INCREASING RESILIENCE IN THE UNITED KINGDOM WAREHOUSE SECTOR IN RESPONSE TO SEVERE FIRE INCIDENTS

by

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Dedication

I'm dedicating this dissertation to my lovely wife, Tracy, and my beautiful granddaughter, Annabella. I hope that this achievement will inspire Annabella to pursue her dreams and achieve whatever she desires in life, no matter what path she takes. I also want to dedicate this dissertation to my late mother, who always believed in her family and supported us through thick and thin. I know that both she and my late father would be incredibly proud of this accomplishment, and their love and guidance will always be with me.

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ABSTRACT

INCREASING RESILIENCE IN THE UNITED KINGDOM WAREHOUSE SECTOR IN RESPONSE TO SEVERE FIRE INCIDENTS

This research set out to identify critical gaps in the overall business resilience of the warehouse sector in the context of fire safety. This need arose due to the increase in automation and an ever-increasing demand for warehouse space in the UK following COVID-19 and BREXIT, meaning warehouses were working at a greater capacity. Along with the literature review, a mixed methods approach was used for this study, incorporating qualitative and quantitative methods for collecting and analysing the data via interviews and a survey. Results showed that, while respondents were aware of trends that have impacted the warehouse sector, they were not aware of the increased fire risk, and what this may mean for overall business resilience. Furthermore, respondents showed gaps in their understanding regarding current fire safety regulations, insurance coverage and their responsibilities to the local community and environment in the event of a severe fire. They were further often unaware of the safety mechanisms in place within their own warehouses. Failure to adequately address these gaps could have severe financial, moral, and environmental implications for the business, potentially impacting its reputation in the local and broader business communities, and even resulting in business closure. This research recommends greater awareness regarding the impact of fires is necessary, and supports the need for better regulations along with support for measures such as sprinkler installation, especially for smaller warehouses. This research indicates that businesses

operating from smaller warehouses are more likely to be exposed to higher risk factors. To validate and quantify this risk, further research into patterns of fires and business failure is necessary

Keys Words: warehouse, fire safety, business continuity, resilience, education, insurance, environment, new threats, sprinklers

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LIST OF ABBREVIATIONS

AFFF	AQUEOUS FILM FORMING FOAM
ADB	APPROVED DOCUMENT B OF THE BUILDING REGULATIONS
ALARP	AS LOW AS REASONABLY PRACTICABLE
AFFF	AQUEOUS FILM FORMING FOAM
AHR	ARYL HYDROCARBON RECEPTOR
AZDN	AZODISOBUTYRONITRILE
B(A)P	BENZO(A)PYRENE
BCP	BUSINESS CONTINUITY PLANNING
BRE	BUILDING RESEARCH ESTABLISHMENT
BREXIT	BRITISH EXIT FROM EUROPEAN UNION
BTEX	BENZENE TOLUENE ETHYLENE XYLENES
CAS	CHEMICAL ABSTRACT SERVICE
CEN	EUROPEAN COMMITTEE FOR STANDARDIZATION
CFC	CHLOROFLUOROCARBON
CL, CL2	CHLORINE
CO	CARBON MONOXIDE
CO2	CARBON DIOXIDE
COD	CHEMICAL OXYGEN DEMAND
COMAH	CONTROL OF MAJOR ACCIDENT HAZARDS REGULATIONS 1999
CPD	CONTINUED PROFESSIONAL DEVELOPMENT
CPH	POLYCHLORINATED PHENYLS
CX	CONCENTRATION OF SPECIES X
DECABDE	DECABROMODIPHENYL ETHER
DCLG	DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT
EEA	EUROPEAN ENVIRONMENT AGENCY

EA	Environmental Agency
EMS	Environmental Management System
EU	European Union
FRS	Fire and Rescue Service
ESFR	Early suppression fast response
FSC	Fire Safety Consultant
FWR	Fire Fighting Water Run-Off
FRA	Fire Risk Assessment
FED	Fractional Effective Dose
FR	Flame Retardant
F, Fx	Fluorine, F-factor for species x
FS	Fire Strategy
GW	Groundwater
GSM	Global System for Mobiles
HSE	Health and Safety Executive U.K.
H2S	Hydrogen Sulfide
HCN	Hydrogen cyanide
HCI	Hydrogen chloride
HRR	Heat Release Rate
IC	Incident Commander
IBC	Intermediate Bulk Containers
ISO	International Organization for Standardization
LPM	Litres Per Minute
LCA	Life Cycle Assessment
LIB	Lithium ion Battery
MSDS	Material Safety Data Sheet
MTBE	Methyl Tert-Butyl Ether

N2O	Nitrous Oxide
NiMH	Nickel Metal Hydride
NIST	National Institute of Standards and Technology
NO	Nitric Oxide
NO2	Nitrogen dioxide
NOx	Nitrogen Oxides
LPAH	Polycyclic Aromatic Hydrocarbon
PBB	Polybrominated biphenyls
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzodioxin
PCDF	Polychlorinated dibenzofuran
PE	Polyethylene
pH	Potential of hydrogen
PFC	Perfluorinated organic compound, perfluorocarbon
PFOS	Perfluorooctanesulfonic acid
PM	Particulate Matter
POF3	Phosphoric trifluoride
PPE	Personal Protective Equipment
PVC	Polyvinylchloride
RRO 2005	Regulatory Reform (fire safety) Order 2005
S	Soil
Sed	Sediment
SO2	Sulfur dioxide
SO3	Sulfur trioxide
SOx	Sulfur oxides
SW	Surface-water

STW	SEWERAGE TREATMENT WORKS
SPS	SODIUM PERSULPHATE
T	TEMPERATURE
TEF	TOXIC EQUIVALENCY FACTOR
TEQ	TOXIC EQUIVALENT
UK	UNITED KINGDOM
USA	UNITED STATES OF AMERICA
UV	UNDER-VENTILATED FIRE CONDITIONS
VOC	VOLATILE ORGANIC COMPOUND
WEEE	WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT
WHO	WORLD HEALTH ORGANIZATION
WV	WELL VENTILATED FIRE CONDITION

Chapter I:

INTRODUCTION

1.1 Introduction

The COVID-19 pandemic has definitely changed the way we live and work. E-commerce has been one of the industries that has seen a huge increase in demand. With people staying at home and shopping online, there has been an unprecedented rise in the need for warehouse space in the UK. However, it is alarming to note that many businesses that operate out of these warehouses in the UK are ill-prepared for a worst-case scenario—a severe fire outbreak at their premises. While it is essential to keep up with the demand and continue growing, it is equally critical to ensure that proper measures are in place to maintain business continuity in the face of unexpected events (Cheshire FRS, n.d.).

Recent research from Cheshire Fire and Rescue Service indicates that 25% of businesses do not reopen following a severe fire, while a further 80% of companies that do not recover within a month are likely to go out of business soon thereafter. They also state that 75% of businesses without comprehensive business continuity plans (BCPs) fail within three years (IBM Services, 2021), which underpins the importance of robust business resilience planning. Modern warehouses have evolved significantly over the years, with multiple levels and automated machinery optimising space and efficiency. However, this arrangement poses a significant challenge to fire safety. The concentration

of combustible materials in these spaces can lead to a rapid spread of fire, causing significant damage. It is crucial for warehouse owners and operators to prioritise the necessary precautions to minimise the risk of fire and ensure the safety of their businesses and assets.

The impact of technology on the warehousing industry is truly remarkable. Over the years, there has been a significant evolution in the way businesses operate out of warehouses. The automation or semi-automation of operations has been crucial for these businesses. The exciting part is that these changes can enhance efficiency and productivity, while also presenting new avenues for growth. With technology ever evolving, warehouse businesses can adapt to market changes and stay ahead of the competition. Thanks to artificial intelligence software, many operations can now be completed without the aid of people. For example, scanning and order fulfilment can now be done using this technology. These businesses thus rely heavily on lithium ion batteries (LIBs) for their operations which introduces the risk of substantial fire due to “thermal runaway”. More warehouses storing more battery-powered products brings more risk (Diaz, n.d.).

Modern warehouse businesses are highly likely to utilise a variety of lithium ion battery-powered equipment to run their operations effectively. This can include rugged tablets, barcode scanners, and other hand-held operational devices, as well as self-parking automated vehicles that can easily self-dock and recharge. Additionally, they may have LIB-powered forklift trucks located in charging areas or located at the end of racking

systems. While LIBs are generally stable and reliable when used properly, it is important to understand that the consequences of a LIB fire can be catastrophic, potentially resulting in complete warehouse devastation and business failure. Therefore, it is crucial to take all necessary precautions to ensure the safe use and storage of LIB-powered equipment within the warehouse environment.

Similarly, introducing newer materials is also argued to increase fire risk (Roken, n.d.). For example, cardboard and polystyrene are usually the first to ignite and help a fire spread in warehouse fires (Overholt et al., 2011). Despite this, older fire standards and regulations do not seem to consider these new materials.

It is important to keep in mind the potential hazards that can arise from storing products, packaging, and storage aids in large warehouses. The risk of fire is particularly high in these situations, but businesses can take the necessary precautions to prevent disaster. With the increasing prevalence of lithium ion batteries in warehouses, businesses must be aware of the risk and intensity of fires that can result from them. To ensure the safety of the business and the warehouse structure , it is imperative to implement proper fire prevention and suppression systems and conduct regular safety audits. By prioritising safety, businesses can minimise the risk of accidents and protect both the warehouse and the business that operates out of it with increased confidence.

When dealing with large fires in warehouses, it is crucial to take into account the limitations of the fire and rescue service. Given the vast space of the warehouse, controlling the flames may prove challenging and make it necessary to prioritise

protecting neighbouring properties. It is therefore imperative to come up with effective methods for containing or extinguishing fires within warehouses. Moreover, businesses must realise that relying solely on basic building regulations may not suffice to provide comprehensive protection for their property and the business that operates within it.

Despite these risks, the UK appears to be lagging far behind many of our European neighbours, with respect to legislation. A key example of this is that sprinklers are only legally required in UK warehouses above 20,000m^2 (Cox, 2022). To put this into perspective it would need to be a warehouse the size of nearly three professional football pitches before it became mandatory to install sprinklers. Yet, other European countries insist on sprinklers in much smaller areas, including 1,800m^2 in Austria, 5,000m^2 in Belgium, 2,000m^2 to 5,000m^2 in Denmark, 3,000m^2 in France, 2,000m^2 in Spain, 1,800m^2 in Germany, 1,000m^2 in the Netherlands, and 800m^2 in Norway (European Fire Sprinkler Network, n.d.). As a result, only 67% of warehouses larger than 10,000m^2 and 20% of warehouses between 2,000m^2 and 10,000m^2 in England and Wales are protected from fire with sprinklers (Cox, 2022). This means the warehouse site is entirely reliant on the fire and rescue service to attend the site before the fire is tackled. This has implications for business resilience and continuity. Furthermore, more stringent guidance levels in Europe mean that these markets are far better prepared to recover from devastating fires that threaten their businesses.

It is important to have sprinkler systems in place to prevent fires from spreading and causing extensive damage to businesses and the environment. By containing the fire

to its place of origin, sprinkler systems minimise the amount of contaminants that could potentially harm the local surroundings. This is due to the fire being knocked down very quickly rather than waiting for the FRS to attend before the extinguishing operation commences; hence less fire water runoff (FWR) is created. Sprinklers also cover a site 24/7 and protect firefighters (Abdulrahman et al., 2021). That said, trying to cool affected damaged lithium ion battery cells to stop thermal runaway can prove difficult due to the battery design, which is often compact with each cell in close proximity to the other. Also, the risk of adding water can, in fact, "fuel" a fire, creating highly inflammable and explosive hydrogen gas. Then there is the environmental damage that needs to be considered, as pouring large amounts of fire suppressant onto these fires creates a toxic mix of chemicals such as lithium hydroxide which if not contained on site can flow into local rivers via storm drains. Regardless of these caveats, this topic seems to be poorly understood, with businesses operating out of warehouses ill-prepared for containment of fire water runoff (Fogarty, 2022).

Businesses must fully comprehend the financial repercussions that accompany negative publicity. They not only risk monetary losses, but their standing can also be severely harmed through social media and news outlets. Therefore, it is paramount for businesses to place equal importance on their reputation as they do on their financial prosperity.

The annual average number of fires in UK commercial warehouses that do not have automatic fire sprinkler systems installed as a preventative measure is 588. These

588 fires are estimated to have the following annual impacts on business, the economy, employment and the Exchequer: A total direct financial loss to business of £230.2 million per year with an aggregate direct economic loss of £62.8 million to GVA, and a more significant loss of £127 million when the 'ripples' through the economy are accounted for by lost indirect and induced multiplier impacts. There is an employment loss of 996 jobs per year, of which 612 jobs are lost indirectly and tax losses of £31.7 million to the Exchequer from reduced business rates, employers' national insurance contributions, income tax, and corporation tax (Hogan, n.d.). The time that a warehouse is not capable of conducting business or having its functionality can have a major impact on profits. This can be caused by both extensive or limited damage, which leads to a period of repair, replacement, recovery, or service interruption when the business is not operating (FEMA, 2015).

1.2 Research Problem

Business Continuity Plans (BCP) frequently only account for financial shocks and supply chain disruption, but the devastation of a severe fire is often underestimated and, as shown above, minimally understood. Different priorities exist regarding the link between BCP and fire risk assessment (FRA). Those who consider BCP alone are mainly concerned with recovering from disasters such as fire and flooding, or power outages, so risk mitigation is the primary emphasis for BCP (IBM Services, 2021). On the other hand, those focused on FRA are mostly concerned with life safety ("The Regulatory Reform (Fire Safety) Order 2005", n.d.). Research has shown that "resilience" in the

context of prevention does not seem to be adequately covered. This appears to present a gap in terms of incorporating and understanding resilience in this context, and, more practically, in how business owners can build resilience in their businesses relating to fire safety.

The research gap between fire safety and business continuity planning means businesses are vulnerable when market forces change, as we have seen with COVID-19 and BREXIT (the withdrawal of the United Kingdom from the European Union) (Fogarty, 2022). This has shown the need for standard legal requirements to keep pace with change and allow businesses the flexibility to adapt to any new or emerging risk. This is especially important when it comes to fire safety due to the destruction and devastation it can cause to a business.

1.3 Aim of the Research

As businesses continue to use warehouses for their day-to-day operations, it is becoming increasingly clear that there are certain areas where knowledge gaps exist. These gaps can ultimately impact a company's resilience, particularly as we navigate new challenges such as BREXIT and COVID-19. With the rise of modern technologies, warehouse usage has also increased, so it is more important than ever to address these gaps and ensure that businesses are equipped to weather any storm, especially in relation to fire safety.

It is important to understand how these align with current building and fire safety regulations and how they can impact the business operations of the warehouse. This research will explore whether basic building regulation fire protection measures are adequate to prevent business failure following a serious fire in UK warehouses and how this can be improved. The study will also evaluate the extent to which current building regulations and standards regarding fire safety hazards are understood and complied with by business owners and managers of UK warehouses, and how these warehouse managers/business owners interpret the current situation. The level of understanding warehouse business owners have regarding the potential impact and consequences of fires for their businesses, both financially and reputationally, will also be examined.

1.4 Significance of the Study

The challenges of the UK warehouse sector in recognising new and emerging fire risks are substantial and have serious financial implications for the business. As the COVID-19 pandemic has accelerated a shift to online shopping platforms, outdated building regulations and a lack of research into modern warehouse automated facilities mean many businesses are even less resilient to cope with a severe fire (Bush, 2021). Furthermore, building regulations and fire safety standards often lag behind technology, creating a "gap". Previous research by the insurance company Zurich supports this theory. In the words of Charles Bush, Zurich's Head of Property and Energy Claims:

> *Warehouses underpin the huge and growing e-commerce sector. Against the tens of millions of pounds Britons spend online every day, current sprinkler standards*

> *look increasingly inadequate. As well as posing a threat to life, warehouse blazes devastate businesses, send shockwaves down supply chains, and lead to the loss of jobs and productivity. While we're committed to helping firms of all sizes manage their warehouse risks and recover after a fire, the government must address this issue. A failure to make new warehouses more resilient to fire risks is damaging Britain's growing e-commerce economy and the many jobs and businesses that depend on it.* (Bush, 2021)

Research into this topic will shed light on what is currently understood by existing business owners. The knowledge gained from this research could provide valuable recommendations for both business owners and regulators to build future business resilience and offer better long-term protection to the warehouse sector.

1.5 Research Purpose and Questions

It has become clear that modern warehouses have gone through a number of changes that could potentially make them more vulnerable to fire safety risks. This could have a detrimental effect on the long-term future of businesses. Additionally, current regulations and research do not seem to be focused on business resilience, and there are some key omissions that leave many businesses without adequate guidance, such as sprinklers for smaller warehouses. It is unclear how aware business owners are of this gap between policy and risk. This research aims to demonstrate that increased awareness and improvements to building regulations would greatly reduce the impact of a serious fire within the UK warehouse sector, specifically in premises that currently fall outside of the

limited current sprinkler requirements. Business owners should go beyond these regulations and take a holistic approach to assessing if current policies meet risk and, if not, what can be done to reduce the risk to "As Low As Reasonably Practical" (ALARP). This will help them to recover quickly should the business be affected by a fire, regardless of the severity, which will ultimately reduce any financial liability both in the short and long term.

To assist the current level of understanding of the UK warehouse business sector, the research will address the following questions:

1. To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?
2. To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouses?
3. What level of understanding do warehouse business owners have regarding the potential impact and consequences of fires for their business in the short and long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?

1.6 Research Design

The primary research method for this study is qualitative. Open-ended questionnaires will be designed to elicit feedback that demonstrates a clear picture of the current situation in the UK regarding business resilience and fire safety. The process will include interviews with fire safety professionals and those who have overall responsibility for fire safety for warehouses, such as facilities managers and safety managers rather than insurance companies or business owners. This is because they have first-hand experience and are therefore more aware of the everyday protocol in their facilities. Their understanding of the legislature is key to identifying the knowledge gaps among those at the forefront of the issue, providing an in-depth insight into their experiences of fire safety resilience. The intention is to use a sample size of 20 businesses which should give a clear picture of the current level of resilience. Once gathered, the information will be reviewed inductively using reflective thematic analysis (Braun and Clarke, 2012).

1.7 Thesis Outline

Chapter 1 discussed the current situation with regard to fire safety in UK warehouses, emphasising the need for further research to determine the necessary changes to protect businesses in the short and long term. This chapter outlined the pivotal questions that will be asked during the research and included the study's purpose. Chapter 2 will examine the existing research and legal framework surrounding fire safety in the UK warehouse sector. Chapter 3 will present the research methodology, and the rationale

behind the chosen technique. This leads us into Chapter 4, which will discuss the outcomes of the research interviews, their relevance to current practices and the need for future adaptations to the legal framework and BCP. Chapter 5 will analyse the research findings and compare them to previous studies. Finally, Chapter 6 will provide recommendations based on the previous chapters while also identifying the need for future research.

Chapter II:

REVIEW OF LITERATURE

2.1 Introduction

Fire is a highly threatening disaster that can happen at any time and in any business facility. It is an ever-present danger and can spread rapidly, regardless of the size, construction, or type of the business. In this chapter, we will review prevention issues and response measures, as well as fire protection systems and building and hazard classifications. We have discussed how the UK appears to be lagging far behind many of our European neighbours with respect to legislation. A key example of this is that sprinklers are only legally required in UK warehouses above 20,000m^2 (Cox, 2022) and that Business Continuity Plans (BCP) frequently only account for financial shocks and supply chain disruption within the business; but the devastation of a severe fire is often underestimated and, as shown previously, minimally understood (IBM Services, 2021). We now need to look further to understand what research has been completed and understand the gaps that exist.

2.2 Theoretical Framework

BCP forms part of business supply chain risk management and is an important competitive factor for businesses because it ensures the smooth functioning of critical business processes in the case of failures. If business operations are severely disrupted, the

companies' decision maker is confronted with a situation which is characterised by a high degree of uncertainty, complexity and time pressure (Schätter et al., 2019).

According to Zamoum and Gorpe (2018), crisis situations share six characteristics which are rare, significant, high impact, ambiguous, urgent and involve high stakes. They can affect all businesses and range from cyber-attacks to floods or even supply chain failure, with these disruptions occurring at any moment. BCP is often about dealing with difficult situations so the business can continue functioning with little disruption. An effective BCP will recognise potential threats to an organisation and analyse what impact they may have on day-to-day operations. It also provides a way to mitigate these threats, putting in place a framework that allows the business's vital functions to continue even if the worst happens. For example, in 1996, the Manchester bombing affected over 600 businesses. Within six months, 250 of these had gone out of business. Many of those that survived had a BCP in place (Fire, n.d.).

When we look at the link between BCP and fire safety, it is essential for all staff to know the routine to be undertaken in the event of a fire—how to react upon discovery of fire or on hearing the premises fire alarm. Furthermore, it is essential that management draw up an effective routine which covers all likely types of situations, which includes minor or major fire situations. This is where BCP has the essential link to fire safety.

BCP will help prepare the business for future business shocks; however, once the event occurs, there is a need for Crisis Management (CM) (Lockwood and SPHR, 2005). BCP enables the business to put procedures in place to allow continued operation. At the

same time, CM takes control once an event takes place to manage the crisis until standard business patterns resume. While much research focuses on BCP in terms of IT and other technological disasters, effective BCP should address much more. And just as importantly, CM should be recognised as both a tactical and a strategic responsibility that extends far beyond business continuity. While, in practice, BCP is proactive (enabling discipline), CM is reactive (controlling discipline). CM only takes control of the event once initiated, yet BCP will help prevent it.

But we will also need to remember that not all incidents are crises, and not all incidents are in need of business continuity planning, so it is essential that businesses understand and recognise trigger points that apply specifically to their business model, which we will examine in the next section.

2.2.1 Evolution of Business Continuity Plans and Fire Risk.

Business continuity planning (BCP) was introduced in the 1970s when financial institutes such as insurance companies realised that if a fire or flood was to occur in the premises where they stored critical IT data, then this was likely to destroy essential records and critical information. Many decided to invest in alternative sites which housed backup tapes and critical information (IBM Services, 2021). For the next decade, BCP grew organically but was still mainly influenced by the need to protect critical IT data and was, therefore, very one-dimensional (ibid.). From the start of the 1990s and into the 2000s, businesses have seen a need for not just protecting data via disaster recovery but for focusing on prevention. This is critical to protect a business's reputation. Research studies

have shown that, without proper planning, businesses that somehow recovered from an immediate disaster event frequently did not survive in the medium term. This is due to what is known as consequential losses—the loss of reputational damage, image and market share. Therefore, BCP becomes a source reference during a business continuity event or crisis and the blueprint for strategy and tactics to deal with the event or crisis (ibid.).

One of the biggest threats to the UK warehouse business sector is the risk of fire which can be devastating to the business, meaning the need for prevention is just as crucial as the need for recovery. When you consider that the average cost of a large warehouse fire is £5.9m and that 43 warehouse fires occur every month in the UK (Smith, 2021), these businesses cannot afford to take any risks when it comes to fire protection. Statistics show that many UK warehouses are not resilient regarding BCP (Cheshire Fire and Rescue Service, 2021). Recent research from Cheshire Fire and Rescue Service indicates that 25% of businesses do not re-open following a severe fire. In comparison, 80% of companies that do not recover within a month are likely to go out of business. They also state that 75% of businesses without comprehensive BCPs fail within three years (ibid). which underpins the importance of robust resilience planning. However, a study titled "Supply Chain Disruptions and Business Continuity: An Empirical Assessment" by Azadegan in 2020 considered whether business continuity plans (BCPs) are useful in improving a business's performance. The study developed hypotheses on how BCPs channel resources to recover from supply chain disruptions, contingent on a company's flexible or procedural response orientation. In Study 1, the hypotheses were tested based on a combination of subjective (Likert-based responses) and objective (historical financial performance) data gathered and

matched from a cross-section of Italian companies. Results suggested that BCPs are beneficial to businesses with a procedural or flexible orientation in limiting the damage caused by supply chain disruptions. Companies with strong BCPs show better financial performance in comparison to their competition. In Study 2, a vignette-based factorial experiment was used to gain insight on how managers perceive the effect of flexible or procedural response orientation on limiting the operational damage of disruptions. Finally, post-hoc analyses using fuzzy set qualitative comparative analysis (fsQCA) offered further evidence of a strong link between BCPs and financial performance (return on assets). Risk management research suggests that BCPs are essential in response and recovery from disruptions (ibid.).

2.2.2 Legal and International Frameworks

Another consideration for BCP (specifically relating to fire safety) is legal expectations**.** Fire safety in warehouses specifically is covered by building regulations and, in particular, Approved Document B (ADB), which sets the framework of controls that need to be in place when constructing or making material changes to buildings. ADB addresses fire safety precautions which must be adhered to in order to ensure the safety of occupants, firefighters and those close to the building in the event of a fire. The document covers all standards related to this, including means of escape, the ability to internally isolate a blaze to prevent a fire from spreading, external fire spread, firefighter access to the building and facilities, fire detection and warning systems in place within a building. The Regulatory Reform (Fire Safety) Order 2005 requires any person who exercises some

level of control for premises (the ‘responsible person’) to take reasonable steps to reduce the risk of fire and ensure that people can escape safely if a fire does occur. It requires the responsible person to carry out a fire safety risk assessment (FRA) and implement and maintain a fire management plan. When undertaking major refurbishments or construction of non-standard constructed buildings, there is an option to use BS 9999. This is an alternative to ABD, but guidance given in BS 9999 is intended, like ADB, to safeguard the lives of building occupants and firefighters. Some recommendations and guidance might also assist in achieving other fire safety objectives, such as protecting property, the environment, communities and business/service viability.

A UK business-owners survey showed that 69% felt that their business was protected from the impact of fire by following UK Building Regulation guidance (Cox, 2022). While the study did not explicitly look at businesses operating out of a warehouse, this may provide an indication that business owners, in general, do not fully consider additional needs that are not directly related to legal expectations. Yet, while the legal framework focuses on lives, other aspects that may ensure business continuity are not necessarily prioritised.

It is, therefore, important to compare the formal legal framework to BCP. Specifically, it is crucial to acknowledge that the above is a legal requirement, but BCP is not; therefore, we do not find any legal framework in BCP, just a focus on best practices. However, there is an international standard that companies can follow in the form of ISO 22301, an international network standard for Business Continuity Management. The

standard provides a framework to plan, implement, operate, monitor, review, maintain and continually improve a BCP. Regardless of the organisation's size, nature of business or sector, it covers all major forms of disruption, including natural/manmade disasters, political disturbances, terrorism, and technology failure, which may occur at any time and lead to business disruption. An abstract from ISO 22301 (2019) states:

> *This document specifies requirements to implement, maintain and improve a management system to protect against, reduce the likelihood of the occurrence of, prepare for, respond to and recover from disruptions when they arise. The requirements specified in this document are generic and intended to be applicable to all organizations, or parts thereof, regardless of type, size and nature of the organization. The extent of application of these requirements depends on the organization's operating environment and complexity.*

Therefore, it is clear that the legal framework and the BCP do not necessarily interact, with both operating on two different platforms. While the legal framework sets out minimum legal standards, BCP relies on the business interpreting the requirements of ISO 22301 (2019). **Figure 1** below follows the common principle of "plan-do-check-act" (PDCA), a four-step problem-solving process used in many other management planning processes, so it is a very familiar format.

- **Plan**: Establishes objectives, targets, controls, processes and procedures
- **Do**: Implements and operates the business continuity policy, controls, processes and procedures

- **Check**: Monitors and reviews performance
- **Act**: Maintains and improves the program by taking preventive and corrective actions.

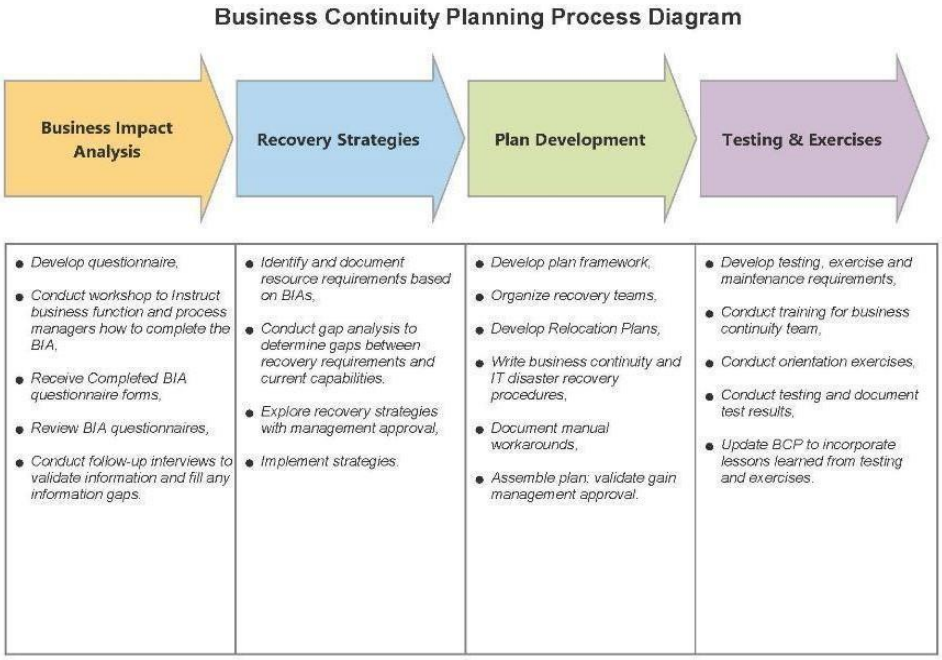

FIGURE 1. BUSINESS CONTINUITY PATHWAY CHART (ISO 22301, 2019)

As we see throughout this chapter many fire-related risks should be considered when formulating a BCP. We are well aware of the serious effects even a small fire can have on a business, from water damage to destroying or halting production and distribution, which can be devastating. **Figure 2** shows the current FRA processes which are widely

used in the UK. These are very similarly aligned with the PDCA process. **Figure 3** shows how easily PDCA and FRA could be integrated to improve business resilience.

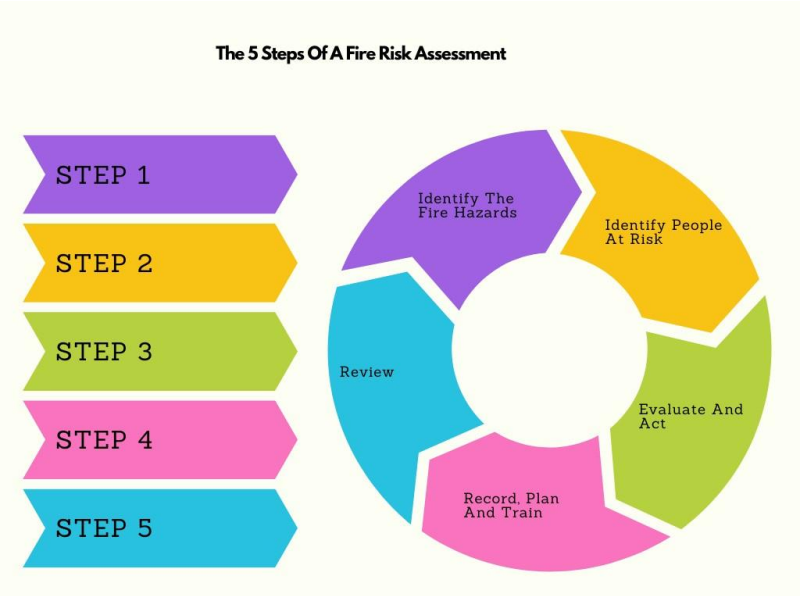

FIGURE 2. FIVE STEPS TO A FIRE RISK ASSESSMENT (GOV.UK, N.D.)

FIGURE 3. PDCA IN CONJUNCTION WITH FIRE SAFETY (GOV.UK, N.D.)

The above diagrams set out the broad frameworks, covering the BCP and FRA. However, these show that fire safety could and should be integrated more into BCP which would allow an opportunity for a more robust and resilient BCP which presently could be being missed. In the next section, we will look at how this impacts resilience.

2.2.3 Resilience

According to the United Nations, resilience is:

> *The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management.* (Raj et al., 2022)

We discussed resilience in chapter one but need to explore this in more detail as there is currently a “gap" between prioritising life safety and business continuity. This means businesses are vulnerable when market forces change, as we have seen with the impact of COVID-19. The effects of the coronavirus outbreak on global supply chains have emerged on three different sides: supply side; demand side; and logistical side (Raj et al., 2022). Similarly, BREXIT has generated a high, broad and persistent increase in uncertainty, with more than half of businesses having reported Brexit as being one of their top three sources of uncertainty (Bloom et al., 2019). Such events also have a knock-on effect when it comes to fire safety; and research has shown that current standard fire safety legal requirements are not keeping pace with changes i.e., the modern warehouse

will have a large volume, may be arranged on multiple levels, and will utilise automated machinery. Concentrations of combustible materials in regular storage arrangements make them ideal to aid fire spread, and this is where businesses are at their greatest risk. The fundamental challenge with current building regulations is that they make no consideration for minimising of the spread of fire within the large compartment sizes of the warehouses (Smith, 2021).

According to Binding (2021), the recent move by the UK to leave its European trade partners (BREXIT) in 2020 meant many warehouses were at maximum capacity due to the problems faced with delays at ports and borders; an occurrence that continued into 2022. Along with the recent increase in online shopping, continuous maximum capacity storage adds to the fire load of the warehouse. Before the COVID-19 era, supply chain managers generally focused on just-in-time inventory management, which helps to reduce costs and increase efficiency. However, following the COVID-19 outbreak, it has become clear that this approach fails to prepare global supply chains to combat extreme shocks, such as those owing to the COVID-19 pandemic (Binding, 2021). Furthermore, the way that the coronavirus pandemic has affected global supply chains has only increased the importance of risk management and mitigation strategies. Businesses need to evaluate their supply chain strategies, supply chain designs, and supply chain dependencies to avoid improvised reactions to future natural disasters and prepare themselves to adequately address unexpected disruptions (Raj et al., 2022).

The modern warehouse may be arranged across multiple levels and can have a variety of materials with various risk levels each requiring careful consideration when it comes to managing fire safety. Many warehouses have large, stacked shelves, often over 15 metres, with flammable packaging covering vast floor areas, making it difficult and dangerous to extinguish fires (Gollner et al., 2011). Similarly, with automated machinery working within a large volume, any fire in a warehouse will have severe consequences for the business. This fundamental challenge of having concentrations of combustible materials in a regular storage arrangement makes them ideal for aiding fire spread (Smith, 2021). Yet even without largescale, immediate changes, technological and other innovations need to be considered in business resilience planning.

Computer software, Computational Fluid Dynamics (CFD), is used to understand and measure the fluid flow and heat transfer phenomena associated with fires. This helps predict smoke and heat movement in buildings of any design and, with the advent of performance-based codes, is increasingly being used in fire safety engineering (Huang et al., 2020). However, it is noted that for storage fires such as those that may impact warehouses, a generic risk management model is still absent (Ding et al., 2020). A paper produced by Khan et al. in 2021 stated: “In the near future, more sophisticated models might be required because of new architectural practises for designing innovative and large floor compartments” (Khan et al., 2021).

Fire incidents tell us a lot about the challenges of such concentrated amounts of combustible storage, and the challenges for the fire service in trying to contain them without early intervention of systems like sprinklers. This will be discussed in the next section.

2.3 The Role of Sprinklers in Fire Risk Aversion

In the introductory section, we discussed the UK lagging far behind many of our European neighbours propping up the bottom of the table, with sprinklers only guided in warehouses above an enormous 20,000m^2 area under current guidance (Cox, 2022). That will not make the warehouse and the business operating within it more resilient but instead will only meet the minimum outcomes required by these regulations (Kung et al., 2011).

Kung et al. (1997) conducted a series of seven large-scale rack storage fire tests, using four Early Suppression Fast Response (ESFR) sprinkler models, to determine the required sprinkler spray characteristics for achieving effective protection of rack storages of the standard plastic commodity up to 10.8 m high in a 12.2 m high area. A measured water flux of 0.667 l/s/m^2 over a 2.15 m x 2.15 m area, centred below the two sprinklers and 1.77 metres beneath the ceiling, was found to be sufficient for achieving fire suppression (Kung et al., 1997). However, many sprinkler systems are ceiling-based and not the more efficient Early Suppression Fast Response (ESFR) type, which should be fitted to both ceilings and racks. Other research supports this and, in order to achieve the goal of complete initial extinguishing, a concentrated watering method that can

compartmentalise the fire area and spray water intensively to the fire area should be introduced. According to the test results, the maximum installation height of in-rack heads must be every 2.5 m for complete fire extinguishing. In the load fire test, the fire grew rapidly in the air supply space at 3 minutes and 30 seconds after ignition. If the head is automatically opened within 3 minutes and 30 seconds, it is expected to achieve a faster extinguishing effect. Research by Myoung and Jeong (2018) supports this .The performance of sprinkler systems is mainly determined by fire size, the degree of obstruction, ventilation conditions, compartment geometry, spray characteristics of the water mist systems and their configuration in the warehouse.

Fires in warehouses can cause very big monetary losses to the business operating out of it. There have been reports of some extremely large business losses in warehouses worldwide in recent times, some of which caused insured losses of well over EUR 100 million (Roken, n.d.). Today's modern warehouses are not the "standard types" envisaged by Building Regulations ADB and perhaps require holistic solutions. This is a change that the government needs to consider when reviewing the current compartment sizes for warehousing and the guidance on the provision of sprinklers in these buildings.

Fire incidents tell us a lot about the challenges of such concentrated amounts of combustible storage and the challenges to firefighting by the fire service to contain them without the early intervention of systems like sprinklers. For instance, in automated warehouses, while the containers may sometimes be cardboard or metal, goods are more often stored in plastic containers about the size of a household recycling bin. These

containers burn much more severely than cardboard or wooden containers. The containers themselves, no matter what material they are made of, can also create problems with water flow down through the rack where the sprinkler water is needed. When they are open-topped, as they often are, they collect sprinkler water and prevent it from cascading to lower tiers of burning product in a timely manner. The rack structure itself can create a problem with water flow as well. Angle irons, which often hold the containers in place, can divert precious water away from the fire area (Baker, 2018).

As robots are more agile than people driving forklifts, automated warehouses tend to optimise storage space by reducing the size of aisles—typically to 1.2 meters or less—as well as by minimising the spaces between container loads, both horizontally and vertically. While this arrangement increases storage efficiency, it also increases the ease with which fire can spread horizontally, not only within the rack of fire origin but also to adjacent racks due to the narrow aisle widths (Jr, 2017). M Global Property Loss Prevention Data Sheets 8-34 produced by the FM Global offer well researched and practical solutions as an alternative to the well-known NFPA® 13, which is the standard for the Installation of Sprinkler Systems, but it only provides the minimum requirements for the design and installation of automatic fire sprinkler systems.

A technical study carried out by FM Global in 2016, titled "*Development of Protection Recommendations for Li-ion Battery Bulk Storage Sprinklered Fire Test,"* completed various tests to determine the best way to store lithium ion batteries to maximise sprinkler efficiency. It made protection recommendations for warehouse

storage of cartoned lithium ion batteries based on fire testing and comparison to analogous commodities with similar hazard characteristics. A unique approach was developed that incorporated four different fire test evaluations, ranging from small- to large-scale, with the goal of extending the application of a successful large-scale fire test to different types of lithium ion batteries. Where applicable, best protection recommendations, based on current knowledge, were provided. The combination of the intermediate- and large-scale tests confirmed that sprinklers can protect a growing rack storage fire, as well as a developed battery fire. However, the cost of installation can be high, with an average cost of £42 per sm^2 (Ditch, 2018).

The introduction of new threats will be expanded upon later in this chapter. These will no doubt impact how we need to research and design sprinkler systems in the future, with research already taking place on the most efficient way to extinguish the emerging threat from lithium ion batteries. Sprinklers will help contain a fire which has already started, but it is important to analyse the risk and reduce this to its lowest level. This is known as ALARP "As Low As Reasonably Practicable" and will be discussed in the next section.

2.4 Risk-Based Approach to Fire Safety and Resilience

Normally, risk is defined as the product of frequency of accident and consequence of accident; thus preventive measures are aimed at reducing the frequency of accident, whereas mitigative measures are aimed at alleviating consequences of accident (Kim and Lee, 2016). Although fire risk cannot be totally eliminated, the risk can be reduced as

much as possible through preventive and mitigative measures, which are aimed at maintaining product storage safety through fire prevention, fire detection and fire extinction (Ding et al., 2020). Below is a brief overview of what could be considered when looking at fire prevention, fire detection and fire extinction.

Fire prevention: Preventative measures include controls that manage housekeeping; storage (including high fire loads and high rack storage); dangerous substances; equipment and machinery; electrical safety; unauthorised smoking by staff or visitors; managing building work and alterations such as hot works; existing layout and construction such as unmanaged penetrations through walls; particular hazards in corridors and stairways used as escape routes; restricting the spread of fire and smoke; and arson.

Fire detection: This would include measures such as designing fire detection in key locations, and installing correctly specified beam detectors in high level ceilings and detectors in racking systems. In warehousing, each part of the building may present different fire risks. These areas will include offices which are lower risk as people are generally completing low risk tasks there; warehousing which is generally medium risk but could have high risk areas, for example where LIB are being stored/charged; canteens and kitchens which need careful design consideration to prevent false alarms; and external loading bays which would also need careful design consideration. Therefore, the detectors need to be able to sense all the potential indicators of a real fire risk according to that particular environment. When installed correctly, the fire detection devices (AFD)

need to be carefully positioned to detect the early signs of fire as required by BS 5839-1:2017,which covers the planning, design, installation, commissioning and maintenance of fire detection and fire alarm systems in and around commercial buildings.

Fire extinction: The role of sprinklers in fire extinction has already been described in previous sections. However, consideration should also be given to smaller hand-held extinguishers and fire blankets which may be recommended by the FRA.

Many purpose-built warehouses, which are the ones designed by the occupier specifically with their product in mind, can, and often do, have increased fire resistance built into the initial design to protect the stored product in case it is directly exposed to fire. Essentially, it is designed to give maximum protection to the known risks; therefore, the highest level of both fire detection, prevention and extinguishing elements are included. Lindt & Sprüngli, for example, produce chocolate goods, which have a high combustion temperature due to their high calorific value. For this reason, the distribution centre design required higher fire protection standards than others. Its area amounted to approximately 7,600 m^2, including a 7,000 m^2 warehouse section (Korzeniowska, 2020). This is a good example of where a warehouse was designed specifically to suit the needs of the occupier, an arrangement which can often suit both developer and business occupier with extended leases agreed to cover the extra construction costs.

However, this is not always the case and, due to the pandemic-propelled e-commerce boom (Smith, 2021) which has sparked a surge in demand for storage and distribution space for many businesses, fire crews in England attend an average of 336

warehouse fires every year—nearly one a day. More than one in 10 blazes (14%) in the UK results in the destruction of an entire warehouse building (Johnson, 2021). In the last decade, fires are recorded to have caused 99 fatalities or casualties. Shockingly, of the 3,400 warehouse blazes attended by fire crews in the UK since 2010, half (49%) did not have alarms and just 6% had sprinklers. Losses have been driven by the demand for same- and next-day deliveries which has sprouted an increase in smaller 'last-mile' warehouses located closer to, or in, urban centres. These are typically older buildings that pose higher fire risks. The growth in online retail has also sparked a trend towards taller and larger 'big box' warehouses, with more tightly packed goods. Automation—including the use of robots—has further ratcheted up the risk and costs of warehouse fires (Bush, 2021). This new technology has introduced new threats, some of which has already been mentioned, but will be discussed in more detail in the next section.

2.5 New Threats

Modern warehouses are often automated or semi-automated, meaning many operations are carried out without the aid of people, but rather using artificial intelligence software for scanning and order fulfilment. Various technologies have been presented as opportunities for manufacturing and logistics firms to secure a competitive advantage. Hofmann and Rüsch (2017), Rakyta et al.(2016) and Bag et al. (2020) mention multiple examples of Logistics 4.0 initiatives, including warehouse management systems (WMS), the real-time tracking of material flows (e.g. through auto-ID technology, radio frequency identification [RFID] tags and scanning devices), autonomous and self-controlled

material handling and storage (e.g. by loading, unloading and picking robots, laser-guided vehicles [LGVs], automated guided vehicles [AGVs], conveyor systems), autonomous order processing (i.e. autonomous release of replenishment orders) and real-time monitoring and planning of product distribution (e.g., by intelligent transportation systems [ITS] and a telematics control unit [TCU], which can track the location of freight and relevant data and recommend an optimal route to drivers) (Nantee and Sureeyatanapas, 2021).

Furthermore, in order to reduce CO2 emissions and help prevent global warming, many alternative energy resources are being adopted today, such as nuclear, hydrogen, wind, solar and geothermal energy. Additionally, electric vehicles (EVs) and hybrid electric vehicles (HEVs) are being developed at a fast pace, and are expected to ultimately replace the traditional vehicles powered by gasoline. Lithium ion batteries (LIBs) are seen as the key technology that will enable the transition to EVs and thus replace the traditional vehicle design based on the internal combustion engine, and they are also the most viable candidate device to store the electric energy from renewable energy in electric grids. Currently, the dominant power sources for a variety of portable electronic devices are LIBs due to their high working voltage, low memory effects and high energy density compared to traditional batteries. It is no exaggeration to say that LIBs are booming all over the world and are being used in many fields (Wang et al., 2019). This massive increase in the use of lithium ion batteries poses a new threat in terms of fire related incidents.

Although statistically rare, LIB fires pose hazards which are significantly different to other fire hazards in terms of initiation route, rate of spread, duration, toxicity, and suppression. The first major product recall due to fire safety took place in 2006, when Sony recalled more than 9.6 million LIB that powered notebooks of well-known computer manufacturers, with an estimated direct cost of $360 m. Ten years later, in 2016, Samsung made one of the largest recalls in history: 2.5 million Note 7 smartphones, with an estimated direct cost of $5.3bn (Diaz et al., 2020).

The term “lithium battery” is an umbrella term referring to many different battery systems in which lithium is used in its pure form or in compounds as active material for the battery’s electrode (Buser and Mähliß, 2016). Basically, there are two different battery types. While primary lithium batteries (lithium metal batteries) usually are non-rechargeable and thus intended for single use only, secondary lithium batteries (lithium ion batteries) are rechargeable and allow for the conversion of chemical energy into electrical energy which can be reversed several times, making it possible to use these batteries multiple times. It is characteristic of a battery in that it releases chemically stored energy in the form of electric energy in the course of the discharging process. In the case of a “thermal runaway”, the entire energy is not released as electrical energy in a controlled manner, but uncontrollably in the form of thermal energy. In the event of such a failure, the thermal energy released by a lithium ion battery may be 7 to 11 times higher than the energy stored electrically. The produced heat accelerates the reaction, resulting in a critical overheating of the battery which can burn at temperatures of up to 1,200°C. In addition, it is possible that cathode materials disintegrate at high temperatures (ibid).

Thermal runaway occurs when the heat release rate from internal chain reactions is larger than the external cooling rate. This reaction also produces heat (exothermic reaction) and releases bound oxygen; when fire breaks out, this released oxygen makes it difficult to control the fire. It is even impossible to extinguish such a fire using conventional fire extinguishing methods (Buser and Mähliß, 2016). The challenge is that there are currently no standardised fire extinguisher systems that can be specified to protect warehouses and current standard sprinklers may offer insufficient control; however research has shown water mist sprinklers can offer a greater effect (ibid.). Due to the demand for high-energy applications, lithium batteries often appear in the form of multiple packs. Once one single cell is subjected to thermal runaway, its heat will rapidly spread to surrounding ones by heat conduction. When the heating power of the adjacent cell is greater than its own heat dissipation, its temperature rises, and then the thermal runaway may occur (Chen et al., 2020).

This makes it important for fire risk assessments to take into consideration the threat of both increasing usage and increasing storage of lithium ion batteries. Yet there are currently no specific UK or European guidelines for fire protection relating to the storage of lithium ion batteries (Fire Protection Association, 2023).

Lithium ion batteries can also contribute to the environmental damage associated with fires, which will be discussed in the following section.

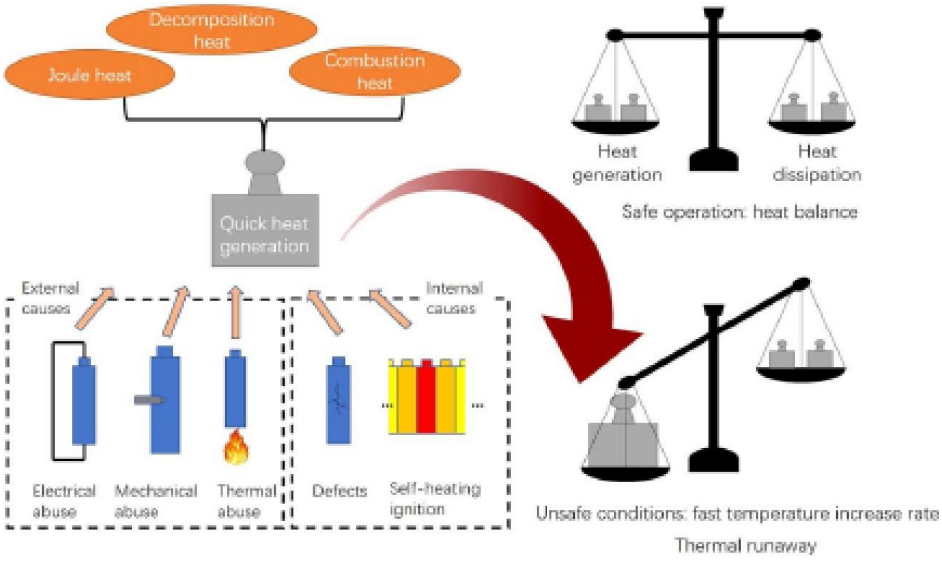

FIGURE 4. KNOWN ABUSE CONDITIONS THAT CAN LEAD TO LIB THERMAL RUNAWAY AND THE IMBALANCE BETWEEN HEAT GENERATION AND HEAT DISSIPATION (DIAZ ET AL., 2020)

2.6. Environmental Risk Factors from Fire

A severe consequence of warehouse and industrial fires that is often overlooked and underreported is the environmental damage caused by firefighting water runoff (FWR). This is the excess water used to tackle a fire emergency. While some water will evaporate, large quantities will often be released into local drainage networks and the ground to drain away. The business owners of such premises often lack an understanding of the risks of firefighting water runoff and how to mitigate these risks (Fogarty, 2022). The 2010 EEA report states that the ecological impact of industrial firefighting activities, which can contaminate surface and groundwater, is more severe than the smoke from the

fires (Amon, n.d.). Often the environmental cost goes under-reported as headlines tend to concentrate on the loss of life or property.

Pollutants can affect the environment in various ways, including direct FWR into a water body, soaking away into the ground, or entering drainage systems. This allows chemicals and pollution to enter rivers, lakes, groundwater (GW) or sewerage treatment works (STW). Often these liquids or foams will cause de-oxygenation, killing many organisms. This type of water pollution, known as oxygen depletion, destroys the natural balance of water. Oxygen depletion enables bacteria to thrive, killing wildlife and harming fish and aquatic species (Fogarty, 2022).

Furthermore, fire extinguishing agents (water, foam, etc.) used to mitigate the incidents will be a carrier of all pollutants released from lithium ion batteries and other warehouse chemicals. Lithium ion batteries contain a variety of chemicals including reactive salts, volatile organic electrolytes and additives; the latter are often commercial secrets and hence their toxicity and combustion products are largely unknown. Moreover, battery fires may release toxins into the air or leach the harmful contents into the soil, groundwater, and surface water. Once released, they pose risks to the surrounding environment alone or in combination with other pollutants (Mrozik et al., 2021). Add the emerging threat in a fire situation from the increased use of LIBs, which takes substantially more water to bring under control compared to other fires, and we now face a bigger problem, especially when LIBs in buildings are emitting toxic fumes, and could explode catastrophically at any moment. The primary reason is that lithium burns in the

air we breathe, and moreover reacts with water to form explosive hydrogen that may develop a chain reaction.

During a fire, leaching can be yet another way that pollution can be spread. There are many hazardous materials that can be released from lithium batteries, such as vapours and gases (such as HF, CO, or HCN), metal nano oxides (such as LMO or NMC), degradation products of the electrolyte (alkyl fluorophosphates), and even tiny traces of additives. It is important to be aware of all the potential dangers that can arise during a fire and take appropriate precautions. These pollutants may be released into the soil, and water (groundwater). Released pollutants may pose a serious threat to wildlife and humans with often immediate effects like in the case of contact with HF during EV fire (Mrozik et al., 2021).

The law is clear that causing or allowing pollution is a criminal offence. It can result in significant fines and even imprisonment for anyone found guilty. Additionally, any ‘responsible individual’ can be personally prosecuted if found guilty of such an offence. The “Polluter Pays” principle allows for the recovery of costs needed to put the environment back to how it was before the incident (Cole, n.d.). While most businesses believe that they are fully insured under their standard material damage liability policy, an incident involving the regulator is unlikely to be fully covered under this type of policy (ibid.). The penalties are usually a fine and/or imprisonment. For cases tried in the Magistrates’ Court, the maximum penalty is usually a fine of up to £50,000 and/or six months’ imprisonment. For cases tried in the Crown Court, the maximum penalty is

usually an unlimited fine and/or two years imprisonment. For Environmental Damage where damage has occurred (or if there is an imminent threat of damage) to protected species or natural habitats, a site of special scientific interest (SSSI), waters or land, the environmental damage regime, set out in the Environmental Damage (Prevention and Remediation) Regulations 2009, comes into play. Operators are required by the regime to be proactive in dealing with imminent threats of environmental damage and in remediating any environmental damage that does occur. The relevant regulator (usually the Environment Agency) will serve a notice on the relevant operator requiring it to conduct potentially extensive remediation including 'complementary' and 'compensatory' remediation. Furthermore, liability for many operators is strict (Association of British Insurers, n.d.).

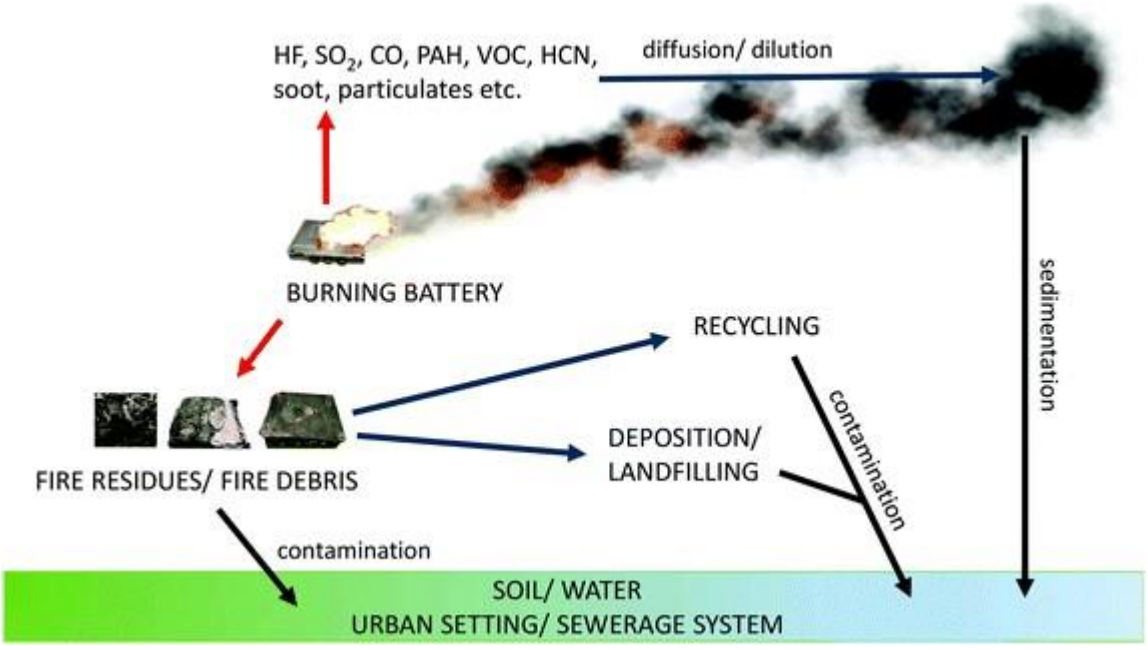

FIGURE 5. EMISSION PATHWAYS FROM FIRES (STEC ET AL., 2019)

2.7 Influence of the Insurance Company

Business owners often make the mistake of insuring for the market value of the property, rather than the full cost of a rebuild. Market value is often not an accurate reflection of the cost to rebuild a premises, and other features such as car parks, driveways, lighting, fencing, and gates are often overlooked (Cockburn, 2022). When calculating rebuild costs, estimates should include materials and labour, professional fees such as architect and planning costs, legal fees, demolition or make-safe costs, site clearance and access costs. If the property is a listed building, it will typically take longer and cost more to rebuild, as these buildings must use specialist materials and traditional construction methods ("Calculating your rebuild cost | ABI," n.d.). Buildings that are furnished to an unusually high standard (including those with eco-friendly features) or that have been constructed using unconventional materials may also be more costly and time consuming to rebuild (Cockburn, 2022).

Furthermore, insurers can apply the 'Average Clause' to claims made by underinsured businesses, which can result in a lower settlement amount than the policy limit. If an insurer discovers that a business has inadequate insurance, the settlement can be reduced by the same percentage as the asset is underinsured (Joraschkewitz, 2022).

2.7.1 Claims Example with the Average Clause Applied

One example presented by Cockburn explains the following: Business A has stock with a total value of £100,000. When taking out insurance, the policyholder decides that

they would be unlikely to lose more than 60% of total stock. Therefore, they take out a policy with a maximum of £60,000 cover, but do not inform the insurer of the total value of the stock. A fire destroys 50% of the stock, resulting in £50,000 of losses. The insurer deems Business A to be underinsured by 40% and applies the average clause. This results in Business A receiving only £30,000 (60% of the insured damages). This leaves Business A with a £20,000 deficit for the lost stock, which would have been covered if the policyholder had given an accurate stock valuation to the insurer upfront (Cockburn, 2022).

Furthermore, unexpected problems with a plant or machinery can be very costly, and it is important to consider not only the direct costs of replacing machinery or equipment, but all the costs associated with delays to production, fulfilment of orders and additional labour costs. The British Insurance Brokers' Association (BIBA) strongly advises that all machinery (both hired and owned) is insured for the full value of replacing 'new-for-old'. In addition, delays caused by any specialist machinery that would take a significant amount of time to replace must be accounted for (ibid.).

Adding to this uncertainty, there is currently no simple yet scientifically robust method for calculating insurance loss estimates due to a warehouse fire (Porter, 2006). Therefore, building owners and insurers cannot make suitably informed decisions when selecting fire protection measures or setting premiums as they have no way of defining the true risk they face (Atkinson and Jagger, 1994).

Supply chain delays have been significantly exacerbated in recent months by a combination of factors including the COVID-19 pandemic, BREXIT and the Ukrainian conflict (Azadegan et al., 2020) Yet there are many scenarios that should be considered to fully understand how a business's trading could be interrupted. From physical events such as a fire or flood, to supply chain disruptions and cyber-attacks, multiple factors will inevitably influence how long a business would need before it resumes normal trading following a major incident. Selecting a much shorter period of cover for business interruption than the likely period of actual disruption is a common oversight, leaving businesses with ongoing additional costs after insurance pay-outs have ceased (Cockburn, 2022). In times of strong economic growth, finding that a claim is being proportionately reduced as a result of underinsurance can make it difficult for a business to bounce back after a loss. But, with many businesses struggling to get back on their feet after the pandemic, underinsurance could prove to be the final blow for some businesses (Allianz UK, n.d.).

We discussed in the previous chapter that many standard business insurance policies do not cover the environmental clean-up that can be associated with fires (Hunt, 2022) and, with clean-up operations running into tens of thousands of pounds, it is something that should be reviewed by all businesses operating out of a warehouse. An example was when Bartoline suffered a massive fire at their factory in 2003. Fire water runoff which contained chemicals and firefighting foam posed a risk to local watercourses. The environmental regulator exercised its statutory powers and carried out emergency works to protect the local watercourses. Bartoline were also ordered under the

Water Resources Act 1991 to carry out further work to reduce contamination and prevent pollution. The environmental regulator sought to recover the costs for the emergency works from Bartoline. The total cost for the environmental regulators action and further clean-up by Bartoline was approximately £770,000 (Zurich, n.d.). A separate environmental insurance policy is often required because public liability insurance typically excludes environmental liabilities (IUA, 2021).

2.8 Negative Impacts of Fire Damage on Health

An additional, but little studied, source of significantly elevated particular matter (PM) concentrations arises from uncontrolled open fires involving industrial or commercial premises which, if located near to residential areas, will represent a clear risk to public health from exposure to the plume (Griffiths et al., 2018). The magnitude of the public health risk from any uncontrolled major incident fire depends on the scale of the fire, composition of its fuel source, duration and temperature of burn, ventilation conditions, firefighting methods used, proximity to human populations, and plume dispersal characteristics, as influenced by the prevailing meteorological conditions (Stewart-Evans, Kibble & Mitchem, 2016; Environment Agency, 2009; Powlesland, 2008; World Health Organization, 2009). The default UK advice in major incident fires is to recommend sheltering indoors with windows and doors closed, where pollutant concentrations will be significantly reduced, and protection will be given against concentration peaks (Stewart-Evans, Kibble & Mitchem, 2016). Most evacuations occur

because buildings are already inundated with products of combustion such that it makes sheltering impossible (Griffiths et al., 2018).

The Grenfell Tower fire in central London spread toxic effluent via the plume and particulate deposits. Soil samples from six locations up to 1,2 km from the Tower, together with semi-burnt fire debris and char samples, were collected one and six months after the fire. Additionally, dust samples and condensates were collected from a flat 160 m away from Grenfell Tower after 17 months. Samples were analysed for common potentially toxic components of fire effluents and synthetic vitreous fibres (Stec et al., 2019). UK National Fire Statistics (2018) show that the acute toxicity of fire effluents is the biggest short-term cause of death and injury from unwanted fires. Large fires produce smoke containing high concentrations of particulates and toxic gases such as the asphyxiant gases, carbon monoxide (CO), hydrogen cyanide (HCN) and respiratory tract deep lung irritants. As the fire develops, the yields of all products of incomplete combustion including CO, HCN, organic compounds and soot increase—typically by factors of 10–50. Molecular toxicants bind to smoke particles (airborne soot and tarry droplets) allowing them to penetrate deep into the lung causing respiratory distress and pulmonary oedema (flooding of the lungs). This is closely followed by incapacitation and death, from a few hours to several days or even years after exposure (Stec and Hull, 2010; Stec, 2017). The recent $4bn settlement reached by DuPont and its spinoffs in the US may seem a long way away and largely irrelevant to many public and private sector organisations in the UK. However, this pay-out relates to the resolution of personal injury claims as a result of exposure to chemicals within a class termed per- & polyfluoroalkyl

substances (PFASs), which have been and continue to be used extensively by many UK organisations (Ross, 2021). PFAS are a large group of some 5,000 individual compounds. Many of the polyfluorinated PFAS go undetected by commercial chemical analysis, but they bio transform in the environment to form the extremely persistent and regulated perfluorinated PFASs, and so are termed precursors. As the risks posed to human health and the environment from a very limited number of individual specific legacy PFASs are assessed (ibid), these chemicals are often found in foam fire-fighting mediums knows as Class B extinguishing agents, and form a film over the fire to starve it of oxygen. However, when it comes to warehouses and what can be stored in the warehouse, PFASs can be found in anything from plastics, to polish paints, to non-stick coatings such as Teflon. An assessment of the occurrence of PFASs within UK waters was undertaken by the Environment Agency in 2006 which identified PFASs at 26% of selected groundwater sites, including those located away from potential sources. PFASs were detected at 52% of surface water sites at drinking water abstraction points. This study indicates PFASs to be widespread at µg/L concentrations within the UK surface and groundwaters assessed (ibid). We discussed in previous sections how many UK warehouses are poorly prepared when it comes to managing FWR which can contain various chemicals, and therefore potential litigation claims similar to the DuPont case should not be ignored.

Recent studies support previous findings that fire disasters are associated with a negative impact on the mental and physical health of employees and local communities, proximate to the disasters. These effects can be delayed in onset and can persist over at

least several years, although long-term follow-up studies over 20 years or more indicate that the psychological effects on victims are minimal relative to controls by this stage (Maybery et al., 2020). Regardless, fire disasters, like other natural or man-made disasters, can have a significant mental health impact on individuals directly and indirectly affected, and on communities caught up in the events (ibid)

Similarly, a study of smoke exposure from the 2014 Hazelwood open-cut coalmine fire in the Latrobe Valley, Victoria, Australia, was conducted between two and three years after the incident. More than two years after the mine fire, Morwell residents reported moderate levels of distress relating to the incident. This impact was also evident in interviews, where intrusive thoughts were the most frequently reported symptom of post-traumatic stress. Furthermore, interviews highlighted the vulnerability of people with pre-existing mental health conditions. Conclusions noted that the elevated psychological distress still apparent within the Morwell community over two years after an extended pollution event highlights the need to improve post-incident recovery responses to such events, particularly in terms of supporting residents who are more vulnerable (Maybery et al., 2020).

Other impacts on mental health can come from the secondary actions of the fire, such as school closures and road closures, especially in the initial 24-hour stage. Furthermore, the UK-based Daily Telegraph reported that emergency service workers were also suffering post-traumatic stress following the Grenfell Tower fire. It was stated that, ‘Around 80 police officers and firefighters are seeking help for post-traumatic stress

every day and two have taken their own lives, as they struggle to cope with events such as the recent terror attacks and the Grenfell fire' (zeroignition, n.d.).

The psychological effects of a fire on the survivors should not be underestimated. Direct witnesses, indirect witnesses, those who fought the fire, those who lost all their possessions because of the fire, and those with memories—whatever the memories— all suffer in different ways and at several levels which could lead to employee morale loss or lack of trust from the local community (zeroignition, n.d.).

2.9 Research Gap

Research does not seem to cover "resilience" in the context of prevention of fires in warehouses and its effect on the business operating out of it. This appears to be an oversight with many UK warehouse business owners relying heavily on building regulations which, as we have seen in this chapter, only offer a basic (and outdated) framework when it comes to fire safety. This is particularly evident for legislation around sprinklers. We have seen that the ADB, which covers the fire safety standards for warehouses, only expects larger warehouses to have sprinklers which has led to renewed calls for automatic sprinkler protection to be made compulsory in all new warehouses over 2,000 square metres (roughly a third of the size of a football pitch). It is concerning to hear that the UK is lagging behind other European countries when it comes to fire safety in warehouses; and it is surprising that government guidance only recommends sprinklers in warehouses of more than 20,000 square metres, while other countries

require them in much smaller sites. We need to build resilience into businesses in the UK warehouse sector and prioritise fire safety to prevent devastating consequences.

Similarly, research also suggests many businesses may be underinsured, and therefore may fail to recover if a serious fire occurs. This could be down to poor BCP or just businesses trying to keep insurance premiums to a minimum while hoping the worst never happens. Furthermore, while research shows the devastation and impact of fire on the local community, the environment, the economy and the supply chain, little research shows how businesses factor these events into FRA's or BCP planning. This presents an opportunity to improve overall business resilience that is often missed.

This research will firstly consider the impact of a potential fire incident on business continuity; what current insurers highlight as crucial for business continuity; and the awareness of businesses when it comes to these issues. Secondly, the research will seek ways to make warehouses and the businesses that operate out of them more resilient. Specific attention will be given to the newly arising challenges of severe fires, the consequences of which many UK warehouses are ill-prepared for. These challenges include the increased risk from lithium ion batteries (LIBs) and the demand for same- and next-day deliveries which has led to the rise of smaller 'last-mile' warehouses located in or near city centres. These warehouses are often housed in older buildings that present higher fire risks. As these buildings were not designed as purpose-built warehouses, fires can be difficult to control, resulting in significant losses that can quickly accumulate. Since they fall outside current regulations that would require sprinklers to be fitted, they

would rely solely on the intervention of the local FRS, meaning an increased risk to the overall business resilience and increased effects on the local community as discussed in earlier sections. Despite the research mentioned above, multiple gaps present themselves in the literature.

Furthermore, this research will look at the current elements used within fire safety frameworks and legislation, including ADB, RRO and FRA, and discuss with managers and those responsible for implementing fire safety whether they are just meeting basic fire safety standards required under UK law. It will then evaluate how consideration can be given to creating a fire safety golden thread which increases resilience when it comes to fire safety in the UK warehouse sector which integrates with the company's BCP.

It is important for businesses to understand their liabilities when it comes to the environment, and how a serious fire can impact them negatively, not only locally but on a national, or even international scale, especially when it comes to reputational damage. The research will also assess the understanding of the environmental and community-level implications of fires, and whether these are factored into business's BCPs.

It is important that businesses take a holistic approach to fire safety rather than just meeting minimum standards, which research has shown is often poorly understood by business owners and managers within the UK warehouse sector. In the following chapter, the methodology used within this research will be described and further justified.

Chapter III:

METHODOLOGY

3.1 Introduction

A mixed methods approach, incorporating both qualitative and quantitative methods for collecting and analysing the data, was chosen for this study. In this chapter, the research problems and questions will once again be outlined to explain the rationale behind the research choices further. Following this, the research design, sample and methods will be described more fully and justified.

3.2 Overview of the Research Problem

As indicated in the previous chapter, the modern warehouse has undergone various technological advances in recent times which, along with the need for greater storage capacity, make it potentially more vulnerable to the devastating effects of a severe fire. To compound this, current fire regulations are designed primarily to protect life and therefore do not consider business resilience. The regulations also have clear omissions, such as the requirement for sprinklers at smaller to medium-sized warehouses. Regulatory requirements are not keeping pace with a fast-changing industry, potentially leaving warehouses exposed to risk and needing improved guidance to increase overall resilience. The extent to which owners are aware of this gap between statutory regulations and risk is examined in this study.

This aim of this research is to demonstrate that enhanced awareness and improvements to Approved Document B (ADB) and other relevant fire safety regulations would substantially reduce the impact of a severe fire within the UK warehouse sector. This is particularly relevant for those businesses that currently fall outside the current building regulation sprinkler requirements, mainly smaller to medium-sized warehouses. It is hoped that, by creating this awareness, warehouse owners will consider going beyond these regulations and take a holistic approach to see if the existing guidance on offer adequately covers the risk for today's modern warehouse. This means not just complying with the statutory legal obligations but considering issues beyond these minimum requirements and deciding what can be introduced to reduce the risk to "As Low as Reasonably Possible" (ALARP), which will undoubtedly go a long way to improving overall fire safety resilience.

3.3 Operationalisation of Theoretical Constructs

From the literature review, it was evident that there is no clear theory to assist those responsible for fire safety in the UK warehouse sector; and to improve resilience when it comes to fire safety. While there are currently some important items in place such as the FRA and BCP, the literature has indicated that these need to be considered in tandem if resilience is to be achieved. The literature review also did not reveal a clear theory when it comes to improving overall "resilience" in the context of the prevention of fires in warehouses. While there are fire safety frameworks and legislation in place,

including ADB and RRO, these are not integrated to offer a better solution to assist the warehouse RP and, in many ways, do not offer up any theories. When it comes to assessing the warehouse manager's understanding of fire safety, resilience and regulations, there are many areas of knowledge which can be used to gauge this, such as: the use of sprinklers, LIBs, environmental impacts, and increased capacity. These topics were covered in both the interview and survey design. However, considering the lack of awareness regarding many of these topics this research relied on the interviews in particular to establish the true extent of awareness, as they provided the opportunity for expansion and clarification.

3.4 Research Purpose and Questions

The purpose of this research was to identify the gaps in knowledge when it comes to warehouse resilience. The emergence of new events, such as Brexit and COVID-19 (discussed in the previous sections) and how the impact of these may affect resilience, made the research all the more critical. Understanding how the resultant increased warehouse usage and demands align with current building and fire safety regulations was also essential. This research thus explored whether current basic building regulation fire protection measures are adequate to prevent business failure following a severe fire in UK warehouses and how this can be improved. It also evaluated the extent to which current building regulations and standards regarding fire safety hazards were understood and complied with by business owners and managers of UK warehouses and how these warehouse managers/owners interpreted the current situation. It examined the level of

understanding warehouse business owners have regarding the potential impact and consequences of fires for their businesses.

The research aimed to address the following questions:

RQ1: To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?

RQ2: To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouses?

RQ3: What level of understanding do warehouse business owners have regarding the potential impact and consequences of fires for their business in the short and long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?

3.5 Research Design

According to Rossman and Wilson (1991), a multi-method approach to research holds the potential for understanding the complex phenomena of the social world, seeing this world through multiple lenses, and using eclectic methodologies that better respond to the multiple stakeholders of policy issues than a single method or approach to research. The primary research methodology selected for this study was a concurrent triangulation and mixed methods approach. While triangulation uses multiple sources of data or

multiple approaches to analysing the data (to enhance the credibility of the research study), the mixed methods approach combines quantitative and qualitative data in the same study. The purpose of concurrent triangulation designs is to use both qualitative and quantitative data to more accurately define relationships among variables of interest (Creswell et al., 2003). Research questions are increasingly answered through mixed methods studies. Combining qualitative and quantitative evidence means recognising that both have advantages.

For this research, the qualitative data was collected in both the interview and the open-ended aspect of the survey questionnaires. Closed-ended questions within the questionnaire were used to establish what safety measures are currently in place and provide relative proportions. Therefore, the questionnaire was designed with both open- and closed-ended questions to elicit feedback and to demonstrate a clear picture of the current situation in the UK regarding business resilience and fire safety.

The research was predominantly qualitative as there seemed to be very little information on the research topic. The quantitative aspect did allow some generalisation of the issues that can be unpacked from the literature; however, the end goal was to identify gaps and find new theories on increased resilience in fire safety, making qualitative key. For the research to be considered a true mixed methods study, there must be genuine “integration of the data at one or more stages in the process of research” (Creswell et al. 2003, p. 212).

3.6 Population and Sample

The population for both the interviews and survey was drawn from the UK warehouse sector. Those who make key decisions when it comes to both fire safety and business continuity such as Facility Managers and Safety Managers were targeted.

The sample of participants for the interviews was based on purposive/convenience sampling (qualitative) with people selected not only for working in the sector but for holding critical positions relevant to the topic. They were either known contacts—or individuals recommended by industry colleagues—with the required experience who were willing to assist in the research and add value.

> Purposive sampling is a non-probability sampling method and it occurs when elements selected for the sample are chosen by the judgment of the researcher. Researchers often believe that they can obtain a representative sample by using a sound judgment, which will result in saving time and money (Purposive Sampling, n.d.).

The sample size for the interview was seven, which we believe was adequate as similar themes emerged from all respondents, indicating we had reached saturation. Similarly, the number of participants in the survey was deemed sufficient, as it is a very specialist area of research and there may be a limited number of individuals with intimate knowledge of the subject. Furthermore, the number of interviews conducted for

qualitative studies is correlated with cultural factors, implying the subjective nature of sample size in qualitative studies (Marshall and Cardon, 2013).

The sample size for the survey was initially 278; however, after screening, this was reduced to 205. This was above initial expectations, as it was originally anticipated that a sample of around 100 would be used. This is because the research targets a specific group with experience in the areas of the research. The sampling strategy for the surveys was quantitative in the form of random sampling; this involved using social media and email to ensure greater awareness of the research. LinkedIn was used to target the warehouse industry via key contacts who were asked to encourage industry connections to participate; and emails were distributed through the Institute of Fire Safety Managers (IFSM), which has many members working in this sector. With the assistance of "snowball sampling" via industry experts, it was possible to increase the reach of the survey. Snowball sampling is a non-probability sampling method where new units are recruited by other units to form part of the sample. Snowball sampling can be a useful way to conduct research about people with specific traits who might otherwise be difficult to identify (Nikolopoulou, 2022). As this is a very specialist select group, the sample size is proportionate, with the targeted audience being around three to five thousand.

3.7 Participant Selection

The participants' experience and knowledge, and their understanding of fire safety controls and how these interrelate with the important FRA and BCP documents, were essential parts of this research. As a result, the interview candidates were selected purposefully for their wide range of experience, ranging from 7 years to 25 years. They were all involved in roles that included critical decision-making with regard to fire safety and/or BCP. The process therefore only included interviews with fire safety professionals and those who have overall responsibility for fire safety within the warehouse sector, such as facilities managers and safety managers.

The survey candidates were selected from a target audience; therefore, the invitation to participate in the survey went primarily via professional bodies that had access to these purpose groups or using the snowball method via social media which was again targeted. As indicated above, snowball sampling was used as it can be a useful way to conduct research about people with specific traits who might otherwise be difficult to identify. However, all participants were first screened (both for the interviews and survey) to ensure they possessed the necessary experience and skills to add value to the research.

3.8 Instrumentation

The interview guide was based on the three main research questions outlined in section 3.4. The interview commenced with an introduction in which candidates were

asked to comment on their experience in the warehouse sector, and define two specific areas of the overall research: Fire Risk Assessments and Business Continuity Planning. Each research question was broken down into a set of relevant interview questions, allowing the candidates to be more specific regarding important topics that were highlighted in the literature or the broader research aims, such as whether they had experienced a fire in the workplace or, for example, whether they felt it should be mandatory for all warehouses to have sprinklers fitted. This is expanded in Table 1.

Table 1: The Interview Guide

Section	**Interview Questions**
Introductory Questions/ Demographics	Could you tell me about your experience in the warehouse sector?
	What are your expectations and understanding of Business Continuity Planning (BCP)?
	What is your definition of a Fire Risk Assessment (FRA)?
RQ1. To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?	To what extent have you had any experience of a fire in the workplace ?
	In your opinion, to what extent do you feel fire safety is adequately controlled when it comes to building regulations?
	Over the previous years, warehouses have been used much more extensively. How do you feel about this and to what extent do you think this increases overall fire risk?
	To what extent do you feel completing a fire risk assessment and complying with the recommendations fully protects your business?

	What are your expectations regarding your current insurer when it comes to fire?
RQ2. To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouses?	Smaller/medium warehouses are not expected to fit sprinklers to comply with building regulations. How do you feel about this?
	What do you think the role of other stakeholders, such as insurance companies or the government, should be in ensuring or incentivising these protections?
	What are the barriers, do you think, for considering these kinds of protections for you and other warehouses?
RQ3. What level of understanding do warehouse business owners have regarding the potential impact and consequences of fires for their business in the short and long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?	If relevant, how have you regarded or discussed the consequences of a serious fire within your management team, and how this would affect your business?
	To what extent has the effect of a serious fire stemming from the location been considered broadly (i.e., outside the specific business)?
	Tell me your thoughts, now that we have had this conversation, around future regulation and best practices.

The survey was similarly developed to cover these research questions as well as the critical areas identified in the literature, namely BCP and FRA. Participants were asked whether they felt these two documents should work closely together, and if this was currently taking place in the workplace. They were asked how they understood insurance coverage, and whether their policies covered areas of shortfalls identified in the

literature. How ADB was interpreted, specifically when it came to sprinklers and new threats such as the increased storage and LIBs, was also explored.

The survey comprised 33 questions, the first two of which were designed to screen the candidates for relevant experience before completion of the survey and confirm they had read the consent sheet:

> *Before completing this survey, I can confirm that I have the necessary experience to allow me to answer the questions. By this, we mean your role involves activities within Facility Management or Safety Management.*
>
> *I confirm I have read the participant Information Sheet/Consent Form which can be found at https://drive.google.com/file/d/1WSxko5JZfLDEUebD6hgXo-940pji29Br/view?usp=sharing and by ticking "yes" agree to take part in the survey.*

This was followed by 31 specific questions that covered various topics discussed in the literature review section. The majority of questions had various Likert or categorical options ranging from two to five options per question (Table 2). Likert is a psychometric response scale primarily used in questionnaires to obtain participants' preferences or degree of agreement with a statement or set of statements. Likert scales are a non-comparative scaling technique and are unidimensional (only measure a single trait) in nature. Respondents were asked to indicate their level of agreement with a given statement by way of an ordinal scale (Bertram, 2007).

As with the interview, the survey questions were initially checked by two researchers, one being the research paper supervisor, before being sent out to potential respondents. A copy of the survey can be found in Appendix A.

Table 2: Types of Survey Questions

Total number of questions	33
Qualification questions	2
Categorical or Likert with five categories	19
Categorical or Likert with three categories	3
Categorical or Likert with two categories	7
Open-ended questions	2

3.9 Data Collection Procedures

The information for both the interviews and the surveys was collected separately, but they were conducted over the same period of time.

Interviews

Each of the interview participants received an email inviting them to participate in the survey, either sent to them directly, or via known contacts who felt these people could add value to the research (i.e., snowball sampling). The email set out how the interview would take place, which was via Zoom. The proliferation of video conferencing tools offers unique data generation opportunities for qualitative researchers. While in-person

interviews were the mainstay of data generation in qualitative studies, video conferencing tools, such as Zoom Video Communications Inc. (Zoom), provide researchers with a cost-effective and convenient alternative to in-person interviews (Gray et al., n.d.). Each session was recorded, transcribed and coded. This process was checked with the research supervisor. Each interview lasted approximately 30 to 45 minutes. They were semi-structured, which allowed the candidates to expand on their responses and provide additional information should they wish to do so. Each candidate was allocated a pseudonym code ranging from P1-P7. This was for reasons of confidentiality and ensured that personal identifiers were not revealed during the analysis and write-up of the findings.

A semi-structured interview approach was specifically chosen as it allows the researcher to collect open-ended data; to explore participant thoughts, feelings and beliefs about a particular topic; and to delve deeply into personal and sometimes sensitive issues (DeJonckheere & Vaughn, 2019). During the research process, a method was utilised that involved a dialogue between the participant and the researcher. This approach was guided by an interview protocol that was flexible enough to allow for follow-up questions, probes, and comments. The interviews were recorded and transcribed, after which the key findings were summarised.

Surveys

The survey invitations were sent via social media (LinkedIn), and also via email to professional bodies that have access to the target audience, such as the Institute of Fire

Safety Managers (IFSM). The survey was hosted using SurveyMonkey, an assessment tool with advance planning by evaluators that captures the responses and opinions of users. Overall, it is a cost effective and time-saving option for small assessment projects (Symonds, 2011). The survey was open for two weeks, which was the timeframe specified in the invite; therefore, it was not extended or closed early.

3.10 Data Analysis

The data was coded and grouped into themes to identify critical issues emerging from the responses. Coding is an almost universal process in qualitative research; it is a fundamental aspect of the analytical process and the way in which researchers break down their data to make something new. “Coding is the process of analysing qualitative text data by taking them apart to see what they yield before putting the data back together in a meaningful way” (Creswell, 2015, p. 156).

The information gathered was reviewed inductively using reflexive thematic analysis, quantitative and qualitative analysis. Reflexive thematic analysis is an easily accessible and theoretically flexible interpretative approach to qualitative data analysis that facilitates the identification and analysis of patterns or themes in a given data set (Braun and Clarke 2012). This method is helpful, particularly when used inductively, as was the case for this research. It allows for the development of theory from the data. The reflexive thematic element of the analysis allows and encourages the researcher to contribute to the theme making this ideal. The reflexive aspect was helpful to me, as the

researcher and someone embedded in the industry, as it allowed me to use my extensive knowledge of fire risk and, therefore, act as a valuable contributor to the research.

The survey used both closed and open-ended questions, which were evaluated using descriptive statistics, looking at proportions of responses for various categories. These results were then used for triangulation, which allowed for comparisons between what was said in the open questions and interviews with respect to resultant themes. The purpose of concurrent triangulation designs is to use both qualitative and quantitative data to more accurately define relationships among variables of interest (Creswell et al., 2003). The interviews were abductive as many of the categories/themes follow the interview questions. However, the way in which they were presented ultimately stemmed from aspects that were largely aligned, i.e., themes and sub-themes grouped together in ways previously not anticipated.

3.11 Research Design Limitations

As with the majority of studies, the design of the current study did have limitations. We have to consider that interviewees may have given biased answers due to concerns about providing negative answers and thereby admitting limitations, which may be seen as a weakness; also, they may have felt reluctant to divulge sensitive information.

The sample size for the interview was somewhat limited due to time constraints. Using mixed methods is also time-consuming. The supporting literature recognises that

sufficient resources are required to facilitate the collection of two sets of data at the same time (Halcomb and Andrew, 2009). However, by using a triangulation method, it is hoped that some of these issues were better resolved.

Furthermore, each method has its limitations. When it came to the surveys, it was not possible to confirm or expand on the actual position of the participants and, therefore, the research relied on the qualitative questions to filter out those who did not possess the correct experience; however, the positive was that the sample size far exceeded the original estimation.

My own bias also needs to be considered as I have considerable experience working in the field of fire safety, and specifically the warehouse sector. However, this did also allow interpretation of the data from the themes identified in the research due to possessing this essential experience and knowledge of fire safety which would ideally be acknowledged through reflexivity.

3.12 Conclusion

It has already been discussed that the primary research method for this study was a triangulation concurrent mixed method approach. Qualitative data was collected through semi-structured interviews. This involved seven participants deemed to have the necessary experience to bring value to this research, i.e., warehouse staff with experience in business continuity planning and fire safety. The survey part of the research also targeted a very specialist select group of warehouse staff with experience in business

planning and fire safety. The sample size is seen as adequate for quantitative descriptive research, with 205 participants completing the survey, including both open and closed questions. Limitations have been discussed based on the sample size for each method, but this was offset by the use of the triangulation method for greater trustworthiness of data. The following chapter will examine the themes of the interviews and compare these to the surveys.

Chapter IV:

RESULTS

4.1 Introduction

This chapter will examine the findings of the interviews and survey in relation to the research questions. In addition, by using comparisons with the literature, it will establish the gaps between what those who work within the warehouse sector are currently experiencing in their day-to-day on-site operations and the suggestions presented by the literature review findings. To assist the level of the current understanding of the UK warehouse sector, the research will address the following questions:

- *To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?*
- *To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouses?*
- *What level of understanding do warehouse owners have regarding the potential impact and consequences of fires for their business in the short and*

long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?

The interview and survey questions were designed to obtain a clear picture of the current situation in the UK with regard to understanding the potential consequences of severe fires in warehouses and how this impacts the business that operates within. They included interviews with facilities and safety managers who will more often than not have overall responsibility for fire safety, or work alongside other competent team members when it comes to making key decisions in relation to fire safety. The interviews were conducted with seven participants via Zoom video calls. The surveys were conducted via a link sent through social media using a snowball method to reach known contacts and institutions in the warehouse industry. All participants were first screened (for both the interviews and the survey) to ensure they possessed the necessary experience, skills, and knowledge to participate and add value to the research.

In this chapter, findings from both the interviews and survey will be presented. First, the overall demographics, knowledge and experiences of the participants in both research methods will be shared. This will be followed by reflecting on their experiences of a workplace fire and how this may have affected their decision-making post-event. Then their understanding of how BCPs and FRAs fit into the workplace, along with their knowledge of what active fire safety controls they currently have in place, will be explored.

4.2 Demographics, Experience, and Knowledge of Participants

In this section, we will be discussing the participants' work experience and knowledge, as well as their perceptions of fire safety controls. We will also be exploring how these factors align with the crucial FRA and BCP documents. Additionally, we will be taking a closer look at the active controls that are currently in place in their warehouse, and examine any past experiences they may have had with workplace fires, reflecting on these events and discussing any valuable lessons that may have been learned.

4.2.1 Experience and Role of the Participants

As part of both the interviews and the survey, all participants were asked about their experience in the industry. This was to ensure participants held an excellent all-round understanding of the practical aspects of how a warehouse functions on a daily, weekly and yearly basis, taking into account the unique pressures for their business sector, along with the associated risks these add when it comes to fire safety.

The individuals interviewed for this research had a broad range of experience, with tenure ranging from 7 to 25 years. All of the interviewees held positions of responsibility that involved making critical decisions related to fire safety and/or business continuity planning (Table 1).

TABLE 1: INTERVIEW PARTICIPANTS' WORK EXPERIENCE AND CURRENT ROLES

Participant Pseudonym	Number of years' experience working in the warehouse sector	Current role within the sector
P1	20	Head of Facilities Management
P2	15	Manager covering two sites
P3	20	Supervisor
P4	25	Safety Rep
P5	7	Warehouse Manager
P6	15	Safety Manager
P7	12	Maintenance Manager

The online survey showed 61% (N=126) as having over ten years' experience and only 11% (N =24) with less than five years' experience (**Figure 6**); again, this was a broad range of experience which ensured practical and extensive insight into day-to-day warehouse operations.

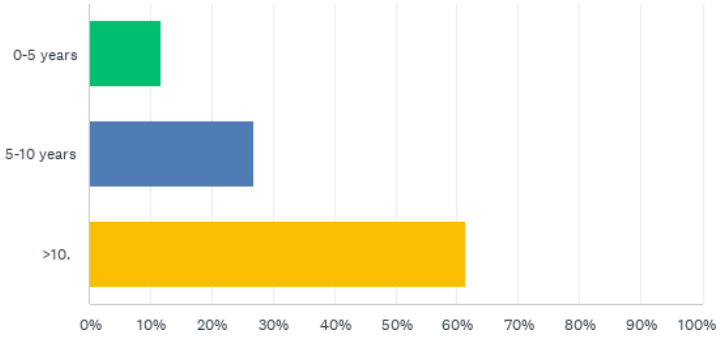

FIGURE 6. SURVEY PARTICIPANTS' EXPERIENCE WORKING IN THE WAREHOUSE SECTOR

4.2.2 Experience of Workplace Fires

When asked, "*Have you had any experience of a workplace fire?*" three of the seven indicated having had some personal experience of a fire in the workplace, with the remaining four indicating an understanding of the devastation and chaos a fire can cause based on knowledge of other known fires, either locally or nationally. One participant, when asked about their experience of a fire in the workplace, stated:

> *"Many years ago, and it caused chaos for both our business and our customers, something I would not like to see again, that is for sure."* **[P2]**

Another stated**:**

> *"We have had some small internal and external fires, the internal one was an electrical fault on the AC, and the external one was local youths setting bins alight. Both of these caused minimal damage, but hopefully, we have learned lessons from these."* **[P6]**

4.2.3 Knowledge and Understanding of the FRA and BCP

As part of the overall objective of this research, it was important to understand how the participants interpreted the relationship between FRA and BCP. We therefore asked the interviewees to define both FRA and BCP. This was to gauge their level of understanding of both processes. Generally, the answers provided were very similar, with one participant defining FRA as follows:

"Assessing the risk in the workplace from fire and taking steps to mitigate this risk." ***[P5]***

Another stated:

"BCP is a close examination of our processes and procedures, making sure we have contingencies in place to cover every eventuality." ***[P4]***

The survey participants were provided with pre-existing definitions of FRA and BCP and asked if they agreed with them. For the FRA definition, 33% (N=69) strongly agreed and 58% (N=119) agreed. No one disagreed **(Figure 7).** For the BCP definition, 30% (N=62) strongly agreed, a further 60% (N=124) agreed and only one participant disagreed **(Figure 8)**, although they did not provide an alternative definition**.**

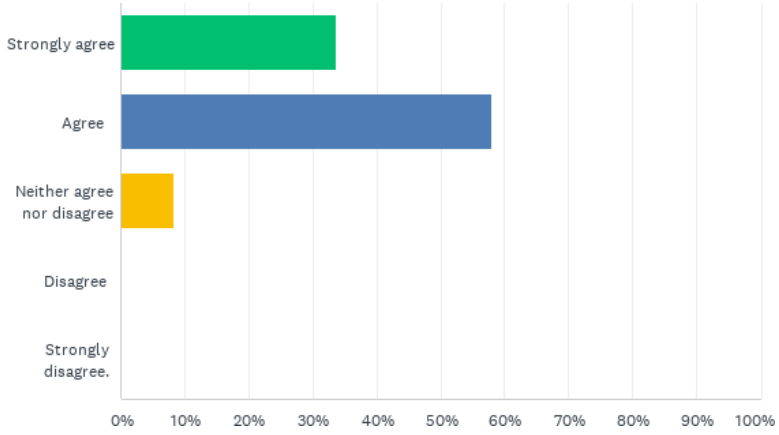

FIGURE 7. SURVEY PARTICIPANTS' RESPONSE TO THE DEFINITION OF FRA

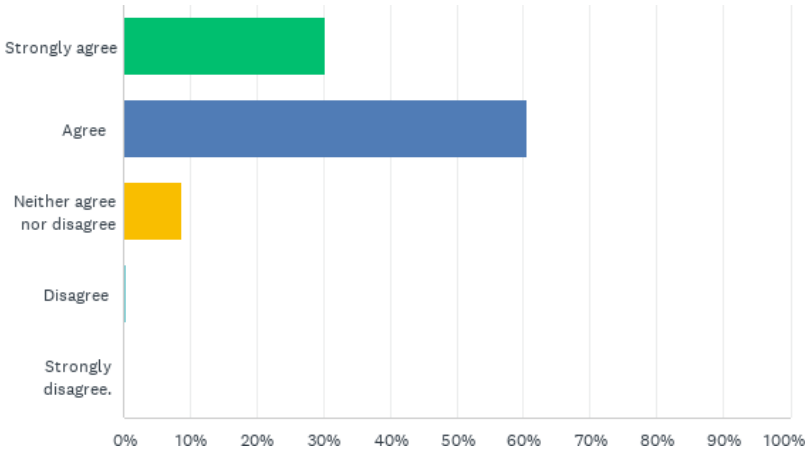

FIGURE 8. SURVEY PARTICIPANTS' RESPONSE TO THE DEFINITION OF BCP

They were also asked whether they had both of these documents in place at the time of the survey, with 99% (N=204) having an FRA and 63% (N=129) having a BCP **(Figures 9 and 10)**. This indicated that the majority of businesses were complying with legislation and preparing for any disruption to the business. It should be noted, however, that 38% (N=76) did not have a BCP in place which shows that some businesses may be vulnerable when it comes to business protection. It is also clear that there is room for improvement when it comes to implementing BCP, which will be discussed later in this section.

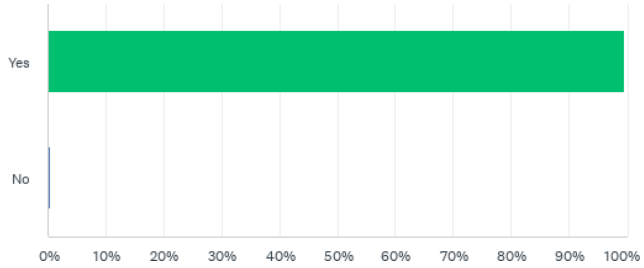

FIGURE 9. SURVEY PARTICIPANTS THAT CURRENTLY HAVE AN FRA IN PLACE

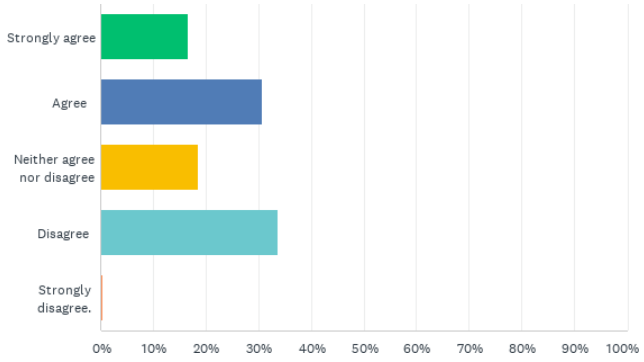

FIGURE 10. SURVEY PARTICIPANTS THAT CURRENTLY HAVE A BCP IN PLACE

4.2.4 Active Fire Safety Measures

As part of the survey, participants were also asked some supplementary questions that were not included in the interviews. This looked to evaluate participants' understanding of what active fire controls were currently in place in their warehouse. Many respondents 42% (N=87) were unsure as to what was currently fitted in the warehouse; 35% (N=72) stated they had a fully functioning fire detection system; and

17% (N=34) said they had either a standard ceiling mounted sprinkler system or an ESFR sprinkler system fitted.

Furthermore, the results showed that, although the participants were in a position that required them to oversee or be involved in fire safety (and therefore make critical decisions in this regard), a large percentage (42%) were not aware of what was installed on-site. This is a concern if they were expected to manage and oversee additional risk measures for fire safety, and then also consider these in the BCP **(Figure 11).**

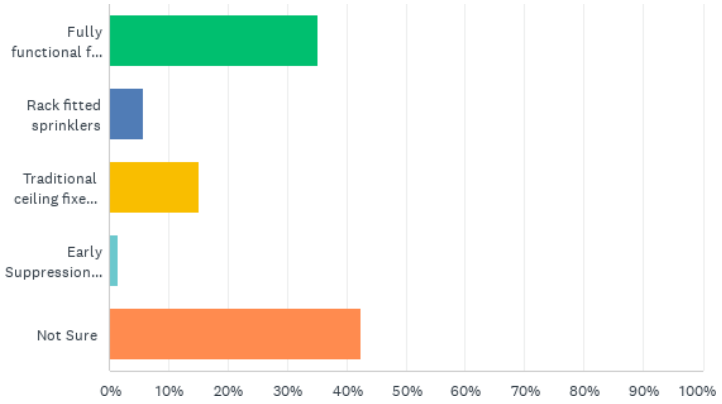

FIGURE 11. SURVEY PARTICIPANTS' ACTIVE CONTROLS CURRENTLY IN PLACE

Additionally, the survey participants were asked whether the automatic fire detection system that had been fitted in their warehouse was standard (based on occupation) or whether it had been specifically designed (based on their specialist requirements, i.e., a risk-based approach). 80% (N=166) indicated that their fire detection system had been fitted as standard, based on occupation. When it comes to the question

of whether their fire detection had been fitted to their specialist needs, 74% (N=151) said no, with 26% (N=26) saying yes **(Figures 12 and 13)**.

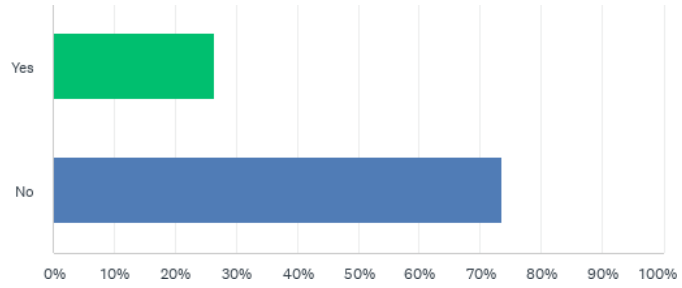

FIGURE 12. FIRE DETECTION SYSTEM DESIGNED AND INSTALLED TO BESPOKE

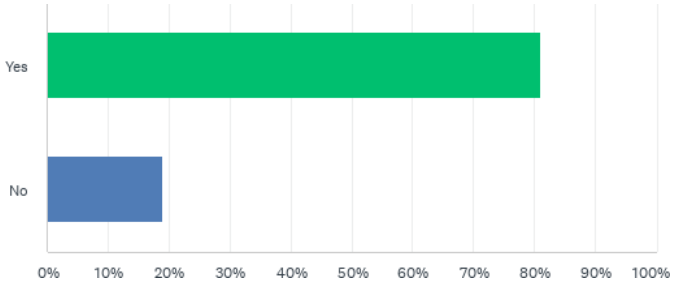

FIGURE 13. FIRE DETECTION FITTED BASED ON OCCUPATION WITHOUT SPECIALIST NEEDS ASSESSED

Therefore, the survey showed that many warehouses had not had their existing fire detection system designed based on their specific needs. In fact, 74% relied on the standard system, installed when the tenant or business originally occupied the warehouse

which was likely undertaken while it was unoccupied, and had not had it reviewed since to see if it still met current risk requirements. This means it may not cover any new and/or emerging threats, such as increased risk from LIB fires and extra storage capacity (fire load), both of which will be discussed in the next section.

4.3 Warehouse Trends

As previously discussed, staying up-to-date with building regulations, particularly ADB, is critical when it comes to the warehouse sector. It is also important to examine whether recent developments, such as the surge in LIB usage and the increased storage capacity brought on by BREXIT and COVID-19, have influenced how these regulations are understood and whether they are keeping pace with the fast-moving changes within the industry. This section will discuss these matters further.

4.3.1 Trends in Warehouse Capacity

This research has identified three key issues that impact warehouse trends in the UK: the increased use of automation (including the use of LIBs); COVID-19; and BREXIT. All three were identified as impacting the modern-day warehouse and potentially affecting its overall resilience when it comes to fire safety and BCP.

During the interview process, each participant was asked whether they had noticed any significant changes in the industry since joining the warehouse sector. The overall aim was to assess how trends may have evolved compared to fire safety regulations and whether both are being fully taken into account when looking at the

overall risk analysis. Respondents pointed out critical areas of change stemming from automation and technology. They mentioned the rapid expansion of growth that has taken place since COVID-19 and BREXIT, with one interviewee stating:

> *"Change is constantly happening both in the warehouse itself and the logistics side of it. Since COVID-19 was put on the map, people have appreciated the role of logistics. The main changes would be from the boom in online deliveries, we are busier than ever, and we are continually operating at a high capacity."* **[P5]**

And another stated:

> *"I feel the last five years have seen major changes since COVID-19 and BREXIT. Mostly this is the use of robotics and unmanned picking devices. It has certainly made things busy with the increase in home deliveries"* **[P2]**

Based on this information, the interviewees were asked whether, over the previous years, warehouses have been used much more extensively *("How do you feel about this and to what extent do you think these increase overall fire risk?").* All agreed they are busier, stating that COVID-19 and BREXIT have caused delays and bottlenecks in the supply chain. This has resulted in limited warehouse floor space, with increased stocks being stored longer to compensate for importation delays. Together, this has increased the overall fire load within the warehouse, with one interviewee stating:

"Change is constantly happening both in the warehouse itself and the logistics side of it. Since COVID-19. The main changes would be from the boom in online deliveries; we are busier" ***[P5]***

And another stated:

"Technology has changed, making many tasks automated in the warehouse, and it has also got a lot busier since COVID-19. I am lucky as I work for a larger company which invests in new technology, so things change quickly" ***[P3]***

This change seems to be confirmed by the survey respondents, who were asked whether they agreed on a similar statement: *"Since COVID-19, our business has been working at more storage capacity than before the pandemic"*. Here, 56% (N=119) agreed, 9% (N=19) strongly agreed and 8% (N=17) disagreed. This shows that the majority agreed with the statement **(Figure 14)**.

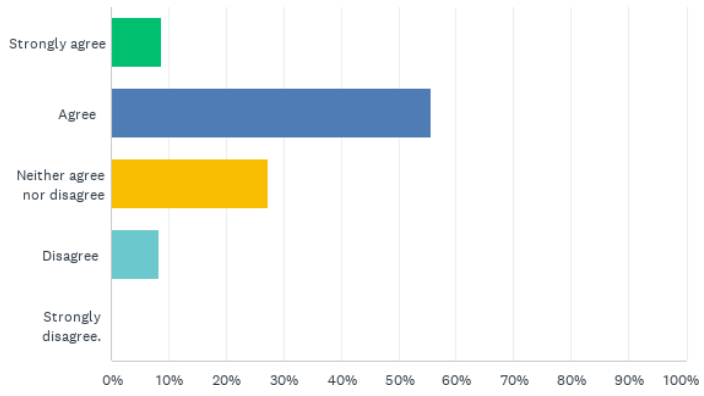

FIGURE 14. SURVEY PARTICIPANTS' RESPONSES ON WHETHER THEY HAD EXPERIENCED INCREASED STORAGE LEVELS SINCE COVID-19 OR BREXIT

The literature review findings confirmed the increase in online shopping due to COVID-19 and BREXIT. According to Binding (2021), the recent move by the UK to leave its European trade partners (BREXIT) meant many warehouses were at maximum capacity due to the problems faced with delays at ports and borders. With warehouses working close to or at total capacity, this undoubtedly adds to the fire load of the warehouse. This was confirmed by the interview/survey results outlined above, which indicated that warehouses have experienced an increased need for capacity over the last few years.

It is important to consider that as the load of a warehouse increases, so does the risk of fire. This risk can lead to more severe fires, which may not have been fully accounted for in the warehouse's original fire strategy or business model. As a result, the current fire safety measures in place may not be adequate to meet the needs of today's fast-paced market trends. This widening gap between market trends and fire safety regulations can cause a shock to the supply chain, highlighting the need for updated safety measures to compensate for any emerging changes.

4.3.2 New threats: The Increased Risk from LIBs

As discussed in previous chapters, the warehouse sector has seen a substantial increase in the use of and reliance on automation which is primarily powered by LIBs. The interviewees were asked if they felt the accelerated use of LIBs had increased the fire risk in their warehouse. They indicated that they did not really see any increased risk within the warehouse sector, with one interviewee stating:

"*Yes, you can see more incidents occurring in the broader sector, such as cars and E-scooters, I don't see an increased risk in the warehouse, though, should I?"* **[P3]**

And another stating:

"I've heard of this on the news but feel we have this managed unless legislation changes; of course, I think our FRA would look at this anyway." ***[P2]***

The survey participants were asked two questions on LIBs. Firstly, they were asked if they agreed with the following statement: *"I have taken specialist advice to manage and mitigate the risk of fire from lithium ion batteries."* Here, 42% (N=65) disagreed with this statement, 26% (N=55) agreed and 27% (N=56) neither agreed nor disagreed.

They were then asked if they agreed with the following statement: "*The additional risks from lithium ion batteries have been assessed and other controls implemented."* Here, 43% (N=90) disagreed with this, 22% (N=45) agreed and 30% (N=61) neither agreed nor disagreed **(Figure 15**).

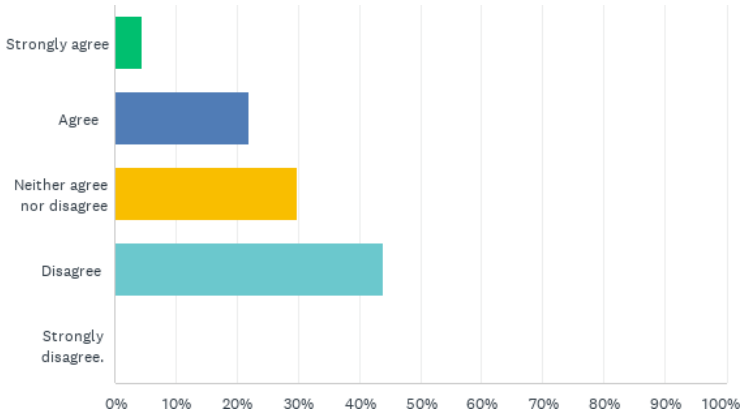

FIGURE 15. SURVEY PARTICIPANTS' RESPONSES ON WHETHER THEY HAD TAKEN SPECIALIST ADVICE WHEN IT COMES TO MITIGATING THE RISK FROM LIBS

From the interviews and surveys, it is clear that many within the warehouse sector are unaware of, or not keeping pace with, emerging fire risks from LIBs. Yet the literature highlights that any fire from LIBs can be severe. It appears that this potential threat is being underestimated or perhaps even completely ignored throughout the warehouse sector as there are currently no specific UK or European guidelines for fire protection where lithium ion batteries are stored (Fire Protection Association, 2023). This sheds light on one of the objectives of this research which is to establish whether warehouses have regard for business resilience in the short and longer term.

4.4 Perceptions of Building Regulations and Safety

When it comes to Approved Document B (ADB) and the fire risk assessment (FRA), it is important that we understand how participants perceive these standards. We need to determine if meeting these primary standards provides warehouses with full protection and resilience in terms of both fire safety and business protection. As we have learned from previous chapters, fire safety precautions are crucial for ensuring the safety of everyone inside a building, including occupants and firefighters, as well as those nearby in the event of a fire. However, it is worth noting that these precautions do not necessarily cover business protection, which we will discuss in the next section.

4.4.1 Current Perceptions of the ADB

In previous chapters, we also discussed the emerging "gap" when it comes to ADB and how robust this is in protecting the resilience of UK warehouses when it comes to fire safety, especially with the increased use of technology that relies heavily on LIBs. That, along with increased capacity, has changed substantially since the latest amendments to ADB which were made in 2013. While an amendment was made in 2019, this mainly concentrated on cladding for high-rise residential buildings. It did not go beyond the recommendations from the Hackett Report, which was published following the Grenfell Tower disaster. Therefore, one of the objectives of this research is to understand how the modern warehouse interprets the ADB in relation to their overall fire safety resilience. It was discussed in the literature review that a UK business-owners

survey showed that 69% felt that their business was protected from the impact of fire by following UK Building Regulation guidance (Cox, 2022).

As part of the interview process, it was necessary to gauge the participants' understanding of the current building regulations, and in particular ADB. Therefore, the interview participants were asked the following question: *"To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?"*

Overall, the interviewees indicated a belief that the current regulations are adequate and provide a good level of safety for building occupants, However, some indicated that, following the Grenfell Tower fire, they believed there were some weaknesses in the Approved Document B (ADB) which need to be addressed. Therefore, it is important that we continue to review and improve building regulations to ensure that we are doing everything we can to prevent tragedies like this from happening in the future. Despite these reservations, most interviewees expressed confidence in the safety of current regulations and felt that they were doing a good job at keeping people safe with one stating:

> *"I would like to think so, but after the Grenfell fire, I do have doubts, as building regulations only apply to a new build or renovation, but what happens once the building is occupied matters."* **[P4]**

And another stating:

> *Being in the UK would be very safe, and building regulations are the cornerstone of safety in warehouses when constructed. That said, we all look at Grenfell, and it reminds us that maybe not."* **[P2]**

The survey participants were asked whether they agreed with the following: "*Ensuring our Warehouse complies with all building regulations and legal requirements concerning fire safety shows our business is resilient in fire safety."* Here, 48% (N=98) agreed, a further 18% (N=37) strongly agreed, and 18% (N=35) disagreed **(Figure 16)**. Again, this indicates the majority felt that complying with ADB was sufficient to ensure their warehouse was resilient when it comes to fire safety. However, since the Grenfell Tower fire on 14th June 2017, in which 72 people died, the subsequent focus on the failings of ADB to protect the residents seems to have placed doubt on the reliability of ADB.

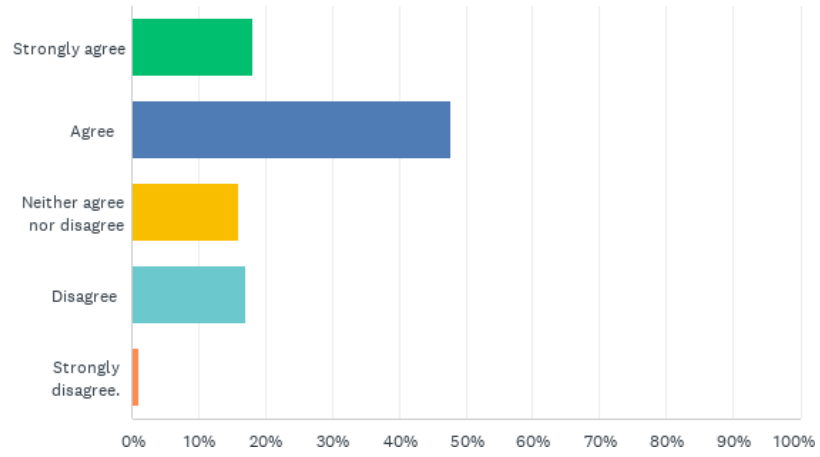

FIGURE 16. SURVEY PARTICIPANTS WERE ASKED IF THEY AGREED WITH THE STATEMENT THAT FOLLOWING ADB AND OTHER FIRE SAFETY REGULATIONS SHOWED THEIR BUSINESS WAS RESILIENT WHEN IT COMES TO FIRE

During the interview, when asked about the effectiveness of completing an FRA and addressing any issues raised during the assessment to safeguard their businesses from fire hazards, all participants showed a positive response. In fact, one individual even expressed feeling more secure and confident in their business's fire safety measures after carrying out the assessment and stated:

> *"Yep, I would agree with that; we have an independent survey done, so it makes sure we are fully compliant with legislation, then guides us if we are not".* **[P1]**

Another stated:

> "*It is only as good as us following up on recommendations and keeping everything ship-shape; you do not want a tick box exercise, and then it gathers dust on someone's desk. It needs to be fluid, and everyone takes responsibility. It is about teamwork".* **[P6]**

In the survey, participants were asked whether they believed the FRA should advise on business and property protection, such as installing or adding sprinklers in unprotected zones. They were also asked if the FRA should advise on any environmental protection issues likely to be caused in the event of a severe fire. When it came to advice on sprinklers, 55% (N=113) agreed, a further 19% (N=37) strongly agreed, and only 7% (N=16) disagreed. Concerning the impact on the environment and subsequent clean-up advice, 43% (N=87) agreed, a further 15% (N=31) strongly agreed and 19% (N=39) disagreed **(Figure 17).** When it came to advice on environmental protection 43% (N=87) agreed, a further 15% strongly agreed (N=31) and 19% (N=39) disagreed **(Figure 18).**

One survey participant shared their opinion in the open-ended section, stating that they believe many businesses use legislation as an excuse to avoid spending money when they don't feel it is necessary stating :

> *"I find many businesses hide behind legislation and won't spend if they don't have to."*

In conclusion and based on interviews and surveys, it was discovered that individuals believe that completing an FRA is enough to safeguard their business. However, it is vital to acknowledge that the RRO 2005 legislation, which serves as the foundation for the FRA, primarily concentrates on life protection and not property or business protection. This is similar to ADB. Unfortunately, many businesses misinterpret the regulations and assume that the FRA will cover them for environmental and property damage protection. This is not the case since the standard FRA has its limitations and may leave businesses vulnerable when it comes to environmental and fire-related property protection. This is because the legislation that consultants use to conduct the assessments does not include such protection. It is worrying that the RRO 2005 legislation does not mention the environmental protection of BCP.

As previously stated, the primary focus of ADB is to prioritise the safety of building occupants and firefighters. It is crucial to note that this prioritisation does not extend to safeguarding property, the environment, communities, or business resilience. This reinforces the research goal to assess the interpretation of building regulations, as these regulations may no longer be adequate for modern warehouses.

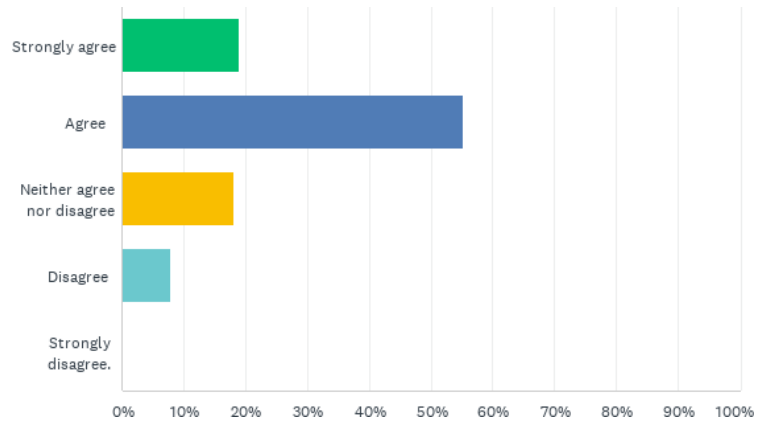

FIGURE 17. SURVEY PARTICIPANTS ON WHETHER THEY EXPECTED THE FRA TO ADVISE ON ADDITIONAL SPRINKLERS TO PROTECT THEIR BUSINESS

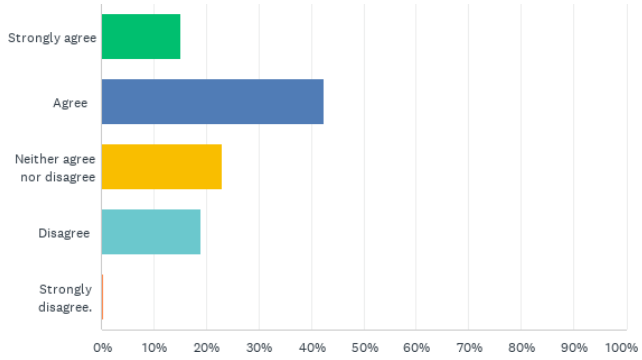

FIGURE 18. SURVEY PARTICIPANTS ON WHETHER THEY EXPECTED THE FRA TO ADVISE ON ENVIRONMENTAL PROTECTION

4.4.2 The Case for Sprinklers

Previous chapters have highlighted the UK's potential deficiency in mandating warehouse sprinklers, which may suggest that the country is falling behind other European

nations. Currently, smaller and medium-sized warehouses do not possess this crucial safety feature as only larger ones are required to have them. The research is now centred on whether warehouse owners would be willing to implement changes if provided with the appropriate incentives, such as insurance companies or government programs. This is a critical area of the research

The interviewees were asked: *"To what extent are warehouse owners open to improved transparent regulations concerning active firefighting controls on smaller to medium-sized warehouses?"* In particular, they were informed that, under current UK building regulations, it is not mandatory for them to have sprinklers fitted, and they were asked if they felt it should be mandatory for all warehouses to be fitted with sprinklers. All seven interviewees agreed it would be a good policy to make this mandatory, with one stating:

> *"I am surprised; surely even medium ones can be complex buildings with many toxic materials stored in them."* **[P5]**

Another added**:**

> *"Yes, I did know this as we have branches in Europe, and they have to have sprinklers fitted in many small premises; you would have thought we would be the same regulations, wouldn't you?"* **[P6]**

.

The survey responses supported this view, with 51% (N=106) strongly agreeing that it should be mandatory for all UK warehouses to be fitted with sprinklers, a further 36% (N=73) agreed and only 3% (N=6) disagreed **(Figure 19)**.

Three comments were left on the open-ended section of the survey concerning their support for greater expectations regarding sprinklers with one stating:

> *"More should be done to review the use of sprinklers in specific areas within a warehouse to encourage their use."*

And another stating:

> *"Fire risk in warehouses is not decreasing due to the increase in the storage of combustible materials. There are also not enough warehouses fitted with sprinklers to suppress fires."*

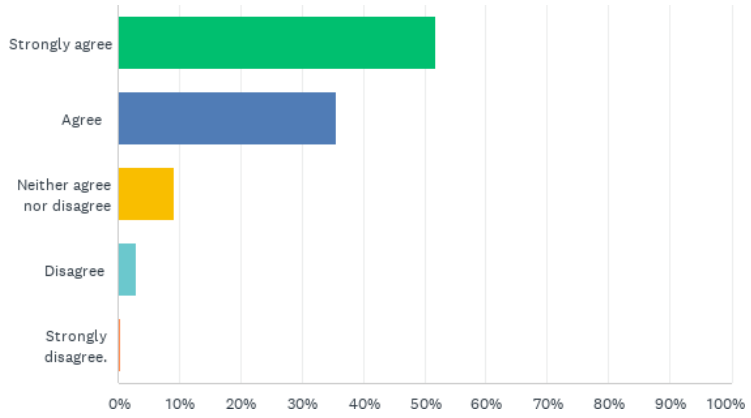

FIGURE 19. SURVEY PARTICIPANTS ON WHETHER IT SHOULD BE MANDATORY FOR ALL UK WAREHOUSES TO HAVE SPRINKLERS

Based on the interviews and survey conducted, it was found that a large proportion of individuals believe that it should be compulsory for all warehouses to have sprinklers installed. However, upon further investigation through the literature review, it was evident that the current state of affairs is quite different. The UK is significantly trailing behind several other European countries in terms of enforcing sprinkler regulations. As a consequence, warehouses are entirely dependent on the fire and rescue service to respond before a fire can be extinguished. It is important to consider the implications for business resilience and continuity when it comes to preparing for devastating fires. Europe's more stringent guidance levels have put them in a better position to recover from such disasters compared to their UK counterparts. In fact, a recent research objective was to understand if warehouse owners would be open to improved controls in small- to medium-sized warehouses. The results were clear: over 80% agreed that it should be mandatory for all UK warehouses to be fitted with sprinklers. This highlights the need for a review of current building regulations to improve overall resilience.

The interviewees were then asked whether they felt incentives would encourage them to go beyond the current legislation and consider installing sprinklers. To establish this, the interviewees were asked about the role of insurance companies or the UK government and whether they should offer incentives for warehouses to fit sprinklers or even have insurance companies offering discounts on premiums for those who fit sprinklers in warehouses that fall outside the current ADB requirement.

All seven interviewees thought this was a good idea, with one stating:

> *"There would need to be an incentive. Otherwise, who is going to invest hundreds of thousands of pounds when nothing changes financially?"* **[P4]**

And another stating:

> *"Again, it is down to cost. No one will fit them if they are not legally required, so without incentives, it would never get done."* **[P1]**

The survey participants supported this finding. When they were asked if government grants would encourage them to invest in sprinklers, 74% (N=152) strongly agreed, 20% (N=24) agreed, and only one strongly disagreed **(Figure 20)**.

The interviewees were also asked whether the cost was potentially the only barrier to installing sprinklers, with participants agreeing that upfront costs would be a stumbling block. They also acknowledged that many warehouses are rented or leased, impacting this decision, with one interviewee stating:

> "*We lease our warehouse, so it was fitted as part of the terms of the lease, so companies could sign up for a longer lease to make it worth it for the developer fitting sprinklers to all new builds"* **[P6]**

And another stating:

> *"Money is always a concern when fire safety investment is suggested so this will impact on sprinklers investment."***[P4]**

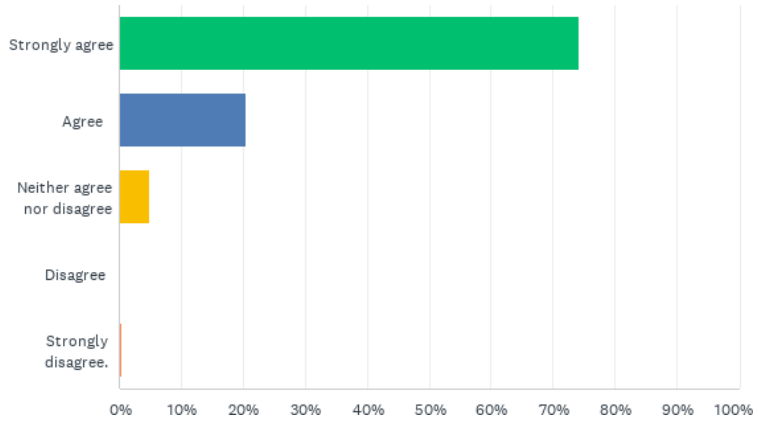

FIGURE 20. SURVEY PARTICIPANTS ON WHETHER GOVERNMENT GRANTS WOULD ENCOURAGE THEM TO INVEST IN SPRINKLERS

Research showed that there are currently no schemes in place in the UK to assist businesses financially either with retrofitting sprinklers into an existing warehouse, or with going above and beyond the current building regulations standard ADB by installing additional sprinklers. However, issues relating to the lack of sprinklers fitted are clearly recognised in the literature review, with evidence showing that severe fires send shock waves down the supply chain potentially damaging the UK's e-commerce economy (IBM Services, 2021). Improved sprinkler coverage is undoubtedly necessary for small to medium warehouses. Providing businesses with this type of assistance would significantly increase their overall resilience, safeguarding jobs, businesses, and the essential supply chain that drives the UK economy.

4.4.3 Perception and Understanding of the Broader Fire Risk

A serious fire will not only affect the warehouse and its business but can also devastate the surrounding environment and impact the local community, having both short-term and long-term effects (Fogarty, 2022). It is important to remember that even smaller incidents can have a ripple effect on the community. While the larger incidents often receive more attention, it is crucial to take into account the potential impact of smaller incidents when considering fire safety measures and developing the BCP. These two areas are closely related and should be approached with caution and care.

The interview participants were asked: "*To what extent has the effect of a serious fire stemming from the location been considered broadly (i.e., outside the specific business)?"* Based on the literature review, it needed to be determined whether the business had taken all the necessary precautions to mitigate any potential impact on local traffic with road closures and diversions, mental health issues, and the environment, including pollution to local streams and rivers following a severe fire.

All seven interview interviewees stated that they did not feel it had been considered, or knew it had not been considered, with one stating:

> *"Shouldn't the local authority and fire service deal with that? We don't have any authority outside our perimeter ?"* **[P7]**

And another stating:

"Obviously it would have some impact, but I wouldn't say it's been looked at in-depth, I suspect the fire service would manage that?" **[P3]**

The survey respondents seemed to agree with the views of the interviewees. When asked whether they agreed with the following statement, *"Our BCP has considered the impact of a fire on the local community",* 53% (N=108) disagreed, 17% (N=34) agreed, and 23% (N=48) neither agreed or disagreed. This shows that the majority of respondents agreed they had not considered the wider community when it comes to the impact of a serious fire **(Figure 21)**. One participant stated in the open-ended section:

"Our BCP doesn't cover any of the local community issues"

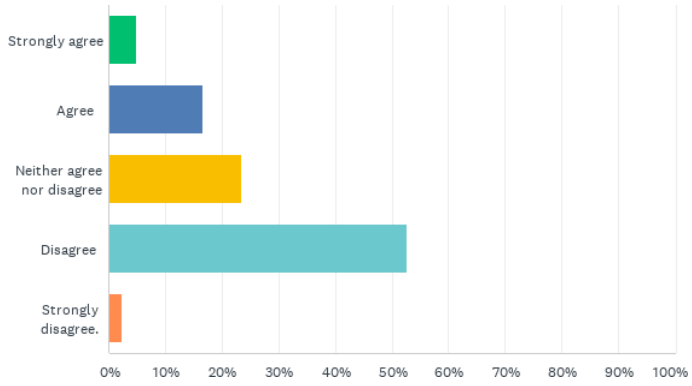

FIGURE 21. SURVEY PARTICIPANTS ON WHETHER GOVERNMENT GRANTS WOULD ENCOURAGE THEM TO INVEST IN

According to the research findings, it seems that a significant number of participants in the survey did not feel that their BCP took into account the potential

impact of a severe fire on the local community. It is important for organisations to ensure that their BCPs are comprehensive and take all possible scenarios into consideration, in order to minimise any adverse effects on the community. Following a review of the literature, it is evident that the aftermath of a severe fire can be incredibly devastating for the local community. The effects can range from mental and general health concerns to catastrophic damage to local amenities such as roads, rivers, and ponds. This can have a major impact on the residents who enjoy activities like fishing, dog walking, and interacting with the local wildlife. It is a difficult and challenging situation for everyone involved. When a fire occurs near waterways, the consequences can be devastating. Chemicals from the flames can contaminate the water, making it uninhabitable for a long time. It can take weeks, months, or even years for the area to recover from the damage caused by the fire. This is why it is important for warehouse owners to fully comprehend the impact of a serious fire on their business in both the short and long term. Through research, we hope to gain a better understanding of these effects and how to mitigate them.

We therefore need to fully understand if warehouses have considered the financial impact of such events. The following section will consider if this has been a factor when considering suitable insurance policies.

4.5 The role of Insurance Companies in Fire Safety and Business Continuity

We asked the interviewees whether they felt their current insurance policy would fully protect them against a severe fire, including possible environmental damage caused

by a fire, such as FWR. This resulted in mixed responses. When it came to cover for a severe fire, all agreed that they expected their current cover should be enough, with one interviewee stating:

> *"Yes, I would; premiums are so high these days, and they ask so many questions before they put the cover in place, so yes, I would."* **[P1]**.

Another stated:

> *"Yes, I would, if not someone is not doing their job properly."* **[P6]**

Regarding the environmental cost as part of insurance coverage, most agreed it should be, with one interviewee stating:

> *"Surely it is all the same thing, isn't it? Fire causes environmental damage, so that insurance would cover all the clean-up costs."* **[P6]**

Another stated:

> *"If it were related to the fire, then yes, isn't that all part of the process? So of course, I would."* **[P1]**

When we compare this to the survey participants, 44% (N=90) strongly agreed, and 32% (N=66) agreed that their insurance would fully cover them for a severe fire, with 8% (N=18) disagreeing **(Figure 22)**. When asked whether their insurance would cover any environmental clean-up following a severe fire, 36% (N=74) strongly agreed, a

further 36% (N=74) agreed, and 19% (N=22) disagreed and did not think their insurance would cover them for any environmental clean-up **(Figure 23)**.

One survey participant stated in the open-ended question section:

"Insurance policies should cover all cost related to a fire, they can't just cherry pick what they cover."

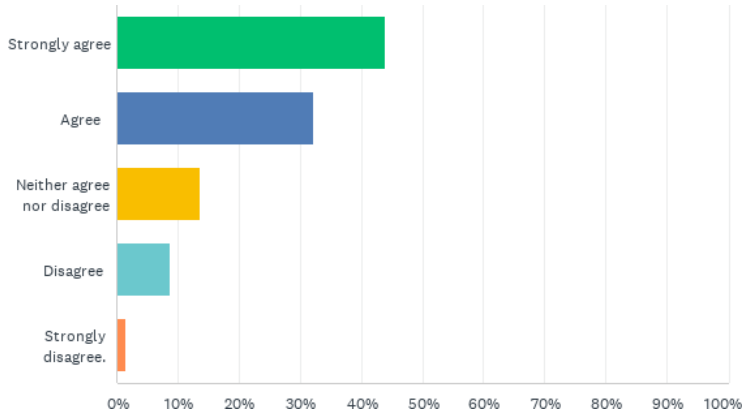

FIGURE 22. SURVEY PARTICIPANTS ON WHETHER THEIR INSURANCE POLICY WOULD ADEQUATELY COVER THEIR BUSINESS IN THE EVENT OF A SEVERE FIRE

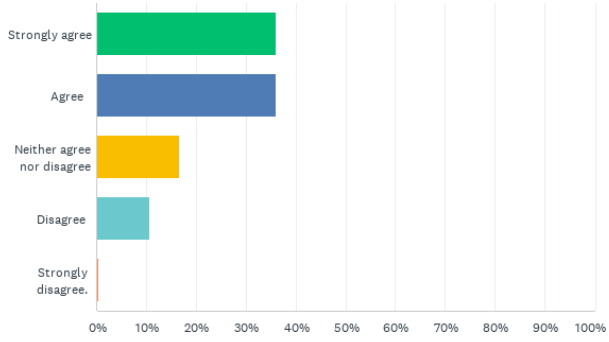

FIGURE 23. SURVEY PARTICIPANTS ON WHETHER THEIR INSURANCE POLICY WOULD COVER ANY ENVIRONMENTAL CLEAN-UP FOLLOWING A SEVERE FIRE

We have discussed insurance coverage for fire and the potential environmental clean-up following a severe fire, with the interview and survey and findings indicating that most warehouses felt they were adequately protected and that their policy would likely cover the cost of any environmental clean-up. However, this is not supported by the literature review, which indicates business owners often make the mistake of insuring the property's market value rather than the total rebuild cost (Cockburn, 2022). Market value needs to reflect the cost of rebuilding premises accurately. Other features like car parks, driveways, lighting, fencing, and gates are often overlooked when agreeing on policy cover.

When it comes to cleaning up the environment, most business insurance policies will not cover the costs. The literature review made it clear that businesses that have any sort of likely environmental impact should strongly consider investing in a separate environmental insurance policy. This will ensure that they are fully protected in case anything goes wrong and they need to clean up any environmental damage, which is especially likely after a severe fire. This is because standard public liability insurance typically excludes any environmental liabilities, which means businesses could be left with significant financial and legal consequences if any environmental damage were to occur. It is always better to be safe than sorry when it comes to protecting both the business and the environment. While most companies believe that they are fully insured under their standard material damage liability policy, an incident involving the regulator is unlikely to be fully covered under this type of policy (Cole, n.d.). It is essential to be aware that insurers have the option to apply the 'Average Clause' to claims made by

underinsured businesses. This means the settlement amount could be lower than the policy limit, which can be a significant financial setback. It is always a good idea to review and update insurance coverage regularly to ensure the business is adequately protected in the event of a claim. Failure to do so could mean a business may not have the ability to recover following a severe fire. One of the objectives of this research was to highlight the potential financial impacts of fire on warehouses in the short and longer term.

4.6 Improving Fire Safety

In this section, we discuss how participants felt when it came to the FRA and BCP working together, if fire safety plays a crucial role in BCP, and if the consequences of severe fire had been discussed at a senior management level so any risks can be reduced to As Low As Reasonably Practicable (ALARP).

4.6.1 The Integration of BCP and FRA

The interviewees were asked what level of understanding they have regarding the potential impact and consequences of fires on their business in the short and long term (i.e., business resilience), and how future regulations may build greater resilience regarding fire safety in the UK warehouse sector. Specifically, they were asked if they had discussed the consequences of a severe fire within their management team, and how this could affect their business resilience. Again, this was one of the research objectives we wanted to explore. Six interviewees stated that they had not discussed this topic with

their senior management, meaning the impact of a severe fire and mitigating any risks has yet to be considered. Two interviewees felt the FRA should take care of this. One stated:

> *"We would discuss if anything significant were identified after the FRA is completed, and we would put measures in place. However, that has not flagged any shortfalls to date."* **[P7]**

Another stated:

> *"If we are proactive with what the FRA requires, and maintenance is good, then prevention is better than cure. I cannot remember discussing this topic in isolation though."* **[P2]**

Similarly, we know that fire safety and BCP play a vital role in the overall resilience of the warehouse, so we asked the interviewees: *"Does fire safety play an active part in your BCP?"* All interviewees stated that it generally does, often having its section within the BCP; however, they all stated that this was not in any depth, with one saying:

> *"I would say not as much as it should, but we have many other items likely to cause severe disruption, such as power outages or IT issues."* **[P6]**

Another stated:

"I would need to look, but from memory, it is covered but not in-depth, just making sure FRA is undertaken, and policies and procedures are followed." **[P2]**

The survey participants were asked if they felt BCP and FRA documents should work closely together. This produced mixed responses: 17% (N=34) strongly agreed, 31% (N=63) agreed, and 34% (N=69) disagreed **(Figure 24).**

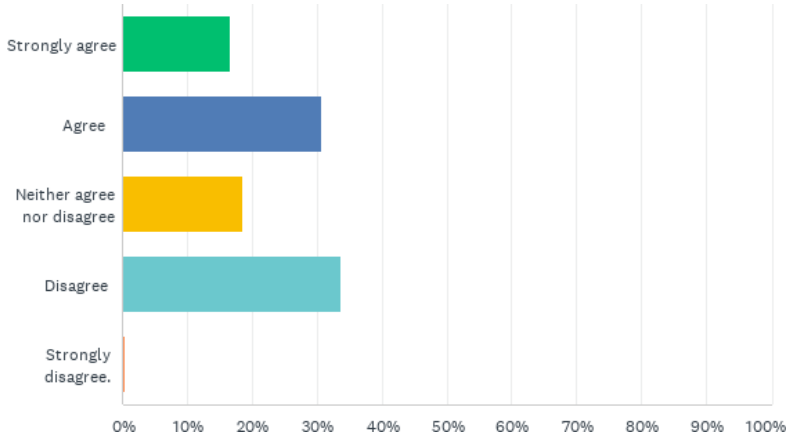

FIGURE 24. SURVEY PARTICIPANTS ON WHETHER THEY FELT THE BCP AND FRA SHOULD WORK CLOSELY TOGETHER

The literature review highlighted the implications of not including fire safety in the BCP. It indicated that 25% of businesses do not reopen following a severe fire; and 80% of companies that do not recover within a month are likely to go out of business. Therefore, warehouses seem to miss the opportunity to merge the FRA and BCP so it

works in tandem. Even though most participants (in both the interviews and the survey) thought these documents should work together, the literature review findings indicated this may not be covered in sufficient depth to add better value; and, therefore, fire safety should feature more prominently in the BCP.

4.6.2 Improving Regulations and Fire Safety

Each interviewee was asked if they had any final thoughts concerning the improvement of future regulations and fire safety before the interview was closed. They all agreed there is a discussion to be had regarding the mandatory installation of sprinklers regardless of the warehouse size. However, this had to be balanced against the cost of installation, with one interviewee stating:

> *"It seems there is a conversation to be had about various topics, such as sprinklers and insurance."* **[P5]**

Another stated:

> *"We should always be open-minded to changes and improvements. From our conversation, sprinklers could be mandatory, but I cannot see that happening."* [**P2]**

This seems to support the objectives of the research which were to determine whether warehouses needed improvement to future fire safety regulations if they are to keep pace with the needs of a modern warehouse which has seen advancements in technology and storage capacity without fire safety regulations being fully reviewed.

4.7 Summary and Conclusions

Based on the interviews and survey results, eight key gaps in resilience when it comes to fire protection and BCP were identified. The summarised findings are depicted in **Figure 25**. Both the research and the literature review highlighted a need for changes to be implemented to make warehouses more resilient against the risk of severe fire. One such change could be the mandatory installation of sprinklers which can help prevent major fires from spreading. In case of a severe fire breakout, having a solid BCP that covers all the gaps shown in Figure 25 can help improve resilience and enable the warehouse to recover and continue serving the UK economy and local community while protecting the environment. In the subsequent section, each branch of the figure will be examined in detail.

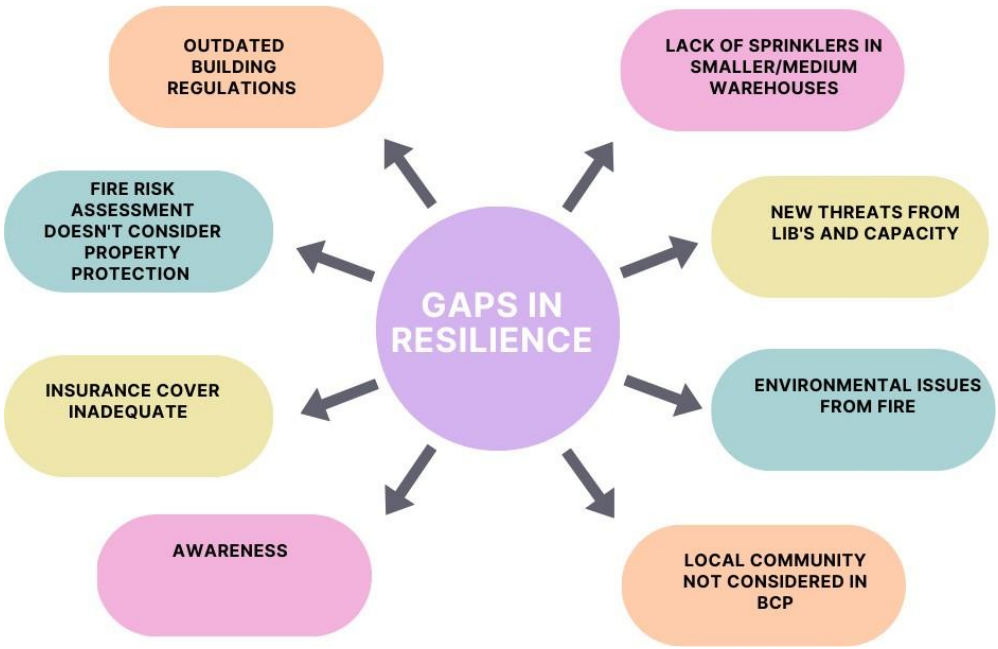

FIGURE 25. GAPS IN RESILIENCE

4.7.1 Outdated Building Regulations

It is clear that there are significant gaps in understanding and interpretation of current building regulations. Those responsible for implementing fire safety on-site often believe that following ADB regulations alone is enough to fulfil their legal obligations. However, research has shown that this is not the case. The literature review demonstrated that ADB regulations have not kept pace with modern technological advances, such as automation, or the evolving complexity of modern-day warehouses, which have

experienced significant changes due to COVID-19 and BREXIT. This research further confirmed that warehouses are operating at higher capacities than ever before.

4.7.2 Lack of Sprinklers

It is clear that technology has revolutionised the way warehouses function in modern times. However, with the increased use of lithium ion batteries (LIBs), there is a greater risk of fire that needs to be carefully managed. Following the literature review, it has become apparent that standard sprinkler installations are not sufficiently effective in dealing with fires involving LIBs. As a result, it is crucial that businesses assess the implications of relying on current sprinkler systems to ensure they are not putting themselves at risk.

It is noteworthy that the research reveals a consensus among participants that installing sprinklers in all warehouses across the UK, rather than just those legally required, would be a prudent measure. However, the lack of government or insurance backing makes this a remote possibility. Participants also emphasised that the upfront expenses for sprinkler installation can be quite substantial, necessitating financial assistance. Furthermore, the literature review advocates for the revision of ADB to address small and medium-sized warehouses. Without legal mandates for these changes, the industry is unlikely to take the initiative due to insufficient financial support. Additionally, while LIBs are generally stable, a single fire can have devastating consequences due to "thermal runaway" and the difficulty in extinguishing these fires. Hence, it is imperative to develop sprinklers tailored to extinguishing LIB fires.

4.7.3 New Threats

It was highlighted in the research that although the literature review clearly showed an increase in new risks, such as those found with LIBs and increased capacity, this is not being recognised or perceived by those who have an influence on fire safety in the warehouses, with the participants generally feeling this is not impacting them at this point. They indicated not taking specialist advice on how to mitigate this risk from LIBs —both those in operational use, but also those in storage (LIB products bought in as goods and stored within racking systems located in the main warehouse facility). This again highlights the risk that current controls may be inadequate (as discussed in the previous section); and, with warehouses operating at higher capacity, any subsequent fire would most probably be more intense than the original warehouse was designed to cope with.

4.7.4 Environmental Concerns

It is important for businesses to understand the potential consequences of warehouse fires, both in terms of physical destruction and environmental impact. One of the most concerning consequences is the contamination that can occur as a result of the fire, particularly from FWR. This excess water used to tackle a fire by the FRS can spill over from the site at various pinch points, potentially affecting the local environment. It is crucial for businesses to take steps to prevent these kinds of disasters from happening in the first place, and to be aware of the potential risks so they can prepare accordingly. Unfortunately, many businesses may not be fully considering the impact of a severe fire

on the environment, which could lead to costly negative outcomes that could harm the business's long-term reputation and standing in the local community. It is important to ensure that BCPs fully account for the environmental risks of warehouse fires in order to minimise potential damage.

4.7.5 FRA and BCP

One area of concern was that many participants in both the interviews and survey assumed that the external fire safety consultant undertaking the FRA should advise them on business protection e.g., if supplementary sprinklers were required in racking. Therefore, when reviewing the action plan from the FRA with nothing having being highlighted relating to property protection, their assumption has been that no additional controls were required. This may, however, not be the case.

The literature review of the FRA regulations clearly states that under RRO 2005, the FRA is a life safety assessment and is not required to comment on property protection and certainly would not be looking at additional facilities such as supplementary sprinklers or upgrading existing systems. This is creating a vacuum when it comes to interpreting the legal framework, with opportunities being missed to improve the overall safety of the warehouse and resilience of the business. Some supplementary questions in the survey showed that most participants indicated that their warehouse had the original AFD fitted or were unsure what was installed. This original AFD would have been fitted before the warehouse was occupied and would usually have been installed by the developer. Although this would have been installed to BS 5839, it would not have been

explicitly designed to cover the newer threats experienced since COVID-19 and BREXIT, such as extra stock and increased volume.

Again, the FRA would not be reviewing the detection that is installed as part of the property protection. It would only be assessing the system from a life protection point of view, which means some warehouses may assume that their current AFD installation is the most effective when it comes to property protection; however, this may not be the case. We have seen that the literature review, and the interviewees and survey respondents in this study, recognised COVID-19 and BREXIT as impacting fire safety along with the increasing reliance on LIBs. We also know that the FRA is only required to consider life protection and not property protection. This therefore highlights a potential gap between the BCP and the FRA which can impact the overall resilience of the business.

4.7.6 Inadequate Insurance Cover

The research has revealed a common misconception among warehouse managers and owners about the adequacy of standard insurance policies when it comes to coverage. Specifically, they tend to assume that such policies provide sufficient cover to handle environmental clean-ups and large-scale reconstruction. However, the empirical evidence shows that this is not always the case. When we talk about the comprehensive rebuilding of the business after a severe fire, we are not referring just to the building itself, but also the machinery and materials required for the business to function as it did prior to the fire. The literature provides evidence showing that many businesses are inadequately covered,

or underinsured. In relation to environmental clean-up costs and possible fines following a severe fire, the literature review showed that most standard policies do not cover this, and supplementary cover may need to be in place. There appears to be a pressing need for a more comprehensive understanding of the coverage provided by insurance policies. Based on the feedback received from the interviewees, they were not actively involved in the policy selection or coverage determination process. This lack of involvement could potentially render businesses vulnerable, particularly in the case of a major fire. It is plausible that there may be gaps in the policy that would only become evident when it is too late. It is crucial for businesses to acknowledge this and take the necessary steps to mitigate such risks.

4.7.7 Effects on Local Community

Based on the feedback received from both the interviews and the survey, it is clear that not much thought has been given to the potential impact of a serious fire beyond the immediate boundaries of the business. This is especially concerning when it comes to the impact on the wider community. It is important to take a broader perspective when considering fire safety measures, and to consider the potential consequences for everyone who could be affected. Interestingly, only 34 out of 205 (17%) of the survey participants included this in their BCP. Some also thought this should be the local authority's responsibility or that of the FRS. However, the literature review clearly showed how a severe fire can affect residents' short- and long-term quality of life. A severe fire can cause environmental damage, problems within the community and can

impact local attractions such as ponds and rivers in both the short and long term. In addition to examining the various sources of smoke, the literature review also considered the potential health hazards posed by pollutants found within the smoke. Through its comprehensive analysis, the review underscored the fact that these risks can manifest both in the short and the long term. This information is crucial for policymakers and individuals alike, as it underscores the importance of taking proactive steps to mitigate the impact of smoke on public health and wellbeing.

It is crucial for businesses and those managers responsible for implementing BCP to prioritise the impact on the local community and environment. This must be included in any business continuity plan and must be given thorough consideration. By carefully assessing and addressing these concerns, they can ensure that the warehouse operations will be successful and sustainable in the long term. Keep in mind that responsible management practices are essential for establishing a positive relationship with the community and safeguarding the environment for generations to come. It is crucial for business owners to understand the gravity of their responsibility in the case of a severe fire outbreak. They should not rely on external agencies such as the FRS or EA to handle the aftermath. Failure to do so could result in severe financial penalties and substantial costs required for the clean-up of any environmental damage that may occur as a result of the fire. It is therefore important for warehouse owners to take proactive measures to prevent such incidents and be prepared to deal with the consequences should they arise. It is interesting to note that, according to the literature review, severe fires can have a significant impact on local businesses. In some cases, they may even have to relocate to

other parts of the UK, which can have a negative effect on the local community. This is because not only do direct jobs get lost, but smaller local suppliers who depend on the warehouse and other amenities built around it, such as shops, cafes, and gyms, can also suffer. The long-lasting effects of a severe fire on the local community are clear and must be carefully considered to ensure the overall resilience of the area where the business is located is not compromised.

4.7.8 Overall Awareness

The results of both the interviews and the survey revealed that the participants possessed a good level of fire safety awareness and comprehended the severe consequences of a fire breakout. However, concerning the active fire safety controls—specifically AFD or sprinklers—they lacked the necessary awareness. Alarmingly, 44% were unaware of the controls in place, which raises a concern about their preparedness to identify the potential risks and the need for improvements or additional coverage. It is crucial to have a clear understanding of the active fire safety controls to ensure adequate protection against fire hazards.

It is imperative that we enhance awareness training for those responsible for critical areas of fire safety. They must possess a thorough understanding of the current controls in place and be able to identify any potential risks outside of the existing FRA. Following this assessment, they must decide whether they need specialist advice and support to complete the task. Moreover, warehouses can ask for a separate report on

property protection to be reviewed by the same person conducting the life FRA while on site.

In the upcoming chapter, we will discuss the conclusions that have been drawn from the findings and recommendations made in the previous chapters. Additionally, we will evaluate the need for further research that would be required to address any unanswered questions and to build on the current knowledge base.

Chapter V:

DISCUSSION

5.1 Introduction

As we have discussed previously, there seems to be a lack of research on the potential disconnect between fire safety and Business Continuity Planning (BCP) in UK warehouses and the impact this could have on the financial stability of businesses that operate within them. This is particularly concerning as, in the event of a serious fire, these gaps could jeopardise a business's ability to survive and continue trading. It is important for companies to examine and address any potential gaps in their fire safety and BCP protocols to ensure they are fully prepared for any situation that emerges from a severe fire. The lack of research in this particular sector can have serious implications on the policy and advice provided, particularly during times of market changes such as those brought about by COVID-19 and BREXIT. It is important to have a thorough understanding of the industry and its dynamics in order to make informed decisions and provide relevant guidance. It is crucial that businesses adhere to the clear and accurate guidance provided to avoid any negative impact on the industry as a whole.

As part of the research, interviews and surveys were conducted with managers and owners of UK warehouses to gain a better understanding of their perspectives on the situation. It is important to gather insights from key stakeholders to ensure that we make

informed decisions and take appropriate actions to address any challenges that may arise. From this research, five key themes emerged, namely:

- Outdated building regulations
- Lack of sprinklers
- New threats
- Inadequate insurance cover
- Overall lack of awareness

In this section, we will examine the outcomes and evaluate them against the results of the literature review to determine if there is consistency, and if not, what might account for the differences.

5.2 Discussion of Results

The participants in both the interviews and survey came from within the UK warehouse sector, each working in a role that has practicable implications for the overall resilience of the business regarding fire safety and BCP. All interview and survey participants, when asked to define and determine the essential qualities of the FRA and BCP process, indicated that they understood these. However, while the majority of businesses were complying with legislation and preparing for any disruption to the business, nearly 40% did not have a BCP in place which showed that some businesses may be vulnerable when it comes to business protection. It is important to identify the risks in any situation before taking action. After all, if you have not identified the risk, you will not be able to take steps to mitigate it.

The results of the research highlighted eight areas of concern when it comes to business resilience and fire safety which could impact the ability of a business to recover and continue trading should it be affected by a severe fire , which included the following:

- Outdated building regulations in relation to new threats—it is concerning to see how outdated building regulations are failing to keep pace with new threats posed by technology and recent trends. It is becoming increasingly clear that legislation needs to be updated.
- It seems that many businesses are unaware of how the FRA deals with property protection. The main focus of this regulation is to safeguard human life, rather than property or businesses. Unfortunately, there is a lot of uncertainty surrounding current fire safety regulations, and this is leading to missed opportunities to adequately protect businesses in the event of a fire. It is important to clarify these regulations and take steps to ensure that businesses are adequately protected.
- While researching insurance policies for businesses, it was found that there are some serious concerns when it comes to inadequate coverage for rebuilding costs and environmental protection. Additionally, it seems that key employees do not have much input on the content of the policy, which means that key areas could be omitted. This could have serious financial implications for the business, as any shortfalls in pay-outs would have to be made up from other areas of business income. It is important that management take a closer look at the insurance policies to make sure that the business is adequately covered in all areas .

- Lack of awareness when it comes to active fire safety controls at the warehouse is of concern. The current installation was most likely installed to a specification that probably does not reflect the actual risk of today's modern warehouse and will not have taken into account the modern threats.
- It is extremely concerning that small to medium warehouses in the UK lack adequate sprinkler coverage, making them highly vulnerable to severe fires. It is unfortunate that current legislation only mandates larger warehouses to install sprinklers, causing a negative impact on businesses and their ability to recover from such incidents. Warehouse owners must prioritise investing in sprinkler systems to safeguard business assets.
- It is important for warehouse managers to be aware of new threats that may arise, such as those from LIBs. With the increasing use of automation, LIBs have become essential for powering many of the devices in modern warehouses. However, the potential risks associated with LIBs may not have been fully considered. It is crucial for managers to prioritise safety and take steps to mitigate any potential dangers.
- It is unfortunate that there seems to be a lack of awareness when it comes to the environmental impact of fires that occur outside of business perimeters. It is important to remember that fires can have far-reaching consequences beyond just the immediate area where they occur. Businesses need to take responsibility for doing their part to protect the environment and prevent the impact of any fire from spreading beyond their intended boundaries.

- It is concerning that pollution from FWR is still poorly understood. If there were to be a severe fire, it could have a significant impact on the local community. For example, it could have harmful effects on local amenities like ponds and rivers, not to mention the potential health risks for the surrounding community. It is important that businesses work to better understand the potential impacts of FWR and take steps to prevent any negative consequences.

To fully understand the original research questions, consideration needs to be given to thoroughly examine each of these eight points and their correlation. By conducting a detailed analysis of each point, it is possible gain an understanding of the overall findings and draw more significant conclusions.

5.2.1 Discussion of Research Question One

Introduction

Warehouse managers and business owners have a responsibility to ensure the safety of the business that operates out of the warehouse. This includes the safety of employees, and that of the local community. To achieve this, it is crucial to have a thorough understanding of current fire safety legislation and building regulations, especially ADB. This knowledge is essential for the overall resilience of the business. It is important to interpret and implement these regulations accurately, as this directly impacts the both the business and the warehouse. The significance of correctly interpreting these regulations cannot be overstated.

RQ1: *To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?*

After conducting interviews and surveys, it is evident that participants mistakenly believe that simply adhering to building regulations and fire safety standards in the UK is sufficient for their business's resilience. However, this highlights potential gaps in their comprehension of these regulations. It is crucial to note that FRA and ADB prioritise protecting human life, as we previously discussed in earlier chapters, rather than the outcome for the business itself.

Many warehouse managers may be failing to fully protect their business by following outdated building regulations which, as the literature has shown, are not keeping pace with recent trends and changes. This is especially true since the COVID-19 pandemic and BREXIT which has resulted in increased demand for warehouse space along with increased automation (Raj et al., 2022), as confirmed by the participants in this study. This greater demand for space increases the risk of a severe fire taking hold, due to the more significant overall fire load, leaving smaller businesses that operate out of warehouses more exposed due to the lack of sprinklers.

It is interesting to note that the literature suggests building regulations are not keeping up with the trends in warehouse usage. This research also highlights that ADB may not be keeping pace with modern businesses operating out of these warehouses, which may be associated with increased risks. It is important to consider how these trends

could impact overall risk to the business, even if respondents may not have made that connection themselves.

The utilisation of LIBs in businesses is increasingly common, particularly due to the growth of automation and demand for larger storage capacities. This trend was evident in both the literature and interviews/surveys conducted. Many respondents highlighted that warehouses are frequently working to capacity. However, it is concerning that the dangers associated with these technologies may be intensifying.

It is crucial to note that numerous businesses are at risk of susceptibility without proper sprinkler installation in their smaller to medium-sized warehouses, as highlighted in the literature. This situation is primarily due to the current building regulations' inadequacy in covering such establishments. It is imperative that businesses take immediate action to safeguard the security and protection of their businesses and assets. The literature shows that ADB sets a very high storage capacity threshold before it becomes mandatory to install sprinklers, meaning only the larger warehouses are legally required to install them (Cox, 2022).

It is evident that a considerable number of warehouses in the UK are not adequately safeguarded against fire, despite the regulatory framework in place. It seems that some warehouse proprietors are under the impression that adhering to these regulations is sufficient to ensure compliance and resilience, yet this is not necessarily the case. Extensive research has indicated that while there is some awareness of the issue, there is little action taken to address it. It is crucial for all warehouses owners to prioritise

fire safety and take proactive measures to protect their businesses. It is no surprise that the UK is falling behind other European countries when it comes to warehouse fire safety standards and regulatory requirements—it has been well documented in the literature, so this finding was expected. We need to do better and prioritise the safety of businesses that operate within warehouses. The threshold for mandatory sprinkler installation in Europe means a far higher percentage of warehouses are required to fit sprinklers as standard (Cox, 2022). To put this into perspective, as highlighted in earlier chapters, the UK only requires warehouses to install sprinklers in spaces above 20,000m^2; in the Netherlands, the requirement is 1000$m^{2,}$ and in Norway, it is 800m^2 meaning business protection in these European countries is far greater than in the UK.

After gathering feedback from interview and survey participants, it was clear that they were of the view that trusting in their FRA consultant's advice was sufficient in handling their business protection concerns. This involved implementing measures such as adding more sprinklers to the main warehouse, securing inventory, and identifying any possible threats. However, this commonly-held view of UK warehouse managers and business owners contradicts the literature review, which showed that the FRA only interprets the RRO 2005 regulations as guidance which focuses on protecting life safety and does not expect the person completing the FRA to comment on property protection (Cox, 2022). There seems to be a misunderstanding among warehouse managers and business owners regarding their legal obligations and the role of the annual FRA. While following the advice of the ADB and the FRA can help with compliance, it is crucial to for the business owner or warehouse manager to ensure that all aspects of the business,

such as stock and infrastructure, are sufficiently protected. Consideration is needed to exploring additional resources and seeking professional guidance to ensure full compliance and protection for the business.

Through the research, it has been discovered that certain participants may lack sufficient knowledge when it comes to insurance coverage. While most of the interview and survey participants expressed confidence in their insurance policy's ability to cover business and environmental recovery costs in the event of a severe fire, there were some potential gaps identified. It is imperative to review and evaluate one's insurance plan to ensure full coverage of all possible scenarios. They were unaware of the level of increased risk that the business would face in the event of a severe fire, especially in the form of fines, and environmental clean-up costs, which would be additional expenses on top of the rebuilding costs.

Many business owners assume that their current insurance policy will cover all costs associated with fire damage, including rebuilding costs, stock replacement, and machinery repairs. However, the research has shown that a significant number of businesses are underinsured for fire protection and underestimate the high cost of rebuilding after a serious fire. It is essential for business owners to carefully review their insurance policies and make sure they have adequate coverage to protect their assets in the event of a fire. Furthermore, most standard policies do not, in fact, cover the cost of environmental clean-ups, which, according to the literature, can be very high and often require an additional insurance policy (Cockburn, 2022). Also, insurers can apply the

'Average Clause' to claims made by underinsured businesses, which can result in a lower settlement amount than the policy limit. If an insurer discovers that a business has inadequate insurance, the settlement can be reduced by the same percentage as that by which the asset is underinsured (Joraschkewitz, 2022).

Based on the findings, it appears that the participants had a good understanding of both FRA and BCP, and were able to define and agree with pre-described definitions. However, the research also revealed that businesses are not implementing BCP to the same level as they are undertaking FRA. It seems that there may be room for improvement in how businesses are preparing for potential disruptions. It is possible that some business owners are relying too heavily on certain resources, such as ADB and the FRA, to protect their business. However, it is important to note that fire safety may not be getting enough attention during the business protection planning stage. It is always better to be prepared for any potential disruptions, so it may be worth revisiting the implementation of BCP to ensure that businesses are adequately prepared. This supports the literature review findings, which highlight that businesses are often under-prepared regarding BCP, and many fail to recover from a severe fire (Cheshire FRS, n.d.); this includes fines and loss of reputation for fires that may not be covered by insurance due to poor procurement of insurance policies. A loss of income due to misinterpretation of insurance coverage or having a severely damaged warehouse that cannot operate as a functioning business all impact the ability of the business to survive following a severe fire which was an expected outcome going into the research.

5.2.2 Conclusion

Improving the link between the BCP and FRA is vital for enhancing the overall business resilience of the warehouse. However, the research has revealed that there is a misunderstanding of the fire safety regulations, which can leave warehouse managers and business owners ill-equipped to handle the aftermath of a serious fire. This, in turn, can put the warehouse's business resilience at risk. While participants demonstrate a sound understanding of the regulations, the issue appears to lie in their interpretation.

In summary, the participants thought that following the FRA and ADB would be sufficient to protect their business from a severe fire . Survey respondents agreed that integration between the FRA and BCP is needed. However, it was clear that the extent of the implications of a severe fire had not been realistically considered in current BCP. It is alarming to discover that many warehouses may lack sufficient insurance coverage to bounce back from a major fire. This, combined with the poor interpretation of building regulations, can significantly weaken the overall resilience of the business. It is crucial for businesses to ensure they possess adequate insurance coverage and comply with building regulations to safeguard themselves in the event of a severe fire. It is imperative that building regulations in the UK are reviewed and updated to align with other European countries. These countries have more rigorous sprinkler requirements, which necessitates that UK businesses become more informed about these limitations. This is crucial not only for building regulations, but also for insurance policies. It is essential that businesses comprehend the limitations and requirements so that they can be adequately protected. When it comes to insurance settlements after a severe fire, it is essential to

thoroughly consider all implications. Failing to do so could result in a significant shortfall that the business may have to cover. This could have negative effects on other areas of the business or future growth plans. To avoid any unpleasant surprises, it is crucial to take these consequences seriously and ensure everything is accounted for accurately.

5.2.3 Discussion of Research Question Two

Introduction

This research looked into the crucial role of sprinklers in ensuring warehouse safety. The research assessed the participants' willingness to embrace the mandatory installation of sprinklers, irrespective of the size of the warehouse. It examined the need for legislative changes to promote fire safety. Moreover, it considered whether businesses would invest in sprinklers if financial incentives were offered. Lastly, assessed the extent to which participants can influence insurance policies and ensure that all aspects of fire safety and BCP are included in their policy document.

RQ2: *To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouses?*

According to the research findings gathered from the interviews and survey, it was revealed that a significant majority of participants support the notion that sprinklers should be mandatory in all warehouses, regardless of their size. Nonetheless, the recommendation comes with a caveat concerning financial support. The candidates

expressed concerns about securing funding directly from their respective businesses for this type of initiative and suggested that alternative means of financial assistance would have to be explored.

As previously discussed, the high installation costs of sprinklers may be discouraging for business owners. Without government financial assistance, some owners may opt out of installing sprinklers altogether. To address this issue, offering financial incentives such as a grant scheme or reduced insurance premiums to those who exceed legal requirements in protecting their businesses could be a viable solution.

It is evident that the UK is lagging behind other European nations in terms of mandatory sprinkler installation. As per current UK laws, only warehouses exceeding 20,000m^2 are required to have sprinkler systems installed. It is important for businesses to understand that simply complying with building regulations does not necessarily fulfil all of their legal obligations. This research has shown that many businesses make this assumption, and as a result, they may miss out on opportunities to protect themselves from the devastating effects of a fire. It is crucial to take proactive measures to ensure the safety of business, customers, and assets. Encouraging them to go above and beyond current legal requirements voluntarily may be extremely difficult due to substantial upfront costs which if we take a basic figure of £42 per m^2 (Ditch, 2018), then a small warehouse of 5000m^2 would have to invest in the region of £230,000. Therefore, it is likely a change in legislation making sprinklers mandatory for smaller warehouses would

be required which would mean that going forward a substantial proportion of newly built and refurbished smaller warehouses would be covered.

Based on our research, it is evident that smaller warehouse businesses may not find it necessary to invest in sprinklers unless there is a change in legislation or if they receive assistance from the UK government and insurance companies. This is a viable solution for those who may not meet the current legal requirement. When we analyse the cost of these installations compared to the average cost of a UK business warehouse fire—which the literature stated is in the region of 5.9 million pounds (Business Sprinkler Alliance #))— surely the incentives are there for businesses to invest in sprinklers to protect the warehouse they operate from.

It is evident that the increasing popularity of LIBs and the growing demand for storage capacity in warehouses have significantly amplified the risk of fires. It is concerning that current regulations are lagging behind these trends, underscoring the urgency for businesses to prioritise their ability to withstand potential disasters. Fires have become increasingly severe in recent years, causing significant damage to businesses. The presence of LIBs intensifies these fires, posing a significant risk, especially in automated warehouse facilities where the potential for a total loss of the business is much higher. All businesses should take fire safety seriously and implement preventative measures to minimise the risk of fire. As a responsible business owner, it is essential to consider the potential consequences of a fire not only on your own property but also on the surrounding area. The loss of critical facilities like parking, perimeter

fencing, and auxiliary structures such as security huts and small workshops can cause severe disruption to operations. Moreover, a fire's impact on the community and environment can lead to fines and damage to reputation, which can have significant financial implications. Therefore, it is crucial to take necessary measures to prevent fires and have a well-thought-out plan in place to minimise the potential harm in case of an unfortunate event such as severe fire. Loss of income during downtime—while waiting for insurance claims to be processed and rebuilding takes place—is also a consideration. Market value is often not an accurate reflection of the cost to rebuild a premises, and other features such as car parks, driveways, lighting, fencing, and gates are often overlooked (Cockburn, 2022). To accurately determine rebuild costs, it is imperative to take into account all variables that can affect the final amount. This encompasses not only materials and labour, but also professional costs such as those charged by architects and planners. Therefore, business owners, must also consider legal expenses, demolition or make-safe fees, site clearance charges, and access expenses. Failing to properly assess any of these factors can have severe financial consequences for the business, making it more challenging to bounce back. It is paramount that businesses undertake a comprehensive evaluation of rebuild costs to ensure this has been factored into any insurance policy. However, it is not only about sprinklers but rather a need to look wider and consider other active controls designed to protect the warehouse from a severe fire, such as automatic fire detection (AFD).

According to the research, many warehouse managers and key staff seemed uncertain about the active fire safety controls fitted in their warehouses, as well as

whether they had AFD specifically designed for the risks inherent to their warehouse. There is a clear need to increase awareness and understanding of fire safety measures in warehouse environments. The lack of confirmation regarding whether the fire safety controls are designed to cover the increased risks highlighted in the literature is concerning. The literature has shown that factors such as LIBs, increased capacity due to COVID-19 and BREXIT, can significantly impact warehouse businesses. It is essential to ensure that everyone is aware of these risks and taking necessary steps to protect warehouses and the business that operates out of them .

It has been noted in the literature that the conventional sprinkler design, which is mounted on the ceiling, is not effective in fighting new threats like LIBs. Moreover, traditional sprinkler systems are not engineered to handle thermal runaway that can happen during a fire that involves LIBs. In fact, it is worth noting that many standard sprinkler systems are typically designed to be ceiling-based rather than using the more efficient Early Suppression Fast Response (ESFR) system, which has the capability to be fitted to both ceilings and racks. This has been supported by the research as well, which suggests that in order to achieve the goal of complete initial extinguishing, it is important to consider upgrading to a more advanced system like ESFR. When it comes to sprinkler systems, there are many factors that determine their performance. One of the most important factors is the size of the fire that needs to be put out. The degree of obstruction, ventilation conditions, and compartment geometry can also play a significant role in how well the sprinkler system works. Another critical factor to consider is the spray characteristics of the water mist system and how they are configured in the warehouse.

By taking all of these factors into account, you can ensure that your sprinkler system is designed to provide maximum effectiveness in the event of a fire. It is important to consider all aspects of the system, such as the location of the sprinklers, the water pressure, and the type of sprinkler heads used. With careful planning and attention to detail, you can create a sprinkler system that will perform optimally when it matters most. In order to ensure maximum protection for businesses, warehouses require a new, comprehensive approach to risk management that incorporates modern design. This includes taking into account the specific risk factors associated with the warehouse and installing sprinklers that are specifically designed to address those risks. By tailoring the sprinkler system to the specific needs of the warehouse, businesses can enjoy greater protection and peace of mind.

Based on research and literature, it appears that small to medium businesses who rely on warehouse structures may not improve their fire safety resilience without changes in legislation or financial assistance from the UK government and insurance companies to install sprinklers. It seems that the UK is lagging behind other European countries in this regard. Without these changes, it is unlikely that businesses will take measures to increase their resilience on their own. It has to be noted that the risk of a devastating fire inside a warehouse does not decrease due to its size; the risk is just as significant in a smaller warehouse, and any fire will have a devastating impact on the overall ability of the business to recover and re-open (Cox, 2022). This was clearly indicated in the literature and was an expected outcome.

Based on the interviews and survey conducted, it was revealed that individuals responsible for managing fire safety and business continuity planning on site, including the Facilities Management team and safety managers, expect to have greater involvement and input in their company's insurance policies. This would ensure that policies are aligned with their specific needs and requirements, ultimately leading to better risk management and mitigation strategies. In order to have more control over the insurance policies, there needs to be a deeper understanding of the procurement process. This understanding would give them the ability to provide input into the policy itself and ensure that it meets the specific needs of their business.

It is important to note that many policies are implemented without proper discussion or input from those who are responsible for managing and mitigating risks. This lack of collaboration often leads to missed opportunities to customise policies to best fit the needs of the business. It is crucial for managers and staff to have a say in the development and implementation of policies to ensure they effectively address the risks at hand. As a warehouse manager or business owner, it is important to ensure that your insurance coverage is comprehensive and covers all potential shortfalls. This includes not only realistic rebuilding costs, but also areas that are likely to be affected, such as loss of income, potential fines, and reputational damage. It is crucial to take the time to carefully review the current insurance policy and make any necessary adjustments to ensure that the business is adequately protected in the event of a severe fire.

5.2.4 Conclusion

The research findings indicate that a change in legislation is necessary, as agreed by many participants. It is imperative that all businesses relying on warehouse structures, irrespective of their size, must install sprinkler systems. It was noted that financial support would be required to implement this change. Incentives from either the government or insurance companies could aid in covering the costs of such installations. The consensus is that safety measures in warehouse facilities need improvement, and it is essential to take steps towards making this a reality. It also suggested that, without any new legislation or financial support, the industry would be unlikely to make changes. As discussed, the cost to install sprinklers is circa £42 per m^2 so in a 5000m^2 warehouse that would be in the region of £230,000. However, when compared to the average cost of a warehouse fire (£5.9 million) along with the severe impact on the business operations that would be affected such as loss of income, fines and loss of reputation, surely this should be considered as a good long-term investment. With the increased risks identified in the literature from LIBs and today's increased storage requirements then the threats this has on the business cannot be understated; the mandatory installation of sprinklers in all warehouses, regardless of size, should be considered. The literature shows the recent trends justify this change, and it would go a long way to increasing the overall business resilience of this vital business sector.

5.2.5 Discussion of Research Question Three

Based on the literature review, it can be seen that the impact of a fire when exposed to LIBs is far greater due to thermal runaway and increased pollutants. In case of such a failure, the thermal energy released by LIBs may be 7 to 11 times higher than the energy stored electrically. The produced heat accelerates the reaction, resulting in a critical overheating of the battery which can burn at temperatures of up to 1,200°C (Buser and Mähliß, 2016). As a result, this section will discuss the level of understanding and awareness of businesses in the warehouse sector on topics such as these.

It is crucial to improve awareness regarding new threats such as LIBs. The literature clearly shows that there is a rise in the threat of fire involving LIBs. This can cause devastating consequences, and it is difficult to bring such fires under control. These fires can impact not only the business itself but also the wider community it is located within. In recent years, the increased use of batteries in the automation of warehouses has introduced new fire threats to the warehouse sector. It is also important to note that the increased likelihood of having battery-powered items stored in the racking areas as incoming stock further exacerbates these risks. It is concerning that the participants of both the interviews and surveys are not aware of the broader risks, along with their own responsibilities as business owners when it comes to the broader community and environment. This lack of awareness can impact business resilience, due to factors such as loss of income, possible fines, and reputational damage. Therefore, it is vital to take

proactive measures to address these risks and ensure that both businesses and the wider community are protected.

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RQ3: *What level of understanding do warehouse business owners have regarding the potential impact and consequences of fires for their business in the short and long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?*

Businesses operating in the warehouse sector must fully acknowledge the potential damage that a severe fire can cause and take necessary measures to mitigate these risks. Surveys and interviews conducted have revealed that many participants fail to recognize the increased risk posed by LIBs, and have not sought any specialist advice. It is imperative for businesses to take the responsibility to acknowledge these risks and take appropriate actions to minimise the threats posed by LIBs. It is not the responsibility of the FRA consultant to bring this to their attention and offer advice on mitigating the risks associated with LIBs, as some participants assumed. A study of the literature clearly shows that the use of LIBs is not part of the brief of the FRA unless it is a threat to life—an example of this would be if it was located or stored in a fire exit route and, therefore, could have an adverse effect on the safe exit of staff during an emergency situation ("The Regulatory Reform (Fire Safety) Order 2005", n.d.). It is important to clarify that the FRA consultant would not consider LIBs that are simply being stored in racking as this falls under property protection and is outside the scope of the FRA. However, this can lead to confusion and it is important for both consultants and management to understand

the FRA brief clearly. This was an expected outcome based on the literature review, as there is a lack of broader knowledge on the emerging threats posed by LIBs and their potential impact on fire safety.

It is important to consider the potential environmental impact following a severe fire and to take steps to clean up the local environment. According to literature, failing to do so can result in contamination of nearby rivers and water courses. Unfortunately, many standard insurance policies do not cover the cost of environmental clean-up associated with fires, which can run into tens of thousands of pounds. As a result, it is essential for businesses operating out of a warehouse to review their policies and make sure they are adequately covered. Interestingly, interview and survey participants generally felt that environmental impacts were not their concern. However, they should consider the potential impact on the local community. Ultimately, it is up to everyone to take responsibility for mitigating the effects of severe fires and minimising their impact on the environment. The literature clearly shows the massive environmental impact a severe fire can have both in the short and long term (Stec et al., 2019); and the contamination of the local area due to the lack of risk analysis and preparation in the BCP often means further consequences for the business facing possible litigation and losing support from the local community. Fogarty (2012) has shown that businesses are often fined following a fire due to a lack of prevention that allows contamination of the environment. Therefore, the BCP needs to make sure that the effects of a severe warehouse fire, both in the short and longer term, are recognised and, where possible, this risk is managed by ALARP. It is important for business owners and warehouse managers

to review their insurance policies to ensure that any damage outside of their property's perimeter is covered. Additionally, seeking specialist advice on the potential impact on local ponds and rivers due to the risk of pollution from FWR is crucial. With the increased use of water to fight and control fires involving LIBs, it is essential to contain FWR on site before it reaches nearby bodies of water (Fogarty, 2022). This is something the literature review shows is not happening and again this was an expected finding.

5.2.6 Conclusion

It is concerning to learn that many businesses do not recognise the increased fire risk from LIBs and feel that current controls will be adequate. According to research, this goes against the literature, which suggests that many businesses are ill-prepared to deal with such fires and would require specialist advice that is not currently included in the FRA. It is important to raise awareness about these threats and their potential impact on the business and the local environment. To address this issue, it will be necessary to improve knowledge and leadership at the highest level within the business, update policies and procedures, and provide adequate training to those responsible for adhering to them on a day-to-day basis. Taking these steps will help ensure that the business is better equipped to handle any potential fire risks from LIBs and minimise their impact .

5.3 Summary

As we have discussed, it is clear that businesses in the UK warehouse sector need to make some significant changes when it comes to fire safety. This includes everything

from stricter building regulations to identifying and mitigating risks that could impact the local environment. Additionally, it is important that staff responsible for implementing fire safety measures receive proper training and awareness-raising, particularly key individuals such as facilities and safety managers. By understanding the limitations of current systems and procedures, they can work towards developing more effective strategies for the future.

It is clear that there is a pressing need for increased sprinkler coverage in the UK warehouse sector. It is no longer enough to base installation decisions solely on warehouse size, as this doesn't take overall risk into account. It is essential that all relevant factors are considered when making these important decisions. The research suggests that many warehouse businesses would be receptive to this approach if the right incentives were in place. This could include government support or incentives from insurance companies, such as reduced premiums. Given the potential costs of a warehouse fire and the ensuing closure of a business, the installation of sprinklers is a serious consideration that should not be overlooked.

It is important for businesses in the warehouse sector to fully understand the serious consequences of a severe fire and how it can impact their operations. Failing to take these issues seriously can lead to devastating consequences, particularly for smaller businesses who may not have the resources to recover. Inadequate insurance coverage and the lack of mandatory sprinkler systems can further exacerbate the situation. Therefore, it is crucial for businesses to properly prepare themselves by understanding the

link between FRA, BCP, and overall resilience. By doing so, they can mitigate the broader impacts and costs of a fire and ensure their survival in the long run.

As we have previously discussed, warehouses can be complex structures with a variety of combustible materials stored within them. Considering the emerging threats from LIBs and the increased storage requirements, mitigation strategies should no longer be based on the size of the warehouse alone, but rather the overall risk. This means taking into account what products are stored and how much of them there are. The literature supports the overall benefit of mandatory sprinkler installation, which is something that the research has welcomed. It is important to note that the research has identified eight gaps that need to be addressed if businesses want to make the whole warehouse sector more resilient. Additionally, there needs to be greater awareness of the short- and longer-term impacts of a severe fire on business resilience and the broader environment and community impacts. This has been discussed in earlier chapters. By connecting fire safety directly within the business continuity plans, businesses can adequately protect the key assets and improve business resilience. This is especially important in light of recent market shocks such as COVID-19 and BREXIT.

Chapter VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

Based on the research questions, it has been revealed that there are certain areas of weakness in the warehouse sector that could have a negative impact on business resilience. One major issue is the fact that building regulations in the UK have not kept up with the rapid changes that have occurred in the warehouse sector in recent years. The growth of the sector due to factors such as the COVID-19 pandemic and BREXIT has led to increased demand, which has in turn brought increased risk in areas such as storage capacity and automation. Additionally, new technologies such as LIBs have the potential to cause more complex and devastating fires, which are often ignored due to a misinterpretation of current regulations. Businesses are relying on the findings of the FRA instead of seeking specialist advice on how to mitigate risks from LIBs. However, the FRA focuses on the protection of life, not business protection, which could leave businesses at risk of total failure following a severe fire if this issue is not resolved.

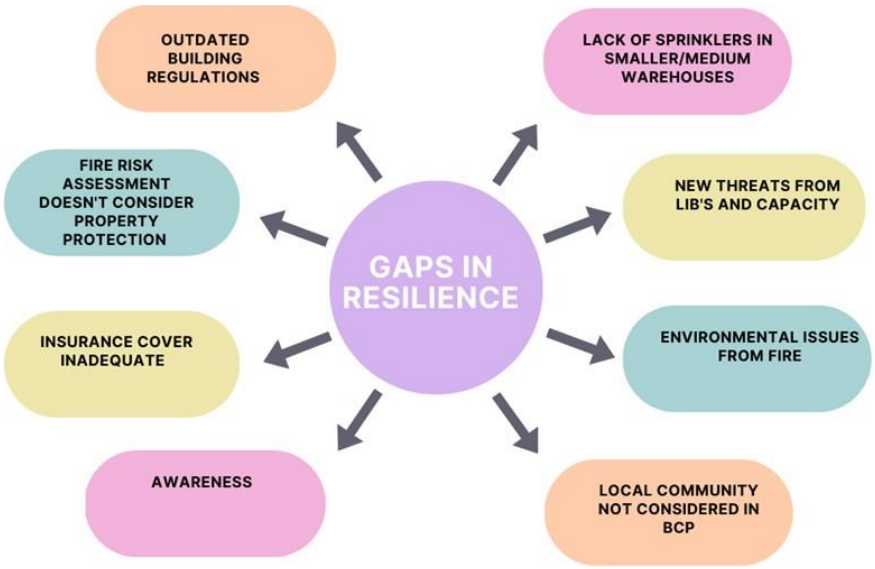
The research indicated that there might be an over-reliance on ADB and the FRA in various areas of fire safety, including property and environmental protection. However, these regulations are not specifically designed for such purposes, which leaves a gap in the management of fire safety on site. It is crucial to include both property protection and

business protection in the business continuity planning, but indications are that this is not happening. This can heavily impact the resilience of the business in relation to fire safety and its ability to recover following a severe fire. Another area of concern is the number of businesses without BCPs in place, and some businesses do not cover fire safety and environmental protection in their BCPs to the extent they should. This indicates a lack of awareness on these topics, and there are missed opportunities to improve business resilience. Improved resilience can provide better protection for the longevity of the business operating within the warehouse.

Following the research on insurance coverage for businesses, it has become apparent that many owners and managers are relying on standard policies that may not provide sufficient coverage for rebuilding costs after a fire. This is further compounded by the additional costs of environmental clean-up which can quickly add up. Smaller businesses are particularly vulnerable as they may not have the resources to cover these costs independently. To exacerbate matters, many of the interviewees reported having limited involvement in the insurance procurement process, making it challenging for them to comprehend precisely what the policy covers. It is crucial for businesses to consider this issue to safeguard their interests in the future.

It's important to note that the issue of staff awareness regarding passive controls has been highlighted in this research. While participants in the study had a solid understanding of various pieces of legislation, they struggled to identify the active controls in place within their business, particularly in terms of sprinklers and AFD

installation. This raises concerns about the suitability of current protective measures in the warehouse, as they may not have been assessed for current business needs or may only meet minimum requirements. The research also reveals a gap in the specification and installation of the correct type of sprinklers, with a need for updated UK legislation to address this issue. By mandating sprinklers in newly constructed warehouses and offering support to warehouses looking to move to a risk approach, we could improve precautionary measures and better protect smaller businesses from severe fires. It is clear that addressing these gaps is critical to improving overall resilience and ensuring employee safety and business security. The chart below was used in a previous chapter to highlight the eight key areas identified in this research where improvement is required.



6.2 Implications and Recommendations

Through this research, it has become apparent that there are various factors that are contributing to the overall lack of business resilience in the context of fire safety. These factors have been carefully categorised into two distinct groups, namely "sector lead implications" and "sector lead recommendations". In the first section, we will discuss the implications that these factors have, while in the second section, we will offer recommended solutions to help combat these challenges and improve overall business resilience.

6.3 Sector Lead Implications

It is crucial for warehouses to prioritise fire safety resilience in their business model to enhance their chances of survival and recovery from severe fires. Despite this, research has uncovered missed opportunities in crucial areas. For instance, regulations mandating the installation of sprinklers based on structure size rather than business risk, and business continuity plans not encompassing critical areas such as business and environmental protection from fire hazards. Insurance policies may also have gaps, with standard policies failing to cover essential expenses like environmental clean-up or total warehouse rebuilds following a fire. These gaps can impede a business's ability to recover, negatively impacting the local community, employees, and the economy. Smaller businesses are particularly susceptible to failing to recover from fires due to a lack of sprinklers, as they may be unable to absorb additional costs like fines or clean-up

expenses. Therefore, it is vital for businesses to consider these factors in their fire safety resilience planning.

It is important to recognise that lack of awareness can be a major concern when it comes to fire safety. It is possible that the staff responsible for implementing fire safety may not fully understand the limitations of current legislation, as well as the fact that ADB and the FRA only concentrate on life protection, not property protection. This limited knowledge and understanding relating to the fire protection controls they currently have in place could have a negative impact on business resilience. They may be unaware of whether their current measures are suitable to mitigate their current risk level, which could ultimately hinder their ability to prevent a fire or reduce its impact. Additionally, this could impact how the business responds to the impact of the fire and its ability to keep trading after the event. It is important for companies to be aware of these factors so they can take appropriate action to ensure their business is properly protected.

The following section will outline recommendations for improving overall resilience and ensuring business continuity, to help safeguard warehouses and the businesses that operate out of them.

6.3.1 Sector Lead Recommendations

It is time to take a more comprehensive look at the building regulations governing sprinklers in warehouses. Rather than relying solely on warehouse size, a more holistic approach to evaluating the risks associated with each business should be

considered. This approach would ensure that the rules are customised to meet the unique needs of each business, rather than using a one-size-fits-all approach. By doing so, we can ensure that the safety of the business and property is given the utmost priority and protection. It is interesting to note that modern warehouses are heavily relying on automation to handle the increasing storage capacities. However, with this automation comes greater risk. Despite this, the threshold for installing sprinklers as a precautionary measure in the UK remains set at 20,000m^2 and to put this into perspective it would need to be a warehouse the size of nearly three professional football pitches before it became mandatory to install sprinklers. It is important for warehouse managers to consider implementing additional safety measures to ensure the protection of their business and products. It is interesting to note that some European countries require sprinklers to be fitted at warehouse spaces of 1000m^2 or less. This seems to suggest that a review of regulations in the UK is well overdue. According to recent research, there is support from the UK warehouse business sector for this type of regulation. However, it is important to note that financial assistance would be required either from the government or via a reduction in insurance premiums. Another option for those who lease their warehouse space would be to negotiate longer terms in return for the leaseholder assisting with installation costs. These recommendations could help address the increased threats to the warehouse sector identified in the research.

It is crucial for businesses to have a solid business continuity plan (BCP) that takes into account all possible risks, including those from severe fires. Research has shown that businesses that are ill-prepared for such events are unlikely to fully recover

from the consequences. For smaller warehouses without sprinkler coverage, it is important to work with fire experts during BCP preparation to ensure all sections and risks are covered, which could have a significant impact on the business and local community. Key staff members with day-to-day responsibilities should also collaborate closely with procurement management to procure bespoke insurance policies that align with the risks identified in the BCP.

Awareness training should be introduced as part of any CPD programme and include staff at all levels from senior management to supervisors; this should take into account building and fire safety regulations highlighting the limitations when it comes to property protection and explaining that they are primarily designed for life protection, not business protection. The implications for business continuity (the business' level of readiness to maintain critical functions after the fire) and the future of the business should also be covered. We know the devastating effects a severe fire can have on a business and its day-to-day activities, and the likelihood of many businesses failing to re-open following a severe fire due to poor business resilience. Educating the business so they are fully aware of all the limitations will go a long way to closing the gaps highlighted throughout this research.

6.4 Recommendations for Future Research

This research has identified limitations when it comes to business owners and warehouse managers comprehending the exact role of ADB and how it can be enhanced

to provide an extra layer of resilience to warehouse businesses. To further investigate this matter, it is recommended that another layer of research should be conducted. This would involve interviews with fire safety experts and insurance companies to gain in-depth insights into the problem. The research findings also suggested that smaller warehouses are more susceptible to risks. Therefore, it is important to study fire and business failure trends to confirm and quantify this risk. In conclusion, this research emphasises the need for continued exploration and decisive action to ensure the safety and protection of all businesses in the warehouse sector.

6.5 Conclusion

This research has successfully identified significant gaps in the UK warehouse sector's knowledge of business resilience, particularly in the area of fire safety. With the increasing use of automation and artificial intelligence software, which rely heavily on LIBs for power, modern warehouses are more vulnerable to the devastating effects of fire. To address these gaps and improve overall business resilience, using a mixed methods approach, which involved both qualitative and quantitative data collection and analysis, was instrumental in achieving these research objectives. The insights shared by participants during the interviews and survey helped identify the critical areas impacting the UK warehouse sector's overall business resilience.

It has been recommended that building regulations, particularly ADB, should undergo a review to decrease the legal threshold for installing sprinklers in warehouses. This move would have a positive impact on smaller to medium-sized warehouses affected

by a fire, making it more likely that they will recover and operate again. It is also important to consider risk rather than just the overall size of the warehouse, which is currently the main criteria when it comes to mandatory installation of sprinklers. The research supports a regulation change to lower the threshold for sprinklers so more warehouses would be legally obliged to comply. However, it may be necessary to provide financial support through grants or other means, such as agreements with leaseholders and insurance companies, to allow businesses to invest in sprinklers that would protect the individual business and the onward supply chain, which is so valuable to the UK economy. This move would also bring the UK in line with other European countries, especially in terms of greater protection of the smaller warehouse businesses.

It is crucial to have comprehensive knowledge about the coverage provided by the business's insurance policy, particularly in case of fire damage. This research has revealed that many companies assume their standard policy will encompass all the expenses associated with rebuilding after a fire, which is not always accurate. In reality, most standard policies do not cover the entire rebuilding cost or the costs associated with any environmental clean-up. It is essential to consider additional policies to ensure complete coverage and prevent any potential shortfalls in the settlement that could negatively impact the business's future.

This research revealed that the businesses operating out of the warehouse often relied heavily on building regulations and the RRO 2005, along with the findings of the FRA, as their only guidance for business protection in relation to fire safety . However, it

was discovered that these regulations were primarily designed for life protection and not for business protection. As a result, relying solely on these guidelines would severely affect the resilience of the warehouse.

The literature review also identified new threats posed by automation and capacity. Despite these threats, warehouse managers and owners did not seem to recognise their implications. Participants in both the interviews and survey stated that they did not consider seeking specialist advice from an outside expert nor implementing additional active controls to mitigate the increased risk. Furthermore, the design of the original warehouse and its risk analysis at the time would not be appropriate in dealing with today's new threats, such as from LIBs and increased demand for storage space in the warehouse, as shown in the literature.

It is clear from the research that there are many areas where the overall resilience of the warehouse can be improved. There are gaps that need addressing, and some of these may require changes to legislation such as the ADB, which would need government intervention to force through changes. As a business owner, it is important to understand the importance of disaster preparedness and fire safety. Both BCP and FRA require substantial improvement so they work more closely together, but it is ultimately the responsibility of the business to take accountability for being more mindful when it comes to fire safety and BCP. Management should comprehend the gravity of the situation and take measures to mitigate any risks identified. By doing so, the overall safety and resilience can be significantly enhanced. This is a collective effort, and both

management and staff in the warehouse have a crucial role to play in ensuring the protection of the business.

Staff who are responsible for fire safety on site should be well-informed about the limitations of FRA and the ADB in their current form. It is crucial that they understand these limitations in order to ensure that their warehouse is equipped with the best and most effective fire safety measures. Better training can help these individuals gain a deeper understanding of the subject matter and make more informed decisions about the appropriate safety measures for their particular business. Businesses should also seek the advice of a competent person to help them assess the suitability of the current active controls in place in their warehouse, such as sprinklers or fire detection systems. It is important to ensure that these controls are aligned with the current business model, and are capable of providing the necessary protection against fire hazards. By working closely with a qualified expert, businesses can gain valuable insights and make informed decisions that will help them mitigate risk and protect their most valuable assets. The management team should take practical steps to mitigate the risks to the business, the environment, and the local community in light of the any new risk level. It is important to increase the resilience in case of a severe fire. Management need to review their BCP and consider the possible impacts of a severe fire, making changes based on safety, environmental, and business continuity concerns. It is important that they take these measures seriously to ensure the safety and well-being of business.

Businesses must recognise that a severe fire can have far-reaching consequences beyond just the physical structure of the building. It can greatly impact the operations of the businesses inside, as well as have a ripple effect on its employees, suppliers and nearby amenities, such as local shops. It is critical not to overlook these potential ramifications. The impact of a severe fire can be far-reaching, affecting multiple facets of society. As a result, preventing such disasters and staying ahead of potential threats must be a critical aspect of any modern warehouse's business model. Addressing the gaps identified in this research is an essential first step in this process; and ignoring these gaps could result in the catastrophic consequence of no business left to reopen in the aftermath of a severe fire.

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APPENDIX A:
SURVEY COVER LETTER

Subject:

Dear xxxxxxxxxxxxxxx,

We are conducting interviews as part of a research study to increase our understanding of how resilient the UK warehouse sector is when it comes to fire safety. Your role covers areas such as facilities management or fire safety and therefore you are in an ideal position to give us valuable first hand information from your own

perspective. The interview takes around 30 minutes and is very informal. We are simply trying to capture your thoughts and perspectives on this very important topic. Your responses to the questions will be kept confidential. Each interview will be assigned a number code to help ensure that personal identifiers are not revealed during the analysis and write-up of findings.

There is no compensation for participating in this study. However, your participation will be a valuable addition to our research. Your findings could lead to a greater industry understanding of resilience in fire safety in the UK warehouse sector. If you are willing to participate, please suggest a day and time that suits you, and I'll do my best to be available; also, by agreeing to the interview, you will confirm that you consent for data to be used as part of our research. You can read the ethics/consent form, which can be found at the following link https://drive.google.com/file/d/1WSxko5JZfLDEUebD6hgXo-940pji29Br/view?usp=sharing

If you have any questions, please do not hesitate to ask

APPENDIX B:
INFORMED CONSENT

Consent Form - *Adult providing own consent*

Title

Short Title

Protocol Number

Project Sponsor

Coordinating Principal Investigator/

Principal Investigator

Associate Investigator(s)

(if required by institution)

Location *(where CPI/PI will recruit)*

Declaration by Participant

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research described in the project.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time during the project without affecting my future care.

I understand that I will be given a signed copy of this document to keep.

Name of Participant (please print)	
Signature	Date

Declaration by Researcher†

I have given a verbal explanation of the research project, its procedures and risks and I believe that the participant has understood that explanation.

Name of Researcher† (please print)	
Signature	Date

† An appropriately qualified member of the research team must provide the explanation of, and information concerning, the research project.

Note: All parties signing the consent section must date their own signature.

APPENDIX C:
INTERVIEW AND SURVEY GUIDE

The research involves a Zoom interview of a sample selection of key people as one of two methods being used (the second being surveys). This form is relevant to your participation in the interviews.

Interviews

Candidates will be screened for eligibility to make sure they have the necessary experience/ management position which relates to the study topic, then participants will be asked to sign a consent form prior to participating in the survey. The candidates will be part of a control group study, this is because they will have first-hand experience and are, therefore, more aware of the everyday protocol in their workplace.

Their understanding of the legislature is key to identifying the knowledge gaps among those at the forefront of the issue, providing an in-depth insight into their experiences of fire safety resilience.

The interviews will be held **via Zoom** on a date and time to suit the candidate and are expected to last **no more than 20 minutes,** this session will be **recorded**, and all candidates will be offered a copy of the interview via a link. It's not anticipated any follow-up interviews will be required.

There will be no requirement for reimbursements or expenses due to the online nature of the interview. Interviews will be confidential, and no details of the person or the organisation they work for will be used. Once the interviews have been concluded and the information extracted then, the recording will be deleted. All candidates will be from the United Kingdom, and all interviews will be conducted in English.

Survey Guide

Any information collected will be non-identifiable, so all information given will be anonymous. All data will be kept on Survey Monkey. The privacy notice can be found by visiting https://www.surveymonkey.com/mp/legal/privacy. The information collected will only be used for this research document, and won't be made available to any third party. No databank will be used to store data. Your information will only be used for the purpose of this research project, and it will only be disclosed with your permission, except as required by law.

The personal information that the research team collects and uses is only the given answers to questionnaires

APPENDIX D:
INTERVIEW QUESTIONS

Introduction

- *Could you tell me about your experience in the warehouse sector?*
    - *Have you seen major changes since joining the sector ?*
- *What is your expectations and understanding of Business continuity Planning (BCP)?*
- *What is your definition of a Fire Risk Assessment (FRA)*

RQ1. To what extent are current building regulations and standards regarding fire safety hazards understood and complied with by managers of UK warehouses, and how do warehouse managers/owners interpret the current situation?

Related Interview Questions

- *To what extent have you had any experience of a fire in the workplace?*
    - *Can you elaborate on this?*
    - *Have you perhaps heard of instances in your network?*
- *In your opinion, to what extent do you feel fire safety is adequately controlled when it comes to building regulations?*

- *Over the previous years, warehouses have been used much more extensively. How do you feel about this and to what extent do you think these increase overall fire risk?*
- *To what extent do you feel completing a fire risk assessment and complying with the recommendations fully protects your business?*
- *What are your expectations regarding your current insurer when it comes to fire?*
    - *Would you expect your current insurance to cover all costs relating to a serious fire?*
    - *Would you expect your current insurance to cover all costs relating to environmental damage caused by the fire ?*

RQ2. To what extent are warehouse owners open to improved and transparent regulations concerning active firefighting controls in smaller- to medium-sized warehouse.

Related Interview Questions

- *Smaller/medium warehouses are not expected to fit sprinklers to comply with building regulations, how do you feel about this?*
    - *For instance, do you feel it should be mandatory for all warehouses to have sprinklers fitted?*

- *What do you think the role of other stakeholders, such as insurance companies or the government, should be in ensuring or incentivising these protections?*
    - *Do you feel insurance companies could offer incentives to retrofit sprinklers?*
    - *What would the role of government be regarding incentivising these kinds of protections?*
    - *Would you personally consider retrofitting if government grants or tax relief were available to assist with costs?*
- *What are the barriers, do you think, for considering these kinds of protections for you and other warehouses?*
    - *Is cost the only barrier that prevents you considering fitting sprinklers?*

RQ3. What level of understanding do warehouse business owners have regarding the potential impact and consequences of fires for their business in the short and long term (i.e., business resilience), and how may future regulations build greater resilience regarding fire safety hazards for UK warehouses?

Sub Questions

- *If relevant, how have you regarded or discussed the consequences of a serious fire within the management team, and how this would affect your business?*

- *To what extent has this prompted you to make changes to improve resilience?*
- *Does fire safety play an active part of your BCP?*
- *How do you feel the emergence of increased us of Lithium ion batteries has increased the fire risk?*

- *To what extent has the effect of a serious fire stemming from the location been considered broadly (i.e., outside the specific business)?*
  - *For instance, how would this affect the local community and businesses around you (traffic, mental health, pollution)?*
  - *Has the environmental impact been considered (ponds, rivers, drains)?*
- *What has been the role of your insurance adviser in developing a BCP that considers fire safety?*
  - *To what extent have they discussed with you all elements of a serious fire and how they would be covered as part of the standard policy (environmental clean-up; rebuild costs etc)?*
  - *How do these fit in within your BCP currently?*
- *Tell me your thoughts, now that we have had this conversation, around future regulation and best practices.*
  - *Do you have any opinions when it comes to improving regulations and fire safety*

APPENDIX E:
ONLINE SURVEY QUESTIONS

1. ***Do you agree with the following definitions***

    - *Fire Risk Assessment may be defined as a careful look at your premises and the people who use them, from a fire prevention perspective. It's about understanding the potential risks, then improving your fire safety precautions to keep people safe and eliminating or reducing the risk to its lowest practical level.*
        - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*

    - *Business continuity may be defined as "the capability of an organization to continue the delivery of products or services at pre-defined acceptable levels following a disruptive incident"*
        - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*

    ** You can add any notes or opinions at the end section of this survey*

2. ***We currently have a business continuity plan in place;***
    - *Yes/No*
3. ***We currently have a fire risk assessment in place;***
    - *Yes/No*

4. ***Based on Q 2+3, I feel these two documents should work closely together;***

- *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*

5. ***Our FRA is reviewed on a regular basis.***
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*
6. ***Our BCP is reviewed on a regular basis.***
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*
7. ***Making sure our warehouse complies with all building regulations and legal requirements concerning fire safety shows our business is resilient when it comes to fire safety.***
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*
8. ***Our BCP has considered the impact of a fire on the local community.***
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*
9. ***Since Covid 19, our business has been working at an increased storage capacity than before the pandemic****.*
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*

10. ***If yes to Q9 would you agree with the following; Our sprinkler design been revisited to compensate for this extra volume.***
    - *Strongly agree/ agree/neither agree nor disagree/disagree/strongly disagree*

11. ***I've had concerns regarding fire safety in my own warehouse.***
    - *Strongly agree/ agree/disagree/strongly disagree*
12. ***Optional depending on answer to Question 11:I raised these concerns with my team or with senior management.***
    - *Strongly agree/ agree/disagree/strongly disagree*
13. ***Optional depending on answer to Question 11+12;These concerns, in my opinion, were dealt with satisfactorily;***
    - *Strongly agree/ agree/disagree/strongly disagree/Not applicable*

14. ***My business is adequately covered by my insurance policy in relation to a serious fire.***
    - *Strongly agree/ agree/disagree/strongly disagree*
15. ***My insurance policy would cover any environmental clean-up costs following a serious fire.***
    - *Strongly agree/ agree/disagree/strongly disagree*
16. ***I would expect my fire safety consultant as part of our FRA to advise me on environmental protection caused by a serious fire****.*
    - *Strongly agree/ agree/disagree/strongly disagree*
17. ***I have taken specialist advice to mitigate the risk of environmental damage following a serious fire.***
    - *Strongly agree/ agree/disagree/strongly disagree*
18. ***I would expect my fire risk assessment to advise if additional sprinklers were required to protect property and stock.***
    - *Strongly agree/ agree/disagree/strongly disagree*

19. ***I have taken specialist advice to manage and mitigate the risk of fire from Lithium ion batteries e.g. used by loading, unloading and picking robots, laser-guided vehicles [LGVs], automated guided vehicles [AGVs]***
    - *Strongly agree/ agree/disagree/strongly disagree*
20. ***The additional risks from Lithium Ion batteries been assessed and additional controls put in place***
    - *Strongly agree/ agree/disagree/strongly disagree*

21. ***I think all UK warehouses should have sprinklers fitted mandatory.***
    - *Strongly agree/ agree/disagree/strongly disagree*

22. ***I feel the capital cost would be a major factor in whether we considered retrofitting sprinklers.***
    - *Strongly agree/ agree/disagree/strongly disagree*

23. I feel government grants would encourage me to invest in sprinklers.

- *Strongly agree/ agree/disagree/strongly disagree*

24. My Warehouse is fitted with the following:

- *Fully functional fire detection system covering all areas: Y/N, not sure*
- *Rack fitted sprinklers; Y/N, not sure*
- *Traditional ceiling fixed sprinklers; Y/N, not sure*
- *Early Suppression Fast Response (ESFR) sprinklers; Y/N, not sure*
- *Has your local fire and rescue service undertaken a recent familiarisation exercise at your warehouse ? Y/N, not sure*
- *My Warehouse is greater than 20,000m2; Y/N, not sure*
- *My Warehouse is smaller than 20,000m2; Y/N, not sure*

25. Which of the following statements applies to your Warehouse .

- *"Choose which best applies: My warehouse...*
- *a) ...hasn't been fitted with sprinklers but it has been considered as a way to improve fire safety*
- *b) has been fitted with sprinklers*
- *c) hasn't been fitted with sprinklers and has not had considerations for the*

26. Our smoke detection was fitted as standard on occupation by the developer,

- *Yes/No*

27. Our fire detection has been designed and installed to our specialist needs

- *Yes/No*

28. When it comes to investing in fire safety, our business is very proactive

- *Strongly agree/ agree/disagree/strongly disagree*

29. What's your experience working in the warehouse sector

- *0-5years; 5-10 years; >10.*

<u>Open ended Questions</u>

1. ***If you have had any experience of a fire in the workplace , how did it change your view on fire safety, i.e., what lessons were learn****ed?*

2. ***Based on the survey, have you any other comments you would like to add, or would you like to expand on any answers you have given.***