Complacency in fire evacuation from buildings.

A Technical Research Report into evacuee complacency, an overlooked component of fire safety management, from the IOSH Fire Risk Management Group.

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Abstract:

This survey involves 413 participants in a questionnaire survey to determine their experiences and attitudes to complacency in fire situations from their own experiences. The survey details the factors that contribute to complacency in terms of human behaviours and looks into human factors that could be utilised to reduce vulnerability and attitudes to fire which may affects people sense of fear and wellbeing in emergency situations. Aspects of fire risk management and fire safety culture have been considered in their interfaces with complacency to determine which additional factors come into play and how influential factors can be used positively to raise the profile of fire safety awareness to reduce vulnerability and risk.

Keywords:

Complacency; fire evacuation; fire risk management; fire safety culture; human behaviour; human factors.

[1] Note to Editors: Dr Rita Fahy PhD and Dr Glyn Lawson PhD have both been affiliated to the FRMG, and this project, from its inception. The IOSH FRMG sincerely acknowledges their significant role as Contributors to the work and is grateful for their expert assistance.

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1 INTRODUCTION

1.1 Background

Within fire safety management strategies, the most important reactions when a fire starts are to: detect the fire; raise the alarm and warn people; encourage people to use safe evacuation routes; call the fire service, extinguish the fire, and to account for the safety of those involved with appropriate responses from everyone affected by the emergency.

For this to be most effective it is important that actions are carried out promptly, without delays, and probably with increasing use of technology through provision and use of automated systems.

However, one aspect of the emergency that cannot be fully automated is the evacuation of people who are being affected by the fire.

1.2 Why focus on complacency?

It has been a long-held belief that people delay in evacuating buildings in the event of fire. This paper investigates many of the reasons for this, including the concept of complacency, although there may be many others including 'following the rules' such as 'Stay Put' policies, fear or uncertainty.

Shortly after the Grenfell tower disaster on 14 June 2017, an article, *Rapid response*, was prepared by the Institution of Occupational Safety and Health (IOSH) Fire Risk Management Group setting out essential steps for managing a safe and effective evacuation following fire safety principles. A Fire Safety and Evacuation Supplement was published in the IOSH Magazine in January 2018. The draft article included a statement that there is frequently complacency by building occupants when an evacuation alarm is activated. The editors of the journal called for significant proof that this was indeed true.

After a literature review, contact was made with the United Kingdom (UK) Fire Safety Association and the United States (US) National Fire Protection Association and a number of universities involved in fire safety to confirm that occupant complacency at the time of alarm activation is a key factor that is poorly documented.

1.3 Recent focus on losses

Recent focus has been on fires in high rise residential buildings (HHRB) or premises [1], [2], [3] & [4]. Significant non-residential fires [5], [6] & [7] have also occurred which have raised the profile through significant loss of life, the fire is perceived to be a national or global trend, or the fire gives rise to a cultural loss.

A third situation is one of fire in shopping centres [8] and leisure complexes where both employees and contractors, who know and understand the workplace, and the public, who are in effect visitors, give rise to different dynamics.

Additionally, there are tragedies of human fatalities and losses of property and livelihoods on a massive scale with bush fires, conflagrations in camps for refugees, such as asylum seekers on the north French coasts [9] or Rohingya refugees in Bangladesh [10].

An IOSH Fire Risk Management Group case study review of serious fires, 1940-2020, [11] suggests that the problems have not 'gone away' and that by looking at the available root cause analysis, some issues are still unchallenged. An abridged version of this report is located at section 16 below.

Although rare in the UK there are still fatal workplace fires [12] & [13] elsewhere in the world. One source of data is detailed in Wikipedia who publish lists of building or structure fires, as well as fires occurring in a myriad of other environments [14].

1.4 Fire incident data

According to databases such as the HSE[2], Statista[3] or the Office of National Statistics[4] there were 318 fire-related fatalities in Great Britain during 2018/19, 82 fewer than occurred in 2017/18 when there were 400. In the early 2000s, the annual number of fire fatalities was consistently over 500, with numbers gradually falling throughout that decade. In 2011/12 the number of fatalities related to fire fell below 400 for the first time, and with the exception of 2017/18 remained below 300 for the rest of the 2010s.

There were fewer fatalities but more incidents. Although there has been a net decrease in the number of incidents attended by fire and rescue services in the United Kingdom since 2010/11 the current trend from 2014/15 onwards has been one of increase. In 2018/19 there were over half a million incidents attended in England, over 92,000 in Scotland and almost 37,000 in Wales. Northern Ireland had the least number of incidents attended at around 24,600.

In occupational fatalities recorded by the HSE in RIDDOR regulations data the number of fatal injuries to employees in Great Britain in 2018/19 were 147 fatal injuries to employees. Summary statistics from the HSE for 2020 show that this data has dropped to 111 fatalities, from all causes, with 65427 serious injuries. The most common cause for fatalities at work were falls from a height, which accounted for 29 fatalities in this year. The construction sector bore the majority of fatalities at work.

Two occupational fatalities due to burns were recorded by the HSE in 2019/20 and 1679 non-fatal injuries.

The UK Department of Transport reports the number of road traffic fatalities in 2019 at 1,752 which was noted as 2% fewer fatalities than in 2018 (1,784). However, this small decrease may be due to natural variation. In 2019, there were 25,945 seriously injured casualties in reported road traffic accidents.

Data from the ONS is available for weekly fatalities from all causes in the UK but at present this data is heavily skewed by recording data sets of those who have died as a result of respiratory issues, influenza and pneumonia and COVID-19.

By comparison, in 2019, there were 7,565 deaths registered in the UK that related to alcohol-specific causes, the second highest since the data time series began in 2001.

1.4.1 Flammable gas incidents

Flammable gas incidents reported to the HSE under RIDDOR show the following data and is significant as it shows trends in relation to gas safety and the health-related consequence related to fire of carbon monoxide poisoning.

Incident / Severity	Incident type	2017/18	2018/19r	2019/20p
Incidents	**All**	**129**	**136**	**150**
Incidents	Carbon monoxide poisoning	100	99	96
Incidents	Other exposure e.g., to unburnt gas		6	13

[2] https://www.hse.gov.uk/statistics/fatals.htm
[3] https://www.statista.com/statistics/291135/fire-fatalities-in-england/
[4] https://www.ons.gov.uk/

Incident / Severity	Incident type	2017/18	2018/19r	2019/20p
Incidents	Explosion/fire	29	31	41
Fatalities	**All**	**2**	**3**	**8**
Fatalities	Carbon monoxide poisoning	1	2	
Fatalities	Other exposure e.g., to unburnt gas			
Fatalities	Explosion/fire	1	1	8
Non-fatalities	**All**	**193**	**246**	**201**
Non-fatalities	Carbon monoxide poisoning	154	196	151
Non-fatalities	Other exposure e.g., to unburnt gas		12	15
Non-fatalities	Explosion/fire	39	38	35

Table 1: Abstract of HSE statistical data for gas safety

[1] An incident can cause more than one fatality or injury.

1.4.2 Summarising the data

Approximately the population of the UK is 66.6 million and the number of people employed at work is 32.5 million. In the general population there are approximately:

- 7500 alcohol related fatalities.
- 1750 road related fatalities.
- 320 fatalities from fires.
- 110 fatalities at work.
- 30 fatal falls from height.
- 10 fatalities from gas safety incidents
- 2 occupational fatalities due to burns and
- 1 or 2 carbon monoxide fatalities in the population (although there are 150+ CO related non-fatal injuries which may indicate that CO detector safety campaigns are working).

Data recording, establishing and promulgating safety policy, writing legislation and guidance and enforcement are addressed by several government departments and interested bodies, including politicians, charities, professional institutions, safety campaigners and safety practitioners etc. There is some coordination of data and information, but this is NOT universal and although there is statutory recording of data there will be error bars attached to datum points given some, albeit, minor hopefully, uncertainty to the numbers.

All fatalities must be avoided, and fatalities at work and from fire or gas safety can be avoided and although fire related data numbers are perceived to be low **every effort** must be made through education, training, learning, practice, mentoring and good design in giving people life skills to reduce the risks from fire.

It is for many of these reasons that learning from incidents the causes and effects of fires etc and what can be done to reduce the toll, particularly of the large number of injuries, that we need skills and practice in the investigation of fires.

2 DEFINITIONS

2.1 Complacency

The first consideration is how do we define the noun complacency and the verb, to be complacent. There are several dictionary definitions and not all agree.

Generally, the definition is:

1. 'A feeling of calm satisfaction with your own abilities or situation that prevents you from trying harder' [15].
2. The Oxford English dictionary (CD-ROM version) [16] defines the adjective of being complacent as 'smug and uncritically satisfied with oneself or one's achievements and further definitions include: 'smug; self-righteous'; 'self-satisfaction'; or 'calmly content'.

Within general fire safety and in Occupational Safety and Health [OSH] definitions are less clear.

3. Lingard [17] conflates it with carelessness and inexperience inferring a meaning of 'a lack of care 'under a broader classification of 'Risk Attribution'.
4. Costella *et al* [18] infer a meaning of 'overlooking' or 'reduced priority' due to other more prominent priorities. Simplified Safety [19] suggest "complacency occurs when you've been doing something one way for so long without incident that you assume there can never be an incident". Wilson [20] states that its biggest problem is that it leads to "mind not on task."
5. Årstad and Aven [21] suggest that "Complacency is used to characterise an unawareness of the presence, the relevance and/or the importance of available information" and go onto say "evidence of danger existed but was not recognized adequately".
6. Hyten and Ludwig [22] give a behavioural definition of complacency which is offered as 'trending behavioural variation that eventually exceeds safety boundaries, manifesting itself especially with outcomes of explosions and fires'.

However, what is clear is that we may want to look again at the definitions for complacency, as what the hypothesis is proposing in fire evacuation of buildings may not be pure of familiar complacency but overfamiliarity with drills and practices, alarms etc that causes people to become overfamiliar with 'just another of the weekly alarms' tests at work, until the moment when the alarm sounds for longer than usual, and they can smell the smoke and see the flames.

In our definition, to prove a state of complacency the following questions have to be answered.

- What personal advantage does being complacent have?
- What is a person or group of people being complacent about?
- Is it complacent to simply ignore the fire alarm?
- What is the real or perceived satisfaction element gained from being complacent?
- When does complacency kick-in?
- How does it manifest itself?

- If a person is complacent, how is complacency rewarded or paid back to the respondent?

Collectively, these concepts tied in with Hyten and Ludwig's [22] definition, suggest that complacency is associated with a higher risk outcome involving a hazardous situation. Therefore to 'prove' complacency suggests that a complacent person has to be hurt, harmed or in a losing situation, and that their complacency, which manifested itself most probably in human error typology by:

- a failure to act when required to do so or when they really know they should have asked
- forgetting what to do
- taking action, but in the wrong way
- taking wholly inappropriate action
- making skill-based errors or mistakes
- making rule, perception and / or knowledge-based errors etc.
- being aggressively or assertively complacent or belligerent causing themselves and others harm and suffering.

2.1.1 Degrees of complacency

It is an oversimplification to suggest that, as a behaviour, there is only one level of complacency. By being a complacent person about something as critical as life safety in a fire situation suggests the following.

1) The person may not have the skill, knowledge, perception or aptitude to be complacent.
2) They may not have had training in the risks from fire. Simply the person is not competent to handle the situation.
3) A constantly complacent person about safety could be reflecting a poor level of safety leadership or training from managers above and showing a poor level of safety awareness and safety culture.
4) Assertive complacency manifests itself by people 'making statements' to show-off.
5) Aggressive complacency is evidenced by arrogance and non-compliance in personal or group collective safety actions, such as effectively evacuating a building for the benefit of all.

2.1.2 Effect of complacency

The effect of complacency and how it is acted out in the evacuation of a building can be complex but essentially focuses on these outcomes.

- Delay.
- Not taking action in a timely manner.
- Returning to their workstation, bench, desk, room or kitchen refrigerator to collect personal possessions.
- Going to a changing room or shift house to change into day clothes.
- A feeling of guilt in leaving work in work clothes.

2.1.3 Degrees of harm and suffering

Our proposition is that complacent behaviour in the evacuation of buildings leads to some negative outcomes for the person. The degree of this harm and suffering could be as significant as loss of life if a person:

- Is trapped by the fire.
- Falls beneath a building collapse.

- Becomes affected by carbon monoxide or other toxic products of combustion.
- Is overcome on the evacuation route to the means of escape by smoke inhalation or heat.
- Falls due to a collapse of the means of escape.
- Falls from height or a staircase.
- Is overcome by people in panic trying to evacuate the building.
- Crushed by the weight of people behind them.
- Encounters a locked final exit on a means of escape or a blocked escape route.
- Reaches an inappropriate place of safety.

Lesser consequences include:

- Being affected by crush injuries leading to fractures.
- Lesser smoke inhalation or respiratory distress which one can recover from.
- Minor first-aid treated injuries.
- Simply being last at the assembly point.

These error paths are illustrated by the Health and Safety Executive in HS(G) 48 [23].

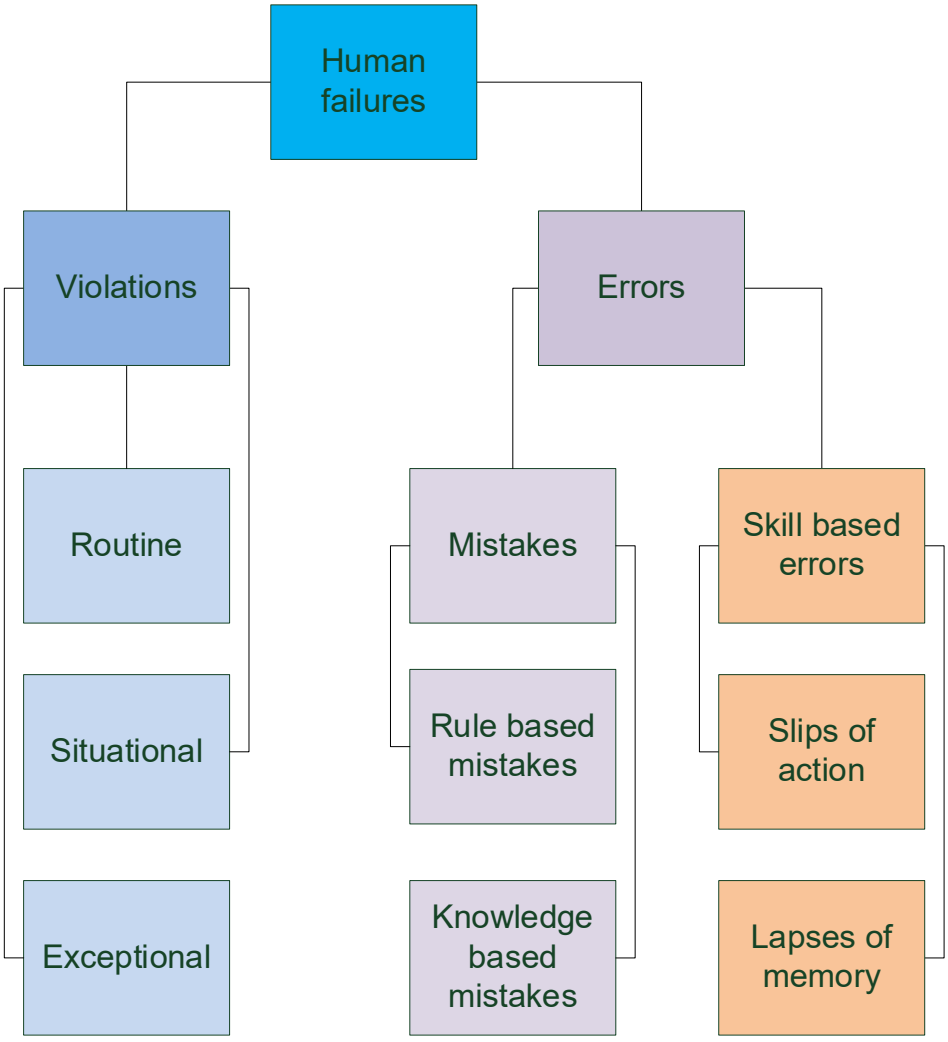

Fig 1: Errors and violations from HS(G) 48: Reducing Error and Influencing Behaviour

and also by NOPSEMA [24] in their illustration below.

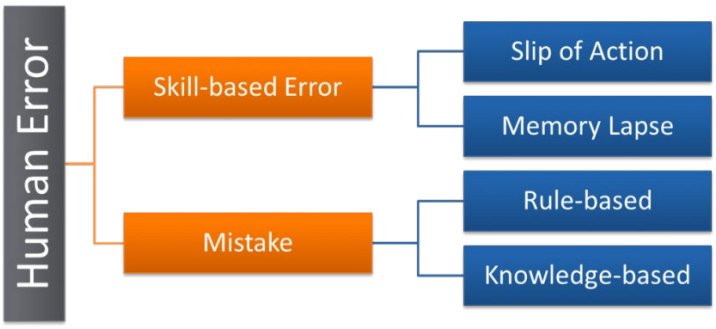

Fig 2: Human errors after NOPSEMA

2.1.4 Complacency and human factors

The definition of complacency set in the context of fire evacuation from buildings must be set in the realm of human factors and behaviour.

The key issues here in defining, acting upon and correcting complacency is to treat the condition as a human factors and behavioural opportunity for improvement. This opportunity for improvement has been granted, in fundamental root cause analysis illustrated by Weigmann and Shappell in their Human Factors Analysis and Classification scheme 2000 [25], by unsafe actions taken by people, because they think they know best, or unsafe conditions. These actions and conditions result from:

- Physical.
- Mental.
- Psychological conditions.

These conditions affect the person and their fitness to act sensibly in an emergency situation which impacts upon their ability to:

- Communicate with others.
- Coordinate their actions with others.
- Use technology as necessary

and to react properly with their physical environment.

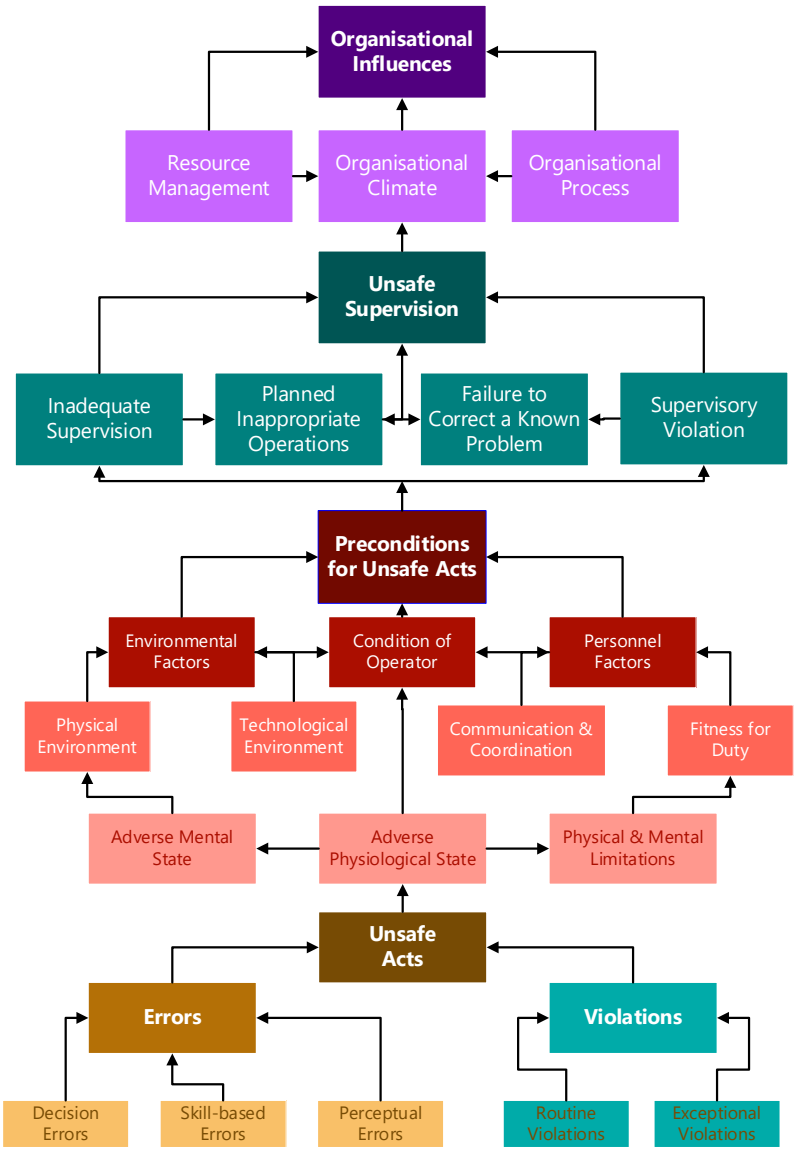

Fig 3: HFACS routes to unsafe acts and conditions which lead to complacency.

2.2 Evacuation

A simple definition of the verb to evacuate would be 'to remove from a place of danger to a safer place'. (Oxford English dictionary. CD-ROM version) [16]. However, in fire safety terms evacuation is rarely simple and is preceded by a term to give a compound verb which defines the type of process planned or underway. Definitions for different types or descriptions of evacuation would include:

- **Simultaneous evacuation:** Defined as residents of a number of flats are asked to leave together. It requires a means to alert all of these residents to the need to evacuate the building, for example, a full building fire detection and alarm system.
- **Vertical evacuation:** Vertical Evacuation, by using a stairway, is usually the preferred method of exiting a building in an emergency. Simply put, this refers to using the stairs to get everyone who is usually housed above the ground floor out of the building quickly. However, this method is for those who are able to evacuate a building with minimal assistance. Consequently, those with mobility needs should be located on the ground floor, where possible.
- **Horizontal evacuation:** Horizontal, phased evacuation is the method of moving people away from the area of danger to a safer place on the same floor. This is one

reason why using fire doors properly is so important, as they can create fire resistant compartments.

- **Selective evacuation**, aka staff alarm evacuation on a silent alarm: Enables stay to move people to a temporary refuge to muster before moving people en mass to a place of safety.
- **Defend in place:** This is a strategy that is used mainly in healthcare for those occupants who are physically unable to leave the facility**.** Many of these occupants are connected to life-supporting equipment and could be in even more danger if they are moved or removed from the facility.

2.3 Heuristics

Heuristics are cognitive rules of thumb, hard-wired mental shortcuts that everyone uses every day in routine decision making and judgment [26]. With enhanced or increasing competence heuristics play a greater part in following expected behaviour paths.

2.4 Fire safety culture

According to the Health and Safety Executive in HS(G) 65 [27], 'ordinary' safety culture is defined by the following expressions:

'Effectively managing for health and safety is not just about having a management or safety management system. The success of whatever process or system is in place still hinges on the attitudes and behaviours of people in the organisation (this is sometimes referred to as the 'safety culture'). One of the original definitions from the original HS(G) 65 [27] featured: control, co-operation, communication, and competence.

Consequently, having a separate definition for fire safety culture should just be an extension of the familiar definition with the inclusion of the adjective 'fire' before the key words, forming a sub-set of occupational safety culture as excellence in organisation of fire safety.

Menhas [28] defines Fire Safety Culture as 'the attitudes, beliefs, perceptions and values that employees share in relation to fire safety'.

Croner [29] discusses fire safety culture in the context of cultural improvement using UK Health and Safety Tools to

- determine aspects of fire safety culture that require greater influence
- identify barriers that may hinder influence and prevent change
- decide what measures are needed to influence fire safety culture, and
- formulate the implementation of the measures to influence the culture.

Galea *et al* [30] also discusses Fire Safety Culture as a subset of Safety Culture. With Fire Safety not a major influence on the Institution of Occupational Safety and Health [IOSH] or identified as a key competency (IOSH 2019) [31], it is often inferred as part of general Occupational Health and Safety Management Systems.

Santos-Reyes and Beard [32] discuss also Fire Safety Culture as a subset of Safety Culture and use the phrases interchangeably whereupon it is submerged within Occupational Safety and Health. It is suggested that this may mean that fire safety is seen (erroneously) as a less obvious business risk and consequently does not achieve sufficient exposure or appropriate commercial funding.

Tavares [33] and Varga [34] both discuss Fire Safety Culture at a national level rather than at an operational level.

2.5 Risk

In terms of fire safety, a **hazard** is something that can cause harm, e.g., fire, flames, smoke, hot surfaces, pyrolysis products, carbon monoxide, electricity, chemicals, firefighting from a ladder, noise, heat stress, etc.

A **risk** is the chance, high or low, that any hazard will actually cause somebody harm. The risk manifests itself by the probability [for a short duration event] or the likelihood, [for a longer-term exposure] that the event will occur, and that the severity of the consequence will be sufficient to cause actual harm, whether or not the harm is reversible. In fire safety, risks should always be reduced to ALARP, as low as reasonably practicable [35].

2.6 Concepts of egress time

With fires at work still causing loss and misery the importance of a prompt response when a fire is first identified is vitally important. Fraser-Mitchell and Charters [36] have identified how people respond to the initial fire cue and suggested that subsequent evacuation time is conventionally split into 'pre-movement' time and travel time.

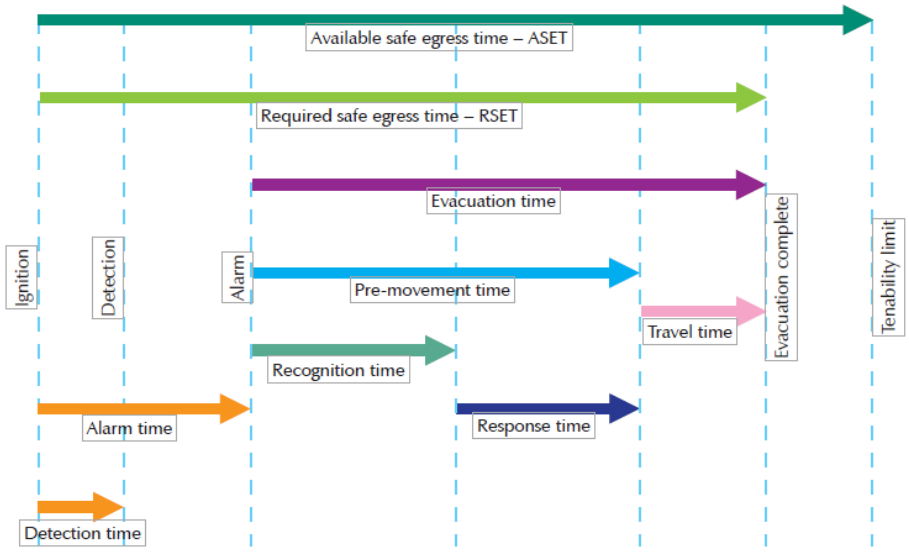

Fig 4: Available safe egress time [ASET] and required safe egress time [RSET] timelines [after Fraser-Mitchell and Charters 2010].

In terms of complacency in evacuation, the focus of this study is primarily on the **Pre-Movement time**, both the recognition and response times, which could be likened to a few golden seconds in a few golden minutes.

This Fraser-Mitchell and Charters model [36] assumes both a clear point between recognition and response time, whereas this 2021 study suggests that this is a simplification and that there is also time spent in human processing of **an 'acceptance' factor** whereupon there is an acknowledgement that a reaction is needed, and quickly.

This paper considers the influential heuristic factors suggested by McCammon [37]: familiarity, social proof, commitment and scarcity in decision making in a work environment, where invariably people will be in company with others. Herbert [26] describes "Heuristics as cognitive rules of thumb, hard-wired mental shortcuts that everyone uses every day in routine decision making and judgment".

3 WHY WAS THIS STUDY NECESSARY?

An academic review paper by the David Gold *et al*, edited by Scott [38] on human behaviours in fires shows that the time window to effect safe evacuation from a building on fire is still very narrow, despite advances in the 21st century with technology.

From a 1972 Sime paper [39] the factors affecting the outbreak of fire were enhanced by the three familiar ones: availability of fuel, availability of oxygen and availability of a significant and credible means of ignition to include a factor which affects human behaviours in fire. This additional life safety factor is essentially an Ignition Time factor, which is defined as:

$$\text{Ignition time } T = \frac{\text{Time } T_d \text{ [to discover and react to a fire]} + \text{Time } T_e \text{ [to evacuate to a place of safety]}}{\text{Time } T_u \text{ [to make conditions untenable]}}$$

Equation 1: Ignition time

For a safe condition to exist $T \leq 1$.

The time to discover and react to a fire T_d is attributable to:

- Technology, in detection and warning, or human discovery and intervention.
- Initial personal human understanding and competence to respond properly.
- Ongoing human behaviour AND
- A total lack of complacency.

T_e, the time to evacuate to a place of safety, is attributable to the building environment and design and T_c is a function of the environment and, as the fire has already started, the availability of fuel and the availability of oxygen.

Making buildings as safe as possible in fires relies on many factors in terms of fire prevention and fire protection, the architecture, design, selection of materials, construction techniques, strength and integrity and in control of internal processes and materials [combustibles and flammables etc] through accurate fire risk assessment.

But above all, it is the one factor that will be inevitably variable throughout, the people and their human behaviours, who need to be helped to make the right decisions and take the proper actions.

3.1 The unique position?

The unique position with this study is establishing links in complacency in evacuation with human behaviour through human factors. The links show that there is complacency in the workplace when the fire alarm sounds.

However,

1. What missing factors in a fire safety culture are associated with complacency?
2. Does complacency exist in companies with a strong fire safety culture?
3. This is a snapshot of complacency [split by business, commercial and industrial sectors / organisation type].
4. Can organisations be clustered by factors ‘x, y and / or z’?
5. And what are these additional discriminating factors?

4 THE PREMISE OF THIS STUDY

In this study there are three premises, theories or propositions on which arguments are based and hopefully conclusions and recommendations are reached through our research. Consequently, our study addresses:

1. Does complacency exist in companies or organisations with a strong fire safety culture?
2. To what extent is there complacency in the workplace when the fire alarms sound? And if so:
3. What are the missing factors in a fire safety culture which give rise to this complacency and how should they be dealt with?

5 THEORETICAL MODELS

Chu and Law [40] identified that a building occupant's background, and knowledge of relevant fire emergency situations, influences how individuals perceive the emergency situations that in turn can lead to different individual behaviours observed in evacuation. This is supported by Kinsey *et al*. [41], who applied the heuristic argument of McCammon [36]. They suggest that once an individual perceives cues from a fire event, they must interpret them to assess the new situation and determine whether action is required. During this decision-making process cognitive biases may occur which cause an individual to neglect or be biased towards certain information: this may potentially lead to an inappropriate and/or unexpected response: in effect if the individual perceives that the alarm is not a real emergency then actions may well be appropriate yet undesired.

Beller and Watts [42] considered four occupant response characteristics:

- Sensibility.
- Reactivity.
- Mobility.
- Susceptibility

of which the first two are most likely to affect timings at the pre-movement stage (Fraser-Mitchell and Charters 2010) [36].

The first, sensibility, can be to a great extent be engineered out. However, reactivity, defined as the ability to correctly interpret cues and take appropriate action and includes cognitive capability, reliability or likelihood of a wrong decision', reflected in whether to actually act on the alarm. Groner [43] identified the weakness in some older simulation models as they ignore individual, cognitive attributes and often calculate optimal times, assuming that people follow the quickest safe route, and thereby underestimate actual evacuation times. This includes pre-evacuation times [i.e., that amount of time the people take before beginning their movement toward egress routes] and interactions of individuals with their environments. Such models are also limited with regards incorporating the variable and adaptive behaviours of building occupants

Lovreglio *et al* [44] identified that the pre-evacuation time can be simulated within computational models using different approach creating a model for the based on the Random Utility Theory[5]. This model represents the pre-evacuation behaviour of simulated occupants considering three behavioural states: normal, investigating and evacuating. A weakness of this study is that it was based on evacuations of the public from a theatre. Lovreglio *et al* [45] also introduced the concept of *behavioural uncertainty* in the model and a formulation to calibrate the proposed model using a likelihood function is then provided. Behavioural Uncertainty is defined as uncertainty associated with the stochastic nature of human behaviour by Ronchi *et al* [46] in 2014.

[5] Random Utility Theory proposes that people generally choose what they prefer, and where they do not, this can be explained by random factors. For example, a person may choose their preferred chocolate ice cream 9 out of 10 times and on the 10th occasion they choose chocolate-mint-chip due to some random factor.

In a 2019 publication Ronchie *et al* [47] discuss 'The defence-cascade model' with has three distinct stages of defensiveness, one of which is the pre-encounter stage where no threat has been detected yet, but a threat has been previously experienced in similar situations leading to increased vigilance. Conceptually, hearing a fire alarm could be classified into this stage, as most people have experienced fire alarms before. However, this will have been mostly in non-threatening fire practice situations. Ronchi's paper [47] identifies data gaps that include employee behaviour.

In retail situations, Shields *et al* [48], suggested that pre-movement time can be as much as six minutes and is a vital component of the total evacuation time. They recommended that staff training must be effective in overcoming complacency. Within retail, the issue was use of familiar routes.

6 LITERATURE REVIEW

6.1 Relationships to risk perception

Bernardes *et al* [49] identified actions linked to individuals' actions and decisions, including risk perception which, if low, implies a response which is non-protecting and ignores the cues. As most workers in modern offices and other workplaces never seeing a workplace fire, the default response when they hear or see an alarm is often that this is just another exercise or a false alarm [50]. Chubb and Williamson [51] stated: "Fire safety hazards exist not because people knowingly or wilfully tolerate otherwise unacceptable risks, but rather because people interpret fire risk as remote" and for individuals: "Fire is more a deterministic, and therefore opportunistic, event than it is probabilistic".

6.1.1 Mutually opposing criteria

It is interesting to note several observations from this work.

- Fires in the workplace are generally rare now.
- Employees and contractors should have a sense about how the risk is represented in their workplace. Is there a fire per week or just one historically in living memory?
- Prevalence of fire depends on hazards and risks in processing and storage of materials, flammability and control of means of ignition and behaviours of co-workers.
- Fire alarm call-point testing, and possibly fire drills should be held each week, so awareness of the alarm sound will become familiar and fire evacuation practice will be a regular event.
- Fire evacuations should be held every 6 months in 'normal' risk facilities. More frequently than that the higher the level of risk.
- Modern fire detection equipment is largely very reliable.

So, as a general rule, if the fire alarm sounds:

- at any time, other than the time of the routine weekly test …
- **and** there has been an evacuation drill recently ...
- **and** the sounder rings for longer than usual …
- **then** the alarm is most probably real.

A qualitative study from the World Trade Centre Evacuation by Gershon *et al* [52] identified a number of individual factors that affected evacuation including perception of risk [formed largely by sensory cues], preparedness training, degree of familiarity with the building, physical condition, health status, and footwear. This was also affected by group behaviour and leadership.

Construct	Characteristics	Major Factor Category
Attitudes, perceptions of safety climate, perception of risk, fear	The individual's perceived risk to self, as well as their perception of their employer's commitment to safe work practices	Individual
Behavioural intentions	The behavioural intentions regarding evacuation	Individual
Beliefs	Belief in one's own ability to determine the need for evacuating and belief in one's capability to do so	Individual
Evacuation Behaviours	Specific actions taken by the individual evacuee regarding evacuation	Individual
Group behaviours	Collective behaviour of a group of individuals Individual and organizational	Individual and organizational factors
Individual Factors	Specific characteristics of the individual that might affect evacuation	Individual
Knowledge	The individual's awareness and understanding of evacuation protocols and procedures, as well as possible means of egress from the building	Individual
Sensory Cues*	Cues in the environment (e.g., smoke, fire, noise, alarms) that served to make the individual aware of an event	Individual
Instinct*	Instinctive sense ('gut feeling') of danger	Individual

Table 2: Model constructs and predefined characteristics, after Gershon 2007 [50].

Kinateder *et al* [53] suggest that Risk Perception has two elements: that of 'expectancy-value' and 'risk-as-feeling'; in effect the personalization of the risk related to a current event, such as an ongoing fire emergency and is influenced by emotions and prone to cognitive biases.

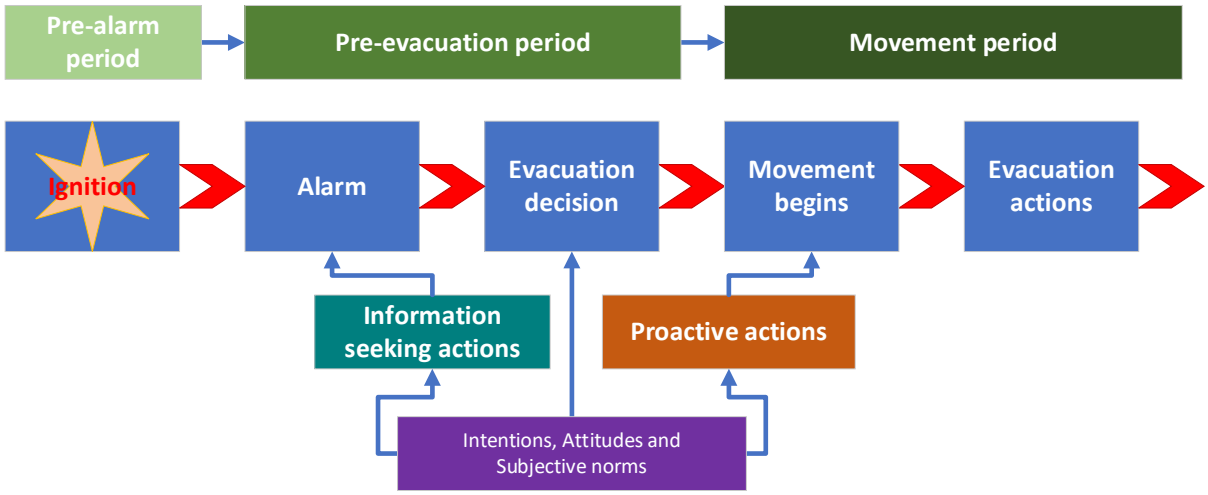

Fig 5: Comparison between the timeline of building fire evacuation and effects of planned behaviour (after Kinateder et al 2015) [53]

Kinateder *et al* [53] gives an overview of the evacuation process comprising the pre-evacuation and evacuation period. The crucial point in the pre-evacuation period is the decision of occupants to evacuate after they have received initial fire cues, which is potentially dependent on occupants' risk perception and other human factors. The model includes the relationship with the Theory of Planned Behaviour which Ajzen [54] describes how intentions are transferred into actions, assuming that 'intentions are the immediate antecedents of behaviour and intentions themselves are a function of attitude toward the behaviour, subjective norm, and perceived behavioural control'.

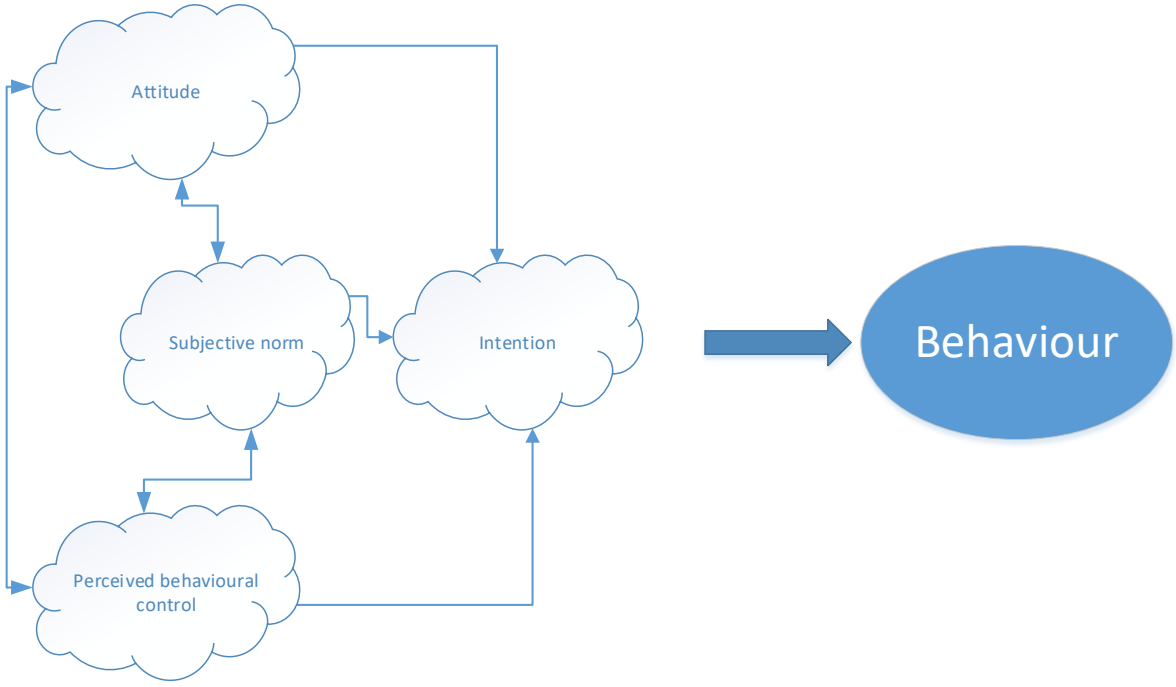

Fig 6: The theory of planned behaviour, after Azjen [54]

Occupant Risk Perception is of course only part of the risk challenge. Under UK Fire safety legislation[6] [55] there is a legal requirement for risks to be assessed, evaluated and mitigated through a suitable process. Within this process there is need to evaluate against 'risk capability' [56] that has to base upon theoretical human behaviour and on the determinants of safe evacuation of occupants during a fire. These human attributes include the following.

- Personality.
- Knowledge.
- Experience.
- Powers of observation.

These attributes coincidentally share a family relationship with the factors that form competence: 'KATE', knowledge, approach, ability or attitude, training and experience.

6.2 Powers of judgement and awareness.

Shaw *et al* [57] identified that people who disregard an emergency have a lower perception of risk with people often completing non-evacuation activities such as collecting bags, collecting the evening meal they bought at lunchtime from the local supermarket, which was in the kitchen refrigerator, making phone calls, shutting down computers and seeking permission to leave.

6.3 Training

Appropriate fire safety training of employees has been an legal requirement for many years in many countries [57], [58]. This training needs to be site specific and should include the findings of the fire risk assessment; explain emergency procedures; relate to the work activity and explain the duties and responsibilities of staff; be coherent to staff and others requiring training and be tested by fire drills [59]. Miguel *et al* [60] studied the influence of a training period on workers behaviour and concluded that the more you practice fire drills gave a 'progressively better behaviour of the workers during the fire drills'. They identified that further study was needed to relate training and motivation may have a positive effect on their behaviour with a direct influence on their evacuation time. Bakar *et al* [61] challenged the value of preannounced fire drills as people do not have a sense of urgency to evacuate the building. Their study highlighted that long evacuation time during fire drill among workers in a tower block in Malaysia is due to low knowledge, lack of awareness, human behaviour and guidance factors with a need to focus and highlight appropriate fire safety training. Proulx [4] discussed the role of a voice alarm in addition to the alarm in informing the evacuation. Galea *et al* [30] suggest that training that develops an understanding of how quickly an emergency situation can deteriorate and reinforces the messages that 'every second counts' and 'immediately' means disengaging from pre-alarm activities as soon as an alarm is sounded to tackle complacency.

Their study on a high-rise construction site identified some workers totally ignored the alarm for a number of minutes, with workers perceiving incredibly that they are in a safe environment while on their construction site.

7 METHOD

7.1 Data collection

An initial team of three people was established to build and test a questionnaire to explore the subject of fire alarm related complacency [Appendix1]. The initial draft questionnaire was reviewed and commented on by the IOSH Fire Risk Management Group (FRMG)

[6] The Regulatory Reform [Fire Safety] Order 2005. Statutory Instrument SI 2005 No. 1541. UK.

Executive Committee, which resulted in further drafts which included additional questions. The questionnaire was subsequently shared with experts internationally and a suggestion was made and incorporated that questions be adapted from the Fire Prevention Research Foundation [FPRF] Research Study on High Rise Building Safety and Emergency Evacuation. This brought the total number of questions to 55 plus 5 sub-questions.

The questionnaire contained mostly closed questions. However, a small number of open questions were also included. The IOSH FRMG has members who are spread across many countries around the world. However, for practicality all communications are in the English language. The questionnaire was not translated into other languages creating the potential for linguistic bias.

7.2 Instructions for the implementation of the questionnaire

Each member of the FRMG was requested to complete, through face-to-face or telephone interviews, the questionnaire at least three times. Once for an employer (or senior manager), once for a mid-level manager (or supervisor) and once for a worker (or operator}. They were told that the quality of the organisation they chose did not have to represent good practice in fire safety, in fact a cross section of commitment to fire safety principles would enhance the quality of the survey. Members received the link to the instructions and the questionnaire in an E-shot. The survey was electronic, so people carrying out the survey were told that they needed a laptop or a tablet with an internet connection to complete it.

Once the interviewer had identified the three above-mentioned individuals, ideally but not necessarily from the same organisation or enterprise, an interview was carried out with each individual separately using the online survey form. The interviewers were instructed to read each question along with the possible responses aloud, exactly as written and to record the response. The interviewers were asked not to provide either a hard or a soft copy of the questionnaire to the interviewee as this could have created bias compromising the integrity of the data. They were told that each question was self-contained, with definitions when necessary, and asked to not further define terminology. If the interviewee could not understand the question, the interviewer was asked to leave it blank and move onto the next question.

7.3 Testing and finalisation of the questionnaire

The questionnaire was subsequently tested in Singapore, Hong Kong, the United Kingdom, the Arab States, Ireland and North America. Testing the questionnaire was completed by carrying it out three times (one worker, one supervisor and one senior manager), to determine if there was any terminology that needed further clarification and for corporate consistency. Suggestions from the test were evaluated and adjustments were made as appropriate.

7.4 Confidentiality

All aspects of the project were designed to respect confidentiality of the interviewees by not identifying names of companies or interviewees completing the survey.

7.5 Implementation of the questionnaire

The questionnaire was uploaded onto the Survey Monkey platform.

The interviewer read the questionnaire from their computer or tablet. Once completed the questionnaire was uploaded onto the Survey Monkey server.

The questionnaire was finalised in December 2018 and went live in March 2019. A link to the instructions and the questionnaire was sent to the approximately 5,000 IOSH FRMG Members. The closure of the questionnaire was initially set to 30 April 2019, extended to

30 June 2019 and once again extended to September 2019 after several requests were received during the summer of 2019. Over 400 questionnaires were completed.

7.6 Analysis

Information regarding attitudes and perceptions concerning occupant complacency when an evacuation alarm was initiated were examined using single and multivariant logistic regression with a view to determine whether the demographic or other variables and safety culture had any influence on complacency.

Within the questionnaire there were twenty questions related to occupant complacency when an evacuation alarm is activated.

It surfaced during a review of the initial response that the level of fire safety culture in an organisation might have an impact on occupant complacency when an evacuation alarm is activated. However, it had then to be determined if this was going to be a positive or a negative contribution and whether an organisation with a higher level of perceived fire safety led to individuals being more complacent or less complacent. A fire safety score was developed from selected questions and organisations were scored as being low, medium or high and brought into the analysis.

Variability in the size on an organisation, the sector in which the organisation is found and the stage of technological development of the country where the organisation is located was also examined.

8 RESULTS

8.1 Demographic data

A total of 413 responses were received. Of those respondents, 305 were male, 104 were female and 4 preferred not to give a gender. The age distribution of respondents is shown in Table 3: Respondents by age group and Fig 7: Age distribution of respondents

The job levels of the respondents are shown in Table 4: Respondents by job level. Half had the job level ‘Manager, and almost a quarter were line managers or supervisors.

Age group	No.	%
18-24	8	2%
25-34	58	14%
35-44	95	23%
45-60	204	49%
Over 60	45	11%
No answer offered	3	1%
TOTAL	413	100%

Table 3: Respondents by age group

Job level	No.	%
Manager	210	50.8%
Line manager / supervisor	97	23.5%
Worker / operator	73	17.7%
Director / CEO / owner	33	8.0%
TOTAL	413	100%

Table 4: Respondents by job level

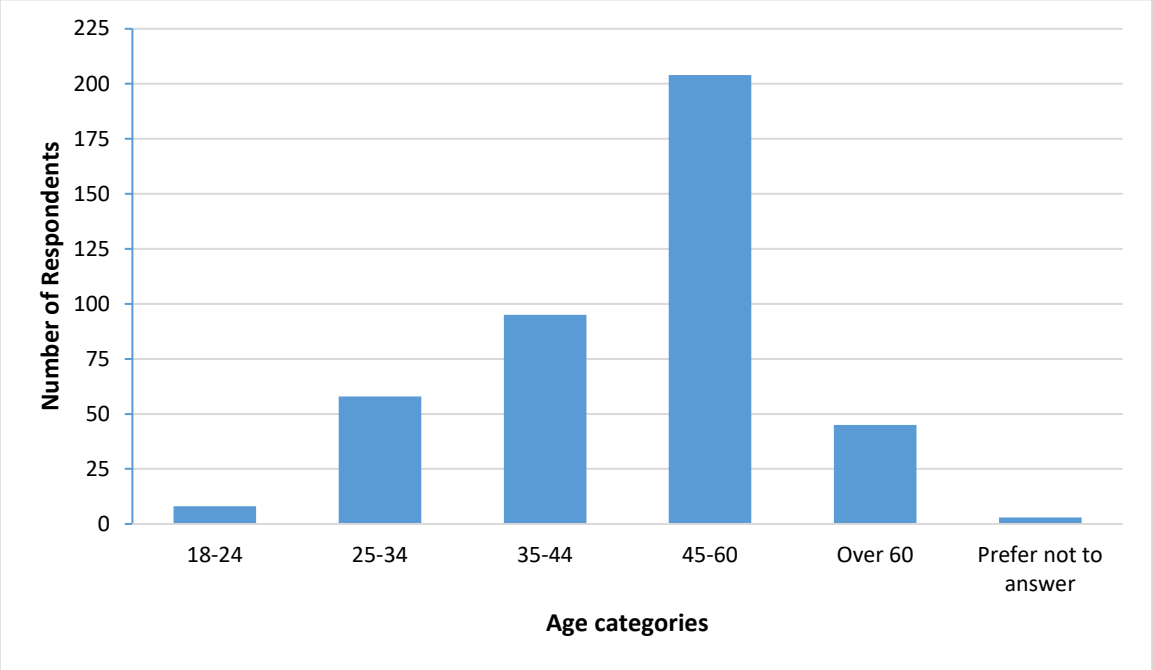

Fig 7: Age distribution of respondents

For country of work, respondents most commonly reported United Kingdom [n=326; 78.9%], followed by Ireland [n=28; 6.8%], United Arab Emirates [n=11; 2.7%] Saudi Arabia [n=7; 1.7%] and Iraq [n=5; 1.2%]. The remaining 36 responses [making up 8.7%] were from 20 different countries, with at most n=4 [1.0%] in any one country.

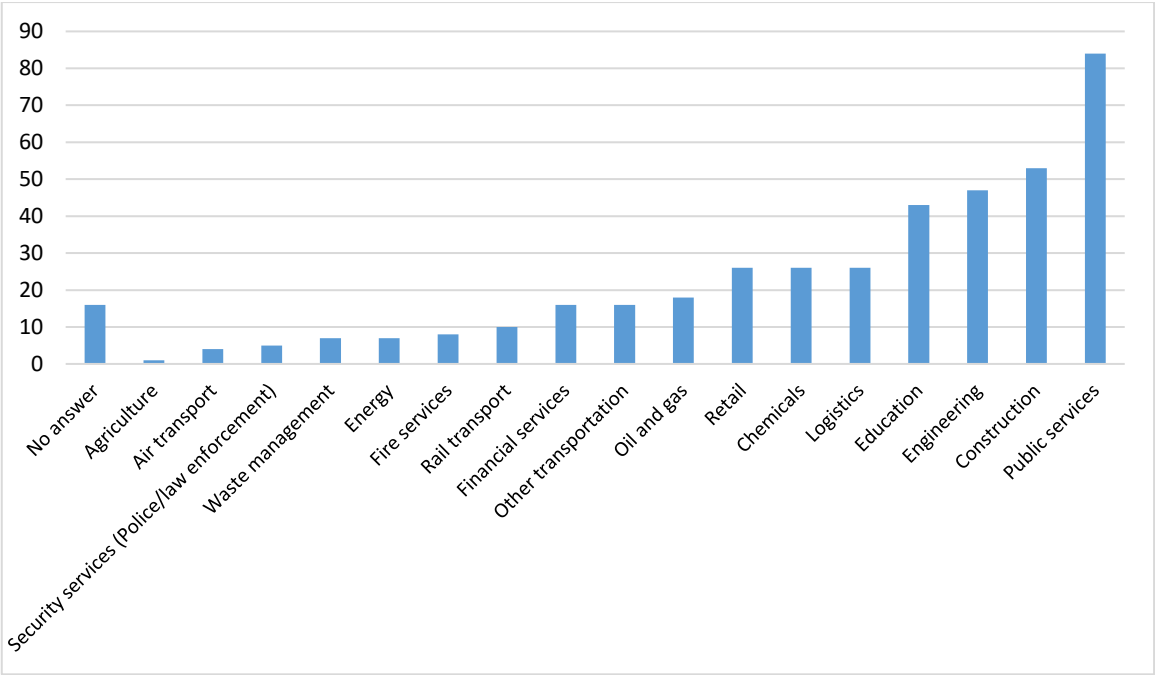

Fig 8: Respondents by type of industry

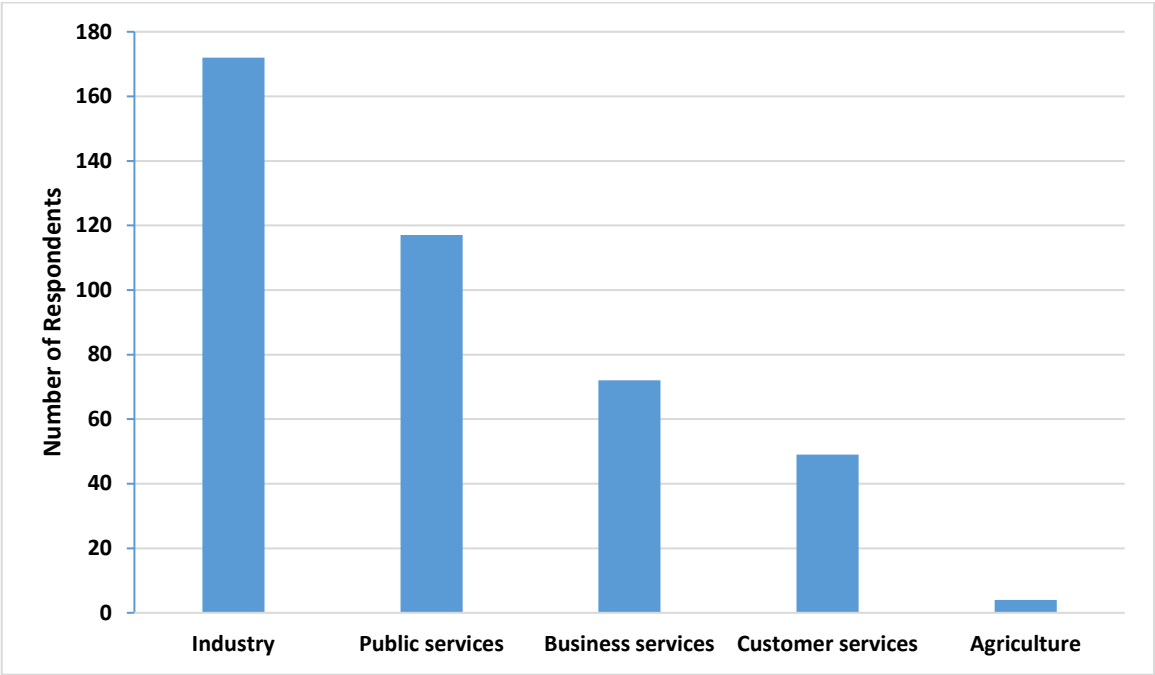

Fig 9: Respondents by category of enterprise

The responses by industry are shown in Fig 8: Respondents by type of industry These responses were grouped by category of enterprise which are shown in Fig 9: Respondents by category of enterprise

When asked the number of years in their building, the largest share responded '>10' [n=152; 36.8%] followed by '0 – 3' [n=136; 32.9%], '>5 – 10' [n=79; 19.1%] and '>3 – 5' [n=46; 11.1%].

8.1.1 How likely were people to experience a fire emergency?

Almost two thirds of the 413 respondents [62.7%] had never evacuated from a building because of a fire. One quarter [24.7%] had evacuated from a fire in their home. Three respondents (3%) had evacuated from a fire at work. The remaining 9% had evacuated from a fire in another location, including previous jobs, hotels, student residences, cinemas and other places of business that may or may not have been previous job sites.

8.2 Fire safety at the work site

The respondents were asked several questions about training, risks on the site, safety features, escape routes, assembly points, and accommodations for disabled workers. Their responses are summarized in this section.

Respondents were asked to rate fire safety on their work site, with fire safety described as a combination of fire prevention and fire protection. Their responses are shown in Fig 10: Respondents rating of fire safety on their work site. More than 80 % rated fire safety at their work site as strong or very strong. About 10 % rated it as weak or very weak. About 7 % had no opinion and one person did not respond.

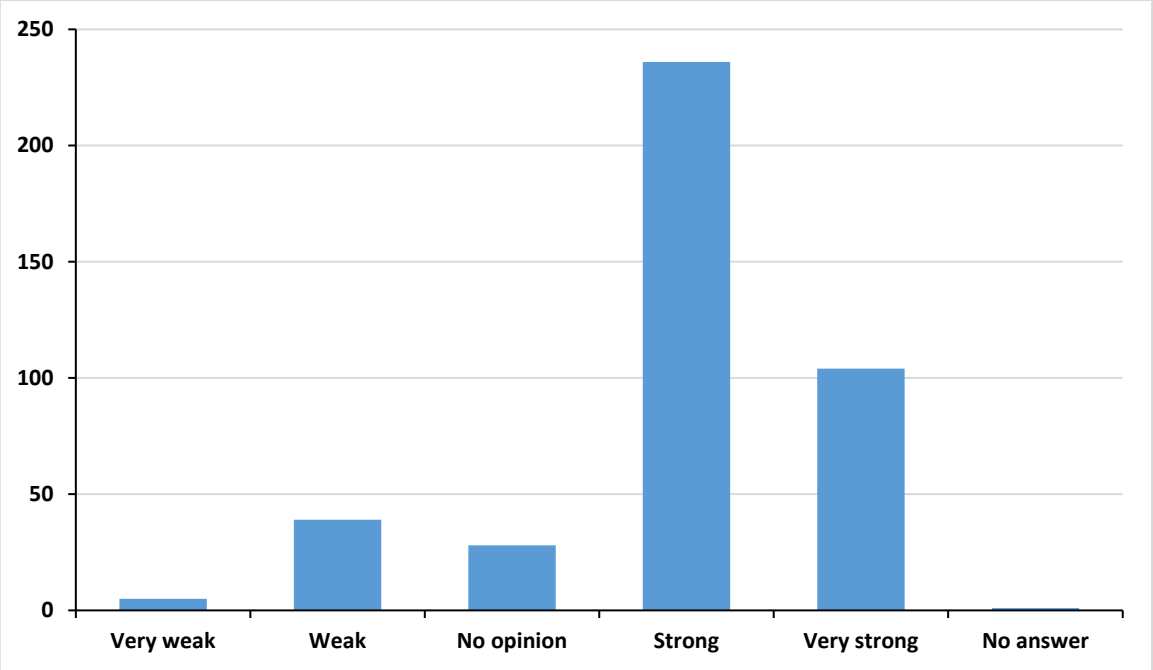

Fig 10: Respondents rating of fire safety on their work site

Anyone who said fire safety at their job was weak or very weak was asked to explain their response. The most frequently mentioned reasons were lack of management commitment or planning, lack of system maintenance and testing, lack of drills and fire wardens, lack of training and general lack of interest on the part of staff and tenants. A few mentioned a lack of funding.

Most of the respondents had received less than five hours of emergency evacuation training over the previous three years [see Fig 11: No. hours of emergency evac training over past 3 years]. Almost 10 % reported receiving no training at all.

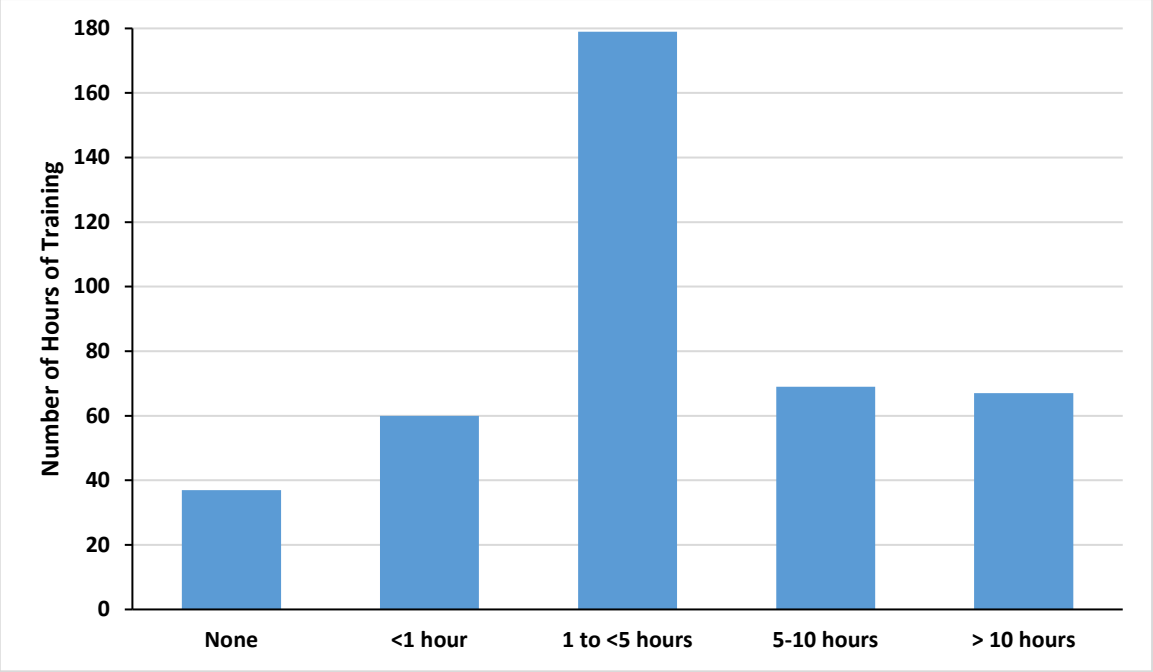

Fig 11: No. hours of emergency evac training over past 3 years

8.3 Greatest fire risks

From Question 14 the survey asked what contributors saw as the greatest fire risks in their workplace. Being free-text answers allowed a myriad of replies and the scope of answers from respondents has given 1178 responses. There is much duplication, and it is challenging to prioritise these. A standard list[7] of fire hazards such as:

- arson or wilful fire-raising
- combustible and flammable materials including flammable liquids, LPG, fuel gas, glues and solvents
- electricity
- heating equipment and portable heaters
- hot works and process safety
- kitchens and cooking equipment
- mechanical machinery
- people [and students in particular]
- smoking and carelessly discarded smoking materials
- waste materials and waste management.

could be used although by keywording the 1178 responses more focussed priority listings have been determined. Some respondents did not answer the question, some only gave one or two risks, and some replies could not be printed.

The greatest fire risks identified by respondents are detailed in Table 5: Distribution of greatest fire risks. Respondents were asked to identify these in a 1-2-3 priority, which have been arranged as top, middle and lower tier risks.

[7] Common-causes-of-Fire.pdf [acha.co.uk]

Risk	Top-tier risks	Mid-tier risks	Lower-tier risks	TOTAL
Arson	7	14	37	58
Building	11	24	11	46
Chemical	22	14	5	41
Combustible	17	45	37	99
Complacency	4	3	6	13
Cooking	23	28	19	70
Electrical	137	85	60	282
Explosion	5	6	9	20
Flammable	33	44	24	101
FRM	14	18	27	59
Gas	11	9	14	34
Hot work	20	11	13	44
Housekeeping	10	5	6	21
Human	30	23	36	89
Process	34	32	29	95
Smoking	11	17	23	51
Terrorism	2	0	1	3
Training	3	3	8	14
Vehicle	2	4	7	13
Waste	7	10	8	25
	403	395	380	1178

Table 5: Distribution of greatest fire risks

This distribution has been illustrated graphically in Fig 12: Fire risks identified by respondents.

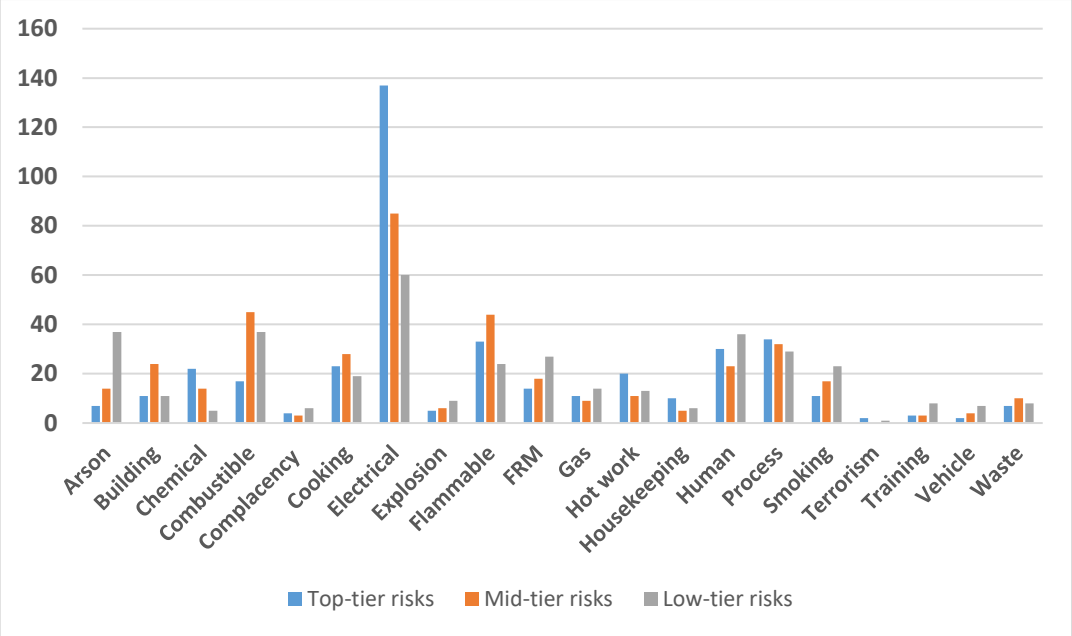

Fig 12: Fire risks identified by respondents

8.4 Classification of risks

A key to the alphabetical classification designed for this study is given in Table 6: Key to classification.

Risk	Key
Arson	Standard familiar definition of deliberate ignition.
Building	Any risk to do with the construction of the building or workplace layout and ergonomics.
Chemical	A risk due to the chemical properties of a material.
Combustible	Presence of combustible materials and issues of storage etc.
Complacency	As defined in section 2.1 above.
Cooking	Any risks to do with kitchens, cooking or food preparation.
Electrical	Risks associated with supply, use, maintenance or provision of mains voltage electricity or high voltage battery charging, vehicles, FLT etc.
Explosion	Any risks posed by condensed phase explosives, pyrotechnics or dusts.
Flammable	Risks associated with STUD[8] of flammable liquids, fuels [inc. road fuels] and solvents.

[8] STUD: Storage, transport, use and disposal.

Risk	Key
FRM	Fire Risk Management issues. Risks typically associated with fire precautions, fire protection, fire safety management policy, systems, procedures etc.
Gas	Risks associated with fuel gases, NG, LPG etc or pyrophoric chemicals.
Hot work	As in the classical definition.
Housekeeping	Risks associated with general fire safety and cleaning in a workplace.
Human	Any risks attributable to acts, omissions, neglect or violations etc by people: employees, contractors, security staff, the public etc which contribute to or exacerbate fire.
Process	Risks associated with the work actually being undertaken open flames, heaters, heating equipment, hot processes, mechanical issues.
Smoking	Any issues with smoking or discarded smoking materials.
Terrorism	A specific, but thankfully rare, example of arson.
Training	Any fire safety issue which occurs due to poor levels of competence and specifically training of people.
Vehicle	Risks associated with vehicles of any type, including aircraft.
Waste	Fire risks associated with collection, storage, distribution and disposal of any process waste materials.

Table 6: Key to classification of risks in this study

8.4.1 Interpretation

Inviting respondents to define in descending order the three greatest risks in their workplace is a form of proportional representation at the ballot box and having chosen a major risk it should not be repeated in a lower tier. The most significant risks and first choice to respondents were clear.

8.4.2 Top-tier risks

The top-tier [first choice] risks are seen as:

- electrical safety
- risks due to process, the work actually being undertaken
- fire risks presented by the STUD of flammable liquids and materials
- any form of human factors fire risks to do with the job, the work undertaken and the environment in which work is undertaken
- chemical risks, associated with reactive, dangerous or hazardous classified materials.

8.4.3 Mid-tier risks

Having chosen top-tier risks the prominent mid-tier risks were identified as:

- combustible materials
- flammables
- process
- cooking
- building fire safety issues.

8.4.4 Low-tier risks

Prominent in the third choices were:

- arson
- combustible materials
- human
- process
- fire risk management issues
- smoking.

8.4.5 Trends in the perception of risks

Regarding trending the risks, the following observations were made.

1. Electrical safety risks are the most prominent at every level.
2. Risks from flammable and combustible materials appear throughout in high numbers.
3. Human factors risk, risks from cooking and in kitchens and processes undertaken are prominent and largely consistent throughout.
4. Hot work risks are highest in tier 1, and decease thereafter.
5. Arson risks and smoking risks significantly increase as lower-tier risks.

Minor risks [although risks NOT to be dismissed] that are consistently represented throughout the respondent replies at a lower recorded level include the following.

a) Terrorism.
b) Vehicles.
c) Complacency.
d) Training.
e) Explosion.
f) Housekeeping
g) Waste.

An interpretation of these trends suggests that practitioners readily identify with the major and well-known fire risks that are prominent in their workplaces.

Mid-tier risks are the traditional fire risks that are always there in business, commerce and industry from flammable and combustible materials.

Lower tier risks that are prominent include arson and smoking. But this decline in ‘popularity’ may be a consequence is stricter controls over smoking at work and increased site security in recent years.

8.5 Fire detection and warning

Respondents were asked if their job sites had fire or smoke detectors, sprinklers or evacuation alarms activated by call points or pull stations. The responses are shown in Fig 13: Protection systems present on job site. Almost all the respondents reported that their job sites had detectors and evacuation alarms but only about one-third had

sprinklers. The installations that had sprinklers generally also had the other two systems. Two respondents said that their job site had none of the mentioned systems.

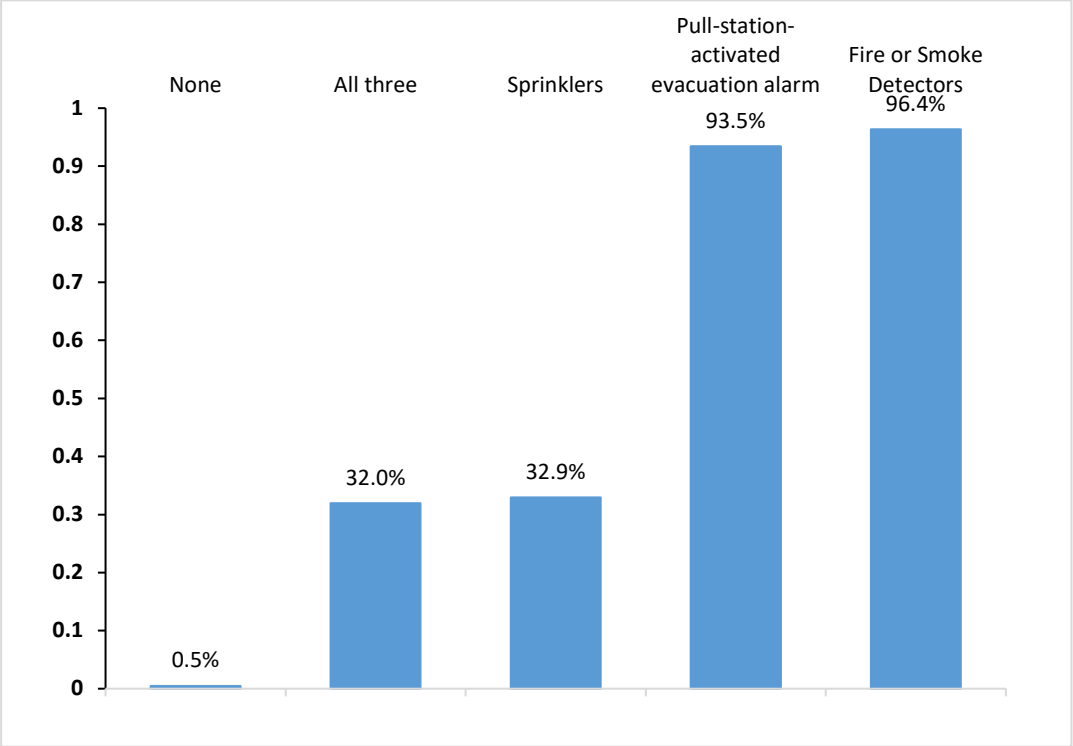

Fig 13: Protection systems present on job site

Respondents were asked how they would know that they needed to evacuate their workstation, choosing from a list of options. The responses are shown in Fig 14: How respondents knew when to evacuate.

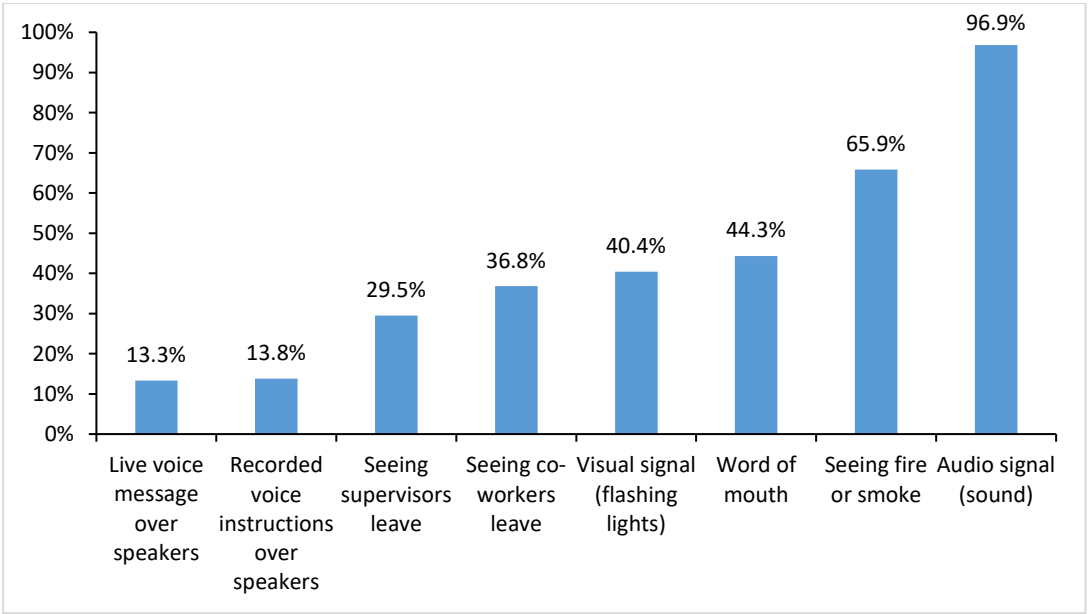

Fig 14: How respondents knew when to evacuate

8.5.1 Evacuation maps

The survey team explained evacuation maps to respondents, describing an evacuation map as a document that should clearly show the location where it is posted ('You are here!'), designated primary and secondary escape routes, exits, (the) external assembly area(s) and firefighting equipment. Almost three quarters of the respondents (73.6%) reported there are evacuation maps at their worksite, 21.6% said there were none and 4.6% did not know. One person did not respond. The 304 respondents who indicated that their job sites had evacuation maps were asked if they were clearly legible, up-to-date, and showed primary and secondary escape routes and external assembly areas. Their responses are shown in Fig 15: Characteristics of evacuation maps.

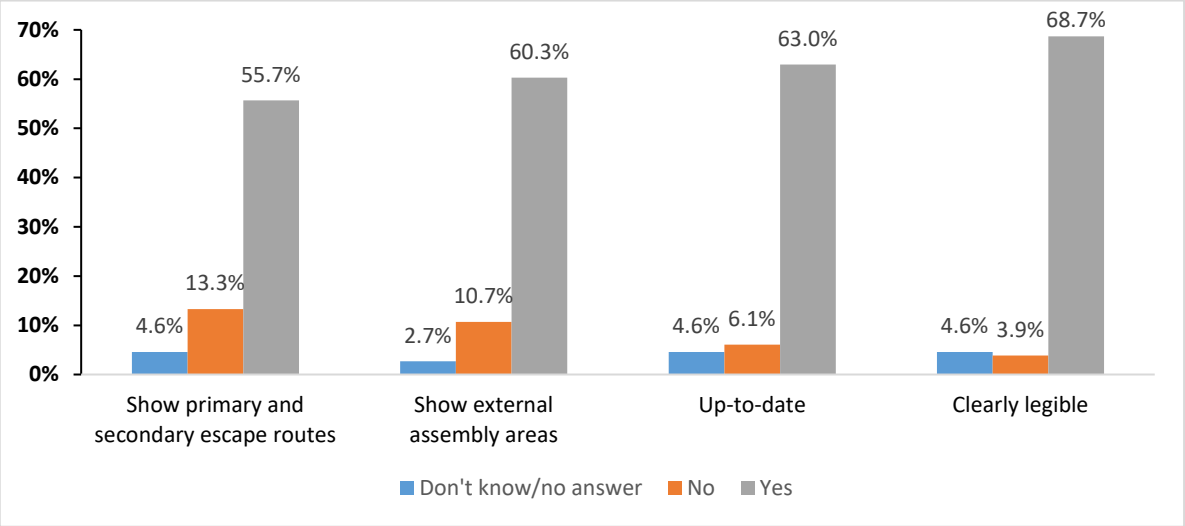

Fig 15: Characteristics of evacuation maps

8.5.2 Fire action notices

Most of the respondents (86.4%) reported that their job site had a fire action notice posted at their work area describing what to do if they discovered a fire or heard an alarm. Almost 10% said there was no notice and 3.9% did not know.

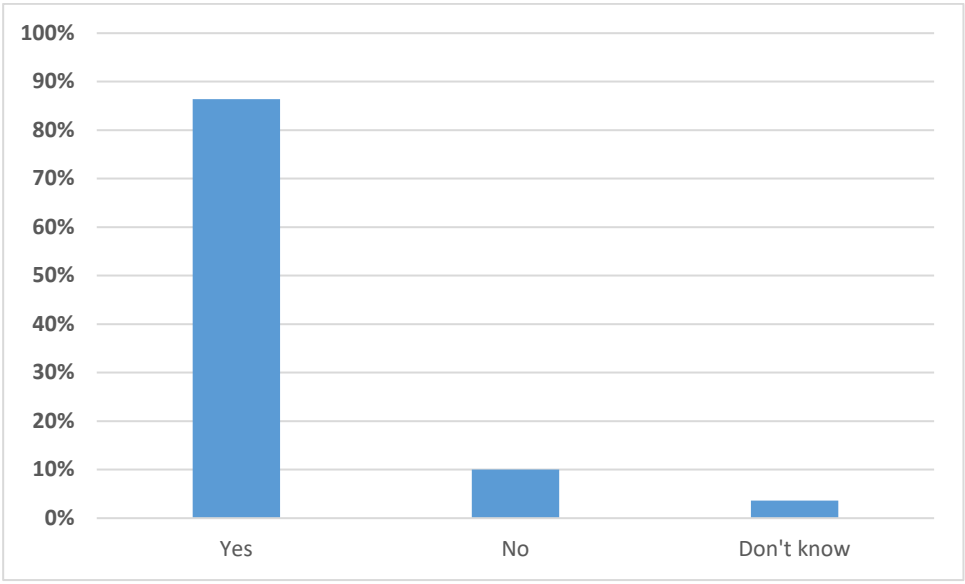

Fig 16: Are fire action notices provided?

8.5.3 Designated escape routes

The respondents were told that a designated escape route is a safe, well-lit, unobstructed and unlocked way out of the building in case of fire and were asked how many designated escape routes there are from their workstation. If they responded that they had one or more designated escape routes, they were asked if they had walked their primary route [and secondary if they had one] and if so, how long did it take, and if it was unobstructed, well-marked, well-lit and led to the external assembly point.

Almost all of the respondents reported that there were two or more designated escape routes from their workstation (42.6% and 43.3%, respectively, for a total of 90.0%). Eleven percent reported that there was only one route, and the remaining 2.9% said there was none, or they didn't know.

Almost all of the respondents reported that their worksite has a designated external assembly point (399 out of 413). Eight reported that they did not, and six did not know or did not answer the question.

8.5.4 Primary designated escape routes

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know the primary route	Grand total
1: None	1	4		1	6
2: One route		44	2		46
3: Two routes	1	159	16		176
4: > Two routes		165	12	2	179
5: Don't know		1	3	2	6
Grand total	2	373	33	5	413

Table 7: Designated escape routes to the external assembly area?

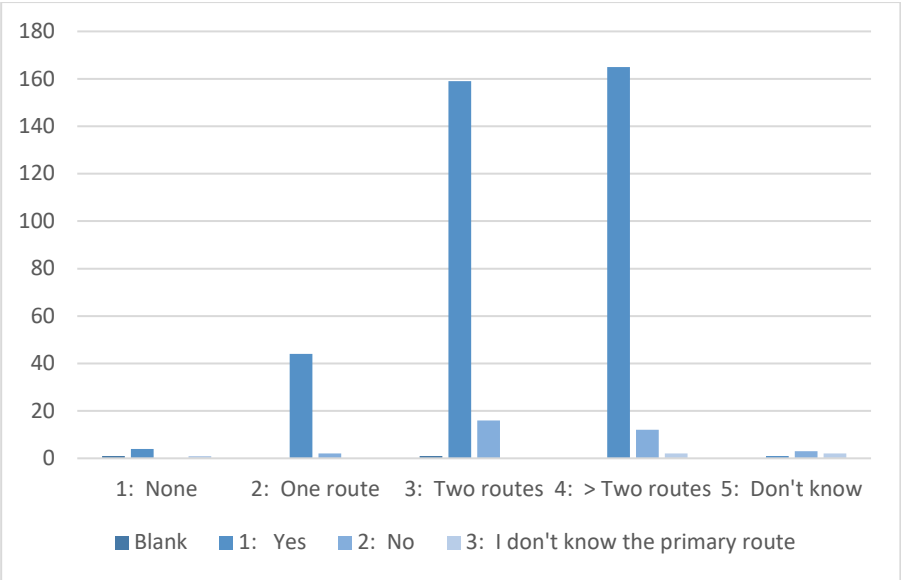

Fig 17: Designated escape route to the external assembly area

8.5.5 Secondary designated escape routes

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know a secondary route	4: No secondary route	Grand total
1: None	1	3	1	1		6
2: One route		11	5	4	26	46
3: Two routes		126	47	1	2	176
4: > Two routes	1	137	35	2	4	179
5: Don't know			3	3		6
Grand total	2	277	91	11	32	413

Table 8: Secondary designated escape route to the external assembly area

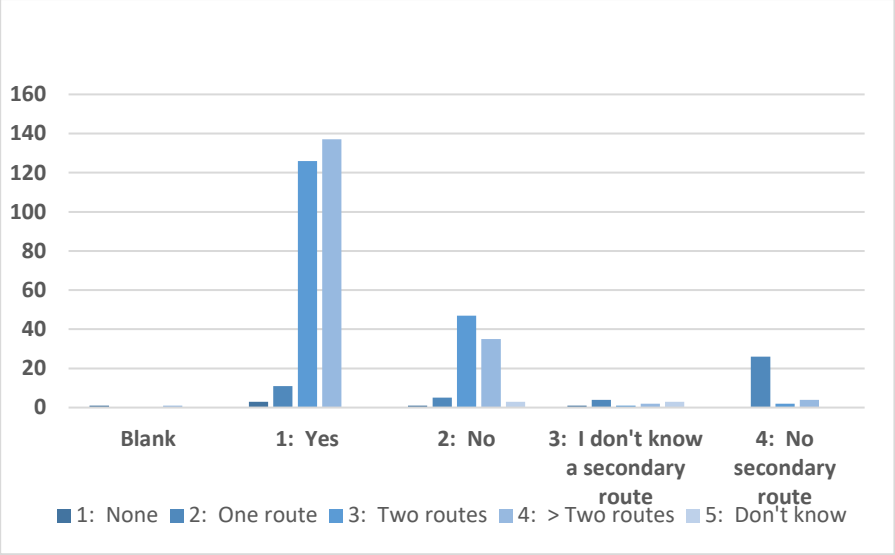

Fig 18: Secondary designated escape route to the external assembly area this year?

8.5.6 Time taken to exit the building

No. of designated routes from your workstation?	Blank	1: <2 min	2: 2-3 min	3: >3 min	4: I don't know how long	5: I don't know the primary route	Grand total
1: None	1	4				1	6
2: One route		42	3	1			46
3: Two routes		128	35	9	3	1	176
4: > Two routes		134	36	4	5		179
5: Don't know		2	1		1	2	6
Grand total	1	310	75	14	9	4	413

Table 9: Time taken to walk the primary escape route

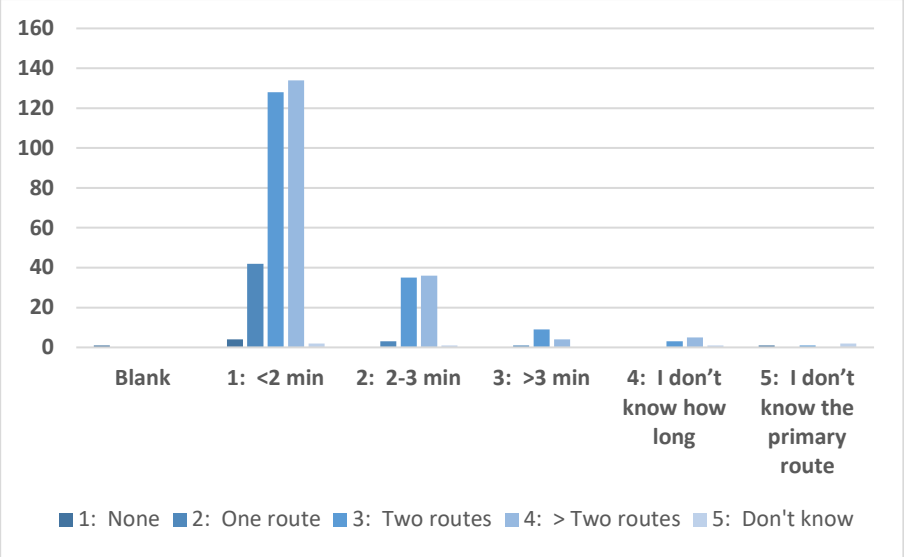

Fig 19: Time taken to walk the primary escape route

8.5.7 Escape route obstructions

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know	Grand total
1: None	1	4		1	6
2: One route		43	2	1	46
3: Two routes	2	166	7	1	176
4: > Two routes		168	9	2	179
5: Don't know		4		2	6
Grand total	3	385	18	7	413

Table 10: Are primary escape routes unobstructed?

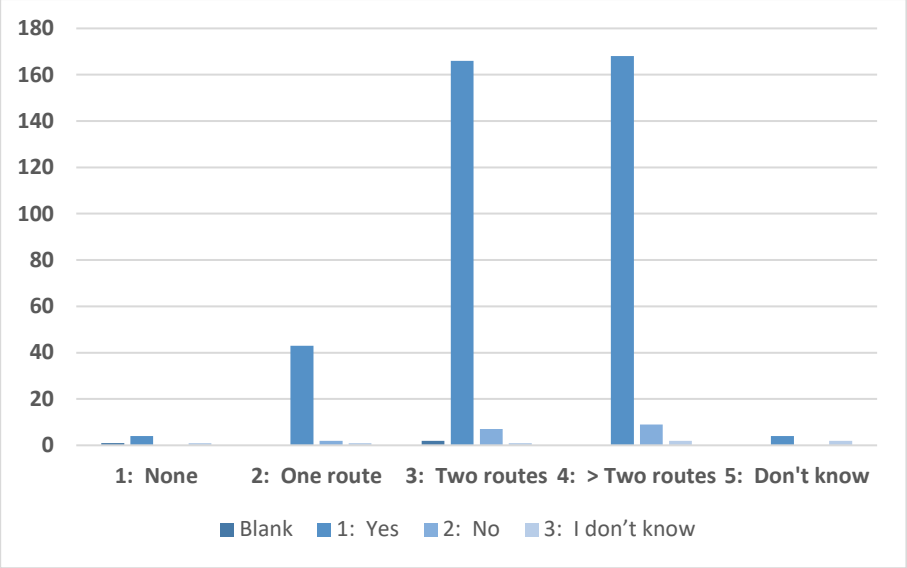

Fig 20: Are primary escape routes unobstructed?

8.5.8 Wayfinding and signposting of escape routes

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know	Grand total
1: None	2	3	1		6
2: One route		40	5	1	46
3: Two routes	3	157	12	4	176
4: > Two routes	1	166	10	2	179
5: Don't know		3	3		6
Grand total	6	369	28	10	413

Table 11: Are primary escape routes well marked?

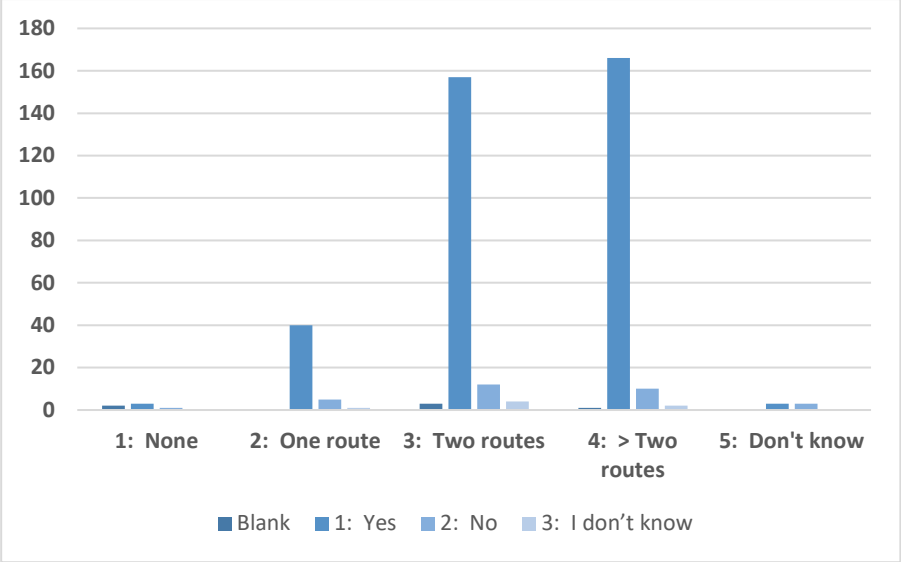

Fig 21: Are primary escape routes well marked?

8.5.9 Escape route lighting

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know	Grand total
1: None	2	4			6
2: One route	1	39	6		46
3: Two routes	4	167	4	1	176
4: > Two routes		174	4	1	179
5: Don't know		2	1	3	6
Grand total	7	386	15	5	413

Table 12: Are primary escape routes well lit?

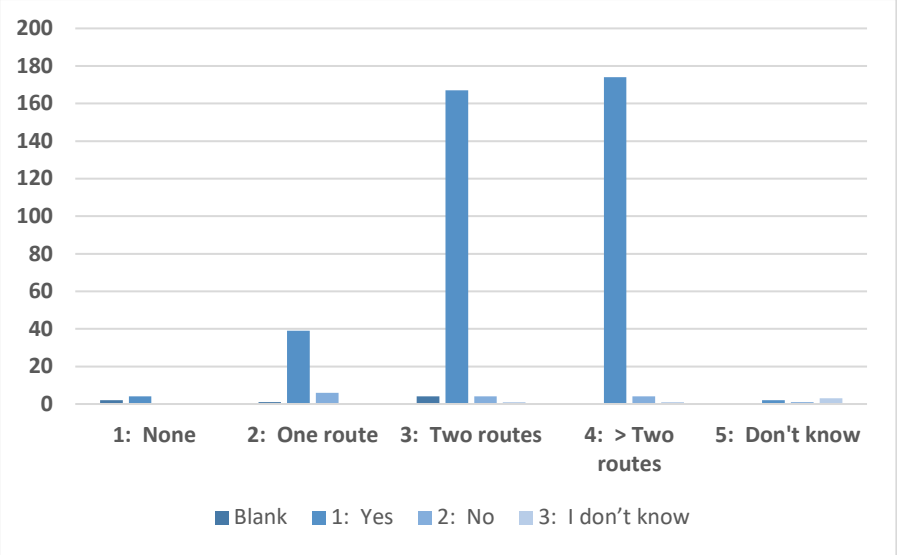

Fig 22: Are primary escape routes well lit?

8.5.10 External assembly points

No. of designated routes from your workstation?	Blank	1: Yes	2: No	3: I don't know	Grand total
1: None	2	4			6
2: One route		40	5	1	46
3: Two routes	1	166	9		176
4: > Two routes		170	8	1	179
5: Don't know		4		2	6
Grand total	3	384	22	4	413

Table 13: Do primary escape routes lead to an external assembly point?

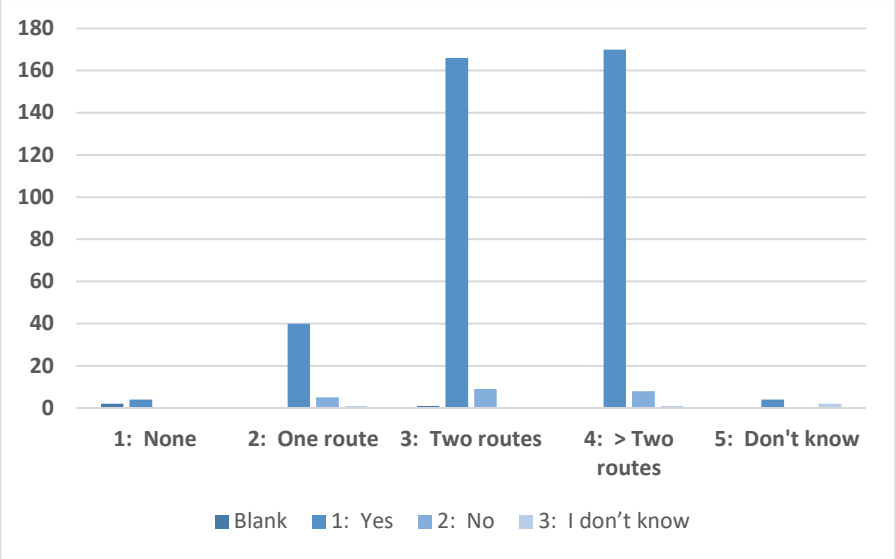

Fig 23: Do primary escape routes lead to an external assembly point?

Of those who had walked their primary route to the assembly point, approximately 80% estimated that it took less than two minutes to reach their destination, 17% said between two and three minutes and 3% said more than three minutes. Data is illustrated in Fig 19: When you walk your primary escape route how long does it take to exit the building?

For those who said they walked the primary or secondary routes to the external assembly point, their opinions on the characteristics of the route [marking, lighting, destination] are shown in Fig 24: Characteristics of primary and secondary designated exit routes.

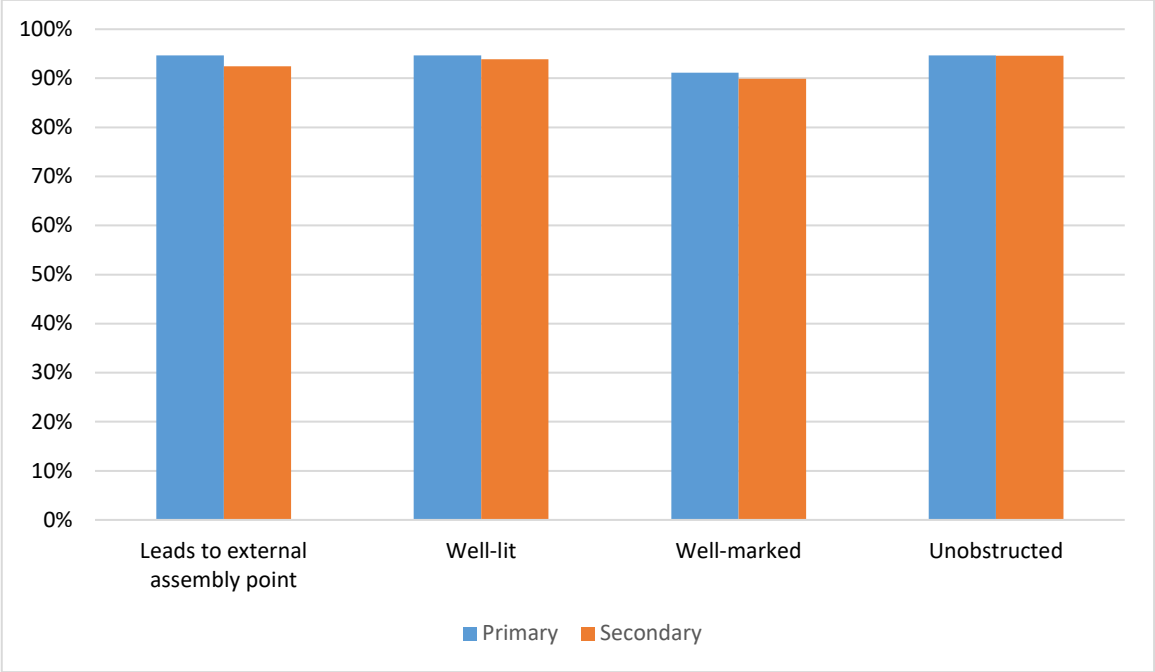

Fig 24: Characteristics of primary and secondary designated exit routes

Respondents were asked how effective they felt the means to account for workers at the external assembly area is. The responses are shown in Fig 25: Perceived effectiveness in accounting for workers at the assembly area.

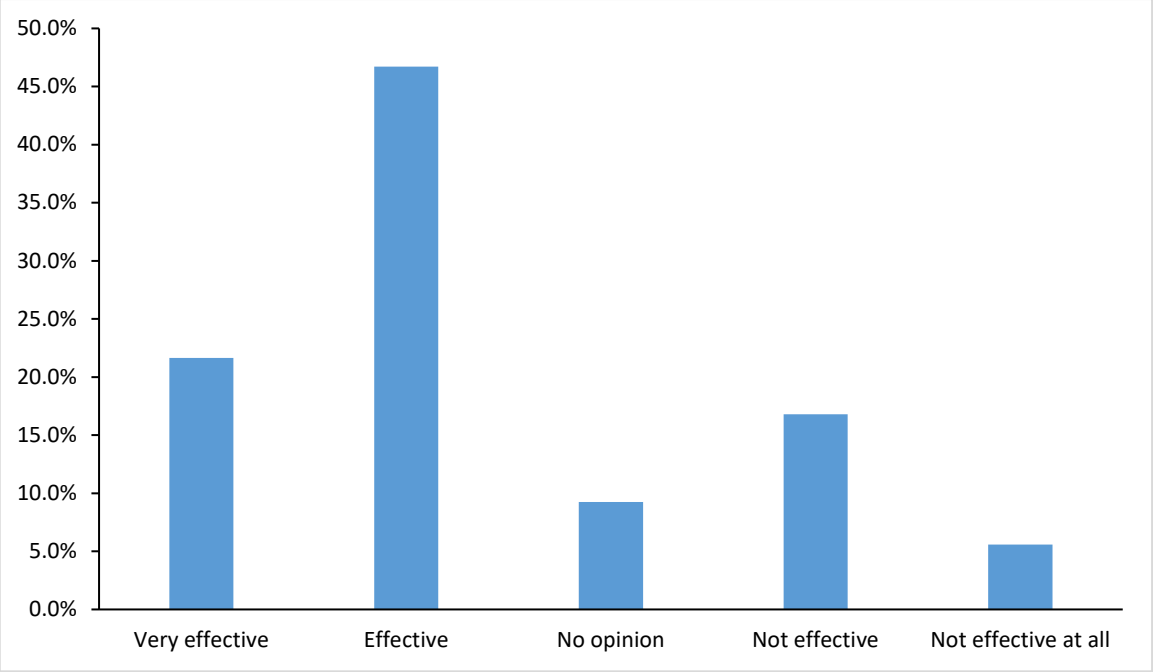

Fig 25: Perceived effectiveness in accounting for workers at the assembly area

After a description of the role of fire marshals or fire wardens in a fire safety management plan, respondents were asked if their organization has easily identifiable Fire Marshals. Almost all [85%] said yes, 13% said no, and 2% did not know.

8.6 Attitudes and perceptions

Respondents were presented with a list of ways to get people to move during an evacuation and were asked to rank their effectiveness from high to low on a scale of 1 to 6.

8.6.1 Effectiveness of evacuation stimuli

The options were as follows.

- Audio or visual signal.
- Recorded voice instructions over speakers.
- Live voice instructions over speakers.
- Seeing fire or smoke.
- Seeing co-workers leave.
- Seeing supervisors leave.

The results are shown in Fig 26: Effectiveness of evacuation stimuli.

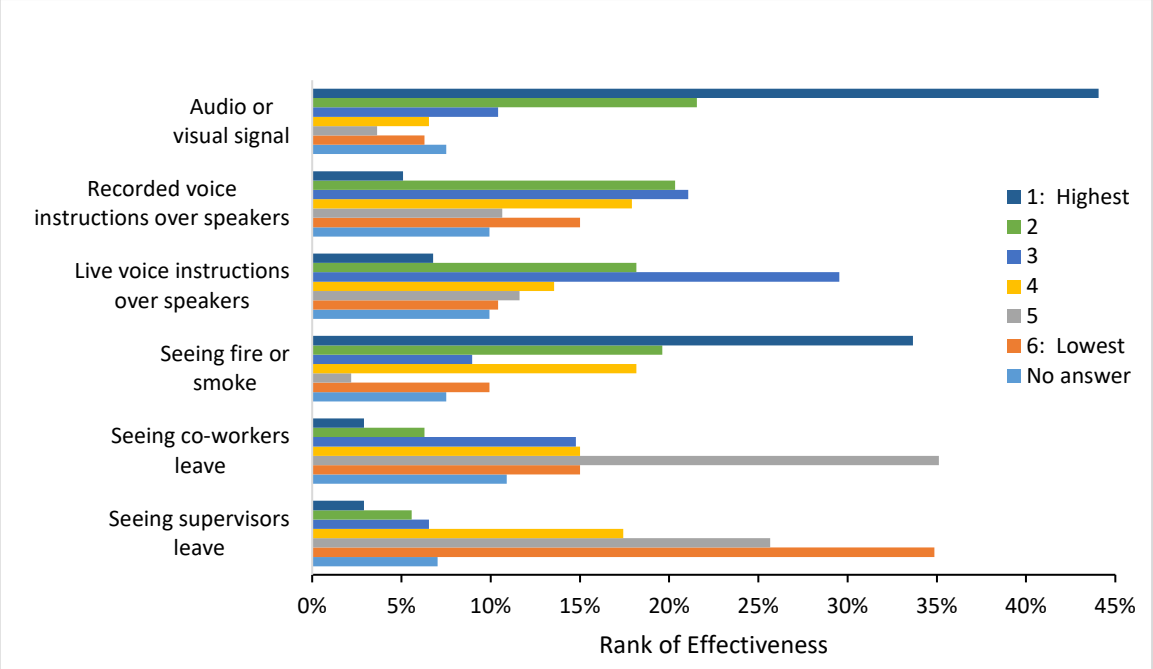

Fig 26: Effectiveness of evacuation stimuli

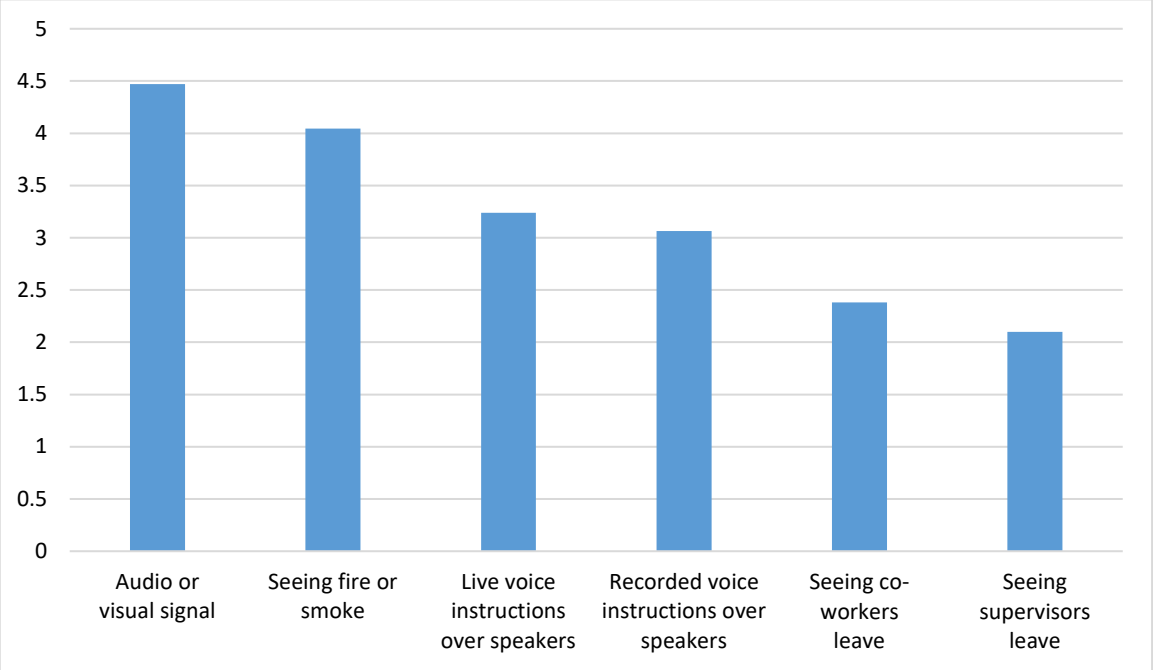

Fig 27: Most effective way to encourage evacuation

8.6.2 Vulnerability to the danger of fire

Respondents were asked when they feel vulnerable to the dangers of fire and could select any number of options from this list.

- When you hear the evacuation alarm.
- When you sense smoke or fire.
- When you see colleagues evacuating.
- When you see managers evacuating.

- None of the above.

The results are represented in Fig 28: Vulnerability to the danger of fire.

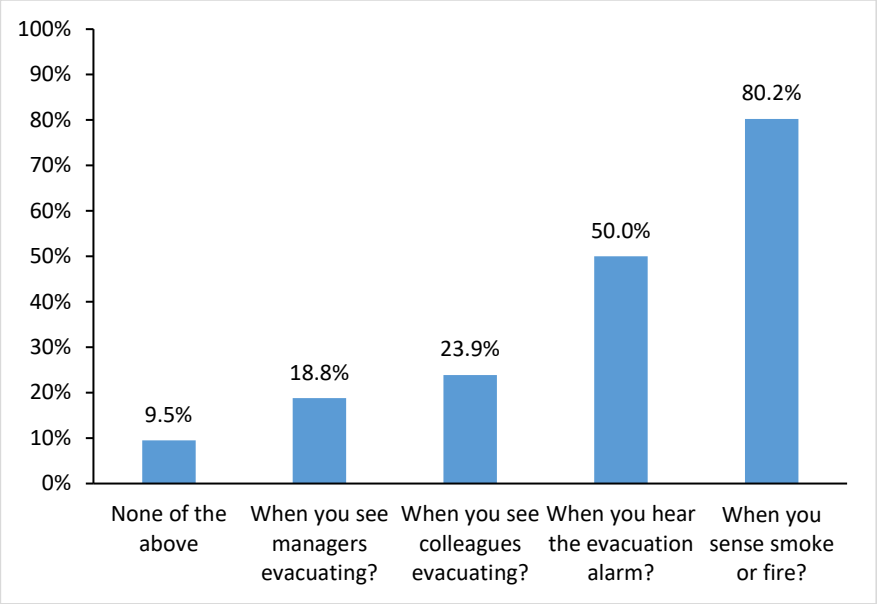

Fig 28: Vulnerability to the danger of fire

8.6.3 Emotional responses

Respondents were asked what emotion best describes how they feel when an evacuation alarm sounds. They were to choose one option from this list.

- Panicked.
- Disturbed or worried.
- Annoyed.
- Calm.
- No emotional feeling.

Their responses are illustrated in Fig 29: Emotional response.

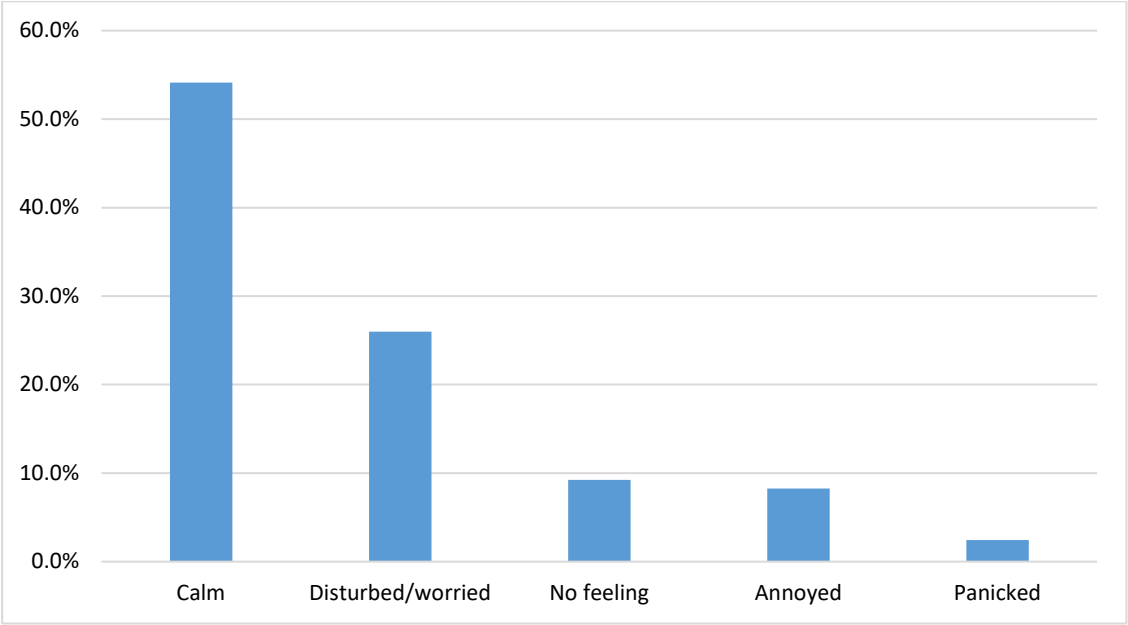

Fig 29: Emotional response

8.6.4 Action on hearing an alarm

Respondents were asked to choose one option for the action they would take when hearing or seeing an evacuation alarm at work. Their choices were available.

- Stop what I'm doing and calmly move to the eternal assembly area, without gathering valuables and clothing.
- Confirm that there is an alarm and if yes, calmly move to the eternal assembly area.
- Gather valuables and clothing and calmly move to the external assembly area.
- Wait for the fire warden to instruct me before moving.
- Nothing.
- Other; specify.

Their responses are shown in Fig 30: Initial actions on hearing the alarm.

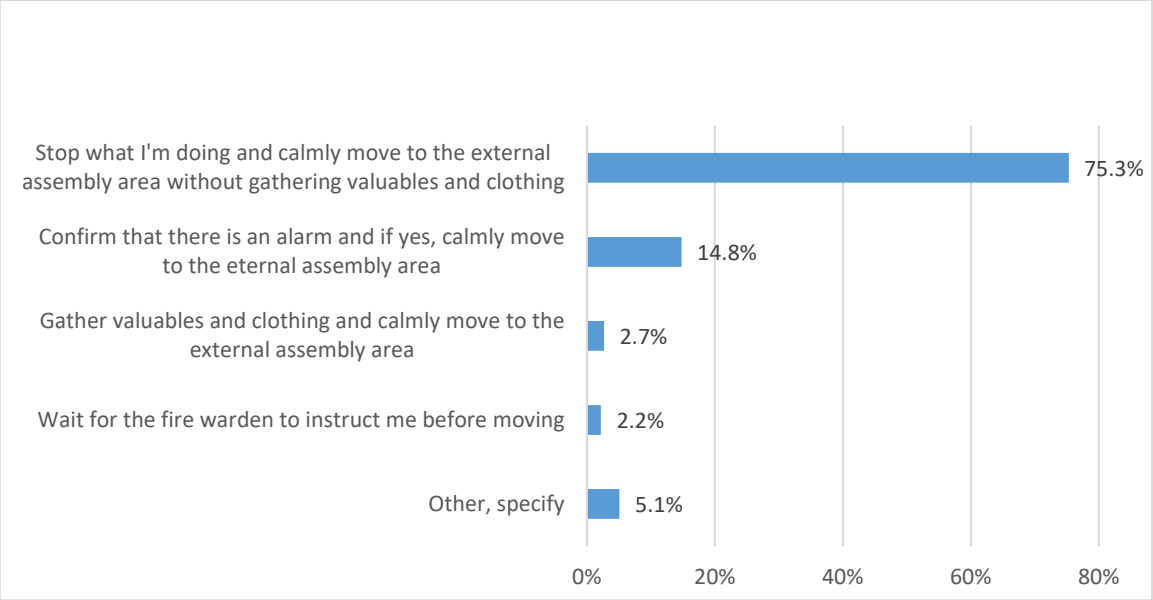

Fig 30: Initial actions on hearing the alarm

Of the 21 respondents who chose 'other', 15 were fire wardens or had other defined responsibilities to take when an alarm was activated. Two others mentioned checking on the evacuation, though it was not clear if they were officially responsible for that or simply took it on themselves. Four respondents mentioned that their workplaces had policies in place that they followed when an alarm occurred.

8.6.5 Commitment from supervisors and managers

Continuing with questions about perceptions and attitudes, the survey asked respondents to judge the level of concern and commitment of their direct supervisor and company manager. The responses are shown in Fig 31: Managerial concern and commitment.

Fig 31: Managerial concern and commitment

One respondent did not provide an answer regarding their direct supervisor and five did not provide an answer regarding their company manager. Three quarters of the respondents judged their direct supervisor and company manager level of concern and commitment positively or very positively.

8.6.6 Mobility impaired employees

Respondents were asked the degree to which they agreed or disagreed that measures to effectively assist disabled workers during fire drills and actual emergencies were in place. The responses are shown in Fig 32: Assistance is in place for disabled workers.

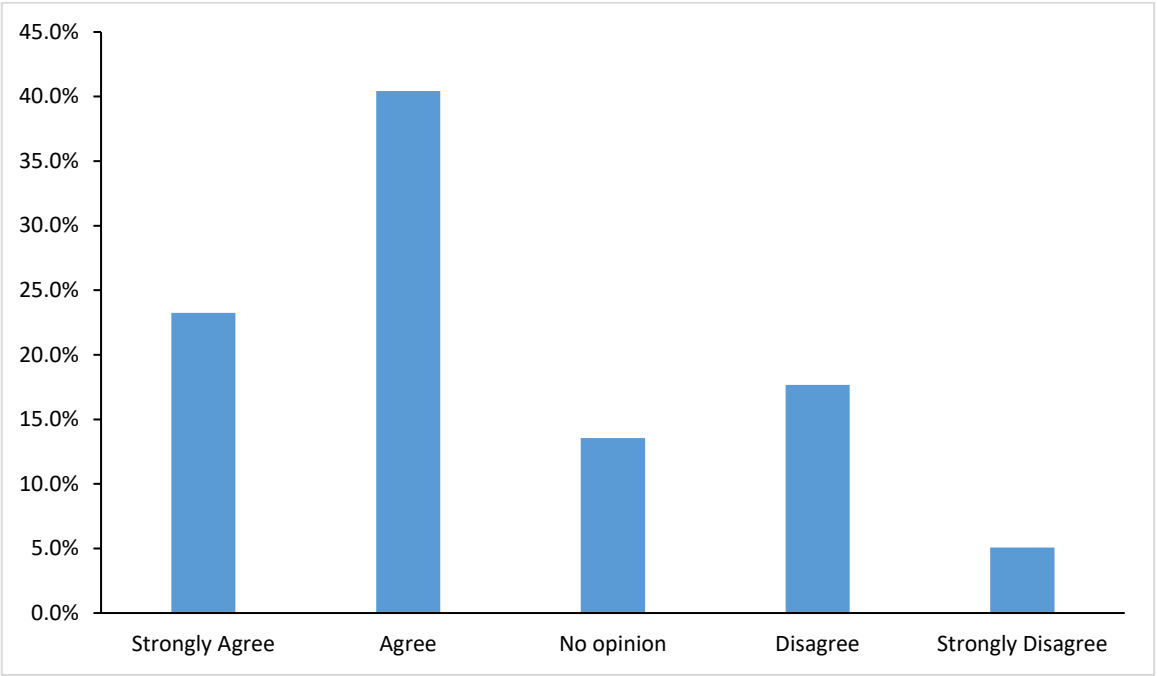

Fig 32: Assistance is in place for disabled workers

8.6.7 Fear of a risk of fire on site

The next set of questions asked if different groups of workers were less likely to fear the risk of fire at their worksite. The groups were those with up to one year of experience on the site, those with one to 10 years on the site and those with more than 10 years on the site. The responses are shown in Fig 33: Fear of risk of fire on site.

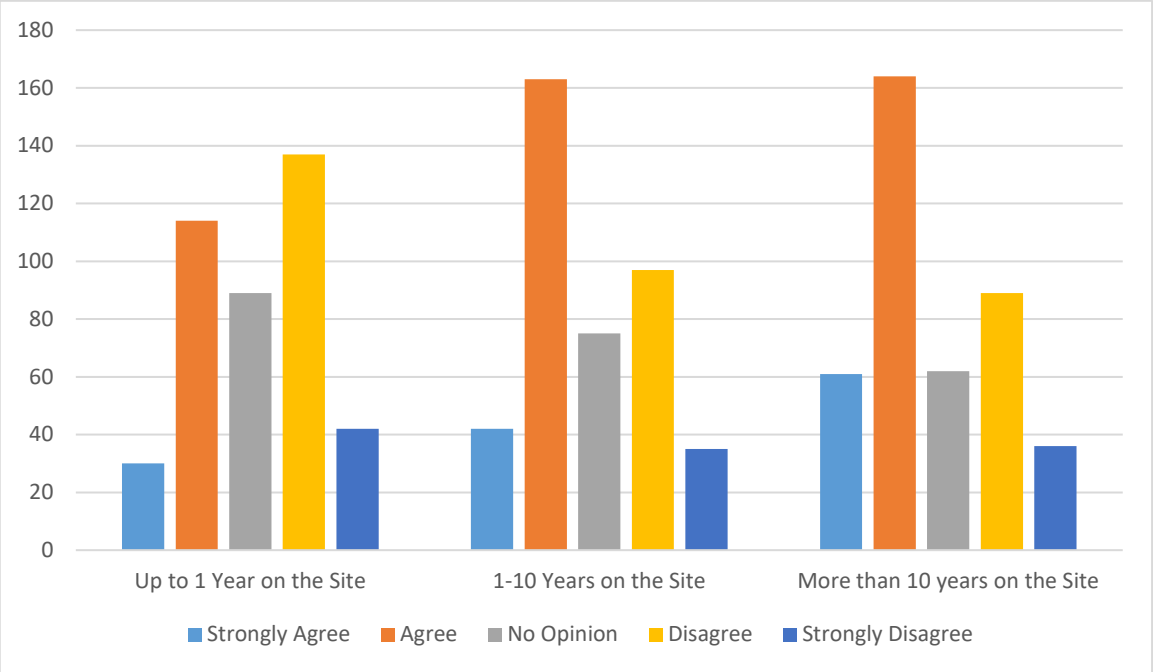

Fig 33: Fear of risk of fire on site

8.6.8 Responsiveness of young workers

The next two questions asked respondents about their perception of the response behaviour of workers in their organization who less than 25 years are old. The first question specifically asked about peer pressure, and if that worker group would be less likely to respond to alarms due to peer pressure. The responses are shown in Fig 34: Are workers <25 years less likely to respond to peer pressure?

More than one-quarter agree or strongly agree that these workers would be less likely to respond due to peer pressure while more than half disagree or strongly disagree.

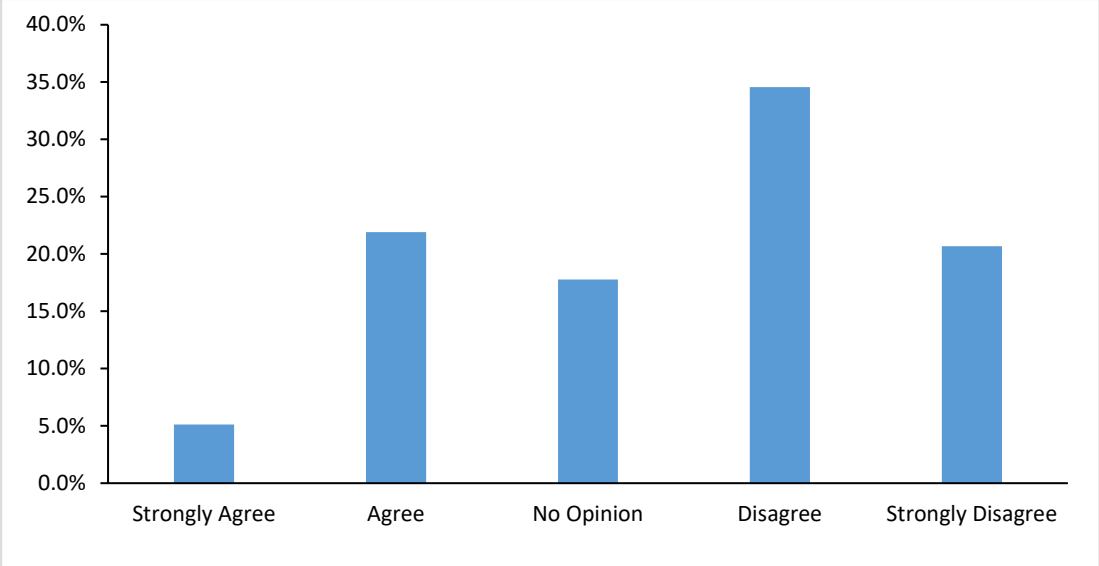

Fig 34: Are workers <25 years less likely to respond to peer pressure?

Respondents were asked if this same group of workers at their site were less likely to respond for another reason besides peer pressure, and if so, what would be the one or two most important reasons for failing to respond. Only one quarter of the respondents thought that members of this worker group would be less likely to respond for a reason other than peer pressure, and half of them provided reasons. The reasons given are listed below. Respondents could give more than one reason.

- Age and inexperience (11).
- Preoccupation with phone, music or social media (9).
- Assume it's a drill or test (9).
- Attitude: defiance, overconfidence, apathy (8).
- Complacency (5).
- Don't understand risks (5).
- Lack of training (5).
- Ignorance/stupidity/lack of common sense (3).

8.6.9 Evacuation discipline

Respondents were asked how important they felt it was for themselves to stay at the assembly point until accounted for.

Their responses are detailed in Fig 35: Importance in remaining at the external assembly point.

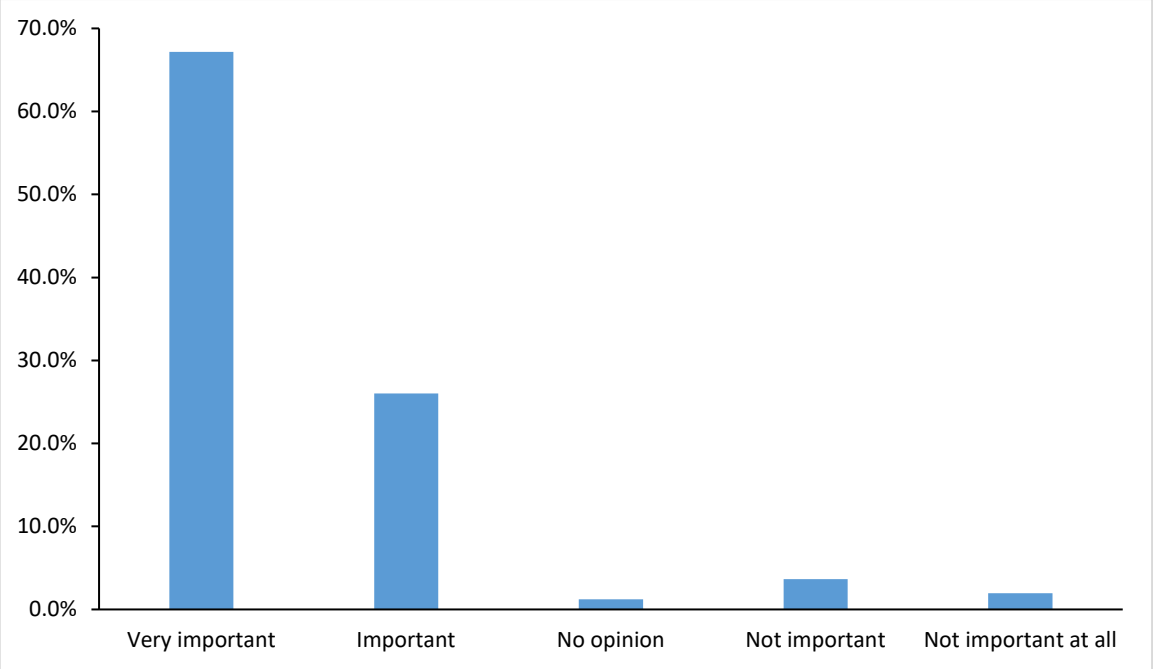

Fig 35: Importance in remaining at the external assembly point

8.7 Comparison of results with the 2007 FPRF High-Rise Report

The last 14 questions on the survey were similar to the questions asked for a study on public perception of high-rise safety conducted for the Fire Protection Research Foundation in 2007 [62]. Respondents were asked if they agreed or disagreed with the following statements.

- I am concerned about fires in my workplace.
- I think my workplace is not prepared for a serious fire.
- I am prepared to take necessary action in case of a fire in my workplace.
- I am well informed regarding safety procedures in my workplace in the event of a fire.
- I take fire drills at my workplace very seriously.
- I have ignored a fire alarm because I was sure it was false.
- I waited until I was told to leave the building in our last fire drill.
- I can get out quickly if there is a fire at work.
- I have co-workers who are not prepared for a fire emergency at work.
- I am willing to walk completely out of a building in a full evacuation drill.
- I am concerned about non-fire events at my workplace such as earthquakes, power outages, tornadoes, terrorist attacks and other acts of violence.
- Once a year, I would be willing to walk completely out my building during a fire drill.
- As a general rule my co-workers take fire drills very seriously.
- Once I leave the building during an alarm or an actual emergency I remain outside until I am informed it's safe to re-enter.

The results are shown in Fig 36: Fire Protection Research Foundation study 2007.

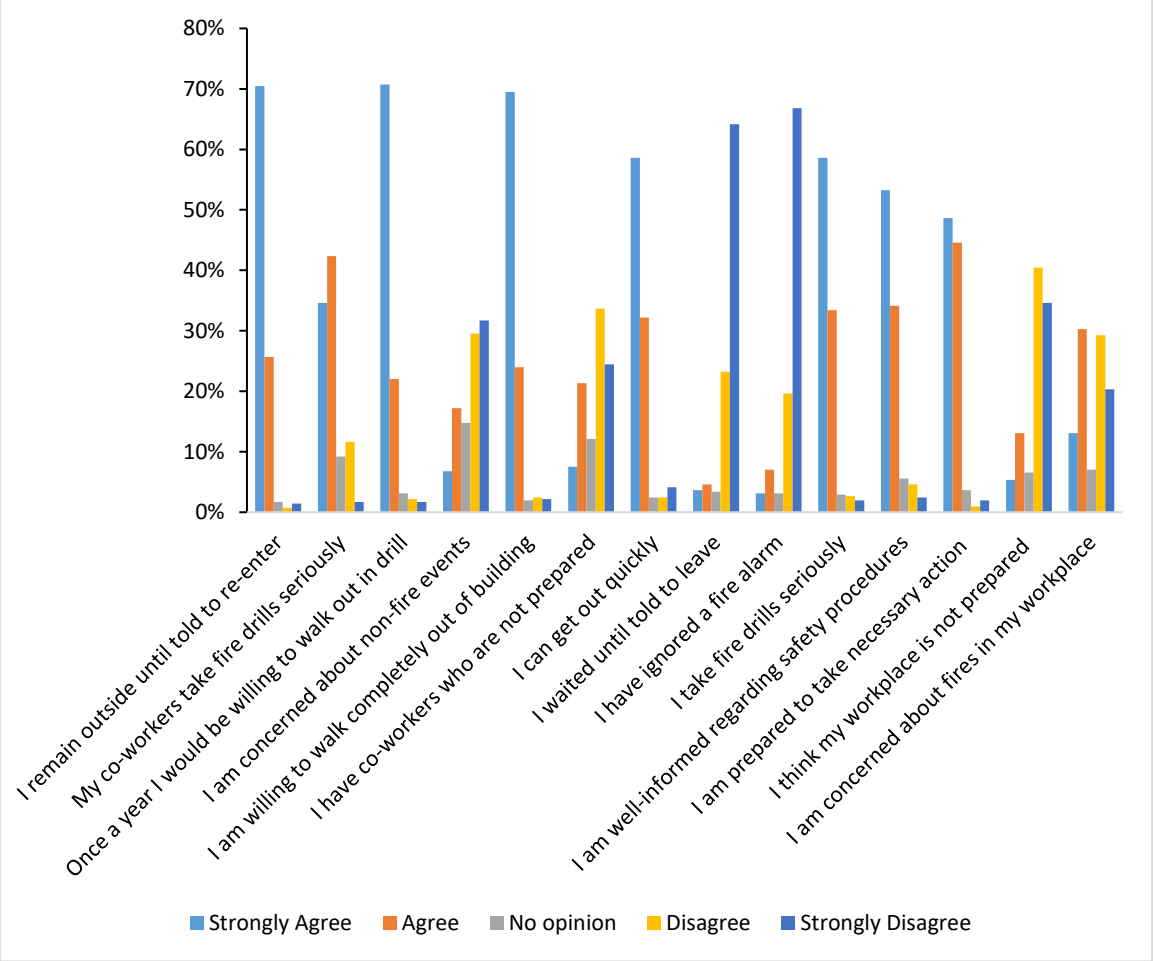

Fig 36: Fire Protection Research Foundation study 2007

8.8 Complacency results

8.8.1 Factors affecting a feeling of complacency

Factors affecting a feeling of complacency to take action in a fire situation and to have a poor fire safety culture could include the following.

- Alarm systems.
- Assembly areas.
- Competence and training: knowing what to do.
- Demographics.
- Evacuation maps.
- Evacuation routes.
- Fire drills.
- Fire protection equipment.
- Fire safety experience / training.
- Workplace status and time served.
- Perceptions of risk / vulnerability.
- Perceptions that the building is safe.
- Predicted actions.
- Provision of Fire Marshals.

8.8.2 Categorical data

The categorical data was considered first. Of these, the questions which related most strongly to the Cambridge dictionary definition of complacency “a feeling of calm satisfaction with your own abilities or situation that prevents you from trying harder”, were:

1. When do you feel vulnerable to the dangers of a fire? (Check all that apply).
    a. When you hear the fire alarm?
    b. When you sense smoke or fire?
    c. When you see colleagues evacuating?
    d. When you see managers evacuating?
    e. None of the above, and

2. When a fire alarm is activated which best describes how you feel? (Check one).
    a. Panicked?
    b. Disturbed or worried?
    c. Annoyed?
    d. Calm?
    e. No feeling.

Considering the context of a fire alarm, it was felt that for (1) respondents who only reported feeling vulnerable when sensing smoke or fire (i.e., ’b’) or those who reported not feeling vulnerable in any of the above situations (i.e., ‘e’) were demonstrating complacency. This was because other indicators of an emergency were not considered threatening, leading to an anticipated sense of calm satisfaction in these situations.

Relatedly, for [2], respondents who reported feeling ‘annoyed’ (c), ‘calm’ (d), or ‘no feeling’ (e), were considered to be those who would demonstrate complacency upon the alarm being activated. Graphs showing total number of responses to both questions are shown in sections 8.6.2 above and 8.6.3 above.

To identify the participants who reported the most likely complacency response to an alarm or emergency, we identified those who met the ‘complacency criteria’ to both the above questions. A total of 151 participants met these criteria out of 413 respondents: 36.6%.

9 DISCUSSION

Reverting to the three original premises, theories or propositions:

1. Whether complacency exists in companies or organisations with a strong fire safety culture?
2. To what extent is there complacency in the workplace when the fire alarms sound? And if so:
3. What are the missing factors in a fire safety culture which give rise to this complacency and how should they be dealt with?

The following assumptions were made and deeper questions posed.

a) There is complacency in the workplace when the fire alarm sounds.
b) What are the missing factors in a fire safety culture which are associated with complacency?
c) Does complacency exist in companies with a strong fire safety culture?
d) Here is a snapshot of complacency [split by sectors / organisation type].
e) Organisations can be clustered by factors x, y and z. What are the factors and how many are there?

9.1.1 Definitions

Our proposed definitions for complacency, evacuation and fire safety culture have been reliable and easy to work with, although they are wide-ranging. No modification to the definition in section 2 above is proposed.

9.1.2 Outline evidence for complacency

From Fig 28: Vulnerability to the danger of fire and Fig 29: Emotional response above, we have evidence to suggest that complacency exists in a fire, at least in some proportion of the population. This is evidenced by the following observations.

- When the alarm sounds people are not initially panicked.
- Effectiveness of alarm signals are highest with audio-visual alarm systems. Hearing the spoken word and commands of instruction, even from an electronic announcer, is valuable.
- Although vulnerability appears highest when people smell smoke or see flames from a fire, people continue to remain calm.

9.1.3 Additional factors encouraging complacency

When looked at separately 'When a fire alarm is activated which best describes how you feel?' there are significant associations with 'Is there a fire action notice posted at your work area' and 'How many designated escape routes are there from your workstation?'

These compound emotional responses, which are based on sequential and consequential feelings or emotions are illustrated better now in Table 14: Emotional response to awareness of fire action notices and Table 15: Emotional response to awareness of the number of available escape routes below.

Response to fire action notices	Blank	1: Yes	2: No	3: I don't know	Grand total
1: Annoyed	1	26	7	5	39
2: Calm		198	16	5	46
3: Worried		88	10	7	176

Response to fire action notices	Blank	1: Yes	2: No	3: I don't know	Grand total
4: No feeling		32	4	4	179
5: Panicked		7	3	0	10
Grand total	1	351	40	21	413

Table 14: Emotional response to awareness of fire action notices

In both instances the results are illustrated graphically in Fig 37: Emotional response to awareness of fire action notices and Fig 38: Emotional response to awareness of the number of designated escape routes below.

These results strongly suggest that when people are aware of fire action notices, giving them specific instructions to follow in the event of a fire and where to assemble etc, they receive a sense of wellbeing. This wellbeing could be reflected in their view that their managers and supervisors, representing their employer, are making provisions for them in the event of a fire and that issues are well organised and 'all will be well'. Essentially the participants report a sense of 'calm' as opposed to worry or panic.

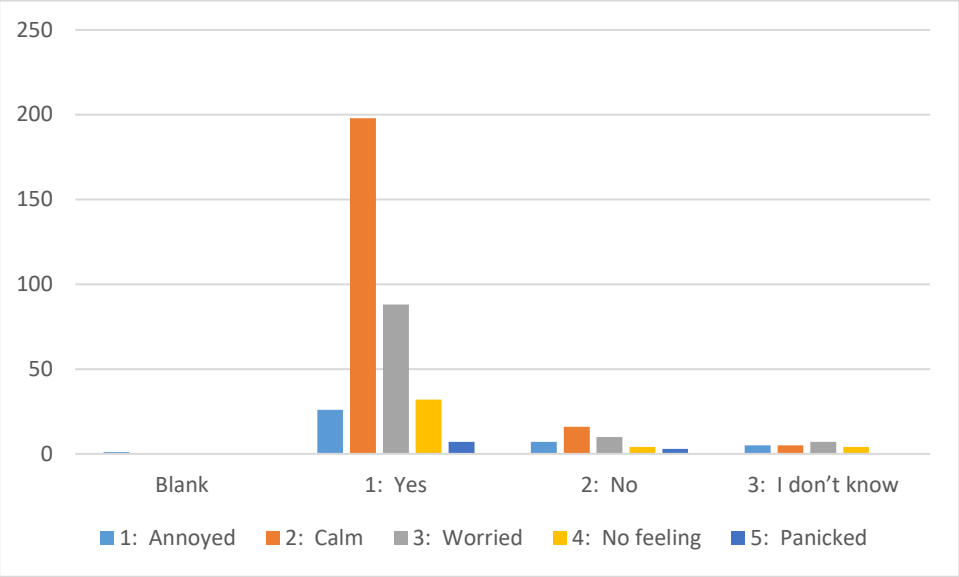

Fig 37: Emotional response to awareness of fire action notices

No. of designated escape routes	0	1	2	>2	Don't know	Grand total
1: Annoyed	0	7	9	17	1	34
2: Calm	2	25	88	105	1	221
3: Worried	4	8	57	34	4	107
4: No feeling	2	6	17	16	0	41
5: Panicked	0	3	2	4	1	10
Grand total	8	49	173	176	7	413

Table 15: Emotional response to awareness of the number of designated escape routes

A similar response is suggested by the results from the data superimposing the emotional responses of the participants onto their awareness of the number of designated means of escape gives respondents a feeling that they know what to do, perhaps reinforced by drills, fire practices and fire safety training, and that there is a feeling of calm as there is no real urgency to leave the building. However, this ill-found complacency could be quickly reversed by the encouragement of Fire Marshals to evacuate the building!

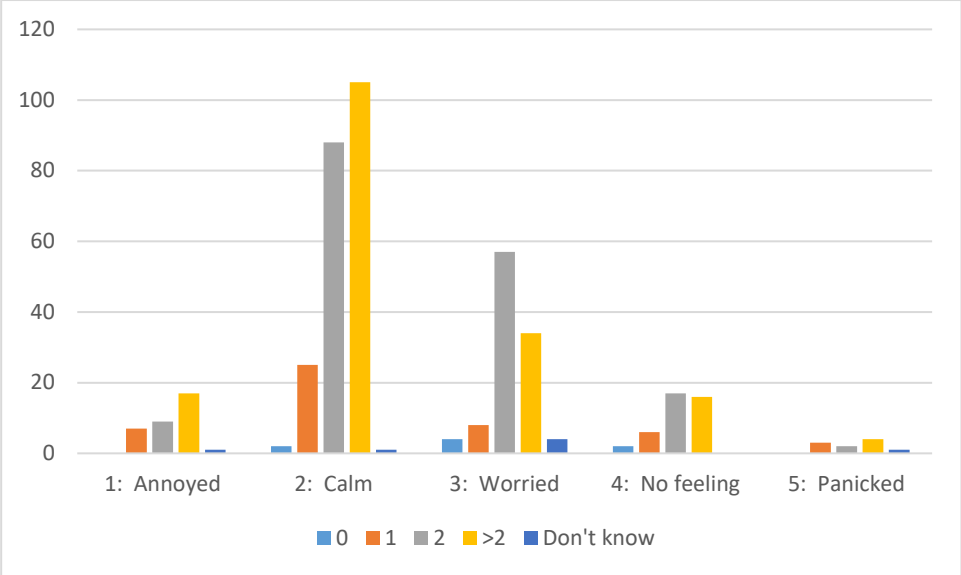

Fig 38: Emotional response to awareness of the number of designated escape routes

9.1.4 Categorical data

The categorical data in section 8.8.2 above suggests that complacency criteria were met in 36.6% of respondents to this survey which is a significant number of people. Additionally, 37% or so of respondents have reported personal in having to evacuate a building on fire, and 25% or respondents have had to evacuate a house fire which seem particularly high. Reported data suggests that there are 37000 household fires in the UK annually giving rise to around 200 fatalities.

Many of the people who had complacent characteristics could have these as they unfortunately knew no better. Fire safety training should be well provided for in larger corporate organisations with safety training budgets to encourage life skills training for all staff. However, smaller organisations may not have these facilities available. Respondents did have a strong awareness of the significant top-tier risks and in the majority of responses it was noted that fire risk management issues, including fire precautions and fire protection measures were very well accounted for. Also well accounted for were issues such as means of escape, assembly points, and wayfinding or signposting to a final exit from a building. Leadership and management issues scored highly too with positive attitudes from responders to their senior colleagues. Response and discipline questions showed generally good levels of compliance with expected norms in training of staff etc.

Traditional audio and visual fire alarms were still rated as the best form of warning staff about the outbreak of a fire although care has to be taken that initial complacency does not set in with people, familiar with regular fire drills waiting to smell the smoke or see the flames before evacuating from a building. By then it may be too late if one is trapped on a means of escape. Up until this moment vulnerability to fire appears to be manageable

for the majority of people although this is perceived to change when people see other leaving and realise the seriousness of the situation.

10 COMPLACENCY, CULTURAL FACTORS AND BEHAVIOURS

In considering the causes and consequences of complacency to fire evacuation in the workplace this section considers some relevant principles of fire risk management, people's behaviours and rules, skills and knowledge based frameworks.

10.1 Classification of groups of people and their beliefs

In considering the potential behaviours of people involved in fire situations, and how they may react in terms of complacency, there could be four types of person.

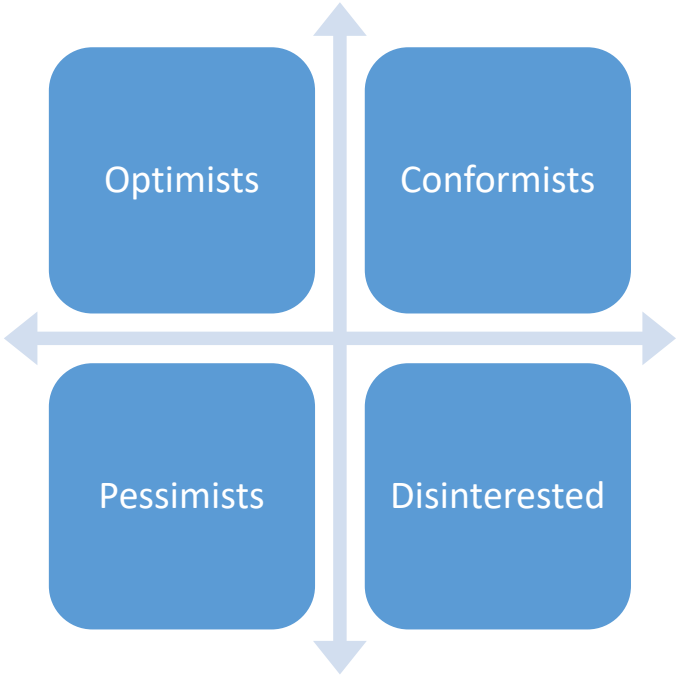

Fig. 1 Classifications of complacent persons

10.1.1 Optimists

- When a fire situation is presented to them they believe that they appreciate and understand the hazards and risks but they also believe that they will be safe.
- They believe that no harm will come to them, and neither will they stumble into harms way because of their mistakes etc
- The workplace is well designed, built, provisioned, maintained and managed, so the fire emergency will be over very soon.
- They believe the facility is well run with effective supervisors and managers, who, if this is a real fire, will get the business up on its feet again quickly.
- The fire precautions are excellent and the fire safety culture among colleagues and co-workers who are employed within the facility is very good.
- If a fire alarm sounds it must be for a good reason, so it's time to go.

10.1.2 Conformists

- Conformists are rule driven people.

- They follow rule driven behaviour by following instructions, rules and procedures.
- They will be expected to be compliant with instructions, calm under pressure, helpful and interdependent workers, illustrated by their position on the Bradley Curve[9], where teams of employees readily feel ownership for safety and take responsibility for themselves and others.

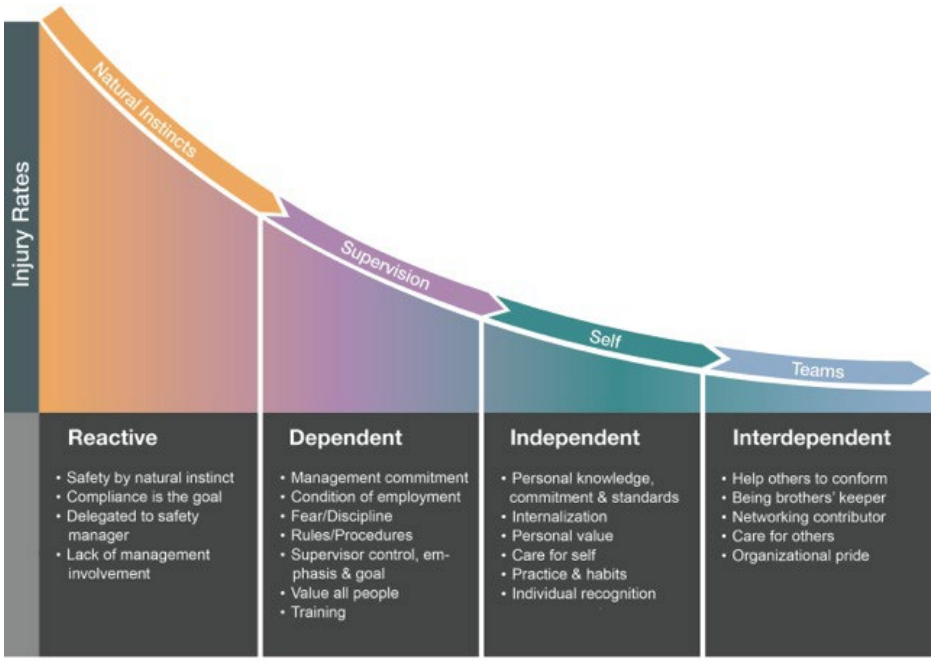

Fig. 2 The Bradley Curve

10.1.3 Pessimists

- Pessimists will have an attitude that the sounding of a fire alarm heralds the warning of a bad day at the office. They will think that the drill or evacuation will end badly and may well have a true fear of fire and the unknown due to uncertainty, not knowing what to do or ignorance.
- These fears may be enhanced by poor supervision and management and inadequate information, instruction, training and supervision.
- Pessimists may be uninformed and ignorant of fire safety and inexperienced in the life skills of fire risk management.

10.1.4 Disinterested

- In this classification, disinterested people are indifferent to the need to evacuate a building on fire.
- They will be in circumstances where they do not appreciate the risk they are in.
- They may even deny the fire alarm entirely, or at least convince themselves that it is never a real occasion to evacuate the building but another of the 'endless' weekly tests by the 'health and safety people' playing games.
- Disinterested people may habitually disregard societal rules at work. They could exhibit laziness and a nonchalant 'can't be asked' attitude.

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[9] www.consultdss.com
The Bradley curve was developed by DuPont in 1995.

10.2 Rules, skills and knowledge frameworks

10.2.1 Skill based level behaviours

People who use skill based level behaviours in fire situations do so from the standpoint that they are following skills which they have been trained in, taught from an early age or have learned on the job in the place where they work. Like riding a bicycle, once the skill has been learned and the practitioner is confident and competent in the process the performance is smooth and automated.

10.2.2 Rule based levels

In following in a detailed manner rules and procedures no great knowledge of the underlying principles and practices of fire risk management are required. However, when one is aware of a fire the person can follow rule based procedures to ensure safe evacuation without detailed knowledge of fire behaviour. They rely on the expertise of others in designing and implementing emergency evacuation procedures to safely exit the building and to assemble at a safe place away from harm.

10.2.3 Knowledge based levels

Knowledge based models of behaviour require a more advanced level of reasoning. This type of control is employed when the situation is novel and unexpected and requires people to think more about the actions that are taking. So people affected by fire alarms and evacuation signals have to know the fundamental principles and practices which systems, controls and measures are based upon. People need to form explicit goals based on their analysis of the situation and therefore their cognitive workload is higher than simply following rules or using skills learned earlier. They need to know why they are doing something or acting in a particular way.

10.3 Avoiding complacency

If complacency is shown by people hesitating to evacuate a building on fire because of fear or ignorance, or because they have a feeling of well-being due to their optimistic perceptions of the fire protection through fire safety engineering that the building offers, or delaying their escape to attend to flippant issues, then steps must be taken to upskill the Pessimists and the Disinterested, as illustrated in Fig. 1 Classifications of complacent persons above.

In addition to provision of Fire Marshals, a great fire safety culture and a fire safety information, instruction, training and supervision some additional controls need to be in place. To design-out complacency from evacuation of buildings more exact means of risk control need to be implemented.

Particularly for inexperienced and younger workers a ‘Four-Eyes’ principle may need to be considered. This principle essentially never allows a person who may be fearful of a fire, an inexperienced employee or a person with special needs who requires some assistance to evacuate safely to be alone. Having the person accompanied by another employee would never allow lone working, or a person to be unaccompanied when a decision to delay evacuation of the building could be taken.

10.4 Factors affecting instances of complacency

10.4.1 Positive factors

Positive factors are ones which **diminish** or work against complacency in fire evacuation in the workplace. They include:

- A sense of worth, well-being and purpose.

- Good awareness of risk and fire in particular, with recent appropriate and focussed training.
- Effective focussed workplace leadership, management and supervision.
- Well established fire prevention in the workplace, with appropriate selection of low risk materials and processes.
- Good fire safety engineering, fire protection and fire precautions with well provisioned fire risk management.
- Provision of aids to escape such as fire action notices, multiple fire exit routes / means of escape, clear final exits and remote safe assembly points.
- A good understanding of fire safety with a knowledge based approach to their established competence.
- An interdependent worker, with positive self-reliance and a team working approach.

10.4.2 Negative factors

Negative factors are ones which **accentuate** or promote complacency in fire evacuation in the workplace. They include:

- General dismissive pessimism and disinterest.
- A low knowledge base in fire safety and low cognitive accountability, giving reliance on a skills based approach.
- A reactive or instinctive approach to risk survival.
- Low pay and low expectations, low self-worth and prospects.
- An unfocussed approach to work and life. Distracted from and disassociated with work and easily prioritised on other peripheral issues.
- Easily swayed by peer pressure and a visible disregard for safety with most probably intrinsic risk taking.

10.5 Principles of Fire Risk Management

In challenging the constructs for complacency, the building blocks of beliefs or theories in why people are complacent, we need to define and establish the fundamentals of safety culture that can influence complacency. An understanding of fire risk management will help with this.

In safety management we have a definition of safety culture that includes: control, cooperation, communication and competence.

In general risk management the following are fundamental stages and are dependent upon whether the organisation is aware of the risk, has an appetite or an aversion for the risk, is prepared to accept, tolerate or deny the risk and wants nothing to do with the consequences.

10.5.1 Stages in fire risk management

The following stages in fire risk management are vital.

- Identify.
- Measure.
- Manage.
- Monitor, and
- Report.

10.5.2 Stages in the management of fire risk

Consequently, there is much to do to manage fire risks and, in full, the list can be expanded to include:

- Identification.
- Communication.
- Analysis.
- Prioritisation.
- Control of the risk by:
    - Accepting the risk, perhaps with a contingency.
    - Avoidance.
    - Transferring the risk.
- Treatment of the risk.
    - Prevention.
    - Reduction.
    - Mitigation.
    - Sharing or distribution of the risk.
- Planning.
- Implementation.
- Management and
- Reporting.

Although these can be focussed on establishing and implementing through a fire safety and fire risk management system to fire policy, fire prevention, fire protection or fire precautions and delivering fire safe solutions in terms of materials and processes.

10.6 Solutions to complacency in the workplace in terms of fire evacuation

From questionnaire and survey data it is clear that complacency in the workplace is present in fire evacuation, even based on the definition 'A feeling of calm satisfaction with your own abilities or situation that prevents you from trying harder' [15]. With small modifications to this definition a complacent person would be seen as selfish in judging that they knew best, that timely evacuation of a building was unnecessary and that they could take care of themselves, by themselves.

At the conclusion of this research it is reasonable to promote some ideas and recommendations on diminishing complacency.

The ideas to promote are detailed as follows.

1. Setting role models of people who are optimists and conformists.
2. Promoting interdependence among the workforce.
3. Raising people's competence to knowledge based levels of fire safety.
4. Working on the above positive factors to avoid or diminish complacency in fire evacuation in the workplace.
5. Enhancing leadership, management and supervision in the workplace.
6. Utilising the 'Four Eyes' models of safety supervision to prevent lone working and crises of fear and apprehension of people who are afraid of a fire and may easily panic or be complacent of taking timely action.
7. Utilising another aviation model of evacuation from an aircraft, with fire marshals strongly encouraging movement of people physically from the building.

11 CONCLUSIONS

Of the factors that affect a feeling of complacency, detailed in section 8.8.1 above there are both positive enhancing factors that promote wellbeing and negative factors that promote complacency. With the survey data suggesting a complacency level of nearly 37% the threshold is already high and therefore that factors that could be seen as reducing this level must be promoted. These factors, which were styled the 'missing factors in fire safety culture' that can reduce vulnerability to complacency, must include issues of competence, (knowledge attitudes, training and experience), control, communication

about the realism of risks and cooperation between staff, supervisors, managers, contractors and the public.

Fundamental in this field is publicity and profile raising in taking seriously fire safety.

This should be promoted now to young people as students, apprentices, graduates and early-stage starters in their first job at work to learn essential life skills for themselves, their families, their colleagues at work and anyone else affected by their employers' undertakings.

12 RECOMMENDATIONS

Recommendations include stage two work on this topic to follow up the early surveys with a human factors approach to fire safety engineering. This will review, identify, prioritise and plan a workflow in focussing on and identifying and implementing the occupational factors that have the greatest impact on reducing complacency among young people and established staff and to then expand this field to reducing vulnerability in fire to the general population.

The workflow could also look at enhancing fire precautions and fire protection technology to increase the reliability of fire detection and waring systems with an intention of reducing false positive detections and false alarms which may increase a person's vulnerability and sense of fear.

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14 APPENDIX 1: QUESTIONNAIRE

The questions used in the survey are published below.

PQ1 In which city do you work?

PQ2 In which country do you work?

PQ3 Size of enterprise organisation? Total number of managers, supervisors & workers?

PQ4 How many floors are there in the building you work in?

PQ5 On which floor is your normal workstation?

PQ6 In which industry do you work?

PQ7 Job level?

PQ8 Years in building?

PQ9 Age of the respondent?

PQ10 Gender?

PQ11 Have you personally had to evacuate a building due to an actual fire?

PQ12 Fire safety is the combination of fire prevention and fire protection. How would you rate fire safety on your site?

PQ13 How many hours of emergency evacuation training have you received over the past three years?

PQ14 Describe in order of importance the three greatest fire risks at your work site.

PQ15 Does your workplace have the following? Check all that apply.

PQ16 Describe how you know there is a need to evacuate your workstation?

PQ17 What do you feel is the most effective way to get people to move during an evacuation?

PQ18 When do you feel vulnerable to the dangers of fire?

PQ19 When a fire alarm is activated which best describes how you feel?

PQ20 What would you do when you hear or see an evacuation alarm at work?

PQ21 Is the evacuation map up-to-date?

PQ21a Does your work area have an evacuation map?

PQ21b Is the evacuation map clearly legible?

PQ21c Is the evacuation map up-to-date?

PQ21d Does the evacuation map show primary and secondary escape routes?

PQ21e Does the evacuation map show external assembly areas?

PQ22 Is there a fire action notice posted at your work area describing what to do if you discover a fire or hear an alarm?

PQ23 How many designated escape routes are there from your workstation?

PQ24 Have you walked your primary designated escape route to the external assembly area this year?

PQ25 Have you walked your secondary designated escape route to the external assembly area this year?

PQ26 When you walk your primary escape route how long does it take to exit the building?

PA27 Are the primary escape routes?

PQ28 Are there secondary escape routes? Where >2 secondary routes are available, go to question 30.

PQ29 Do you have a designated external assembly point[s]?

PQ30 How would you judge the level of concern and commitment of your direct supervisor about fire drills?

PQ31 How would you judge the level of concern and commitment of your company manager about fire drills?

PQ32 Measures are in place to effectively assist disabled workers during fire drills and actual emergencies?

PQ33 Workers in the organisation with up to one-year of experience on the site are less likely to fear the risk of fire on this site?

PQ34 Workers in the organisation with one to ten years of experience on the site are less likely to fear the risk of fire on this site?

PQ31 Workers in the organisation with more than ten years of experience on the site are less likely to fear the risk of fire on this site?

PQ36 Workers in the organisation under 21 years old are less likely to respond to alarms due to peer pressure?

PQ37 Are workers in the organisation under 25 years old less likely to respond to alarms due to other reasons?

PQ38 How do you feel is the means to account for workers at the external assembly area?

PQ39 How is it for you to stay at the external assembly area until accounted for?

PQ40 Does your organisation have easily identifiable fire marshals [fire wardens]?

PQ41 I am concerned about fires in my workplace.

PQ42 I think my workplace is not prepared for a serious fire.

PQ43 I am prepared to take necessary action in case of a fire in my workplace.

PQ44 I am well informed regarding safety procedures in my workplace in the event of a fire.

PQ45 I take fire drills at my workplace very seriously.

PQ46 I have ignored a fire alarm because I was sure it was false.

PQ47 I waited until I was told to leave the building in our last fire drill.

PQ48 I can get out quickly if there is a fire at work.

PQ49 I have co-workers who are not prepared for a fire emergency at work.

PQ50 I am willing to walk completely out of a building in a full evacuation drill.

PQ51 I am concerned about non-fire events at my workplace such as earthquakes, power outages, tornadoes, terrorist attacks and other acts of violence.

PQ52 Once a year, I would be willing to walk completely out my building during a fire drill.

PQ53 As a general rule my co-workers take fire drills very seriously.

PQ54 Once I leave the building during an alarm or an actual emergency I remain outside until I am informed it is safe to re-enter.

PQ55 As a result of taking this survey, is there any action or suggestion you will make to your supervisors in the next two weeks?

15 APPENDIX 2: QUESTION SET

The following tables illustrates the distribution of questions across fire risk management topics.

TOPIC	QUESTIONS [BASED ON QUESTIONNAIRE PRINTOUT]
Demographics	1-10
Perception of fire risk	11, 12, 14, 18-20
Complacency	18-20, 31, 33 – 37, 41, 43, 45-47, 49-53.
Is your building fire safe?	12, 14, 15, 16, 21 – 23, 27, 28, 29, 32, 38, 48,
Does the person taking the survey reflect a fire safety behaviour?	17, 18, 19, 20,24, 25, 26, 39, 41, 42, 44, 45, 46, 47, 50, 51, 54
Co-workers	33, 34, 35, 36, 37, 49
Training	13, 44, 15, 16, 17, 20, 44
Alarm system	15, 16, 17, 18, 20,
Management	30, 31
Fire marshals	20, 40
Assembly area	29, 38, 39, 54
Evacuation map	21
Fire action notice	22, 43
Escape routes	23-28
Fire drills	30, 31, 32, 45, 47, 50, 52, 53

Table 16: Fire risk management question distribution

16 APPENDIX 3: FIRE RISKS

Top-tier risks	Mid-tier risks	Lower-tier risks
Arson	Arson	Arson
Building	Building	Building
Chemical	Chemical	Chemical
Combustible	Combustible	Combustible
Complacency	Complacency	Complacency
Cooking	Cooking	Cooking
Electrical	Electrical	Electrical
Explosion	Explosion	Explosion
Flammable	Flammable	Flammable
FRM	Flammable	FRM
Gas	FRM	Gas
Hot work	Gas	Heaters
Housekeeping	Hot work	Hot work
Human	Housekeeping	Housekeeping
Machinery	Human	Human
Process	Process	Process
Heaters	Smoking	Smoking
Process	Training	Sun
Smoking	Vehicles	Terrorism
Terrorism	Waste	Training
Training		Vehicles
Vehicle		Waste
Waste		

17 APPENDIX 4: NOTABLE BUILDING FIRES IN THE UK AND IRELAND

The following are notable fatal building fires in the UK and Ireland. Some of them involved high-rise buildings.

- Huddersfield 1941. The Huddersfield factory fire occurred on 31 October 1941 in the town inside the H Booth & Son factory. The fire was caused by a smoker's pipe left alight inside a raincoat pocket when work had just commenced. It destroyed the building and killed 49, most of them women and young girls. Many were left trapped in the upper floors of the five-storey building as it did not have a fire escape. The cause of the fire is attributed to discarded smoking materials. The absence of a fire escape in the building contributed to fatalities on the upper floors.
- Glasgow 1960. The Cheapside Street whisky bond fire in Glasgow on 28 March 1960 was Britain's worst peacetime fire services disaster. The fire at a whisky bond killed 14 fire service and 5 salvage corps personnel. This fire was overshadowed only by a similar fire in James Watt Street (also in Glasgow) on 19 November 1968, when 22 people died. The cause is officially unknown.
- Liverpool 1960. On 22 June 1960 a deadly blaze at Henderson's department store, Church Street, Liverpool broke out on a bright, sunny midweek afternoon and claimed the lives of 11 people. The source of the fire was arcing on a steel armoured electricity cable in the roof space. A contribution to the development of the fire would have been the storage and use of furnishing with combustible fillings.
- Keighley 1956. On 23 February 1956 a factory fire in a worsted spinning mill in Keighley, West Yorkshire, took the lives of eight mill workers. The devastating blaze razed the 20 metre, three-storey building to the ground ‘in no time at all’, according to police at the scene. These factory premises consisted of three storeys and an attic. It had an internal staircase at one end and an internal flight of stairs between the attic and the third floor at the other (with access to an external stair). The cause of the fire is attributed to poor control of hot works. Plumbers’ blowlamp played upon combustible materials.
- Bolton 1961. The club was located on Crown Street in Bolton and was on the top floors of an old mill warehouse building was on the third floor of a converted premises and the building had a single staircase, unprotected by fire doors. The fire started on 1 May 1961 in the ground floor joinery shop and quickly spread, trapping all those upstairs. 19 people were killed. Some of the victims smashed windows and jumped to their deaths. The cause is officially unknown. However, the location of a furniture workshop on the ground floor beneath the club must have contributed to the spread and severity of the fire.
- Glasgow 1968. The James Watt Street fire on Monday, 18 November 1968, was a fatal factory fire in Glasgow, leading to a large loss of life, with 22 employees killed. The number of fatalities was a consequence of the building retaining barred windows, a feature remaining from its previous use as a whisky bond. Around 100 firemen from Glasgow Fire Service attended this incident, which reinforced Glasgow's reputation for tragic fires in the 30 years after the Second World War. Escape from the building had been prevented due to fire on the stairs, caused by polyurethane foam, and the escape doors from the first and second floors to the fire escape were

found to have been locked from the inside. The cause of the fire is officially unknown, although the processing of highly flammable polyurethane foam must have been a significant factory in the outbreak of the fire.

- Saffron Walden 1969. The fire broke out at 0147h on Boxing Day 1969 in a TV set in a downstairs lounge and quickly spread due to many doors having been left open. People trapped upstairs were unaware that an alternative exit was available, due to lack of exit signs. Some guests jumped from upper floors and were seriously injured, others knotted sheets together to climb out of windows. Firemen managed to rescue twelve. Eleven lives were lost. The cause was attributed to a defective television set.
- Douglas 1973. The Summerland disaster. A leisure centre fire in Douglas, Isle of Man. Development of the fire accelerated by the ignition of flammable acrylic sheeting covering the building. The fire led to at least 50 deaths. Unintentional ignition by children smoking in a hut. Discarded smoking materials.
- Manchester 1979. A fire on 8 May 1979 at the high street shop Woolworths, situated opposite Piccadilly Gardens, in Manchester killed 10 people and injured six firefighters. Around 500 customers are believed to have been in the store at the time of the blaze. When crews arrived, they found thick smoke billowing from the six-storey building and people screaming for help from the windows. Firefighters fought the blaze for two and a half hours while helping people escape by the shop's doors, windows and roof. The fire was caused by a damaged electrical cable igniting furniture made of polyurethane foam, which produced large amounts of thick toxic smoke.
- Dublin 1981. The Stardust fire was a fatal fire which took place at the Stardust nightclub in Artane, Dublin in the early hours of 14 February (St Valentine's Day) 1981. Some 420 people had attended a disco there, of whom 48 died and 214 were injured because of the fire. The cause of the fire is in dispute. Discarded smoking materials, electrical causes and arson are all mentioned. The presence of flammable liquids in a storeroom would have contributed to the rapid development of the fire.
- Bradford 1985. The fire started on 11 May 1985 in general detritus and match-day rubbish under a wooden spectator stand and spread with great rapidity. Most victims were found by the locked exits at the back of the stand. Fifty-six lives were lost, and a further 265 people were injured. The cause was discarded smoking materials onto combustible rubbish beneath the wooden stand.
- London 1987. The King's Cross Underground railway station fire. On 18 November 1987, at approximately 1930h, a fire started at King's Cross St Pancras tube station, a major interchange on the London Underground. As well as the mainline railway stations above ground and subsurface platforms for the Metropolitan, Circle and Hammersmith and City lines, there were platforms deeper underground for the Northern, Piccadilly, and Victoria lines. The fire started **under** a wooden escalator serving the Piccadilly line but at about 1930h several passengers reported seeing a fire **on** a Piccadilly line escalator. The speed of this fire development and flashover caused the deaths of thirty members of the public and

staff, as well as the first attending Officer in Charge. Poor maintenance and cleaning were discovered to be a contributory factor to the outbreak.

- 1991 Liverpool. Knowsley Heights fire. A fire in an 11-storey tower block in Huyton, Merseyside that had recently been fitted with rain screen cladding. The fire spread from the bottom to the top of the building via the 90 mm air gap behind the cladding. The fire was deliberately started when rubbish was set alight outside the building. The fire spread to all floors of the 11-storey building, causing extensive damage to the walls and windows of the building. The interior of the building did not suffer damage, as the fire did not enter the inside of the building. No-one was injured in the fire.
- 1999 Irvine. Garnock Court fire occurred in a tower block in Irvine, North Ayrshire and spread rapidly up combustible cladding, resulting in one death and four people injured. The incident led to a parliamentary inquiry into the fire risk of external cladding and a change of the law in Scotland in 2005 requiring any cladding to inhibit the spread of fire.
- 2004 Uddingston. The fatal incident which took place at the Rosebank Care Home, Uddingston on January 31, 2004 presented the largest loss of life in a fire within a residential care facility in Scotland. The cause was defective and poorly maintained electrical equipment. The outbreak of fire was exacerbated by the storage of aerosol containers in an open cupboard, poor fire precautions throughout, poor fire management systems and poor human factors response by the staff.
- 2005 Stevenage. Harrow Court fire where a fire in a tower block in Stevenage, Hertfordshire, led to three deaths.
- 2009 London. Lakanal House fire. Occurred in a tower block in Camberwell, South London and led to six deaths and at least twenty injured. An inquest "found the fire spread unexpectedly fast, both laterally and vertically, trapping people in their homes, with the exterior cladding panels burning through in just four and a half minutes." The source of the fire was a faulty television in a flat on the ninth floor.
- 2010 Southampton. Shirley Towers fire. Two firefighters died after the tower block fire rapidly escalated. Cause attributed to curtain material on top of light bulb in living room in 9th floor flat.
- 2012 Derby. The Allenton house fire occurred on 11 May 2012 at 18 Victory Road, a semi-detached house in a residential street in Osmaston, Derby. Five children died at the scene, while the oldest later died in hospital. The parents of the children, Mairead and Mick Philpott, along with their friend Paul Mosley, were later arrested and charged with murder. In December 2012, their charges were downgraded to manslaughter. On 2 April 2013, Mick Philpott and Paul Mosley were found guilty by unanimous verdicts, while Mairead Philpott was found guilty by majority verdict. The causation was arson. Petrol was poured through a letter box and set alight.
- 2016 London. Shepherd's Court fire. An incident on 19 August 2016 in a tower block in Shepherd's Bush, West London where a faulty tumble-dryer caught fire on the seventh floor. The fire spread up six floors on the outside of the building, which is owned by Hammersmith and Fulham Council. There were no fatalities, but some suffered smoke inhalation.

- 2017 London. The Grenfell Tower disaster. A fire at Grenfell Tower, a 24-storey, 220-foot (67 m) high rise residential building of public housing flats in North Kensington, London, England. The fire started in the early hours of Wednesday June 14. The London Fire Brigade was first called at 00:54 BST. 200 firefighters and 40 fire engines attended. The fire killed 72 people, including a stillborn baby. The fire started in a Hotpoint fridge-freezer on the fourth floor as a result of an electrical fault. No product recall was issued as the FF175B model posed a 'low-risk' and did not need modifications. Acceleration of the rate of burning of the building was attributed in greater part to the installation of flammable cladding on the outside surfaces in a recent renovation.
- How the tragedy unfolded at Grenfell Tower - BBC News
- 2019 London. De Pass Gardens fire. A fire in a six-storey tower block in Barking, East London spread through all six floors. Two smoke inhalation injuries.
- 2019 Bolton. The Cube fire. An incident in a six-storey student residence in Bolton, re-clad in 2018 with high-pressure laminate. The fire spread "extremely rapidly" through the top three floors of the building. Although 217 students were in the building and two students were rescued from the roof all evacuated safely. The cause was attributed to discarded smoking materials.
- 2022 North-West England. In July 2022 Forest fires rage in the United Kingdom, as temperatures exceed 40 degrees Celsius for the first time in British history.

18 APPENDIX 5: ABBREVIATIONS AND ACRONYMS:

Abbreviation / acronym	Definition
ALARP	As low as reasonably practicable.
ASET	Available Safe Egress Time. A fire safety engineering concept that must always be < RSET. See below.
CD-ROM	Compact disc – Read only memory.
CEO	Chief Executive Officer.
CO	Carbon monoxide (a toxic gas).
DCLG	Department of Communities and Local Government. Now the Ministry of Housing, Communities and Local Government, a department of UK Government, 2021.
FPRF	Fire Protection Research Foundation.
FRM	Fire risk management.
FRMG	Fire Risk Management Group. A professional group of the Institution of Occupational Safety and Health, UK.

Abbreviation / acronym	Definition
HS(G)	Health and safety guidance series. A set of technical publications from the UK Health and Safety Executive.
HSE	Health and Safety Executive, UK.
IOSH	The Institution of Occupational Safety and Health.
KATE	Knowledge, approach or aptitude, training and experience. Four elements that define competence to undertake a task.
LPG	Liquified Petroleum Gas.
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority, Australia.
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations, 2013. UK statutory regulations.
RSET	Required Safe Egress Time.

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