emergency may also be influenced by several other variables (Grothmann and Reusswig, 2006; Martin et al., 2007; Poussin et al., 2014), including:

- Prior exposure to an emergency;
- Fatalism, denial, and wishful thinking – commonly described as non-protective responses;
- Socio-economic variables such as age, gender and homeownership.

This study extends PMT by including a measure for personal responsibility (Mulilis and Duval, 1997; Mulilis et al., 2001). It was necessary to consider personal responsibility for fire safety as research showed a significant relationship between this and the taking of protective actions (Beringer, 2000; Martin et al., 2007; McCaffrey et al., 2011; McNeill et al., 2013).

3. Methods

3.1. Research design

This study used a cross-sectional design with a sample of 455 respondents drawn from residents of apartments in Dublin. Data collection employed a survey methodology, using a questionnaire designed on the Qualtrics platform. Academic and government questionnaires informed the questionnaire design (FEMA, 2015; Grothmann and Reusswig, 2006; Martin et al., 2007; Terpstra and Lindell, 2013; Poussin et al., 2014). To help ensure accuracy and validity, the questionnaire was pilot-tested with specialists in emergency management and members of the public to refine the questions based on their feedback before its distribution.

The extended version of PMT measured the key determinants of preparedness behaviours, namely: threat appraisal in the form of respondent's risk ratings (likelihood*impact ratings), the influencing factors concern and worry, and coping appraisal through response-efficacy, self-efficacy, and cost-efficacy. Other PMT-related variables recognised in the literature as affecting preparedness were: fatalism (associated with non-protective responses) and direct and indirect exposure to fire. Additionally, several measures related to fire safety and preparedness (e.g., declaring the smoke detector(s) were tested and evidence of fire evacuation plans) were included. Each variable is defined in Section 3.3.

3.2. Data collection procedure

This research complies with the University's research ethics policy. The study, classified as a low-risk social research project, was approved by the Business School Research Ethics Sub-Committee. In line with this policy, participation was voluntary, responses were anonymous, participants received a plain language statement before completing the questionnaire, and respondents provided informed consent before proceeding.

A sample of seven high-rise apartment complexes from a diverse range of locations in Dublin city were randomly selected from the Dublin Fire Brigade database. An overview of the research and its objectives were outlined in a leaflet format and 1500 of these flyers were printed and then distributed at the seven apartment complexes between April 26th and May 27th, 2018.

Similar to McLennan et al. (2015, p.41), it was not "practical (in light of budget and time constraints) to conduct a mail survey of residents, nor to conduct interviews with selected individual householders". Instead, an occupant from each apartment was asked to participate by completing the online questionnaire (linked via URL and QR code). Once the participant opened the online link, they received the plain language statement explaining the purpose of the study and were then directed to the questionnaire. Apartment occupants also shared the questionnaire online, thus participants extended beyond the seven sites originally identified.

3.3. Measures

3.3.1. Dependent variables

General household preparedness tends to be measured using indicators such as the quantity of emergency-related items/resources within the home, existence of an emergency plan, physical protection measures, and preparedness actions (Kirschenbaum, 2002; Levac et al., 2012). Following this approach, a set of four actual fire safety preparedness measures were identified:

1. Having a fire blanket or fire extinguisher (NDFEM, 2013; Knuth et al., 2017);

2. Smoke detector testing (at least yearly testing of the fire detection and alarm systems);
3. Acting in line with the fire evacuation policy for the building (Proulx, 1995; Proulx, 1999; NDFEM, 2018);
4. Having a household emergency plan (Department of Homeland Security, 2018; Red Cross, 2018; Paton et al., 2005).

In addition to these four actual preparedness indicators, respondents were asked to rate their perceived level of preparedness for an apartment fire. Research into household preparedness suggests a weak relationship between perceived preparedness and actual preparedness (Kapucu, 2008; Basolo et al., 2009; Kirschenbaum et al., 2017; Brown et al., 2021a,b). To minimise order effects bias, the effect of the sequencing of questions on the nature of a respondent's answer (Perreault, 1975), perceived preparedness was measured early within the questionnaire before respondents were shown any other fire preparedness-related questions. An 11-point scale measured perceived preparedness within the questionnaire, shown to respondents as a scale from 0% to 100%, at intervals of 10%.

Having a fire blanket or a fire extinguisher was coded as 1 if respondents reported having either resource within the apartment and 0 if they reported having neither.

Smoke detector testing measured the frequency with which the apartment's smoke detector(s) were tested. Responses were coded as 0 if respondents were not aware of the frequency of testing or if they did not test the smoke detector(s) at least once a year. The remainder of the sample, coded as 1, declared the detector(s) were tested between "more than once a month" to "once a year".

Research suggested that a variety of factors may influence occupants' behaviour upon hearing an evacuation alarm. For example, slower evacuations were more likely late in the evening or during the night when "occupants may be asleep, not dressed, etc. (i.e., they are not ready to evacuate)" (Ronchi and Nilsson, 2013, p.6). Others may be hesitant to evacuate, sometimes only leaving when directly instructed to do so. Finally, some choose to ignore the recommended evacuation route opting instead for their most familiar exit route (Proulx, 1995; Proulx, 1999). In the absence of direct observation, respondents were asked to confirm they would act in line with the building evacuation policy in response to a fire alarm, coded as 1, and coded as 0 for those declaring they would not follow the evacuation policy, e.g., investigate the fire alarm or ignore the fire alarm.

Having a household emergency plan was coded as 1 if respondents have an apartment fire or evacuation plan and 0 otherwise.

3.3.2. Explanatory variables

Drawing from the literature and informed by an extended version of PMT (see Section 2.1), several explanatory variables likely to influence fire safety behaviours were selected.

Threat appraisal is indicated by three variables: risk rating, worry, and concern. According to PMT, a higher threat appraisal was expected to lead to a higher motivation to prepare and a greater likelihood of protective action (Rogers and Prentice-Dunn, 1997). However, this relationship between perceived risk and taking protective action is not always evident empirically. For example, Kinateder et al. (2014; 2015) in a review examining the association between perceived risk and evacuation behaviour during the attacks on the World Trade Center on September 11th, 2001, found conflicting results between studies.

To be consistent with other PMT related studies, a risk rating was used (see, Grothmann and Reusswig, 2006; Martin et al., 2007; Poussin et al., 2014; Babcicky and Seebauer, 2019). Risk rating was measured as the likelihood of a fire occurring multiplied by the impact should it occur.

Likelihood and impact were assessed on five-point Likert scales from the Irish National Risk Assessment process (McMullan et al., 2018; Brown et al., 2021a,b). Likelihood was scaled from extremely unlikely to very likely, and impact ranged from very low to very high.

Worry and concern regarding the risk of fire were measured using two independent scales. Worry about an apartment fire was measured using a four-point scale, from no worry up to a high level of worry. The probit models (see Section 3.3.3) included three dummy variables to capture worry levels, using "no worry" as the base category. The factor "concern (fire alarm)" measured how respondents reported feeling when a fire alarm was activated in their building using an 11-point scale and was shown to respondents as a percentage from 0% to 100%, with 10% intervals. 0% indicated staying calm or relaxed, and 100% indicated nervousness or fear.

PMT indicates that higher coping appraisal results in greater motivation to prepare and a higher likelihood of protective action (Rogers and Prentice-Dunn, 1997). Coping appraisal was captured using a dummy variable. This was coded 1 if respondents satisfied the requirements for a high coping appraisal, i.e., selected none of the statements below as applicable to them, and 0 otherwise.

- Related to response-efficacy: "Nothing I do to prepare will help should this emergency occur"; "I don't think it will make a difference".
- Related to self-efficacy: "I don't know what to do"; "I will cope as I am".
- Related to cost-efficacy: "I haven't had time"; "It was too expensive".

The questionnaire included six non-protective response options to account for respondents who adopt a more fatalistic perspective towards the risk of an apartment fire. These related to fatalism, denial, and wishful thinking: "I don't want to think about it"; "I was okay during a previous fire; therefore, I will be okay in the future"; "The buildings fire suppression system will protect me"; "Others will help me, e.g. the emergency services, community members, etc."; "I'm renting, it's the landlord's responsibility"; "I do not need to prepare for this emergency". According to Grothmann and Reusswig (2006), non-protective responses should negatively affect respondents' motivation to prepare and reduce the likelihood they will take protective action. Respondents who presented at least one fatalistic reason for not taking action ("non-protective response") were coded as 1, 0 otherwise.

Stumpf et al. (2017, p.101) recommended that future studies on residential fires consider not just whether respondents had previous experience of such fires, but should differentiate based on the closeness of the experience, "fire at their own home, in someone else's house, etc.". The importance of indirect experience was also emphasised by Becker et al. (2013, p.1718), who found it "could prompt people to think about safety or undertake safe practices". PMT-related research by Grothmann and Reusswig (2006) and Poussin et al. (2014) suggested that risk exposure can positively influence motivation to prepare, which can result in a higher likelihood of protective action. To measure prior exposure to a household fire, respondents were asked whether they had experienced a fire directly or indirectly (someone close to them has experienced a fire). Responses were recorded as two dummy variables.

Respondents were asked to identify with whom they felt responsibility for fire safety within the apartment building lay (termed perceived responsibility). Respondents could select multiple options: "The apartment management company"; "The residents"; "Landlords"; "The fire service"; and "Unsure". In the regression, perceived responsibility for fire safety was coded as a dummy variable. Respondents who perceived the residents hold joint responsibility for fire safety within the apartment building were coded as 1. Those who did not indicate residents were responsible were coded as zero. Taking some responsibility for fire safety was expected to be positively related with protective actions (McCaffrey et al., 2011; McNeill et al., 2013).

Additional factors measured within the questionnaire included:

- Awareness of the presence of an evacuation plan (or set of evacuation instructions) located inside the apartment or within the building's hallway. The purpose of an evacuation plan is to support residents in attaining situational awareness and inform decision making when evacuating a building (Craighead, 2009). It was hypothesised that a positive relationship would exist between an awareness of the displayed evacuation plan and three dependent variables: following the buildings evacuation policy, having a household fire/evacuation plan, and perceived preparedness.
- Whether they received fire safety training/evacuation instructions at their apartment complex or at work/school/college/university. Receiving such training should positively influence motivation to prepare and result in a higher likelihood of protective action.
- Respondents were also asked whether they would try to extinguish a fire or call for help if they discovered a small fire within their apartment. Willingness to fight a small fire was hypothesised to have a positive relationship with perceived preparedness, having a fire blanket or fire extinguisher, and having a household fire/evacuation plan.

Table 1 defines these variables and Table 2 describes the respondents' socio-demographic characteristics.

Table 1
Data description: dependent and explanatory variables.

Characteristic	Summary Statistics	Description
Perceived Preparedness	**N=435**	
Mean (Standard Deviation)	5.05 (2.45)	Range 0 (Not at all prepared) - 10 (Completely prepared)
Fire Blanket or Fire Extinguisher	**N=347**	
Has a fire blanket or fire extinguisher	68.6%	1 if yes, 0 otherwise
Household Emergency Plan	**N=359**	
Has a household emergency plan	60.7%	1 if yes, 0 otherwise
Building Evacuation Policy	**N=355**	
Follows the building evacuation policy	65.4%	1 if yes, 0 otherwise
Smoke Detector(s) Tested	**N=337**	
Aware of a test at least once a year	60.8%	1 if yes, 0 otherwise
Risk Rating	**N=455**	
Mean (Standard Deviation)	13.03 (5.65)	Range 1-25, Mode: 12
Worry	**N=455**	
No worry	19.1%	Reference category
Low level of worry	39.1%	1 for Worry: Low, 0 otherwise
Moderate level of worry	29.0%	1 for Worry: Moderate, 0 otherwise
High level of worry	12.7%	1 for Worry: High, 0 otherwise
Concern (Fire Alarm)	**N=435**	
Mean (Standard Deviation)	4.85 (2.5)	Range 0 (No concern) -10 (Very concerned)
Coping Appraisal	**N=359**	
High coping appraisal	69.6%	1 if high coping appraisal, 0 otherwise
Non-protective Responses	**N=359**	
Selected a fatalistic reason for not taking action	15.3%	1 if respondents presented at least one reason for not taking action, 0 otherwise
Prior Exposure to a Household Fire	**N=416**	
Directly experienced a fire	30.5%	1 if yes, 0 otherwise
Indirectly experienced a fire	16.1%	1 if yes, 0 otherwise
Responsibility for Fire Safety	**N=337**	
The residents	59.1%	1 if respondents perceived joint responsibility for fire safety, 0 otherwise
The apartment management company	65.3%	
Landlords	22.8%	
The fire service	12.5%	
Unsure	4.5%	
Received Safety Instruction Apartment	**N=330**	

Apartment	12.1%	1 if received safety instruction at apartment, 0 otherwise
Received Safety Instruction Workplace	**N=333**	
Workplace	90.4%	1 if received safety instruction at work/school/college/university, 0 otherwise
Willingness to Fight Fire	**N=347**	
Expect they would try to extinguish a fire	36.9%	1 for willingness to fight a fire, 0 otherwise
Displayed Evacuation Map (Aware)	**N=357**	
Awareness of the evacuation plan	43.4%	1 for awareness of evacuation map, 0 otherwise

Table 2
Socio-demographic characteristics.

Characteristic	Summary Statistics	Description
Gender	**N=334**	
Female	50%	1 if female, 0 otherwise
Age	**N=334**	
34 or under	24.6%	Reference category
35-54	63.5%	1 if aged 35-54, 0 otherwise
55 or older	12%	1 if aged 55 or older, 0 otherwise
Child/Children (age<18) in the Apartment	**N=331**	
At least one child present	23.3%	1 for child present, 0 otherwise
Education	**N=334**	
Higher Educated	71.9%	1 if higher educated, 0 otherwise
Household Income	**N=326**	
Below 30,000	12.3%	Reference category
30,000-70,000	61.7%	1 for income 30,000-70,000, 0 otherwise
Over 70,000	26.1%	1 for income over 70,000, 0 otherwise
Rents or Owns the Apartment	**N=334**	
Renting	42.2%	Excluded from the probit analysis
Household Insurance	**N=333**	
Insurance	58.3%	1 for home is insured, 0 otherwise
Ethnicity	**N=332**	
White	97.6%	Excluded from the probit analysis
Reported Physical Disability	**N=429**	
Physical Disability which impacts fire preparedness actions	0%	Excluded from the probit analysis
Floor Apartment is Situated on	**N=455**	
Ground or Basement	20.4%	Combined in reference category
1st Floor	24.2%	Combined in reference category
2nd Floor	22.2%	Combined in reference category
3rd Floor	15.6%	Combined in reference category
4th Floor	8.8%	Combined in reference category
5th Floor or higher	8.8%	1 for 5th floor or higher, 0 otherwise
Number of Floors in the Apartment Block	**N=445**	
Two floors or less	11.5%	Combined in reference category
Three floors	28.5%	Combined in reference category
Four floors	22.2%	Combined in reference category
Five floors	19.6%	Combined in reference category
Six or more floors	18.2%	1 for six or more floors, 0 otherwise

3.3.3. Quantitative data analysis

Analysis was completed using the statistical software package STATA (StataCorp: Release 14.2/SE). Regression analysis was used to estimate the relationship between each of the five dependent

variables discussed above and the same set of explanatory variables. For each dependent variable, Y*, we have:

> *Y* = f [threat appraisal (risk rating, concern, worry), coping appraisal, non-protective response, prior exposure to fire, perceived responsibility for fire safety, safety training, willingness to fight fire, insurance, evacuation awareness, socio-demographics]*

The functional form underlying each regression is: $Y_i^* = X_i\beta + \varepsilon_i$, i = 1…N (Equation 1), where Y_i^* is the value of the dependent variable for individual i, X_i is the $(1xk)$ vector of explanatory variable values for individual i, $\varepsilon_i \sim N(0, \sigma^2)$ is the random error term for individual i, β is the $(kx1)$ vector of coefficients to be estimated, and N is the total number of observations.

For the continuous dependent variable, perceived preparedness, Ordinary Least Squares (OLS) regression was used to estimate β. The OLS results are presented as Model 1 in Table 6. Included are partial eta-squared values (η_p^2) as measures of effect size. For each independent variable, η_p^2 measures the proportion of the variance in the dependent variable explained by that independent variable, having partialled out the contribution of all other independent variables. The benchmark values for small, medium and large effects are taken as 0.01, 0.09 and 0.25 respectively (Cohen 1988).

For each of the four binary variables (fire blanket or fire extinguisher, household fire/evacuation plan, follow the building evacuation policy, and smoke detector(s) tested at least once a year), coefficients were estimated using Probit analysis. It was assumed that for each binary dependent variable, there exists an unobservable continuous variable Y^*, with observations described by Equation 1. This latent variable can be thought of as a measure of the 'tendency' to take protective action. The observed variable, the binary counterpart, Y, is defined as $y_i = 1$ if $Y_i^* > 0$, and 0 otherwise. Under normally distributed error terms, the likelihood of a single observation $(y_{i,} X_i)$ is given by $L(\beta, y_i, X_i) = F(X_i\beta)^{y_i}\,(1 - F(X_i\beta))^{1-y_i}$, where $F(.)$ is the cumulative normal distribution. Given independently and identically distributed (IID) observations, the product $L(\beta, Y, X) = \prod_{i=1}^{N} F(X_i\beta))^{y_i}\,(1 - F(X_i\beta))^{1-y_i}$ is the likelihood of the entire sample. The coefficient vector was estimated as that which maximises the likelihood of the observed sample. That is, β was estimated by Maximum Likelihood Estimation.

Estimated coefficients for the binary dependent variable models are reported as Models 2 to 5 in Tables 6 and 7.

The magnitudes of the impact of explanatory variables on the binary dependent variables are identified more readily in the marginal effects presented in Table 8. These report the change in the predicted probability of observing a 1 on the dependent variable given a unit change in the independent variable. The marginal effect of each independent variable is computed assuming the values of all other explanatory variables at their means.

Where a socio-demographic factor was non-significant across all dependent variables, and where its exclusion improved the OLS-adjusted R^2 and the probit model fit statistic (the percentage of cases correctly classified), the factor was removed from the final model. This resulted in "Renting" being removed from the model. As none of the respondents declared a physical disability and only eight were non-white, these factors could not be tested.

For both the OLS regression and probit analyses, checks for multicollinearity were conducted. The Variance Inflation Factor (VIF) scores did not indicate a problem of multicollinearity, with the maximum VIF at 2.75 and a mean VIF score of 1.42. Thus, these were within acceptable limits as a

VIF score of five or over indicates multicollinearity (O'Brien, 2007). In addition, the analysis used robust standard errors to address any concern of heteroscedasticity.

4. Results and discussion

4.1. Fire safety behaviours: Awareness and preparedness levels

In Ireland, it is a legal requirement for apartment complexes to have smoke detectors fitted and that those in control of the apartment building "take all reasonable measures to guard against the outbreak of fire on such premises, and to ensure as far as is reasonably practicable the safety of persons on the premises in the event of an outbreak of fire" (Fire Services Act 1981, Section 18-2). Therefore, it was not surprising that the results show that 97.4% of respondents reported having a smoke detector within their apartment. In addition to having a smoke detector, the smoke detector must be tested regularly. Fire safety campaigns across Ireland are used to encourage weekly smoke detector testing, for example, the "Test-It-Tuesday" media campaign (NDFEM, 2018). However, the results showed that nearly 40% of respondents declared their smoke detector(s) were not tested at least once a year. Of the remaining 60.8% who did, only 6.8% (23n) declared that the smoke detector(s) were tested more than once a month, with 16.9% (57n) reporting smoke detector tests once a month, 24.9% (84n) once every six months and 12.2% (41n) once a year. This finding is in line with the results of McMullan et al. (2015) and confirms that the concerns of the NDFEM were justified: "it is not as clear that all are tested and are functioning at this high percentage" (NDFEM, 2018, p.22). The results suggest that although there has been an uptake in the installation of domestic smoke detectors, there remains a need for ongoing national smoke detector testing campaigns.

Overall, only 52.4% (175n) of respondents knew of a fire blanket within their apartment. Although legislation within Ireland stipulates that rental properties within multi-unit buildings must include smoke detector(s), an emergency evacuation plan, and a suitably located fire blanket (Housing (Standards for Rented Houses) Regulations, 2017), 43.3% (61n) of renters were not aware of a fire blanket within their apartment. This compares with 50.8% (98n) of owners. A chi-square test of association was undertaken to test for a connection between ownership/rental status and awareness of an apartment fire blanket. The results revealed no significant association.

With regard to respondents' awareness of the presence of a fire evacuation plan, the findings revealed that only 43.4% (155n) of respondents reported they knew of a displayed fire evacuation plan. Further testing of ownership/rental status and awareness of a displayed fire evacuation plan, using a chi-square test of association, suggested no significant connection. Only 12.1% (40n) indicated they had received instruction or training in fire safety/evacuation at their apartment complex, although 90.4% (301n) had received similar training at work, school or college/university.

The findings concerning other safety-related emergency resources are shown in Table 3, with seven of the ten items being held by at least 50% of respondents. Table 3 shows that where a respondent does not have the resource, in most instances, there is an almost 50% split between them stating "No", they do not have the item, and "No, though I should get this". This suggests a further willingness by some respondents, if motivated, to take additional responsibility and enhance their fire safety preparedness.

Table 3
Safety-related emergency resources.

Resource	%(n)	Resource	%(n)
Smoke detector		**Fire extinguisher**	
No	2% (7n)	No	22.8% (79n)
No, though I should get this	0.6% (2n)	No, though I should get this	22.5% (78n)
Yes	97.4% (338n)	Yes	54.8% (190n)
Carbon monoxide detector		**Fire blanket**	
No	26.2% (91n)	No	22.8% (79n)
No, though I should get this	21.9% (76n)	No, though I should get this	24.8% (86n)
Yes	51.9% (180n)	Yes	52.4% (182n)
First aid kit		**Emergency contact information (Paper format)**	
No	16.7% (58n)	No	44.1% (153n)
No, though I should get this	19.9% (69n)	No, though I should get this	36% (125n)
Yes	63.4% (220n)	Yes	19.9% (69n)
Torch		**Extra batteries**	
No	12.1% (42n)	No	19.6% (68n)
No, though I should get this	12.4% (43n)	No, though I should get this	16.7% (58n)
Yes	75.5% (262n)	Yes	63.7% (221n)
A protective container for documents		**Emergency evacuation smoke mask**	
No	48.4% (168n)	No	64% (222n)
No, though I should get this	38.9% (135n)	No, though I should get this	34% (118n)
Yes	12.7% (44n)	Yes	2% (7n)

Notes: N=347

Given that fire preparedness actions taken by residents may be influenced by perceived responsibility for fire safety in the building (Kobes et al., 2010, McLennan et al., 2013) ten chi-square tests of association were completed: four of the ten tests show a significant association with residents' perceived responsibility. These were for having a fire extinguisher, χ^2 (df=1, n=337) = 6.374, p=.012, phi = .14; having a first aid kit, χ^2 (df=1, n=337) = 9.839, p=.002, phi = .17; having a torch, χ^2 (df=1, n=337) = 9.538, p=.002, phi = .17; and having extra batteries, χ^2 (df=1, n=337) = 4.488, p=.034, phi = .12. This indicated the presence of a small, statistically significant association between each of the four emergency resources and residents' perceived responsibility for fire safety in the building.

Hulse et al. (2020) found that personal experience of fire was significantly positively associated with a willingness to attempt to extinguish flames. A chi-square test of association was completed to examine whether respondents' experience of a fire (direct or indirect) influenced willingness to fight apartment fires. The test was not significant, suggesting no significant association between experience of a fire (direct or indirect) and a willingness to fight apartment fires.

Considering fire safety actions taken to protect an apartment, Table 4 shows that 33.1% of respondents indicated they had not taken action. When asked why not, 42.8% of those who stated a reason reported they did not know what action they could undertake, suggesting a greater need for preparedness communication messages designed to assist households in understanding what preparedness actions they should take to mitigate the dangers posed by an apartment fire.

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preparedness communication messages designed to assist households in understanding what preparedness actions they should take to mitigate the dangers posed by an apartment fire.

Table 4

Household barriers to fire safety actions.

	%(n)
Protective Actions	
Acted to protect apartment = Yes	**66.9% (291n)**
Stated Reason(s) for Inaction	**31.7% (138n)**
Don't know what to do	42.8% (59n)
Renting, i.e., the landlord/ management company should take the action	14.5% (20n)
Will cope without needing to prepare	13% (18n)
Don't think it will make a difference	13% (18n)
The building is safe and has a fire system/alarm	9.4% (13n)
Don't want to think about it	8% (11n)
Don't have the time	7.2% (10n)
Others will help me (e.g., emergency services)	7.2% (10n)
Too expensive	4.3% (6n)
Was okay during a previous fire; therefore, I will be okay in the future	0.7% (1n)
No Reason for Inaction Provided	**1.38% (6n)**

Note: N=435

Respondents were asked how they would react when a fire alarm activation occurs in their building. They could select their answer from several choices, as listed in Table 5. If they indicated they would not follow the evacuation policy in response to a fire alarm, they were asked to explain their rationale. In total, 34.6% reported they would not act in line with the fire evacuation policy for their building. 12.4% suggested they first look to neighbours for guidance, and 10.7% suggested they either ignore the alarm or wait until instructed to leave the apartment. For 62.4% of those who did not follow the policy, the reasons given was the "cry wolf" effect; i.e., occupants perceived the fire alarm activation was yet another false alarm.

Table 5

Response to a fire alarm.

	%(n)	N
Fire Alarm Activation		355n
Follow building evacuation policy	65.4% (232n)	
Other response to a fire alarm	34.6% (123n)	
Look to neighbours for guidance	12.4% (44n)	
Ignore the alarm / will not leave until instructed	10.7% (38n)	
Check on neighbours	5.4% (19n)	
Investigate / Check fire panel	3.7% (13n)	
Carry on and complete the current task	2.0% (7n)	
No alarm	0.6% (2n)	
The explanation for the "Negative reaction"/outcome		114n
The fire alarm is continually going off, so I believe that it is probably a false alarm	62.3% (71n)	
I wait for instruction from other people	13.2% (15n)	
Unsure what to do or where to go	13.2% (15n)	
Check/investigate	7% (8n)	
I wait for instruction from emergency services	4.4% (5n)	

A point-biserial correlation showed a statistically significant correlation between preparedness and each of the four constructs for actual fire safety preparedness. Perceived preparedness correlated with:

- Having a fire blanket or fire extinguisher $r_{pb} = 0.103, p = 0.054$. Those having such items presented on average with a higher perceived preparedness score of $\bar{x} = 5.10$, with standard deviation s.d. = 2.49, compared to $\bar{x} = 4.55$, s.d. = 2.40, for those who did not have the items;
- Having a household emergency plan $r_{pb} = 0.467, p < 0.001$. Those who had a household emergency plan presented on average with a higher perceived preparedness score of $\bar{x} = 5.86$, s.d. = 2.25, compared to $\bar{x} = 3.48$, s.d.= 2.13 for those who did not have a plan;
- Declaring smoke detector(s) were tested $r_{pb} = 0.220, p < 0.001$. Those who declared the smoke detector(s) were tested presented on average with a higher perceived preparedness score of $\bar{x} = 5.33$, s.d. = 2.43, compared to $\bar{x} = 4.22$, s.d. = 2.37, for those who did not;
- Following the building evacuation policy in response to a fire alarm activation $r_{pb} = .140, p = 0.009$. Those who suggested they would act in line with the fire evacuation policy presented on average with a higher perceived preparedness score of $\bar{x} = 5.18$, s.d. = 2.39, compared to $\bar{x} = 4.45$, s.d. = 2.60, for those who did not.

4.2. Regression analysis associated with fire safety behaviours

The following section reports the findings relating to objective two by exploring the factors that act as barriers to or facilitators of personal fire safety in residential apartments by applying an extended PMT model. These findings are reported from the five regression models presented in Table 6 and Table 7.

Table 6
Regressions: part 1.

	Model 1				**Model 2**		
	Perceived Preparedness				Fire Blanket or Fire Extinguisher		
Explanatory Variables	Coef.	Robust Std. Err.	P	η_p^2	Coef.	Robust Std. Err.	P
Risk Rating	-0.008	0.028	0.777	0.000	-0.044**	0.016	0.007
Concern (Fire Alarm)	0.031	0.068	0.644	0.001	0.043	0.040	0.285
Worry: Low	-0.030	0.427	0.944		-0.054	0.257	0.835
Worry: Moderate	-0.511	0.477	0.285	0.016	0.303	0.292	0.299
Worry: High	-0.961	0.688	0.164		0.154	0.382	0.687
Coping Appraisal	1.533***	0.302	0.001	0.087	0.712***	0.193	0.001
Non-protective Responses	-0.051	0.370	0.890	0.000	-0.217	0.237	0.360
Fire Exposure (Direct)	1.095***	0.299	0.001	0.047	0.180	0.189	0.340
Fire Exposure (Indirect)	0.038	0.368	0.917	0.000	0.585*	0.263	0.026
Residents Perceived Responsibility	0.592*	0.282	0.037	0.016	0.475**	0.181	0.009
Safety Instruction(s): Apartment	0.696	0.542	0.200	0.005	0.298	0.441	0.499
Safety Instruction(s): Workplace	0.479	0.667	0.473	0.002	0.007	0.532	0.989
Willingness to Fight	0.626*	0.300	0.038	0.017	0.564**	0.194	0.004

Apartment Fire							
Apartment is Insured	0.114	0.311	0.713	0.001	-0.169	0.201	0.401
Displayed Evacuation Map (Aware)	0.363	0.275	0.188	0.006	0.091	0.170	0.592
Female	-0.469	0.297	0.115	0.010	-0.237	0.179	0.185
Age: 35-54	0.830*	0.362	0.023	0.029	0.124	0.216	0.567
Age: 55 or Older	1.207*	0.524	0.022		0.882**	0.331	0.008
Child/Children Living in the Apartment	0.025	0.340	0.941	0.000	-0.248	0.215	0.248
Completed Higher Education	-0.225	0.331	0.496	0.002	-0.106	0.227	0.639
Income: 30,000-70,000	0.236	0.462	0.610	0.001	-0.198	0.318	0.533
Income: Over 70,000	0.190	0.518	0.714		-0.182	0.349	0.601
5th Floor Apartment, or Above	0.235	0.557	0.674	0.001	0.029	0.316	0.926
Building has 6 or More Floors	0.157	0.428	0.713	0.001	-0.070	0.241	0.772
Constant	1.910	0.942	0.044		0.018	0.687	0.979
R^2	0.243						
R^2 (Adjusted)	0.172						
Chi-squared (df = 24)					$\chi 2$=60.75***		
Log Likelihood					-142.859		
Correctly Classified					75.97%		
N	283				283		

Note: *p≤0.05, **p≤0.01, ***p≤0.001

η_p^2 denotes partial eta-squared as a measure of effect size.

Table 7

Regressions: part 2.

	Model 3			**Model 4**			**Model 5**		
	Household Fire/Evacuation Plan			Follow the Building Evacuation Policy			Smoke Detector(s) Tested at Least Once a Year		
Explanatory Variables	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P
Risk Rating	-0.014	0.017	0.402	-0.001	0.017	0.945	-0.044**	0.016	0.006
Concern (Fire Alarm)	0.033	0.040	0.415	0.073ǂ	0.040	0.066	0.056	0.039	0.150
Worry: Low	0.251	0.232	0.279	-0.093	0.256	0.715	0.284	0.241	0.239
Worry: Moderate	0.036	0.272	0.896	-0.287	0.285	0.315	0.255	0.264	0.333
Worry: High	0.425	0.366	0.245	-0.946*	0.379	0.013	0.733*	0.368	0.047

Coping Appraisal	1.085***	0.192	0.001	0.415*	0.184	0.024	0.353ǂ	0.182	0.052
Non-protective Responses	-0.265	0.232	0.254	-0.285	0.226	0.207	-0.294	0.223	0.187
Fire Exposure (Direct)	0.070	0.188	0.710	-0.046	0.184	0.804	0.111	0.181	0.538
Fire Exposure (Indirect)	0.235	0.244	0.337	0.106	0.230	0.643	0.086	0.237	0.717
Residents Perceived Responsibility	0.253	0.175	0.148	0.159	0.177	0.368	0.119	0.171	0.485
Safety Instruction(s): Apartment	0.464	0.422	0.271	0.232	0.360	0.519	0.268	0.356	0.451
Safety Instruction(s): Workplace	-0.386	0.465	0.407	0.455	0.430	0.290	-0.256	0.443	0.563
Willingness to Fight Fire	0.461*	0.186	0.013	0.040	0.181	0.826	0.080	0.178	0.654
Apartment is Insured	-0.066	0.195	0.735	0.216	0.187	0.249	0.283	0.175	0.105
Displayed Evacuation Map (Aware)	0.242	0.169	0.152	0.405*	0.174	0.020	0.054	0.164	0.741
Female	-0.133	0.187	0.477	0.065	0.186	0.726	-0.612***	0.177	0.001
Age: 35-54	0.304	0.231	0.190	0.254	0.215	0.236	0.100	0.202	0.619
Age: 55 or Older	0.314	0.304	0.301	0.628ǂ	0.329	0.056	-0.024	0.288	0.934
Child/Children Living in the Apartment	0.101	0.215	0.639	-0.136	0.210	0.517	0.526*	0.214	0.014
Completed Higher Education	-0.409*	0.205	0.046	-0.039	0.201	0.846	-0.009	0.197	0.963
Income: 30,000-70,000	-0.199	0.296	0.500	0.055	0.258	0.831	0.132	0.284	0.642
Income: Over 70,000	-0.236	0.329	0.473	0.379	0.297	0.203	0.043	0.320	0.893
5th Floor Apartment, or Above	1.029**	0.340	0.003	0.502	0.308	0.103	0.144	0.330	0.662
Building has 6 or More Floors	0.087	0.238	0.714	-0.491*	0.250	0.049	-0.216	0.230	0.349
Constant	-0.421	0.624	0.500	-1.049	0.603	0.082	0.114	0.601	0.849
Chi-squared (df = 24)	$\chi2$=41.33*			$\chi2$=41.33*			$\chi2$=48.40**		
Log Likelihood	-157.610			-157.610			-164.7111		
Correctly Classified	71.38%			71.38%			69.26%		
N	283			283			283		

Note: ǂp≤0.1, *p≤0.05, **p≤0.01, ***p≤0.001

Examining the overall explanatory power of the regressions, for the OLS regression (Table 6) R^2 = 0.243, i.e., 24.3% of the variation in perceived preparedness is explained by the model. For the probit models (Table 6 and Table 7) a relatively high proportion of observations, between 69.26% and 75.97%, are correctly classified by the models.

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The marginal effects from the probit analyses are given in Table 8, with only significant results shown. Note, marginal effect estimates were calculated with all other explanatory variables held constant at their mean values.

Table 8
Marginal effects.

Explanatory Variables	**Model 2** Fire Blanket or Fire Extinguisher		**Model 3** Household Fire/Evacuation Plan		**Model 4** Follow the Building Evacuation Policy		**Model 5** Smoke Detector(s) Tested at Least Once a Year	
	dy/dx	P	dy/dx	P	dy/dx	P	dy/dx	P
Risk Rating	-0.015**	0.007					-0.016**	0.006
Concern (Fire Alarm)					0.026‡	0.066		
Worry: Low								
Worry: Moderate								
Worry: High					-0.336*	0.013	0.274*	0.046
Coping Appraisal	0.238***	0.001	0.400***	0.001	0.147*	0.025	0.132‡	0.052
Non-protective Responses								
Fire Exposure (Direct)								
Fire Exposure (Indirect)	0.195*	0.025						
Residents Perceived Responsibility	0.159**	0.008						
Safety Instruction(s): Apartment								
Safety Instruction(s): Workplace								
Willingness to Fight Fire	0.188**	0.003	0.170*	0.014				
Apartment is Insured							0.106	0.105
Displayed Evacuation Map (Aware)					0.144*	0.020		
Female							-0.229***	0.001
Age: 35-54								
Age: 55 or Older	0.295**	0.008			0.223‡	0.056		
Child/Children Living in the Apartment							0.197*	0.014
Completed Higher Education			-0.151*	0.045				
Income: 30,000-70,000								
Income: Over 70,000								
5th Floor Apartment, or			0.379**	0.002	0.178‡	0.103		

Above		
Building has 6 or More Floors	-0.174*	0.049

Note: †p≤0.1, *p≤0.05, **p≤0.01, ***p≤0.001. Marginal effects were estimated using the mean values for all other explanatory variables.

Regarding the core variables of PMT: coping appraisal was significant and positive across all five models, giving support to the contention that a high coping appraisal is an essential contributor to preparedness motivation (Grothmann and Reusswig, 2006; Poussin et al., 2014). The OLS results in Model 1 indicated that having a high, rather than low, coping appraisal increased perceived preparedness by 1.533 points, all other independent variable values held constant. Coping appraisal had a medium effect size, $\eta_p^2 = 0.087$, the largest effect size among the independent variables. For the probit models, the marginal effects of coping appraisal showed a strong association for each dependent variable in Table 8. For example, the probability that a respondent has a household fire/evacuation plan was predicted to be 40 percentage points (pp) higher if the respondent presented with a high coping appraisal.

Different combinations of variables associated with threat appraisal (risk rating, concern, worry) were significant for each model. Risk rating was statistically significant and negative within two of the five models: having a fire blanket or fire extinguisher and declaring the smoke detector(s) were tested at least once a year. Although statistically significant, the coefficient magnitudes and associated marginal effects were small. A one unit increase in risk rating was estimated to decrease the probability that a respondent stated they had a fire blanket or fire extinguisher and declaring the smoke detector(s) were tested at least once a year by 1.5pp and 1.6pp respectively. To contextualise these magnitudes, the results suggest it would require an increase of approximately sixteen points in risk rating to counteract the positive impact of having a high coping appraisal on the probability of having a fire blanket or fire extinguisher. The equivalent for smoke detector testing is an approximate eight point increase in risk rating. There was no consensus in previous studies on the relationship between preparedness and risk rating (see, Bubeck et al., 2012; Wachinger et al., 2013). This study suggests that a high threat appraisal does not promote fire safety preparedness within the context of an apartment fire. Instead, the results showed a negative relationship, which might reflect a reverse causality, i.e., if a respondent has an extinguisher or blanket, or was conscious of smoke detector testing, and trusts the efficacy of the equipment, this could result in a lower risk rating. However, further research on this relationship is warranted.

Concern upon hearing the fire alarm had a statistically significant and positive impact on respondents following the evacuation policy in response to a fire alarm activation. The marginal effects showed that a one-point increase in the concern scale increased the probability that respondents stated they would follow fire evacuation policy by an estimated 2.6pp (p=0.066). A high level of worry about a fire was also found to influence two of the five dependent variables: acting in line with the evacuation policy in response to a fire alarm and declaring the smoke detector(s) were tested at least once a year. Having a high level of worry about a fire was estimated to increase the probability a respondent declared the smoke detector(s) were tested at least once a year by 27.4pp. This finding is broadly consistent with other research by Miceli et al. (2008) and Terpstra (2011), which showed heightened worry and dread was associated with households undertaking flood-related preparedness. In contrast, this data showed that high levels of worry were associated with a 33.3pp reduction in the probability that a respondent declared they would act in line with the evacuation policy in response to a fire alarm activation.

The influences of prior exposure to an emergency on subsequent preparedness levels are unclear (McGee et al., 2009; Stumpf et al., 2017). For example, Stumpf et al. (2017, p.95) stated, “a common assumption is that once someone witnessed a disaster, this experience will enhance future preparedness. Yet, findings in research are inconclusive”. Regarding the findings from this study,

prior fire exposure (direct/indirect) was only significant within two of the five models: having a fire blanket or fire extinguisher, and perceived preparedness. This supported the observations by Stumpf et al. (2017) and Weinstein (1989), suggesting the effect from exposure to a particular risk (in this instance fire) is limited to only some preparedness actions. The OLS regression result showed a significant positive relationship between prior direct exposure to fire and perceived preparedness. The estimated marginal impact of prior direct exposure was to increase perceived preparedness by 1.095 ($p \leq 0.001$) compared to someone who had no prior exposure. The effect size of prior direct exposure on perceived preparedness was small-to-medium ($\eta_p^2 = 0.047$). Regarding having a fire blanket or fire extinguisher (Table 8), indirect exposure to fire increased the probability that a respondent had a fire extinguisher/blanket in their apartment by 19.5pp.

These findings on prior exposure appear to confirm the research by Allareddy et al. (2007) on rural residential fires, which suggested owning a fire extinguisher is positively associated with fire exposure. However, the Allareddy et al. (2007) result related to direct exposure, not indirect, as is the case with this study. The data in Table 8 shows that those with indirect exposure through family/friends were more likely to be aware of the importance/need for a fire extinguisher or fire blanket within the home. The significance of indirect experience suggests that campaigns aimed at households with no previous experience of a fire could raise preparedness levels if the campaigns featured first-hand accounts from those who had experienced a household fire. However, further research is required to support this assumption, especially as safety instructions within the workplace and apartment were non-significant across all models.

When studying wildfires, Beringer (2000), McCaffrey et al. (2011) and McNeill (2013) found perceived responsibility to be significantly associated with an individual's motivation to take preparedness actions. Concerning residential apartment fires, this paper found similar results where respondents who perceive they have responsibility for fire safety within the building were more likely to have a fire blanket or fire extinguisher within the apartment, and reported higher perceived preparedness. The marginal impact of perceived responsibility on perceived preparedness was 0.592, statistically significant ($p \leq 0.05$). The effect size for perceived responsibility was small ($\eta_p^2 = 0.016$). Likewise, the probit analysis marginal effects revealed that the probability a respondent is prepared for a fire (i.e., has a fire extinguisher or blanket within the apartment) increased by 15.9pp if they perceived they have some responsibility for fire safety in the building. While occupants' perceived responsibility had a motivating effect on having a fire blanket or fire extinguisher, and perceived preparedness, it did not influence smoke detector testing, responding (evacuating) following a fire alarm activation, or establishing a household fire/evacuation plan. There is, however, a link between coping appraisal and smoke detector testing, which suggests that preparedness campaigns designed to drive smoke detector testing should focus on the vital role smoke detectors will play in the event of a fire.

Apartment occupants' willingness to fight a fire had a significant positive relationship with having a fire blanket or fire extinguisher, and having a household fire/evacuation plan. Furthermore, awareness of a building's evacuation map being displayed led to a 14.4pp rise in the probability a respondent said they would act in line with the evacuation policy in response to a fire alarm activation.

Alongside the PMT variables, several significant findings were related to socio-demographics. These are all reported within the Tables and a selection discussed here. The results revealed that the probability a respondent declared the smoke detector(s) were tested at least once a year decreased by 22.9pp if they were female. In the case of perceived preparedness, the coefficients on the age variables increased in magnitude from 0.830, $p \leq 0.05$ (Age: 35-54) to 1.207, $p \leq 0.05$ (Age: 55 or older). That is, the older the respondent was, the higher perceived preparedness is predicted to be. The effect size for age was small ($\eta_p^2 = 0.029$). Respondents in a 5th-floor apartment or above were 37.9pp more likely to have a household fire/evacuation plan. Living in a building with six or more floors was also

shown to negatively impact the probability that a respondent would follow the evacuation policy in response to a fire alarm activation (decreasing the probability by 17.4pp).

5. Limitations

While the study sought to achieve a random sample of Dublin apartments, with representation from high to lower income areas of the city, the use of flyers with an embedded URL linked to the questionnaire, rather than printed questionnaires, resulted in the URL being shared online. As a result, the number of responses increased but some of those who took part may reside in apartments outside of the targeted complexes. To minimise selection bias, considerable effort was placed into distributing the flyer at each apartment complex. A control question, asking in which county respondents lived, was used to exclude non-Dublin apartments (Daniel, 2012).

Alwin (2016) highlights that objective questions can be considerably more reliable than subjective questions. Where possible, factual information was gathered, such as do you have a fire extinguisher, rather than asking respondents if they felt prepared to fight a fire. That said, several of the questions are based on subjective content related to perception and judgment. At all times, however, construction of these measures was linked to the theoretical framework on which this study is based.

Given that context can affect results (Alwin, 2016), it is important to note that at the time of data collection fire in high-rise buildings had featured heavily in the Irish news media due to the Grenfell Tower fire in London and a fire in the Metro Hotel and Apartment complex in Dublin in March 2018 (Young and McKeown, 2018). While there were no fatalities, the Metro Hotel and Apartment fire was technically challenging and severely damaged the building. The extensive media coverage of these two incidents, occurring within months of each other, amplified concerns about fire safety in Irish apartment buildings, bringing it to prominence in the public consciousness. We cannot rule out that this coverage influenced responses by amplifying concerns.

5. Conclusions

As a result of a call for research to determine "the extent to which fire safety measures are in place in peoples' homes and the public's understanding of risk in the domestic setting with a view to informing further fire safety campaigns" (NDFEM, 2018, p.24), this study examined the factors which influenced fire safety preparedness in Irish apartments following the Grenfell Tower fire; at a time when there was heightened awareness of the risk posed by apartment fires. To contribute to this call for research, the first objective was to examine the level of fire safety awareness and preparedness within residential apartments. Given the national focus on smoke detector installation and testing, it was alarming that while 97.4% of respondents had a smoke detector, only 6.8% declared that the smoke detector(s) were tested more than once a month and nearly 40% of respondents reported their smoke detector(s) were not tested at least once a year.

Under Irish legislation rental properties within multi-unit buildings must include a suitably located fire blanket. 52.4% of respondents indicated they knew of a fire blanket within their apartment, with no significant association found between renters and owner occupiers. Furthermore, 31.7% of respondents had taken no fire safety actions to protect their apartment, with 42.8% suggesting they did not know what to do. 34.6% indicated that they would not follow the building evacuation policy in the event of a fire alarm activation. These findings, along with the findings reported earlier, suggest that further engagement with apartment occupants and owners is required to raise the level of fire safety awareness and preparedness.

The second objective of this study was to determine the factors that motivate or deter apartment residents from adopting fire safety measures by applying an extended PMT model. To summarise these findings, Table 9 compares the hypothesised outcomes with the key findings.

Table 9
Comparing hypothesised outcomes with the key findings.

Hypothesised Outcomes Per the Literature Review	Key Findings
A higher threat appraisal leads to an increased motivation to prepare and a greater likelihood of protective action.	Results showed a negative relationship between risk rating for fire and (i) owning a fire blanket or fire extinguisher, and (ii) testing of smoke detector(s) at least once a year. While this is contrary to expectations, Poussin, Botzen, and Aerts (2014) found a similar relationship between perceived risk of flooding and mitigation behaviours. Concern upon hearing a fire alarm was shown to have a positive relationship with following the building evacuation policy. However, a high level of worry had the opposite effect. A high level of worry was found to positively influence frequency of smoke detector(s) testing.
A higher coping appraisal results in greater motivation to prepare and a higher likelihood of taking protective action.	The results show a significant positive relationship in each of the five models in line with the hypothesis.
Prior risk exposure positively influences motivation to prepare and a higher likelihood of protective action.	Results showed indirect exposure had a positive relationship with having a fire blanket or fire extinguisher while direct exposure had a positive relationship with perceived preparedness.
Taking personal responsibility for fire safety has a positive relationship with protective actions.	Testing confirmed taking personal responsibility had a positive relationship with perceived preparedness and having a fire blanket or fire extinguisher.
Awareness of a displayed evacuation plan positively influences: following the building evacuation policy; having a household fire/evacuation plan; and perceived preparedness.	Results confirmed a positive relationship between awareness of a displayed evacuation plan and following the building evacuation policy.

Figure 1 summarises the regression results, with a plus (+) indicating a statistically significant positive relationship and a minus (-) indicating a statistically significant negative relationship with taking a protective response. Non-significant results are not reported.

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Figure 1

Significant factors across all five regression models.

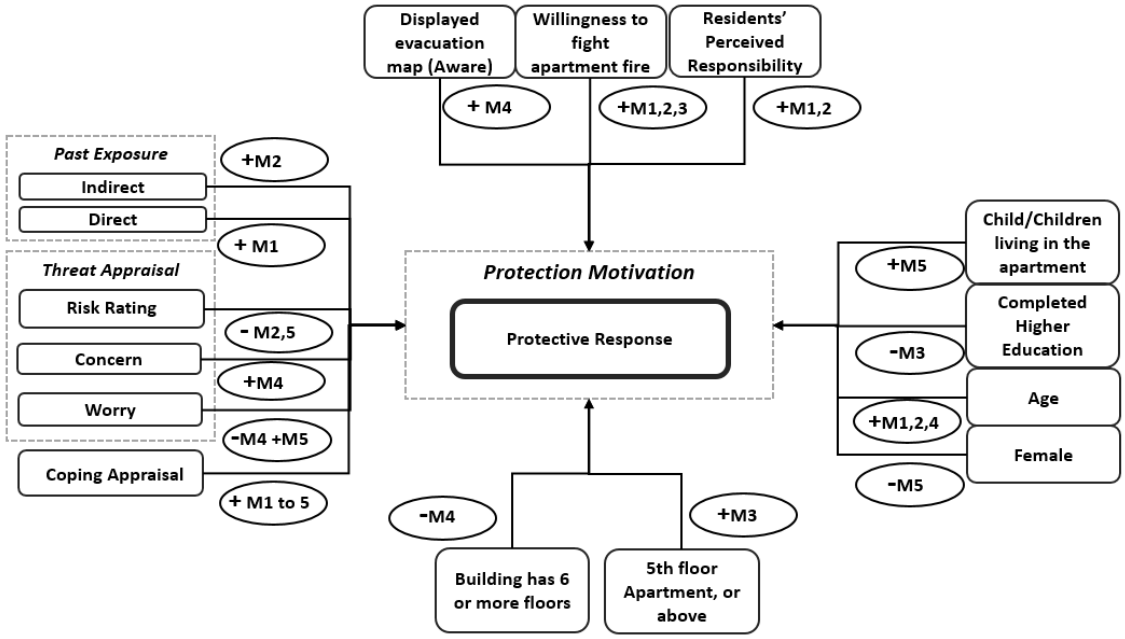

Figure 1 Key

M1 = Model 1: Perceived Preparedness

M2 = Model 2: Fire Blanket or Fire Extinguisher

M3 = Model 3: Household Fire/Evacuation Plan

M4 = Model 4: Follow Building Evacuation Policy

M5 = Model 5: Smoke Detector(s) Tested at Least Once a Year

The results support, in part, the theoretical contention that in the context of apartment fires PMT should be extended to include individuals' perceived responsibility for fire safety within their building. Occupants' perceived responsibility for fire safety in the building was positively associated with having an extinguisher or fire blanket, and an increased perceived preparedness. On the other hand, no relationship was found between perceived responsibility and the presence of household fire plans, declaring the smoke detector(s) were tested at least once a year, or taking the appropriate response upon a fire alarm activation.

Apart from the theoretical contribution, this study has practical implications for policy-makers, enforcers of legislation, those designing public fire safety campaigns, and informing targeted preparedness messaging. For example, the findings of this study suggest that smoke detector testing campaigns for apartment occupants in Ireland should be targeted at encouraging women, and apartments without children, to test their smoke detectors. The data also showed the importance of apartment occupants' threat appraisal and coping appraisal in influencing smoke detector testing. Apartment occupants who present with a higher risk rating or a high coping appraisal were more likely to test their smoke detectors. These results illustrate the importance of communicating the risk of an apartment fire, explaining the difference a smoke detector will make in the event of a fire, how to test smoke detectors, and the related low cost (positive cost efficacy) involved in testing.

To encourage an appropriate response to a fire alarm activation, fire safety campaigns designed to improve evacuation rates in apartments should not attempt to raise the level of worry about fire. Instead, these campaigns should explain how robust fire safety systems and following procedures will improve occupants' safety in a fire, as there is a link between high coping appraisal and following the recommended response to a fire alarm activation. Fire safety campaigns should also be targeted at occupants of buildings with six or more floors as they are less likely to follow the fire evacuation policy.

Recent years has seen a strengthening of Irish legislation around fire safety and the protection of occupants in rental properties within multi-unit buildings. The results of this study, however, reveal that poor compliance with the requirement to have fire blankets in a prominent position within rental apartments and the duty to display a fire evacuation plan in multi-unit buildings requires urgent attention.

This research adds to the body of fire safety knowledge by applying an extended version of PMT to five factors relevant to fire safety preparedness. The findings reveal that fire safety preparedness motivation is complex and that campaigns designed to drive fire safety actions must be targeted at specific population segments in order to achieve optimum results. Informed by PMT research, the application of these findings ought to enhance the effectiveness of fire safety campaigns by identifying the barriers to, and drivers of, fire safety preparedness.

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