The Relative Performance and Consequences of Protecting Crowded Places from Vehicle-Borne Improvised Explosive Devices

by

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to God be the glory

Abstract

Crowded places have been the target of terrorist attacks for many years. Their inherent nature has resulted in a vulnerability to a range of attacks, most notably the threat of vehicle-borne improvised explosive devices (VBIEDs). Government agendas have been seeking to reduce the extent of this vulnerability, by encouraging those who are responsible for the design, construction and operation of such places to incorporate counter-terrorism measures (CTMs) into their designs, and where necessary, retro-fit them into existing places. However, little is known about what measures can be used, as well as their performance and consequences. The aim of the research is therefore to identify the aforementioned range of measures through the development of a typology that also examines their relative performance and consequences for a range of scenarios, in order to inform key decision makers who are responsible for the protection of crowded places. Through the use of a qualitative research strategy and respective research methods, interviews, site visits and document analysis were carried out in both the UK and in the USA. A total of 47 participants were recruited for the research, with the collection of data spanning 16 months. A preliminary study was undertaken that determined a range of influences on whether crowded places are protected, as well as influences on the value of CTMs themselves. A theoretical framework was developed to capture and understand those influences. Conventional data analysis methods and internal validation techniques were used to subject the data to methodological rigour, ensuring the validity and reliability of the research.

While the negative consequences of incorporating CTMs can be profound, every CTM that can be used has additional benefits; measures can be incorporated at no cost and can even generate revenue; and designing-in CTMs has a number of advantages over retro-fitting them. This research's contribution to knowledge in relation to methodology, empiricism, theory, industry, and policy has resulted in the creation of a significant amount of guidance for key decision makers who are responsible for the design, construction and operation of crowded places, as well as providing data on the benefits that can be gained from incorporating mitigative measures that is of interest to those who have a role to play in the design, construction and operation of the built environment more broadly. Recommendations for further research posit that greater understanding is needed in relation to the specific monetary costs of CTMs themselves, the experience of users of protected places, the implications of 'invisible' CTMs, and the need for research into the assessment and incorporation of proportionality into the built environment. Practical recommendations put forward the need for clarification of legislation in relation to duties of care, the dissemination of the incentives to protect, and benefits of protecting, crowded places, the need for further debate and transparency regarding proportionality and what constitutes proportionate design, and the need to encourage greater engagement between stakeholders and the means through which this can occur.

The research posits that legislative requirements encompassing the mitigation of terrorist attacks *are* apparent, and that therefore, organisations should incorporate CTMs into vulnerable places, yet as previously indicated, such CTMs do not have to cost anything.

Key words: building design; counter-terrorism; hostile vehicle mitigation; physical security; protective construction; resilience; urban design.

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However independent this research has been in its execution and presentation, I cannot, out of all good conscience, neglect to acknowledge the unsung sacrifices of those who work to protect us from those who wish to cause us harm. The overwhelming success of their efforts (a double-edged sword resulting in naivety of the threats faced and overcome), undoubtedly deserve our continuing praise. To me, the morality surrounding the proportionate protection of vulnerable places is incontrovertible, and so it is my hope that this research, which highlights the range of factors to be considered in relation to the need for and incorporation of counter-terrorism measures, further incentivises and encourages the protection of such places from this point forward.

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List of Abbreviations

ALO	Architectural Liaison Officer
ASF	Anti-Shatter Film
BBNCBs	Bomb-Blast Net Curtains and Blinds
BCP	Business Continuity Planning
CONTEST	The UK's Strategy for Countering the Threat of Terrorism
CPDA	Crime Prevention Design Adviser
CPNI	Centre for the Protection of National Infrastructure
CPTED	Crime Prevention Through Environmental Design
CSR	Corporate Social Responsibility
CTM	Counter-Terrorism Measure
CTSA	Counter Terrorism Security Adviser
GSA	Government Security Adviser
HVAC	Heating, Ventilation and Air Conditioning
ICE	Institution of Civil Engineers
NaCTSO	National Counter Terrorism Security Office
PBIED	Person-Borne Improvised Explosive Device
PIRA	Provisional Irish Republican Army
RIBA	Royal Institute of British Architects
SBD	Secured By Design
SEB	Security-Explicit Barrier
TARA	Threat and Risk Assessment
VACP	Vehicle Access Control Point
VBIED	Vehicle-Borne Improvised Explosive Device
VSB	Vehicle Security Barrier

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“To read the ideas of others is an affirmation that we require more than personal experience to understand the world” (Brabazon, 2010)

1.0 Introduction

> "For many years discussions have occurred amongst built environment professionals, urban managers and the agencies of security (especially the police) regarding the costs and benefits for urban authorities adopting counter-terrorism measures in the face of real or perceived terrorist threats" (Coaffee, 2008a, p.300)

1.1 Research Context

Three important issues are captured in the preceding quote: the multitude of stakeholders involved in the design, construction and operation of the built environment; the costs (both monetary and in terms of trade-offs and consequences) and the benefits of incorporating counter-terrorism measures (CTMs) into vulnerable components of the built environment; and the distinction between real and perceived terrorist threats, with actions resulting from their assessment directly impacting the way in which the aforementioned stakeholders do or do not protect vulnerable places through the incorporation of CTMs. However, the built environment is vulnerable to a plethora of hazards, threats and major accidents, each of which have their own individual consequences should they come into contact with the built environment itself. Each also demand attention in their own right, with natural hazards and threats (and the resulting emergencies, disasters and criminal acts of varying scales) seemingly increasing in both frequency and severity. Each has their own impetus on the aforementioned multitude of stakeholders in the form of design considerations, not forgetting the vast amount of legislated and non-legislated considerations that do not revolve around such phenomena. The above raises four key questions that this introduction answers in order to provide the context in which this research is rooted:

1. Why does this research focus on the threat of terrorism, and more specifically, the threat of vehicle-borne improvised explosive devices (VBIEDs) against crowded places?
2. What is the role of those stakeholders involved in the design, construction and operation of the built environment?
3. What are the cost-benefits of incorporating CTMs into the built environment?
4. What are the influences of, and distinctions between, real and perceived terrorist threats?

Each of these questions are answered in sections 1.1.1 to 1.1.4 respectively, and the answers themselves will lead to the identification and detailing of the research problem (section 1.2), the aim and objectives of the research (section 1.2.1), and how this thesis has been structured as a result in order to fulfil its purpose (section 1.3).

1.1.1 Terrorism, VBIEDs, and crowded places

A vast array of political, economic, social, technological and environmental considerations, some of which are legislated for, some not, influence the design, construction and operation of the built environment. Most notably however, a range of hazards, threats and major accidents pose significant risks to the built environment itself (HM Government, 2010a, p.27; Mullins and Soetanto, 2010, p.45; Ota, 2010, p.10; Edwards, 2009, p.15; Harre-Young *et al.*, 2009, p.8), which as highlighted by Bosher and Dainty (2011, p.2), affects everyone, as everyone interacts with the built environment. Whilst there is growing appreciation that the identification of every risk is not achievable (Bosher and Dainty, 2011, p.2; Coaffee, 2008a, p.307; Dainty and Bosher, 2008, p.259), recognition and investigation of the impacts of the aforementioned hazards, threats and major accidents has resulted in a plethora of research in relation to Disaster Risk Management (DRM) and resilience, in regard to the built environment itself and the socio-institutional systems that are inherent within it. Whilst resulting damages from such risks can be so profound that they can 'wipe out' years of development and investment (Dainty and Bosher, 2008, p.358), one form of risk in particular has caused concern over recent years, that being the threat of terrorism, with terrorist groups actively seeking to cause harm through the intentional targeting of vulnerable places.

Richards (2011, p.189) notes that Britain is not a stranger to the threat of terrorism. Northern Ireland-related terrorism has been evident for decades, with responses to that particular threat resulting in the emergence and use of physical measures to manipulate the built environment in such a way that terrorists are deterred from carrying out their intentions, and are unsuccessful in obtaining preferred outcomes through the mitigation of the impacts of an attack. More recently, the threat from international terrorism and most notably, Al Qaeda, its supporters and affiliates, has dominated political and security discourses, with a plethora of plots and attacks being evident in the UK (Clarke and Soria, 2009; Harre-Young *et al.*, 2009), plots which focussed on crowded public places and favoured the use of VBIEDs. The UK government's strategy for countering terrorism, known as CONTEST, documents the need for such places to be protected, which the National Counter Terrorism Security Office (NaCTSO) contribute to through the protection of crowded places, the protection of hazardous sites and dangerous substances, and by assisting the Centre for the Protection of National Infrastructure (CPNI) to protect critical national infrastructure. The UK focus of the research is due to the evident gaps in knowledge in relation to the aforementioned situation within the UK, but also because of the partner to the research, NaCTSO, who were involved in the research from its conception; the research needs to be based on the situation within the UK.

1.1.1.1 Defining hazards, threats and major accidents

As stated previously, the built environment is vulnerable to a plethora of hazards, threats and major accidents; vulnerability meaning the pre-event and inherent characteristics of systems that create the potential for harm and can result in damage (Willis *et al.*, 2005; Cutter *et al.*, 2008), with both physical and social factors influencing vulnerability (McEntire *et al.*, 2002). Hazards are defined as naturally occurring phenomenon (Harre-Young *et al.*, 2010, p.1122), and therefore encompass meteorological, geological and other such systems that can result in damage to built assets if they interact with them, such as flooding. Threats, however, are distinctly different due to intentionality; they are defined as any action that is carried out with intent and malice, and causes or threatens to cause damage to society and the environment in which it operates (Harre-Young *et al.*, 2009, p.1286). Major accidents, therefore, by their very nature are risks that do not occur 'naturally' or through intent or malice, but as a result of unintentional means, such as technological failure, yet may still cause damage to society and its environment.

1.1.1.2 Defining terrorism, and counter-terrorism measures

The contested nature of defining terrorism is evident in literature (e.g. Coaffee, 2009a, p.76; Flint and Radil, 2009, p.151; Wekerle and Jackson, 2005, p.33; Weidenbaum, 2003, p.9). Then and Loosemore (2006, p.158) assert that terrorism is the systematic use of violence, in order to achieve a political objective. Wilkinson (2007a, p.4) highlights that terrorism can be distinguished from other forms of violence, due to it being premeditated and designed to create a climate of extreme fear, directed at a wider target than its immediate victims, inherently involving attacks on random or symbolic targets, considered by the society in which is occurs as 'extra-normal', and that it is used primarily (though not exclusively) to influence political behaviour. However, as stated by Bleiker (2003, p.437):

> "The key to understanding terrorism, then, does not lie with violence as such, but with the differences between legitimate and illegitimate uses of force. And this division, in turn, is directly linked to issues of statehood and sovereignty"

Although additional terms for terrorism are evident in the literature, including 'superterrorism' (George and Whatford, 2007, p.158) and 'mega-terrorism' (Coaffee, 2003a, p.7; Lenain *et al.*, 2002, p.5), in addition to the use of violence in order to carry out an objective, the psychological dimension of terrorism and the instilling of a disproportionate level of fear is also a component part (Richards, 2011, p.186; Silke, 2011, p.1; Elliott, 2009, p.5; Dolnik, 2007, p.19; Savitch and Ardashev, 2001, p.2519; Laqueur, 1996, p.24; Merari, 1993, p.215). As purported by Wolfendale (2007, p.78):

> "Because it is possible that a single act of terrorism could wipe out hundreds of thousands of people instantly, the mere existence of that possibility is sufficient to

> make the threat of terrorism far more significant than the threat posed by crime, disease and poverty"

Whilst no international consensus on a definition of terrorism is evident, most notably due to the aforementioned issues in relation to the legitimate and illegitimate use of force (and therefore state and sovereignty implications), the UK government has defined terrorism within the Terrorism Act 2000 (UK Parliament, 2000, p.1), which asserts that:

> (1) In this Act "terrorism" means the use or threat of action where –
>
> (a) the action falls within subsection (2),
>
> (b) the use or threat is designed to influence the government or to intimidate the public or a section of the public, and
>
> (c) the use or threat is made for the purpose of advancing a political, religious or ideological cause.
>
> (2) Action falls within this subsection if it –
>
> (a) involves serious violence against a person,
>
> (b) involves serious damage to property,
>
> (c) endangers a person's life, other than that of the person committing the action,
>
> (d) creates a serious risk to the health or safety of the public or a section of the public, or
>
> (e) is designed seriously to interfere with or seriously to disrupt an electronic system

Coaffee (2009a, p.78) suggests that:

> "However we choose to define terrorism it is clear that it has led to both reactive and proactive measures by many governments and organisations"

Part of those reactions has been the encouragement of the incorporation of CTMs into the built environment, in order to deter and mitigate the effects of terrorist attacks on vulnerable places. A CTM is herein defined as any product, or course of action, in which all or part of its specification is to reduce the likelihood and/or mitigate the impacts of a terrorist attack (Harre-Young *et al.*, 2010, p.1124).

1.1.2 Those who design, construct and operate the built environment

A range of hazards, threats and major accidents pose a risk to the built environment and, as a result of the way in which it has been designed and maintained, the vulnerability of built assets has become apparent. DRM and the resilience have emerged in recent years to address such vulnerabilities and the mitigation of potential impacts, with the notion that human beings, not nature, are the cause of disasters (Mileti, 1999, p.12), most notably through the way in which the built environment is designed. Evident in the literature is the perspective that previous and current construction practices, as well as their governance, are insufficient and inappropriate for dealing with hazards, threats and major accidents (ICE, 2010, p.7; Glass, 2008, p.172; Ofori, 2002, p.18), most notably due to the fragmented nature of the construction industry (Bosher and Dainty, 2010, p.6) and the speed and profit motives of urban regenerators (Coaffee and Bosher, 2008, p.75). Whilst the role that those who design, construct and operate the built environment should have in DRM and resilience may be apparent, the aforementioned impediments to their full involvement remain; change is needed through the integration of such principles into the everyday practices of those stakeholders (Li, 2010, p.43; Bogunovich, 2009, p.87; Bosher *et al.*, 2009a, p.11; Godschalk, 2003, p.142; Lorch, 2001, p.416). Glass (2008, p.184) asserts that there is a clear case for stakeholders to have an in-depth understanding of designing and constructing a resilient built environment, as part of such reform. However, the incentives and obligations to adopt such practices also requires understanding. There is therefore a need to understand not just the influences that determine whether vulnerable places are protected, but how, what the benefits and consequences of the measures used to protect them are, and how they can be influenced.

1.1.3 The cost-benefits of incorporating CTMs

Whilst those responsible for the design, construction and operation of such places are being encouraged to incorporate CTMs into their designs, Harre-Young *et al*. (2010, p.1128; 2009, p.1292) assert that little is known about their relative performance (benefits), and their consequences (cost, as well as requirements). The incorporation of physical measures into the built environment in order to deter and mitigate the impacts of various crimes has occurred throughout history (Briggs, 2005, p.68). In contrast, the incorporation of CTMs has only occurred relatively recently, but the related discourse is informed by a plethora of literature on the topic. ‘Fortress architecture’ and ‘defensible space’ have been highlighted as being extensively used in Northern Ireland during the early 1970s and 1980s to territorially control areas (Coaffee, 2004b, p.201), yet the use of such measures arguably emerged beforehand, through the onset of influencing human behaviour through the concept of Crime Prevention Through Environmental Design (CPTED), which is a design concept that asserts the improvement of public safety through the design of physical environments (Coaffee, 2009a; Gunning and Josal, 2004; Thompson and McCarthy, 2004; Crowe, 1991). Notable advancements in relation to this have been the creation of Secured By Design (SBD), which is based on physical security, surveillance, access and egress, territoriality, management and maintenance (Armitage, 2000) and integrates CPTED principles into housing design, which was adopted by the Association of Police Officers in the 1980s (Coaffee, 2009a, p.22). Notions of security have developed over the years to encompass urban and building design, with further developments in terms of ‘invisible’ security and CTMs, and the role of security and counter-terrorism in resilience. Whilst there is a plethora of literature on the perceived consequences of traditional counter-terrorism approaches, which includes contradictory accounts of the militarisation and fortification of urban spaces, none of these identify the range of CTMs that are available; rather, they focus on individual examples and specific implications. Literature on the development and emergence of 'invisible' CTMs raises the prospect of synergies between urban design and counter-terrorism, as well as the potential enhancement of the user experience, through seemingly un-impinged design and permeability of places and spaces. Coupled with the shift that has been evident in the UK, moving from the management and mitigation of individual risks on a case-by-case basis, through to broader notions of resilience, the role and value of CTMs in this regard requires attention. However, a typology of CTMs and their requirements, performance and consequences (defined in section 1.1.3.1) is not evident in the literature. Therefore, such a typology is required to understand CTMs and the protection of crowded places further.

1.1.3.1 Defining requirements, performance and consequences

Whilst the use of the terms 'cost' and 'benefit' are prevalent, the terms 'requirements', 'performance' and 'consequences' were used throughout this research. This was done in order to capture in-depth information on specific attributes of CTMs. Therefore, requirements of CTMs encompass the issues that are inherently required for their use, such as the fixtures and fittings required for glazing, and foundations required for bollards, for example. The performance of CTMs captures not just their benefits; visual and functional attributes that result in the CTM fulfilling its purpose are encompassed in this term, and again enabled the inherent performance and characteristics of CTMs to be identified, analysed and compared. It was felt that the use of term 'benefits' was insufficient, as an issue relating to the performance of a CTM may not be positive, such as poor aesthetic performance. The use of the term 'consequences' is more common and so this was adopted to ensure that the measurable and immeasurable consequences of incorporating CTMs could be identified, such as traffic disruption if certain CTMs were incorporated to exclude or restrict traffic from a given area. These terms are therefore used according to their above definitions throughout the thesis.

1.1.4 Real and perceived terrorist threats

Regan (2006, p.22) states that when Tony Blair watched the events of September 11th 2001, he was convinced that those terrorist attacks had changed the world forever, and that he was right, not just because it led to the invasion of two countries, but that it embedded terrorism into our daily lives that was not the case beforehand. Similar statements and perspectives are also present in other literature (Rigakos *et al.*, 2009, p.286; Rypkema, 2003, p.9; Briggs and Edwards, 2006, p.28). As questioned by Briggs (2005, p.10):

> "We might question whether September 11 was the point of change or the moment of realisation of what had been taking place over the last decade"

The same influences and perspectives are also evident when considering other threats and hazards (Fussey *et al.*, 2011, p.144; Shenoi, 2010, p.1; McEntire *et al*., 2010, p.50; Coaffee, 2010, p.939; Coaffee, 2009b, p.348; Little, 2008, p.1; Tierney and Bruneau, 2007, p.14; George and Whatford, 2007, p.158; Briggs and Edwards, 2006, p.29; McDonald, 2005, p.308). In relation to the influence that perceived terrorist threats can have and in a study on transport patterns, Blalock *et al*., 2008, p.1717) showed that as many as 2300 road deaths were attributable to the terrorist attacks of September 11th 2001, due to resulting fear of flying. Whilst immediate reactions may only be short-term, curtail off, and not endure, terrorist attacks, as well as the manifestation of other threats and hazards, can evidently have significant implications as to whether vulnerable places are protected.

However, the above raises a much broader and more significant question: what other factors influence the protection of crowded places and determine whether CTMs are incorporated? And, to what end do factors influence the value of those measures themselves; can the value of protection be undermined? The beginning of this chapter highlighted three factors that needed to be explored in order to understand the context behind this research, those being the multitude of stakeholders involved in the design, construction and operation of the built environment, the cost-benefits of CTMs, and the influence of real and perceived terrorist threats. Why this research focuses on terrorism and the threat of VBIEDs against crowded places was also addressed as a crucial foundation of this research. How these factors transcend into and result in an identifiable and appropriate research problem is addressed in the following section.

1.2 The Research Problem

The plethora of legislated and non-legislated design considerations facing those involved in the design, construction and operation of the built environment all demand attention, yet this research focuses on the specific threat of terrorism in the form of VBIEDs against crowded places. There is an industrial element to the direction of this research, as NaCTSO is the partner to this research and they voiced that this research would be of use. However, examination of the literature reveals that key gaps are evident in relation to knowledge on CTMs that can be used to protect crowded places, as well as their requirements, performance and consequences, all of which would greatly aid the aforementioned stakeholders in making informed decisions regarding incorporating such measures and protecting vulnerable places. Moreover, and as identified above, factors are present that influence whether crowded places are even protected, regardless of whether information on CTMs themselves is even known, and it was also questioned whether there are factors that influence the value of protecting such places. All these factors require attention. The way in which the built environment is protected from terrorism has been subject to growing concern over recent years; with a sustained threat of terrorism, a trend towards the use of VBIEDs, and the resulting need to protect crowded places that have been targeted repeatedly, research into the CTMs that can be designed-in and retro-fitted needs to be conducted, addressing their relative requirements, performance and consequences. As such information is not currently readily available to those who design, construct and operate crowded places, the aim and objectives of this research will now be presented in order to address these issues.

1.2.1 The aim and objectives of the research

As a result of the previous discussions, the aim of the research was to evaluate the relative value and systemic implications of CTMs that are used to protect crowded places from VBIEDs. To achieve this aim, the objectives of the research were to:

1. Examine current research on protecting key components of the built environment from terrorism and on the emergence of the terrorist threat.
2. Develop a typology of CTMs that are used to protect crowded places from terrorist attacks, specifically in relation to the mitigation of VBIEDs.
3. Evaluate the relative performance of CTMs in relation to their cost, effectiveness and impact for a range of scenarios.
4. Identify the impacts, intended and unintended consequences and trade-offs that derive through designing in and retro-fitting CTMs.
5. Produce guidance for key decision makers who are responsible for the protection of crowded places, to inform future legislation, guidelines and codes of practice.

1.3 Structure of the Thesis

In providing an informed and rigorous account of the research that was undertaken in order to fulfil the aim and objectives of the research, the thesis is presented in a logical and progressive structure, as highlighted in Figure 1.1. There are two core aspects of this research, those being a typology of CTMs, and a framework capturing the influences on the protection of crowded places and on the value of CTMs themselves; the thesis is framed around these integral components. The following three chapters in the thesis (Chapters Two, Three and Four) contain the literature review that was conducted for the research.

Introduction	Research context, problem and structure	**Chapter 1**
Literature Review	Design considerations, hazard/threat mitigation, terrorism and counter-terrorism	**Chapter 2**
	Counter-terrorism and the built environment, influences on the protection of crowded places and on CTMs	**Chapter 3**
	Boundaries of the typology, design philosophy, CTM classification, the relative performance and consequences of CTMs	**Chapter 4**
Research Methodology and Design	Research methodology, strategy and methods, research design, research studies and instrument, research validity and reliability	**Chapter 5**
Results of the Research	Influences on the protection of crowded places and on CTMs, the relative performance and consequences of CTMs	**Chapter 6**
Discussions on the Research Findings	Relative performance and consequences of CTMs, influences on the protection of crowded places and on CTMs, design considerations and agendas	**Chapter 7**
Conclusions	Aim and objectives fulfilment, key findings, contribution to knowledge, research validity and reliability, recommendations, final thought	**Chapter 8**

Figure 1.1. Thesis structure and contents

Chapter Two documents the design and resilience of the built environment, highlighting the plethora of design considerations that are evident in construction today and how concepts of disaster risk management and resilience have gained prominence over recent years. Chapter Three then details the terrorist threat, the UK's counter-terrorism strategy and on-going work, and the relationship between counter-terrorism and the built environment and how they combine to facilitate the protection of crowded places. The chapter also forms a theoretical framework that details the influences on the protection of crowded places, as well as on the value of CTMs themselves. Discussions within then lead to the development of a provisional typology of CTMs in Chapter Four.

Chapter Five then discusses the principles of research methodology and design, providing an understanding of research methodology, strategy, and methods, from which a valid and reliable research design is constructed. The schedule that was undertaken for the research is then presented, leading to accounts of the preliminary and main studies that were conducted, and of the development of a scenario-based research instrument to aid in the collection of data. Chapter Six presents the results of the research that further the aforementioned theoretical framework and typology, and Chapter Seven discusses the relative performance and consequences of the CTMs, and presents the final theoretical framework as well as discussions on the emanating issues from the research itself. The final typology of CTMs is presented in Appendix C7.1. Chapter Seven also utilises the scenario-based research instrument where appropriate to internally validate and work through the discussions themselves. Chapter Eight then presents the conclusions of the research, highlighting its key findings, contributions to knowledge, validity, reliability and limitations, and recommendations for further research. A ‘final thought’ is then posited for the reader’s reflection.

2.0 The Design and Resilience of the Built Environment

Geis (2000, p.154) states that the 'built environment' comprises the substantive physical framework that enables society to function in its social, economic, political and institutional aspects. However, not only does the built environment facilitate the functioning of society, it also represents the majority of national savings and investment (Little, 2002; Ofori, 2008). Yet the built environment itself is not designed purely to accommodate these functions alone, a vast array of legislated considerations and other options and pressures can influence the design, construction and operation of the built environment. However, as this chapter will explore, it is how (or not) the built environment is designed to be resilient to a plethora of natural hazards and human threats that is of particular interest. As Dainty and Bosher (2008, p.358) assert, such impacts can be so profound as to nullify years of investment and development. But what present-day design considerations are encountered by those who design, construct and operate the built environment? Why is there so much emphasis on mitigating the impacts of natural hazards and human threats? What are the perceived and empirically founded benefits and consequences of such mitigation? It is these questions that Chapter Two sets to answer. This will lead to a focus on a particular threat that has been internationally and publicly contested and debated for decades, a threat which it is argued is having a profound impact on the design and resilience of the built environment; terrorism.

2.1 Present-Day Design Considerations

A vast array of political, economic, social, technological and environmental considerations, only some of which are legislated for, influence the design, construction and operation of the built environment. As noted by Bosher and Dainty (2011, p.2):

> "Everyone interacts with and is affected by, the built environment"

The link is clear; how the built environment is designed has a direct impact on those who use it, whether it be publicly or privately owned space. This therefore puts pressure on those who are responsible for the design, construction and operation of the built environment to not only address all the applicable criteria, requirements and risks for such places and spaces, but to reconcile and deliver them in such a way that suits the users of those built assets, as well as a plethora of others. From a construction perspective, such considerations are shown in Table 2.1. The sheer scale of considerations and pressures is clear: each issue demands attention in their own right. Table 2.1 does not represent the varying significance given to the different items, but it aids in putting into the perspective the scale of considerations and pressures that exist today. However, the 'end results' of construction projects (structures) are vulnerable to a plethora of changing natural and human systems, systems which can destroy the structures themselves, systems which will now be explored.

Table 2.1. Strategic risks in construction (Allan and Davis, 2006, p.10)

External Origin		**Internal Origin (7 S's)**
Political	**Social**	**Systems**
Government spending, policies and decisions	Risk to reputation from involvement in a major incident like a major rail accident, dam collapse or flooding the M25	Financial systems
Amount of work done for governments and pseudo-government organisations		Merging two financial systems
		Introducing a new financial system
Future of private finance initiative (PFI) / public-private partnerships	Health and safety of other people	Security
	Demise of the UK skills set and general industry demographics	Hackers into the system and viruses
Government making commitments that then later proved to be unaffordable		Corruption in business practices
		State-of-the-art operation of our systems
War and terrorism and counter-terrorism measures	**Technological**	Failure of a major project
	Pace of technological change within the business	
	The ability to manage information and knowledge	**Structure**
Economic / Markets	Obsolescence	Lack of internal communications
Financial and monetary		Lack of business-to-business level understanding
Vulnerability to failure or takeover	**Environmental / Ethical**	
Relative share price and growth in share price	Sustainability, environmental legislation	Lack of transparency
An acquisition	Ethical failure	
Bad debt		**Strategy**
Cash and getting paid	**Legal**	Failure to grasp or create opportunities
Currency movements	Entering unknowingly into contractual liabilities	Getting left behind
Stability in interest rates and inflation	Collateral warranties	Poor business strategy
Sustainable workloads	PFI contracts	Poor execution of strategy
Uncertainty of funding	Professional indemnity insurance	

Failure appropriately to fund the business because of the deal with the regulator	A big claim against us	**Skills and Staff**
Pensions	Uninsurable losses (e.g. reputation, supply chain loss)	People’s behaviour
Markets	Uncertainty of legislation	The shortage of good people coming to civil engineering
Failure to react to significant market shifts		The quality of existing people
Geographic limitations		Scarcity of capable people to do our business
Shrinking markets		Health and safety of our own people and other people
Winning work		Loss of key staff
Matching competence and opportunity		Loss of key executives
Narrowness of the market		
Supply and demand balance changes		**Style and Shared Values (Culture)**
Loss or failure of a major customer		The ability to truly operate and understand in different cultures
Failure to achieve sufficient customer satisfaction		Not learning from the past
Behaviour of most important clients		Complacency and lack of awareness
Competitiveness		Lack of transparency or openness of communication or information that leaves decision makers completely unaware of the real issues

2.2 From Global Systems to a Single Device…

> "…the built environment in which we live and operate is at risk from a vast range of hazards, threats and major accidents" (Harre-Young, 2009, p.8)

Whilst definitions of such concepts can vary considerably, due to the semantic differences that are inherently involved in the terms (Cutter *et al.*, 2008, p.599), a plethora of hazards, threats and major accidents pose a risk to the built environment. Particular emphasis is placed on the extent to which human influence plays a part in vulnerability of the built environment to such risks, as well as their consequences. Risks themselves are explored first, followed by mitigation and the extent to which human influences are evident.

2.2.1 Hazards, threats and major accidents

Within the context of the UK, national risk assessment positions the threat of international terrorism as the UK's uppermost concern, followed by hazards and major accidents that require a national response (Cabinet Office, 2012; HM Government, 2010a, p.27).

2.2.1.1 Hazards

Bosher *et al.* (2009, p.801) indicate that flooding (riverine, pluvial and coastal), as well as severe windstorms, pose the greatest risks to the built environment in terms of hazards. Risks posed by flooding are also evident in a plethora of other literature (Mullins and Soetanto, 2010, p.45; Ota, 2010, p.10; Edwards, 2009, p.15; Bosher, 2008, p.4; Bosher *et al.*, 2008, p.5), as is their expected increase in number and severity due to changing climatic conditions (Bosher and Dainty, 2011, p.2; Wedawatta *et al*., 2010, p.313; Crichton, 2008, p.130). Earthquakes (Ota, 2010, p.10; Bosher, 2008, p.4; Vora *et al*., 2008, p.602), heat waves (Edwards, 2009, p.15; Bosher *et al.*, 2007a, p.164) and snow storms (Edwards, 2009, p.15) are also cited.

2.2.1.2 Threats

Terrorism is the most evident threat that faces not just the built environment in broad terms, but specific organisations as well (CPNI, 2010, p.3; HM Government, 2010a, p.27; Boin and McConnell, 2007, p.54; Bosher *et al.*, 2007a, p.164), with riots (British Council for Offices, 2009, p.147; Peek and Sutton, 2003), organised crime (CPNI, 2010, p.3; Edwards, 2009, p.15), espionage (CPNI, 2010, p.3) and even war (Ota, 2010, p.10) also evident. However, the risk of a terrorist attack occurring is less than the occurrence of aforementioned hazards, as well as other risks such as fire and transport accidents (NaCTSO, 2010c, p.6; Bux and Coyne, 2009, p.2937; Bosher *et al.*, 2008, p.5; Beall, 2007, p.12; Briggs and Edwards, 2006, p.30). As a result of the intentional dimension that differentiates threats from hazards, the full range of threats is consequently unknowable (Little, 2008, p.10), yet the above highlights the range of potential threats that is apparent.

2.2.1.3 Major accidents

Major accidents are seen as one of the UK's highest risks (HM Government, 2010a, p.27), with such phenomena also evident in literature (Ota, 2010, p.10; Edwards, 2009, p.15; Bosher, 2008, p.4; Curtin *et al*., 2005, p.3). Examples of such accidents are fires at energy plants (Edwards, 2009, p.15) and major transport accidents (Bosher, 2008, p.4). These have the potential for injury and widespread, potentially prolonged, disruption to various systems. A growing appreciation of the hazards, threats and major accidents, as well as their inherent consequences, is apparent in the literature, along with the acknowledgement that, as prescribed by Little (2008, p.10), every risk will never be identifiable (Bosher and Dainty, 2011, p.2; Coaffee, 2008a, p.307; Dainty and Bosher, 2008, p.259). In a study by Bosher *et al.* (2007a), stakeholder perceptions of the risks posed by hazards, threats and major accidents were investigated. Whilst the research showed some correlation between the UK's national assessment of risks in terms of the relatively high prioritisation of flooding, there was a lack of correlation in terms of the perceived terrorist threat, i.e. stakeholders perceived the threat of terrorism to be less significant than national risk assessments stated it was.

2.2.1.4 The interdependent nature of systems

Also evident is a growing appreciation of the interdependent nature of systems (natural, technological and socio-institutional). Whilst little is known regarding the inter-connected nature of the hazards and threats themselves, as well as the consequences of their mitigation (Harre-Young *et al.*, 2010, p.1128), what is evident is recognition of inter-connectivity in relation to cities and buildings (Gilbert *et al.*, 2003, p.44; Godschalk, 2003, p.136) as well as reliance on technology (Institute for Public Policy Research, 2009, p.72; Graham, 2001a, p.411), but most notably in relation to critical national infrastructure (Institution of Civil Engineers (ICE), 2010, p.5; de Brujne and van Eeten, 2007, p.19; Fritzon *et al.*, 2007, p.31; Rinaldi *et al*., 2001, p.11). The inter-connected nature of such infrastructure, referred to as 'systems of systems' by Haimes and Horowitz (2004, p.33) and Haimes and Longstaff (2002, p.440), in relation to the consequences of their failure, is also apparent, with such consequences being seen as amplifying and exacerbating implications due to their nature (ICE, 2010, p.7; Jowitt, 2010, p.6; Gaynor, 2008, p.1; Zimmerman, 2008; Fritzon *et al.*, 2007, p.31; Amin, 2002, p.67). The consequences of their failure, as well as the consequences of hazards, threats and major accidents that manifest, can be disastrous.

2.2.1.5 Disasters and their impact

Whilst the largest loss of life per disaster is observed in under-developed countries (Schipper and Pelling, 2006, p.21; Wamsler, 2006, p.151; O'Keefe *et al.*, 1976, p.566), complexity and impacts have increased over the years (Ofori, 2008, p.39; Menoni, 2001, p.106), most notably due to changes in the nature of hazards and threats, demographics and economic and socio-political issues, such as urbanisation and population growth (Bosher and Dainty, 2011, p.2). Such developments, coupled with the fact that disasters will never be completely preventable (Institute for Public Policy Research, 2009, p.34; von Lubitz *et al*., 2008, p.561; Furedi, 2002, p.7; Ofori, 2002, p.7), result in the need for the holistic consideration and mitigation of the plethora of hazards, threats and major accidents and their potential consequences.

2.2.2 Disaster Risk Management

> "The concept of hazard mitigation begins with the realization that many disasters are not unexpected" (Schneider, 2002, p.142)

Disaster Risk Management (DRM) therefore involves mitigation of such events to society by reducing and, where possible, avoiding the impact a disaster would have (Alexander, 2008, p.20). There are four phases of DRM, those being hazard identification, mitigative adaptations, preparedness planning, and recovery and rehabilitation/reconstruction (Bosher *et al.*, 2009a, p.11; Bosher, 2008, p.9). Mileti (1999) asserts that a DRM approach adopts a global systems perspective, anticipates ambiguity and change, rejects short-term thinking, accounts for social factors and embraces sustainable development, the knowledge base and appreciation for which has grown in recent years (Keane, 2005, p.22; Ofori, 2002, p.7). Through adopting a global systems perspective, also known as an all-hazards approach (Cole, 2010b, p.47), the inter-connected nature of the hazards and their mitigation is recognised. Anticipating ambiguity and change reflects the changing nature of hazards (as well as threats and major accidents), in terms of both number and severity, as previously highlighted. Rejecting short-term thinking encompasses two factors, the notion that DRM should be and endless process (Haigh and Amaratunga, 2010, p.17) and that it should be driven and incorporated in such a way that safeguards future generations (Bosher *et al.*, 2007a, p.165), which also links to sustainable development.

The social implications of disasters means that those societal influences resulting in vulnerability can be reduced, through adopting community-based and long-term (sustainable development) initiatives (Bosher and Dainty, 2011, p.4). Defining sustainable development as the creation and maintenance of prosperous social, economic and ecological systems (Folke *et al.*, 2002, p.7), DRM encompasses and builds on these, enhancing the capacity to manage such environments whilst safeguarding for future generations (Bosher *et al.*, 2009a, p.10). With emphasis on pro-activity (Malalgoda *et al*., 2010, p.426; Wamsler, 2006, p.151; Wilbanks, 2005, p.541; Schneider, 2002, p.142) and the use of both structural and non-structural mitigation measures (Bosher *et al.*, 2009b, p.794; Burby *et al.*, 2000), the UK government has recognised the importance of what is known as 'the resilience agenda' (Bosher *et al.*, 2009b, p.793). Highlighting why such an agenda and its inherent practices are needed, Grabosky (2007, p.9) asserts that:

> "If there is one thing the past two decades have taught us, it is nothing ever stays still for long. Problems and solutions that were barely foreseeable in 1986 are commonplace today. One has no reason to doubt that dramatic changes will continue to take place between now and the year 2026"

2.2.3 Resilience

> "Designing and constructing resilient built assets requires an in-depth understanding of the expertise and knowledge on avoiding and mitigating the effects of disasters in order to secure a safe and sustainable future" (Bosher *et al.*, 2008, p.1)

In defining resilience itself and what constitutes a resilient built asset, it is important to note the origins of the term and concept. Sapountzaki (2007, p.298) and Klein *et al*. (2003, p.35) highlight that the Latin root of the word is 'resilio', when means to 'jump back'; what could be considered as returning to a previous state. Holling (1973, p.14) is cited as being the first to define or identify resilience, in relation to ecological systems (Gunderson *et al*., 2000, p.425). Holling (*ibid*.) asserted that it is the:

> "…measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables"

Recent definitions of resilience seem lucid and, as highlighted by both Holling (1996) and more recently Bosher (2008), vary in distinct ways depending on emphasis. Definitions in terms of engineering put forward the notion that resilience entails the ability and process of returning to a previous, stable state (Gunderson *et al.*, 2002) and therefore stay closely aligned with the literal Latin meaning of 'resilio'. Such an adoption of the term is evident in literature, encompassing resilience as the means through which organisations or other such systems can 'bounce back' and therefore have an inherent 'bouncebackability' (Coaffee and Rogers, 2008a; Coaffee *et al.*, 2008, p.105; Longstaff and Yang, 2008; Fritzon *et al.*, 2007; Coaffee, 2006; Coaffee and Murakami Wood, 2006; Manyena, 2006, p.433; Burke, 2005, p.629). As asserted by Bosher (2008, p.13) however:

> "…the concept of resilience is also evolving to recognise that in some cases it is not sufficient for a system or built asset to merely 'bounce back' to its original state. It is

> essential to acknowledge that there is a need to ensure the system or built asset is a more robust version of what was there originally"

The view of resilience as a process as well as an output, its emphasis on prevention and mitigation as well as response and recovery, as well as capacity and change, is evident in Bosher *et al.* (2009a, p.11), the Institute for Public Policy Research (IPPR) (2009, p.73), Cutter *et al.* (2008, p.599), Tierney and Bruneau (2007, p.14) and Folke (2006, p.253). As notions of resilience can vary considerably, Rose (2007, p.384) asserts that this results in the importance of defining the term precisely, as there is a danger that it could become (or is becoming) a 'vacuous buzzword'. Whilst there is no single, over-arching definition of resilience, due to the context-specific circumstances and multiple levels of meaning that are attributed to resilience (Korhoren and Seager, 2008, p.412; Carpenter *et al.*, 2001, p.765; Gunderson *et al*., 2000, p.425), the IPPR (2009, p.73) have developed a three-generation definition of resilience, as summarised below:

- First Generation resilience is concerned with the ability of systems to absorb shocks and to return quickly into operation.
- Second Generation resilience relates primarily to community resilience and the recognition of social and psychological dimensions.
- Third Generation resilience involves anticipation, as well as recognising that the system is often better off not 'bouncing back' to its original state.

Whilst such a definition is helpful in providing an overview of resilience and its multi-faceted nature, Carpenter *et al.* (2001, p.779) assert that in relation to any context, confusion can be avoided by asking "resilience *of* what *to* what?". Its relationship to DRM is evident in three distinct ways: it encompasses proactive as well as reactive elements, entails an all-inclusive approach, and recognises socio-physical systems and their inter-connections (Bosher, 2008, p.13). The emergence of 'resilience' therefore reflects the recognition that disasters cannot always be prevented and the hazards, threats and major accidents that cause them are inherently connected to the social-physical systems that have been constructed (Dainty and Bosher, 2008, p.357). Glass (2008, p.183) however believes:

> "…there is no quick-fix solution to the mainstreaming of resilience within building design or indeed in the education of building professionals…The complexity inherent in design decision-making, professional relationships and higher order issues such as planning legislation, provide some specific problem areas for future research and policy-making to address"

In answering Carpenter *et al.* (2001, p.779, the IPPR (2009, p.73) and Glass (2008, p.183), the most evident 'form' of resilience has been a move towards what is known as 'urban resilience', which Bosher and Coaffee (2008, p.146) assert that:

’…is of growing importance in design, planning and civil engineering and that it should it be developed in a transdisciplinary way; incorporating a wide range of stakeholders involved with the structural and non-structural approaches that are required to attain urban resilience”

Encompassing all the preceding issues and recognitions, urban resilience encapsulates structural and non-structural mitigative actions, as well as socio-political, socio-technological and socio-institutional systems and their inter-connections, as shown in Figure 2.1.

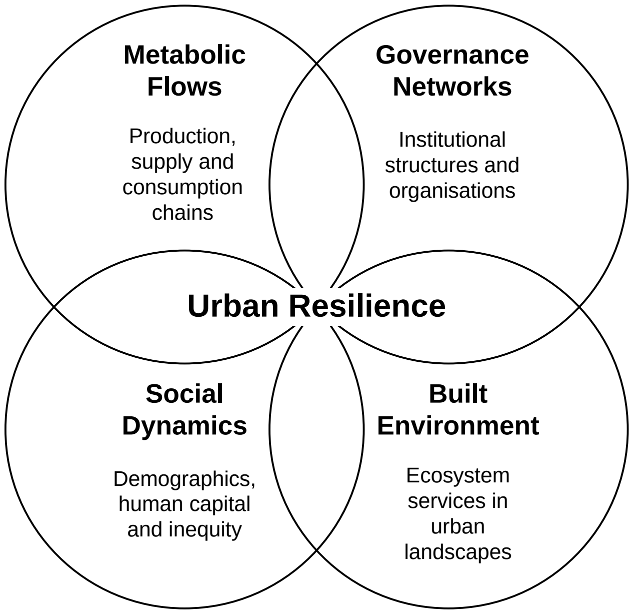


Figure 2.1. The four interconnected themes of urban resilience (Commonwealth Scientific and Industrial Research Office *et al*., 2007, p.10)

As defined by the Commonwealth Scientific and Industrial Research Office *et al.* (2007, p.10):

“What this focus provides is a multi-level understanding of the resilience of urban systems which recognises the role of metabolic flows in sustaining urban functions, human well-being and quality of life; governance networks and the ability of society to learn, adapt and reorganise to meet urban challenges; and the social dynamics of people as citizens, members of communities, users of services, consumers of products, etc, and their relationships with the built environment which defines the physical patterns of urban form and their spatial relations and interconnections”

In order to provide and maintain such a system, Bosher (2008, p.13) states that the built environment itself should therefore be designed, located, built, operated and maintained in such a way that maximises the ability and capacity of built assets, as well as the socio-physical and socio-institutional systems that support and use them, to be able to mitigate and anticipate, as well as respond to and recover from, the plethora of hazards, threats and major accidents that are apparent. Within this discourse however, Dainty and Bosher (2008, p.370) highlight that two factors are evident, those being the inherent complex and inter-related nature of all the systems, as previously highlighted, and the institutional resistance to change that pervades the construction industry and therefore hinders the progress that can be made, which will be explored in forthcoming sections.

2.2.4 The human influence

> "Paradoxically, the built environment (and related planning practices) are not only affected by disasters; they can also constitute one of its main cause[s]" (Wamsler, 2008, p.350)

Ofori (2002, p.2) asserts that the built environment 'bears the brunt' of the damage that is caused by disasters. Arguably however, disasters are 'disasters' because of the loss of life, or detrimental impact on them, that results from the concentrations of people in buildings. Without the aforementioned constructions/built environment, such a high number of people in one place would not be possible. So, disasters are disasters because of the human influence, hence it can be questioned as to whether any disasters are 'natural'. However, evident in the literature is a plethora of work citing the use of the term 'natural disaster' (e.g. Be Safe Not Shattered, 2011; Richards, 2011, p.190; HM Government, 2010a, p.25; Perera *et al*., 2010, p.1; Coaffee and O'Hare, 2008, p.173; Alexander, 2003; McEntire *et al.*, 2002, p.268). Bosher (2008, p.7) summarises the debate:

> "Are 'natural disasters' really that natural?...a flood event that occurs in the non-tidal stretch of the River Thames, inundating people's homes, businesses and lifelines will typically be referred to as a 'natural disaster' but the flood event manifests itself as a disaster because society (and this is predominantly the case in high-income societies) has chosen to build homes, infrastructure and businesses in an area vulnerable to floods"

Moore (2004) finds the idea of citing that human error as an explanation for disasters unsatisfying, but the consideration that people are the 'real cause' of disasters is evident in the 1976 work of O'Keefe *et al.* (1976, p.567) and other work since then has concurred with the socially constructed nature of disasters (Haigh and Amaratunga, 2010; Bosher *et al.*, 2009a; Bosher, 2008; Spence and Kelman, 2004; Weichselgartner, 2001; Geis, 2000; Mileti, 1999).

> "Human beings - not nature - are the cause of disaster losses" (Mileti, 1999, p.12)

Dainty and Bosher (2008, p.358) suggest that the way in which the built environment has expanded over the past 30 years has had little regard for such influences and has not only caused disasters, but has also exacerbated their effects. Those who design, construct and operate the built environment should therefore consider the influence they can have in relation to the hazards, threats and major accidents, in terms of both proactive and reactive efforts.

2.2.5 The role of those who design, construct and operate the built environment

Evident in the literature is the perspective that previous and current construction practices, as well as their governance, are insufficient and inappropriate for dealing with hazards, threats and major accidents (ICE, 2010, p.7; Glass, 2008, p.172; Ofori, 2002, p.18). Within the context of the UK, the ICE (2010, p.7) highlights that:

> "Terrorism is addressed in isolation by the CPNI, emergency planning is dealt with separately by the Civil Contingencies Secretariat, a new team has only just been set up to tackle the effects of climate change, long-term system failure is ignored, and no one is overseeing the resilience of the whole infrastructure network"

Despite resilience being branded as a magnet for built environment professionals in satisfying professional and moral duties in ensuring the sustainability and safety of communities (Fox, 2008, p.297), widespread adoption of DRM and resilience is not apparent. Furthermore, the calls for inter-related responses to the risks, as evident in the above quote, seem a distant objective and are fundamentally impeded by the professional fragmentation of the construction industry (Bosher and Dainty, 2010, p.6) and the broader socio-political landscape in which it sits, as well as the speed and profit motives of urban regenerators (Coaffee and Bosher, 2008, p.75). Whilst the role that those who design, construct and operate the built environment should have in DRM and resilience may be apparent, the aforementioned impediments to their full involvement remain; change is needed through the integration of such principles into the everyday practices of those stakeholders (Li, 2010, p.43; Bogunovich, 2009, p.87; Bosher *et al.*, 2009a, p.11; Godschalk, 2003, p.142; Lorch, 2001, p.416). Designing and constructing a resilient built environment, as part of such reform, demands an in-depth understanding of the mitigation of such risks, as well as an understanding of not just the value of such resiliency measures, but the implications of their incorporation. Whilst there is a clear case for built environment professionals to have such an understanding (Glass, 2008, p.184), the obligations to adopt such practices and incorporate such measures require understanding, as do the benefits of such action in the form of not just their cost-effectiveness, but in terms of their inherent value (Harre-Young *et al.*, 2010, p.1128; Harre-Young *et al.*, 2009, p.1292).

2.3 The Legislation of and Incentives for Mitigation in the UK

The legislation of mitigation and the incorporation of resiliency measures influence the protection of the built environment, yet legislated duties in relation to the mitigation of hazards and threats remain uncertain. Coupled with this is uncertainty surrounding incentives to pro-actively incorporate such measures, not just in terms of their cost-effectiveness but in relation to their value and how their performance is offset by their consequences.

2.3.1 Legislation and regulation

While legislation is evident in the mitigation of major accidents, e.g. Control of Major Accident Hazards (COMAH) Regulations of 1999 in relation to industrial sites, which requires organisations and sites to implement various resiliency measures (other legislation is also apparent in terms of pipelines etc), there is no such legislation in relation to the mitigation of hazards and threats. However, interpretations of existing legislation purport that there are specific duties to mitigate such risks under a number of existing Acts. In regard to broader notions of preparedness and response planning, the most and recent legislation that influences such issues is the Civil Contingencies Act 2004, which places a number of duties on stakeholders who are involved in the short- and long-term response to and recovery from a large-scale emergency (HM Government, 2005). Bosher and Dainty (2011, p.10) believe that the essence of the Act is multi-disciplinary and encompasses an 'all risks' approach, which in itself reflects a paradigmatic shift in the way such risks are managed compared to previous approaches. The Act does not, however, require such places as shopping centres or hotels and restaurants to adopt such practices nor incorporate appropriate resiliency measures.

In relation to the mitigation of threats specifically, two key Acts (the Management of Health and Safety at Work Act of 1992 and the Corporate Homicide and Corporate Manslaughter Act of 2007) are interpretable in such a way as to place duties on organisations and occupiers of buildings that relate specifically to the protection of such places from terrorism. Further information on perceived legislative obligations to protect such places from terrorism is presented in section 3.4.1.1.

2.3.2 Hazard mitigation incentives

Studies have highlighted a range of projects that provide a case for changes; they demonstrate significant incentives for implementing hazard mitigation. Benson and Twigg (2007, p.6) highlight a number of examples, including:

- a programme that was run in Vietnam to protect coastal inhabitants from typhoons and storms that cost an average $0.13 million a year, but resulted in savings of $7.1 million a year and aided in the saving of life and livelihoods, as well as providing further livelihood opportunities.
- a study in the Caribbean that found that through spending 1% of a structure's cost on resiliency measures, the costs of damage from hurricanes was reduced by approximately one third (although whether this offset the invest is unknown).
- a study that proved that for every $1 spent by FEMA on hazard mitigation, an average of $4 was generated in future benefits, including when retro-fitting.

- observations of two schools that remained standing in Grenada following a hurricane, both of which had been retro-fitted following a World Bank initiative.

The FEMA study emanates from research conducted by the Multihazard Mitigation Council (MMC, 2005), which investigated FEMA's initiatives between 1993 and 2003. The research concluded that the initiatives were cost-effective and reduced future losses, resulted in significant benefits to society as a whole in terms of such losses, and represented significant potential savings in terms of tax and reduced hazard-related expenditures (MMC, 2005, p.5). Specifically, the MMC (*ibid*.) found high cost-benefit ratios (as alluded to above), with the initiatives resulting in $14 billion of savings, compared to spending $3.5 billion, which were based on conservative assumptions. Bosher *et al.* (2007b, p.242) also question whether buildings protected from hazards might be sold or let for higher prices, due to their inherent resilience and reduced reparation costs, but there is no evidence of this yet.

2.3.3 Threat mitigation incentives

In a study examining the cost-effectiveness of a specific range of crime prevention measures, Armitage (2000, p.3) found that the average cost of the measures themselves was £440, but the average cost of a burglary to the victim was £1,670. The study also found that in the two schemes that were investigated, crime-rates before the incorporation of the measures were 67% and 54% higher (*ibid*., p.2), providing indicative results in relation to what could be expected for more severe crime prevention, but not a 'blanket statement' that incorporating such measures always works (Welsh *et al*., 2010, p.314); the extent to which the measures had a displacement effect is also unknown. A number of studies identify the costs of terrorist attacks, as well as possible incentives in relation to the protection of the built environment. These studies will now be explored, first providing an account of the literature on the costs that can be incurred as a result of terrorist attacks, then by exploring studies of the cost-effectiveness and benefits of incorporating measures to protect buildings.

2.3.3.1 The cost of terrorist attacks

Cost data on a number of terrorist attacks conducted by the Provisional Irish Republican Army (PIRA) is evident in Andrew (2009), who highlights that a bomb in Bishopsgate, London, on 24 April 1993 caused damaged estimated at £350 million (*ibid*., p.783), a bomb on the Isle of Dogs in February 1996 caused £85 million worth of damage (*ibid*., p.794), and a bomb in Manchester City Centre in June of that year that caused approximately £450 million worth of damage (*ibid*.). In relation to the Manchester City Centre attack, another study suggests that the loss of turnover from local businesses was estimated at £50 million and the rebuilding programme cost over £500 million (Williams *et al*., 2000). In relation to the terrorist attacks of September 11th, 2001, in the United States of America (USA), Coaffee (2009a, p.165) states that insurance losses from the attacks totalled over $40 billion, figures that appear conservative considering Lenain *et al's* (2002, p.17) assertion that such losses could have reached $58 billion. Whilst Marshall (2002, p.2) highlights that the total costs of the attack were estimated at $151 billion, Weidenbaum (2003, p.6) indicates that $135 billion of costs were incurred overall, which is in stark contrast to the figure spent in mounting the attack, which was estimated at approximately $500,000 (resulting in costs of $270,000 being incurred for every $1 spent in mounting the operation, using Weidenbaum's (*ibid*.) figures; $320,000 for every $1 using Marshall's (2002, p.2) figures). The devastation that can be caused by such attacks is most evident when considering the attack on Manchester City Centre in 1996 (Gregory, 2007a, p.187). Insurance claims following the attack on the Baltic Exchange in the City of London in 1992 were even greater than those made following the Manchester attack, reaching approximately £800 million (Andrew, 2009, p.782). What is not evident is how these costs might have been affected if CTMs had been incorporated into all the buildings and local area.

2.3.3.2 The cost-effectiveness of mitigating terrorist attacks

Whilst studies highlight examples where the incorporation of CTMs successfully resulted in the saving of lives and less damage than would have been caused if such measures had not been incorporated (e.g. Andrew's (2009, p.772) account of a mortar attack on 10 Downing Street in 1991), there is a lack of data on the cost-effectiveness and additional benefits of CTMs themselves (Harre-Young *et al.*, 2010, p.1128; Stewart, 2010, p.30; Harre-Young *et al.*, 2009, p.1291; Little, 2004a, p.56). Whilst Cherry *et al*. (2008, p.87) provide an indication as to the potential benefits of certain actions and measures in improving crime and security and rates their cost and effectiveness in terms of being low, medium or high, such assertions are not evidenced. Stewart (2008, p.119), based on preliminary economic analysis in comparison to hurricanes and seismic hazards, asserts that the incorporation of CTMs can be cost-effective for buildings that will incur significantly high damage or which face a specific threat (such as key governmental institutions). These findings are concurred in future studies (Stewart, 2011; Stewart, 2010), with the most recent study asserting that a minimum of 10% of a building's costs should go towards substantial risk reduction (Stewart, 2011). Harre-Young *et al.* (2010, p.1125) question whether organisational CTMs would be the most cost-effective, through the use of Business Continuity Planning (BCP) in order to enhance an organisation's preparedness, response and recovery.

Whilst the Multihazard Mitigation Council (2005) and Armitage (2000) provide indications of what could be expected in relation to other resiliency measures (Bosher and Kappia, 2010, p.1149; Harre-Young *et al.*, 2009, p.8) and literature highlights contributing factors to the cost-effectiveness of such measures, such as the process of the design stage in which they are incorporated (CPNI, 2010, p.14; HM Government, 2010c, p.10), informed or reasoned accounts remain elusive. Furthermore, considering the inter-related nature of the hazards, threats and major accidents that the built environment is at risk from, neither are studies forthcoming in providing research in relation to these issues and how they relate to the protection of the built environment itself. Harre-Young *et al.* (2009, p.8) indicate that those studies form a base from which a more holistic account of what benefits and consequences such measures can bring and to whom can be developed.

Fussey (2011b, p.164) explains that two of the most significant and recent influences in the shaping of the built environment have been the threats of crime and terrorism, with terrorism becoming one of the most high profile societal threats (Bosher *et al.*, 2007b, p.242). This is evident despite terrorism being a relatively small risk compared to hazards in terms of likelihood (NaCTSO, 2010c, p.6; Bosher *et al.*, 2009b, p.801; Bux and Coyne, 2009, p.2937; Stewart, 2008, p.119; Beall, 2007, p.5; Briggs and Edwards, 2006, p.30). Drawing on the specific scope of this research and in relation to CTMs specifically, in the forthcoming sections and chapters it will be made clear that despite such influences (and Government strategy that seeks their incorporation – see Harre-Young *et al.*, 2009), further research is needed. With the aforementioned fragmentation of the construction industry (Bosher and Dainty, 2011, p.6) and the objective of 'least cost' being a key decision-making principle (Devine-Wright *et al*., 2003, p.46), a greater understanding of terrorism is required, as is an understanding of counter-terrorism and how the such practices and the incorporation of CTMs contribute to the resilience agenda, in terms of their benefits and consequences.

2.4 Conclusion

This chapter has highlighted that from a construction perspective, there are numerous risks that face organisations, each of which require attention in their own right. However, a plethora of design considerations are evident in the agendas of those who design, construct and operate the built environment. A range of hazards, threats and major accidents pose a risk to the built environment and, as a result of the way in which it has been designed and maintained, the vulnerability of built assets has become apparent. DRM and the resilience have emerged in recent years to address such vulnerabilities and the mitigation of potential impacts, with the notion that human beings, not nature, are the cause of disasters (Mileti, 1999, p.12), most notably through the way in which the built environment is designed. There is, therefore, a role for those who are responsible for the design, construction and operation of the built environment to incorporate resiliency measures into vulnerable places.

Whilst legislative requirements and incentives aid in the mitigation of such risks, of growing concern has been the nature in which the terrorist threat in particular is mitigated, most notably in relation to concerns regarding cost and return on investment, design and permeability, user experience, and environmental concerns. However, little is known regarding what measures can be used to protect such assets, with their incorporation into crowded places being seen as most important, due to the nature of the threat against them and the potential harm that can be caused through their destruction. The UK government is encouraging those responsible for the protection of public places to incorporate CTMs into building designs where appropriate (Bosher and Kappia, 2010; Harre-Young *et al.*, 2010; Harre-Young *et al.*, 2009). However, numerous and wide-ranging issues are evident in incorporating such measures (Harre-Young *et al.*, 2009, p.1289) and they therefore require further attention, as whist there is an increasing range of information on these issues, there is a lack of suitable guidance on them, most notably in relation to their proactive mitigation (Bosher *et al.*, 2008, p.6). The following chapters therefore aim to explore the relationship between counter-terrorism and the built environment further, in order to research what CTMs can be used to protect such places, as well as their inherent performance and consequences, in order to provide such guidance.

3.0 Counter-Terrorism and the Protection of Crowded Places

The UK's history of terrorism is evident in a range of literature (Silke, 2011, p.12; HM Government, 2009b, p.3; Keane and Esper, 2009, p.4; Makarenko, 2007, p.37; Loukaitou-Sideris *et al*., 2006, p.735; O'Brien and Read, 2005, p.354; Elliott *et al*., 1992, p.287). As highlighted by Richards (2011, p.189):

> "The British are, of course, no strangers to the threat of terrorism"

The threat of terrorism exists in relation to three areas, those being Northern Ireland-related terrorism, international terrorism and domestic extremism. Literature on these threats will now be explored, leading to discussions on the UK's counter-terrorism strategy and the implications it has on the design, construction and operation of the built environment.

3.1 The Terrorist Threat

Whilst the UK may not be a 'stranger to terrorism', it faces threats of longstanding and of relatively recent emergence. Northern Ireland-related terrorism has been evident in political and security discourses for decades, as has the relatively lower threat of domestic extremism (and the occurrence of other threats). However, the emergent threat from international terrorism that has emerged has dominated such discourses in recent years. Crowded places, transport infrastructure and critical national infrastructure are being structurally and non-structurally protected, which has ramifications on their design and experience. Explorations of the threats are therefore required to understand why these places are considered vulnerable and why such actions are being undertaken.

3.1.1 The threat from Northern Ireland-related terrorism

> "It is an absolutist ideology with no room for compromise on complete independence, with the use of 'physical force' seen as the means to achieve its political objectives" (Richards, 2007, p.82)

The threat from Northern Ireland-related terrorism is synonymous with a protracted terrorist campaign that targets crowded places and critical national infrastructure on the mainland. While a protracted campaign had been carried out in Northern Ireland, it was felt that the campaign was not resulting in sufficient pressure on the British Government and therefore, the campaign was extended to England (Coaffee, 2003a, p.75). The use of violence was concentrated in Northern Ireland, but in February 1974 the PIRA began a mainland UK campaign, through the targeting of a coach carrying soldiers, an attack which claimed twelve lives (Andrew, 2009, p.624) and marked the beginning of decades of terrorist plots and attacks. Evident in the campaign was the targeting of economic points (Andrew, 2009, p.655;

Coaffee, 2009a, p.7; Coaffee, 2003c, p.67) and critical national infrastructure (Andrew, 2009, p.795), as well as transport infrastructure and crowded places (Cherry *et al*., 2008, p.77; Dolnik, 2007, p.3). Although there may not have been a coherent strategy encompassing the targeting of economic key points (Andrew, 2009, p.695), there was a growing risk posed by PIRA (Cole, 2010a, p.18; Briggs, 2005, p.24). As highlighted by Dolnik (2007, p.3), between 1991 and 1999, 81 explosive devices were left on the British underground and railway systems. PIRA deployed a range of methods including the use of VBIEDs, mortar attacks and assassinations (Wilkinson, 2007a, p.13) and attacked the same target more than once (Andrew, 2009, p.644), but arguably the most prominent attack that was carried out was the attack on Manchester City Centre in 1996 (Harre-Young *et al.*, 2009, p.1286), an attack that caused over £500 million of damage (Williams *et al*., 2000). The latest edition of the UK's counter-terrorism strategy (see section 3.2) highlights that over the past two years, the threat from such terrorism has increased, with 40 terrorist attacks being carried out in 2010, and 16 having been carried out up to the 30th June 2011 (HM Government, 2011b, p.5). More recently, assassinations, VBIEDs and an IED that was thrown into the bank have been reported (BBC, 2011a; BBC, 2011b). Hence, the threat posed by Northern Ireland-related terrorism is not just seen as continuing to pose a threat (CPNI, 2010, p.3), but is seen as a growing concern (HM Government, 2010f, p.41).

3.1.2 The threat from Al Qaeda, its affiliates and supporters

> "Al-Qaeda is the most dangerous international terrorist network in the history of modern terrorism. This is because of its commitment to mass killing and economic destruction and disruption, and because it has absolutist religio-political beliefs which make it incapable of political pragmatism and compromise" (Wilkinson, 2007b, p.34)

The UK Government asserts that the principal threat from international terrorism is and will continue to come from Al Qaeda, its affiliates and supporters (Cabinet Office, 2012; HM Government, 2010a, p.28; HM Government, 2010f, p.41). The most notable differences between the threat from Northern Ireland-related terrorism and this particular threat are suicide attacks (Richards, 2011, p.189; Makarenko, 2007, p.51; Wilkinson, 2007b, p.30) and mass casualties (CPNI, 2010, p.3; HM Government, 2010a, p.28; Wilkinson, 2007b, p.32). Although such differences are evident, most notably demonstrated by the terrorist attacks of September 11th 2001, Al Qaeda also aspires to use other methods of attack, including chemical, biological, radiological or nuclear (CBRN) weapons (HM Government, 2010a, p.28; British Council for Offices, 2009, p.142; Littlewood and Simpson, 2007, p.59; Makarenko, 2007, p.52; Wilkinson, 2007b, p.30). As with the methods of attack used by the PIRA, Wilkinson (2007b, p.32) asserts that targets and tactics that are deemed as successful are returned to. In 2003, as many as 100 suicide bombers were reportedly residing in the UK, many of whom are likely to be supporters of Al Qaeda (Makarenko, 2007, p.51). While the leadership of Al Qaeda is at its weakest since the terrorist attacks of September 11th 2001, threats still remain from supporters and groups based on their ideology (HM Government, 2011a, p.9). Arguably, the support for such groups has risen due to the 'war on terror'.

> "it is simply ignoring reality to deny that the invasion and occupation have been a big boost for Al-Qaeda and a setback for the coalition against terrorism" (Wilkinson, 2007b, p.28)

The 'war on terror' has been exploited by Al Qaeda through the use of the conflict to boost their propaganda and increase the 'divide' between the coalition and Muslim communities (Makarenko, 2007, p.40; Wilkinson, 2007c, p.373; Briggs, 2005, p.22). Arguably therefore, as the terrorist threat has implications for the design, construction and operation of the built environment (as will be explored in forthcoming sections and chapters), so does the 'war on terror' (Coaffee *et al.*, 2009a, p.262).

3.1.3 Domestic extremism and other threats

Although no attacks have been carried out in relation to animal rights extremism, considering that such experimentation continues, so too will the threat of such attacks being carried out (Richards, 2007, p.107). More recently, threats in relation to crime and disorder have been evident, through the undertaking of protests that have resulted in public disorder and criminal damage, as well as the widespread rioting that occurred in UK cities in August 2011, which resulted in a range of criminal damage and looting of retail outlets (BBC, 2011c). Between January 2009 and December 2010, over 600 people were arrested in the UK for terrorist-related offences (including in relation to Northern Ireland-related terrorism), more than any other country in Europe (HM Government, 2011b, p.5).

3.1.4 The evolution of the terrorist threat

> "Terrorism and counterterrorism are evolutionary processes; once one side gets used to certain tactics and developed countermeasures, the other side has to innovate and develop new ones, and so on" (Stephens, 2009, p.7)

There is a constant change in relation to the targeting and protection of evolving assets. However, as is evident in relation to the methods of attack adopted in relation to Northern Ireland-related terrorism and by Al Qaeda, specific sectors or individual places have been targeted repeatedly (Andrew, 2009, p.644; Wilkinson, 2007b, p.32). The inherent vulnerability of the built environment to terrorism is a factor that will continue to result in its targeting (Little, 2004a, p.53). However, as was evident in the terrorist attacks that occurred in Mumbai, which involved the use of firearms and hostage-taking, terrorist threats will continue to evolve (Harre-Young *et al.*, 2010, p.1128) as well as be sustained (Clarke and

Soria, 2009, p.51; Jenkins, 2001, p.1; Savitch and Ardashev, 2001, p.2524). What has been questioned however, is the extent to which recent evolutions in the terrorist threat, most notably the fear of Mumbai-style attacks, will influence security policies (Coaffee, 2009b, p.350).

3.2 The UK's Strategy for Countering Terrorism

The UK has had a counter-terrorism strategy since 2003, known as CONTEST, which aims to reduce the risk of terrorism so that people can go about their daily lives freely and with confidence (HM Government, 2011a, p.9; Coaffee, 2010, p.944; Harre-Young *et al.*, 2009, p.1285; HM Government, 2009a; HM Government, 2009b). CONTEST is organised around four strands, those being 'Pursue', the stopping of terrorist attacks taking place; 'Prevent', stopping people from becoming terrorists or supporting violent extremism; 'Protect', the strengthening of targets; and 'Prepare', the mitigation of and preparedness for an attack (*ibid*.). In 2009, Jonathan Evans (Director General of the UK's Security Service (MI5)) added that there was a fifth 'P', perseverance, in an address to Security Service staff (Andrew, 2009, p.828). This, along with the notion of 'Prepare', alludes to recognition that it may not be possible to prevent every terrorist attack that is planned (Silke, 2011, p.12). The most recent edition of CONTEST, published in July 2011, reiterates the objectives of the strategy (although more emphasis has emerged on 'Prevent') and sets out the Government's aims for the coming years (see HM Government, 2011a; HM Government, 2011b). Gregory (2007b, p.326) highlights research in 2003 that found that the absence of a publicly available Government counter-terrorism strategy was criticised, as was the absence of a public terrorism threat system. Such a system, along with CONTEST, now exists and is publicly available (see for example www.MI5.gov.uk for up to date information). The system is based on five levels of threat (as shown in Figure 3.1) and corresponds with the enforcement of three security levels (as shown in Figure 3.2).

Critical	An attack is expected imminently
Severe	An attack is highly likely
Substantial	An attack is a strong possibility
Moderate	An attack is possible but not likely
Low	An attack is unlikely

Figure 3.1. UK terrorism threat levels (NaCTSO, 2009b, p.57)

Critical	Exceptional
Severe	Heightened
Substantial	
Moderate	Normal
Low	

Figure 3.2. Corresponding terrorism threat and response levels (NaCTSO, 2009b, p.57)

Assessments of the threat level is made by the Joint Terrorism Analysis Centre, a centre represented by staff from various departments, with the threat levels being designed to indicate the likelihood of a terrorist attack and the response levels providing an indication as to the extent of security measures that should be applied at any given time (HM Government, 2006). Most pertinent to the design, construction and operation of the built environment is ‘Protect’, as it encompasses the protection of critical national infrastructure, crowded places and the transport system, both within the UK and in relation to interests overseas (HM Government, 2009a, p.106). Therefore, whilst CONTEST is non-statutory, the ‘Protect’ strand has implications for those who are responsible for the design, construction and operation of such places (Coaffee, 2010, p.941; Harre-Young *et al.*, 2010, p.1123; Harre-Young *et al.*, 2009, p.1285). This is congruent with the paradigmatic shift reported by Bosher and Dainty (2011, p.13) that has begun to reform how such risks are managed. A further example of such change is highlighted by Coaffee (2010, p.953) who asserts that the publication of a suite of guidance documents aimed at the protection of crowded places (HM Government, 2010b-d), following a consultation period, denotes a more reflective approach to counter-terrorism and how issues such as proportionality, aesthetics and design are being considered.

3.2.1 Protecting crowded places

> “National policy makers and the security services now perceive attacks against crowded public places as one of their key priorities in the ongoing fight against terrorism” (Coaffee *et al.*, 2008, p.105)

As highlighted in the previous sections, the threats from terrorism that are faced in the UK, both in terms of Northern Ireland-related terrorism and the threat from Al Qaeda, show that crowded places have been targeted and attacked repeatedly. While their inherent vulnerability (due to their ‘soft’ or typically unprotected nature) is a considerable factor influencing their targeting, so too is their symbolism of modern-day capitalist living (Fussey, 2011a, p.93; Moller, 2007, p.192; Zilbershtein, 2005, p.807; Bleiker, 2003, p.430; Warren, 2002, p.614). The definition of a crowded place, purported by HM Government (2010b, p.3) is:

> "a location or environment to which members of the public have access that may be considered potentially liable to terrorist attack by virtue of its crowd density"

In terms of a definitive list of such places, HM Government (2010d, p.9) assert that crowded places comprise bars, pubs and night clubs, restaurants and hotels, shopping centres, sports and entertainment stadia, cinemas and theatres, visitor attractions, major events, commercial centres, the health sector, the education sector and religious sites/places of worship. A plethora of plots targeting such places are evident in the literature, including the targeting of nightclubs, pubs and shopping centres (Andrew, 2009, p.817) and the intended use of radiological materials and firearms (HM Government, 2009b, p.7). Of all the publicly evident cases of terrorism since 2001, transport infrastructure and/or crowded places have always been targeted (Clarke and Soria, 2009). Harre-Young *et al.* (2009) add that plots before and after the studied period still conformed to the same principles. The emergence of the threat towards crowded places is also evident in a range of other literature (Coaffee, 2010, p.942; HM Government, 2010b-e; Harre-Young *et al.*, 2010, p.1121; RIBA, 2010, p.5; Coaffee *et al.*, 2008, p.103; Gilbert *et al.*, 2003, p.45). Evident too is the prominent use of VBIEDs (see Clarke and Soria (2009) for details of recent plots), due to their relatively low cost but severe consequences, making them one of the most effective methods of attack (Bosher and Kappia, 2010, p.1143; CPNI, 2010, p.15; HM Government, 2010c, p.5; British Council for Offices, 2009, p.109; Mays and Hadden, 2009, p.12; NaCTSO, 2009b, p.45; Coaffee *et al.*, 2008, p.103). The use of multiple VBIEDs (or the additional use of other IEDs), during the same or simultaneous/sequential attacks is also a possibility (Zilbershtein, 2005, p.807).

3.2.2 Organisations and initiatives

In order to enhance the security of the UK, a number of organisations and initiatives nave been established, i.e. the CPNI and NaCTSO, together with a variety of free-to-attend projects.

3.2.2.1 The CPNI and Government Security Advisers

The CPNI is the Government authority that provides advice on the protection of critical national infrastructure from terrorism and other threats, in relation to physical, personnel and information security (CPNI, 2011). The CPNI publishes a range of guidance documents on protective security and the protection of assets from terrorism (CPNI, 2010; CPNI, 2007; CPNI, 2005), the most recent (and relevant) being a guide specifically advising on integrated security in relation to vehicle-borne threats (CPNI, 2011). The latest edition of the Protecting Against Terrorism series (CPNI, 2010), has one stark difference to its predecessor (CPNI, 2005), that being the prominence and emphasis given to security culture. Whereas the 2005 edition incorporated information on the importance of security culture within and in relation to personnel security, it is now a section in its own right and is woven through the entire guidance document. Again, this reflects the recognition of the inter-related nature of risks and the over-arching cultures and principles that are required to successfully and holistically mitigate them. Within the CPNI are Government Security Advisers (GSAs), who use intelligence regarding terrorist threats and are therefore ideally suited to advise on the protection of assets and potential threat methodologies.

3.2.2.2 NaCTSO and Counter Terrorism Security Advisers

> "The National Counter Terrorism Security Office (NaCTSO) is a police unit responsible for raising awareness of the terrorist threat and for encouraging the implementation of protective security measures to reduce the risk and impact of a terrorist attack" (HM Government, 2010d, p.12)

In order to achieve the above, NaCTSO co-ordinate, train and task a network of Counter-Terrorism Security Advisers (CTSAs), who are trained to assess the risks faced by crowded places and advise on their protection (NaCTSO, 2011, p.1; HM Government, 2010d, p.5). NaCTSO have created a vulnerability self-assessment toolkit (available from their website; www.nactso.gov.uk), and have also published a range of 'counter-terrorism protective security' guidance documents, for each of the crowded place sectors (NaCTSO, 2006a-2011). NaCTSO have also produced booklets on insurance, business continuity and risk management (NaCTSO, 2010a-c), and have produced a self-assessment tool for assessing vulnerability for businesses, which is available from their website. CTSAs become involved in the protection of crowded places either through direct liaison and engagement by stakeholders involved in projects, or through referrals by Police Architectural Liaison Officers/Crime Prevention Design Advisers, who provide crime risk management advice (HM Government, 2010b, p.11). As asserted by HM Government (2010d, p.22):

> "Many sites across the crowded places sectors have briefed their staff on the identification of hostile reconnaissance by suspected terrorists, either through Project Argus, Project Griffin or Operation Lightning"

- Project Argus is a table-top exercise, produced by NaCTSO and delivered by CTSAs, that takes businesses (as well as a range of other stakeholders, such as designers), through a simulated terrorist attack, prompting discussion and exploration of vulnerability and mitigation (HM Government, 2010d, p.23). The events are free of charge, being delivered within businesses themselves or at local or regional events.

- Project Griffin is a Police initiative that accredits security personnel to improve their skills and knowledge in relation to counter-terrorism, most notably in the identification of hostile reconnaissance and the deterrence and detection of crime (HM Government, 2010d, p.24).
- Operation Lightning is a Police-coordinated operation, specifically dealing with the identification of and response to hostile reconnaissance, in order to gather intelligence and investigate suspicious activity (HM Government, 2010d, p.24).

The incorporation of physical measures into the built environment in order to deter and mitigate the impacts of various crimes has occurred throughout history (Briggs, 2005, p.68). In contrast, the incorporation of CTMs has only occurred relatively recently, but the related discourse is informed by the plethora of literature on the topic. How the use of such measures emerged will therefore be explored, through their present-day use and envisaged incorporation into broader agendas of resilience. Although the protection of crowded places may be promoted and envisaged, a number of factors influence whether such places are protected. Furthermore, factors also influence the value attributed to CTMs.

3.3 Counter-Terrorism and the Built Environment

While the use of 'fortress architecture' and 'defensible space' have been highlighted as being extensively used in Northern Ireland during the early 1970s and 1980s to territorially control areas (Coaffee, 2004b, p.201), the use of such measures arguably emerged beforehand, through the onset of Crime Prevention Through Environmental Design (CPTED). CPTED is a design concept that asserts the improvement of public safety through the design of physical environments, in order to influence human behaviour (Coaffee, 2009a; Gunning and Josal, 2004; Thompson and McCarthy, 2004; Crowe, 1991). It emerged as a result of increasing disillusionment with existing frameworks for the management of crime (Cozens *et al.*, 2001, p.147) and encompassed the consideration of territoriality, surveillance, access control, target hardening, image and maintenance, as well as the encouragement of activity (Cozens *et al.*, 2005), as shown in Figure 3.3. Studies into CPTED found that the incorporation of its principles reduced crime levels and the fear of crime, as well as increasing property values and investments in areas where such principles had been incorporated (*ibid*., p.341). More recent studies have incorporated gender sensitivity into CPTED (see Beebeejaun, 2009; DeKeseredy *et al.*, 2009), but the most notable advancement has been in relation to the creation of Secured By Design (SBD). SBD is based on physical security, surveillance, access and egress, territoriality, management and maintenance (Armitage, 2000), integrating CPTED principles into housing design, which was adopted by the Association of Police Officers in the 1980s (Coaffee, 2009a, p.22).

Figure 3.3. The seven elements of CPTED (Moffat, 1983, p.23)

The initiatives lead to a discourse of 'defensible space', which purported to 'design out' crime through the incorporation of specific measures, or the removal of various features (*ibid*., p.4). Such notions of defensible space then transcended into the specific context of counter-terrorism, with such principles being used in attempts to 'plan out' terrorist attacks from occurring in Northern Ireland, by incorporating what became known as 'rings of steel; (Coaffee and Murakami Wood, 2006, p.505). Following its perceived success and due to the embarking of a mainland terror campaign by the PIRA, a 'ring of steel' was set up to protect the City of London (Coaffee, 2003c, p.69). The 'ring of steel' evolved over the coming decades in alignment with the nature of the terrorist threat that was faced (Coaffee, 2009a; Coaffee, 2003a) and additional means of protection were sought, most notably through urban planning and design.

3.3.1 Urban design and counter-terrorism

> "Urban planning and design is increasingly seen as a universal remedy to an ever-increasing array of socio-economic problems, policy priorities, and risk and threats facing contemporary society" (Bretherton and Coaffee, 2009, p.35)

Coaffee *et al.* (2009b, p.489) assert that such measures have traditionally territorially controlled areas, through the regulation, restriction and controlling of access, and ensuring they were covered by surveillance, but such methods have major implications for the experience of such places. However, complexity is evident in the merging of these methods with principles of urban design. Defining urban design as the process of making better places than would have otherwise been produced (Carmona *et al*., 2003, p.3) and it being everything that you can see 'out of the window' (Tibbalds, 1988, p.1), it is evidently apparent how everything that could be seen could be the 'enforced territoriality' alluded to above. Furthermore, with the assertions that better urban design adds value in three ways, those being by increasing the economic viability of developments, delivering enhanced social benefits and by encouraging environmentally-supportive development (Carmona, 2004, p.119), the implications that the incorporation of CTMs has in relation to this requires consideration. Rogers and Coaffee (2005, p.323) assert that government policy has been concerned with making the environment of cities more attractive as a whole, whilst also improving safety and security. HM Government (2010b, p.5) states that the incorporation of counter-terrorism into the built environment is to be achieved within the overall aim to create high quality public places. However, Coaffee (2010, p.940) notes:

> "…we need to consider the 'physical' changes brought about through counterterrorism measures being embedded in the urban landscape as a result of heightened terror threat levels"

3.3.1.1 Fortress UK?

The aforementioned 'physical changes' are apparent in the literature, including notions that the incorporation of counter-terrorism into urban design has resulted in the militarisation of places and spaces, demised the iconography of cities and buildings, decentralised them, increased fear and impeded civil liberties. Much literature alludes to the relationship between counter-terrorism and urban design resulting in the 'militarisation' of urban space, through the use of CTMs that were used in Northern Ireland and London, such as barriers, access control and surveillance systems (Coaffee, 2008a, p.300; Benton-Short, 2007, p.430; Németh and Schmidt, 2007, p.283; Briggs, 2005, p.70; Coaffee, 2005, p.448; Graham, 2001a, p.415). The demise of iconography is raised as a concern due to the potential for buildings to be punctuated by an 'architecture of fear', or become the subject of anonymous design (Coaffee and O'Hare, 2008, p.176; Coaffee, 2003c, p.64). Furthering the issue of iconography and an apparent dichotomy between it and counter-terrorism, Briggs (2005, p.71) asserts that:

> "The point at which iconic buildings and ambitious designs seem dangerous decisions is precisely the moment we need to embrace them more enthusiastically than ever before"

Coaffee (2009a, p.63) states that cities are becoming spatially and socially restructured, incorporating a territorial order that controls and organises space. Such a perspective is also evident in the earlier work of Coaffee (2005, p.448; 2003c, p.64), as well as that of Atkinson and Flint (2004). The creation of 'exclusion zones' and 'gated communities' is argued as being explicit in the incorporation of CTMs, fragmenting the urban landscape as opposed to creating a cohesive (or more 'open') design. The emblematic nature of CTMs is cited in a range of literature, with authors asserting that there is a disproportionate feeling of fear (considering the relatively low likelihood of a terrorist attack occurring compared against other risks), which is influenced by the aforementioned militarisation of urban space (Richards, 2011, p.190; Németh and Hollander, 2010, p.22; Button, 2007; Grosskopf, 2006, p.7; Troutman, 1997, p.147; Marcuse, 1997, p.102) as well as the nature of its reporting by the media (Coaffee and Van Ham, 2008, p.191; Mythen and Walklate, 2006, p.123; Briggs, 2005, p.29). As surmised by Wolfendale (2007, p.75):

> "…many of the current counterterrorism practices pose a greater threat to individual physical security and well-being than non-state terrorism. We should fear counterterrorism more than we fear terrorism"

The impediment and diminishing ethical accountability in relation to civil liberties was evident in Coaffee (2009a, p.254; 2008a, p.304; 2004, p.209; 2003c, p.64) and Vesilind (2003, p.71), with the authors claiming that the incorporation of CTMs will occur at the expense of the aforementioned accountability, most notably through the 'creep' of such measures having begun to 'surge'. Whilst there is considerable literature on the aforementioned issues, the apparent tension between urban design and counter-terrorism, and the loss of public space (Németh and Hollander, 2010, p.24), as asserted by Németh and Schmidt (2007, p.283), few studies have empirically tested such perspectives. Németh and Hollander (2010, p.24) showed that across three cities in the USA, approximately 17% of publicly accessible space was either closed or severely restricted. Furthermore, they assert that the measures used to enforce such restrictions were 'fading into the background' (*ibid*., p.31); becoming increasing 'invisible'.

> "This is an important lesson: it is possible to convert security zones into usable and useful public spaces" (Németh and Hollander, 2010, p.32)

Furthermore, Coaffee (2010, p.940) highlights that the forthcoming US Embassy specifically seeks not to be associated with notions of 'fortification', through the incorporation of ponds and gardens, instead of fences and walls. The challenge for stakeholders is to create crowded places that incorporate CTMs yet maintain quality of place (RIBA, 2010, p.3).

3.3.1.2 Invisible counter-terrorism

However, part of the emblematic nature of CTMs is to show that places have been protected (Harre-Young *et al.*, 2010, p.1124; Coaffee *et al.*, 2009b, p.495), yet as alluded to above, the incorporation of 'invisible' CTMs is apparent, through the incorporation of landscaping and nature as opposed to security-explicit barriers. Whilst its synergy with urban design is evident, how such measures relate to the symbolic notion of protection is not. Briggs (2005, p.77) asserts that the 'toning down' of such measures has been subject to significant attempts in recent years and is even evident in the published designs of public areas (National Capital Planning Commission, 2002). Coaffee *et al*. (2009, p.499) highlight that there is an indicative spectrum of visible security, ranging from overt security features (target hardening and fortress architecture), to stealthy security features (such as street furniture and water features), through to 'invisible' security features, such as sacrificial façades. Whilst it should be noted that the invisibility of CTMs is not necessarily an objective in its own right, certain scenarios will purposefully seek to incorporate visible measures (Coaffee *et al*., 2009, p.490; Coaffee and Bosher, 2008, p.80; Zilbershtein, 2005, p.812), the evolution of such measures from their traditional beginnings is an important development (Briggs, 2005, p.70), especially considering the range of criticisms previously highlighted. Evident, however, are concerns and contrasting opinions regarding the perceived vulnerability of places that incorporate such measures, as it could be argued that the use of invisible measures could be perceived by its users as being vulnerable to attack (Coaffee *et al*., 2009, p.499; Zilbershtein, 2005, p.812). Yet, Guidry (2007, p.69) highlights that it can alleviate such fears and enhance the quality of the area. The effectiveness of such measures is also raised; Coaffee, O'Hare and Hawkesworth (2009, p.506) highlight that the use of such CTMs has been widely publicised. The publication of the whereabouts of, as opposed to the existence of, such CTMs could denote that aesthetics and user experience is a key objective, but it could be argued that the use of invisible CTMs could reduce the risk of being attacked as much as entirely visible CTMs would, as hostile reconnaissance would identify that the place could not be attacked (using certain methods of attack). What is evident is that the visibility of such measures, perceptions of them and the consequences of their use requires further research and clarification (Zilbershtein, 2006, p.810).

3.3.2 Towards a turquoise agenda

The notion of a 'turquoise agenda' refers to the work of Perelman (2008), who suggested that the discourses of security (the blue agenda) and sustainability (the green agenda) were currently handled separately, when in fact a challenge exists to develop a new infrastructure doctrine that integrates the synergies of both, whilst addressing any trade-offs and therefore reaching a 'turquoise' design theory. As highlighted in Chapter Two, there has been a paradigmatic shift in the way that hazards, threats and major accidents are managed in the UK (Bosher and Dainty, 2011, p.10; Coaffee, 2009a, p.298), most notably through the emergence of resilience as the key discourse in relation to security, as well as being an objective of individual buildings and society more generally. Perelman (2008) asserts that this is the essence of the 'turquoise agenda', also referred to as resilience; the merging of security concerns with the broader goals of sustainability and sustainable development. Defining sustainable development as encompassing economic development, social development, and environmental protection (Baker, 2008, p.1; Zimmerman, 2008, p.3; Folke *et al.*, 2002, p.7), the role of resilience in these objectives is evident. As asserted by Coaffee (2008b, p.4636):

> "In future decades it is most likely that the sustainability agenda will provide the most appropriate policy vehicle for the achievement of resilience, with security seen as an essential element of corporate and organisational responsibility alongside economic, environmental and social concerns"

This notion is also evident in UK government policy, with security being held as a key component of the government's sustainability agenda (Fussey *et al.*, 2011, p.32) and in other literature (Coaffee and Bosher, 2008, p.75; Zimmerman, 2008, p.1). However, while such an approach may be evident, how it is carried out in practice, is not (Coaffee and Bosher, 2008, p.76). Coaffee and Bosher (*ibid*.) assert that there are a number of synergies in relation to security and environmental sustainability and that such influences are one way in which their integration will be ensured. Holderman and Harris (2008, p.6) state that such an approach will only be achieved if their respective advocates make it happen, with security and sustainability converging specifically in the area of urban infrastructure (Zimmerman, 2008, p.1), linking directly to notions of urban resilience:

> "In summary, security and sustainability need not be mutually exclusive. We possess the knowledge and capability to do both, and to do them well. However, this will not occur without a conscious and persistent effort to identify and achieve multiple objectives" (Little, 2008, p.10).

There is a plethora of literature on the perceived consequences of traditional counter-terrorism approaches, which includes contradictory accounts of the militarisation and fortification of urban spaces. However, none of these identify the range of CTMs that are available (rather, they focus on individual examples and specific implications). Literature on the development and emergence of 'invisible' CTMs raises the prospect of synergies between urban design and counter-terrorism, as well as the potential enhancement of the user experience, through the seemingly un-impinged design and permeability of places and spaces. Coupled with the shift that has been evident in the UK, moving from the management and mitigation of individual risks on a case-by-case basis, through to broader notions of resilience, the value of CTMs in this regard requires attention. However, prior to the development of a typology that begins to identify CTMs and their inherent performance and consequences, the influences on the protection of crowded places are explored in section 3.4 and influences on the value of the CTMs themselves are covered in section 3.5.

3.4 Influences on the Protection of Crowded Places

> "…there appear to be a number of long-standing disagreements among built environment professionals regarding the desire and practicalities of terror-proofing urban areas and embedding such resilience into the practices of urban regeneration" (Coaffee and Bosher, 2008, p.79)

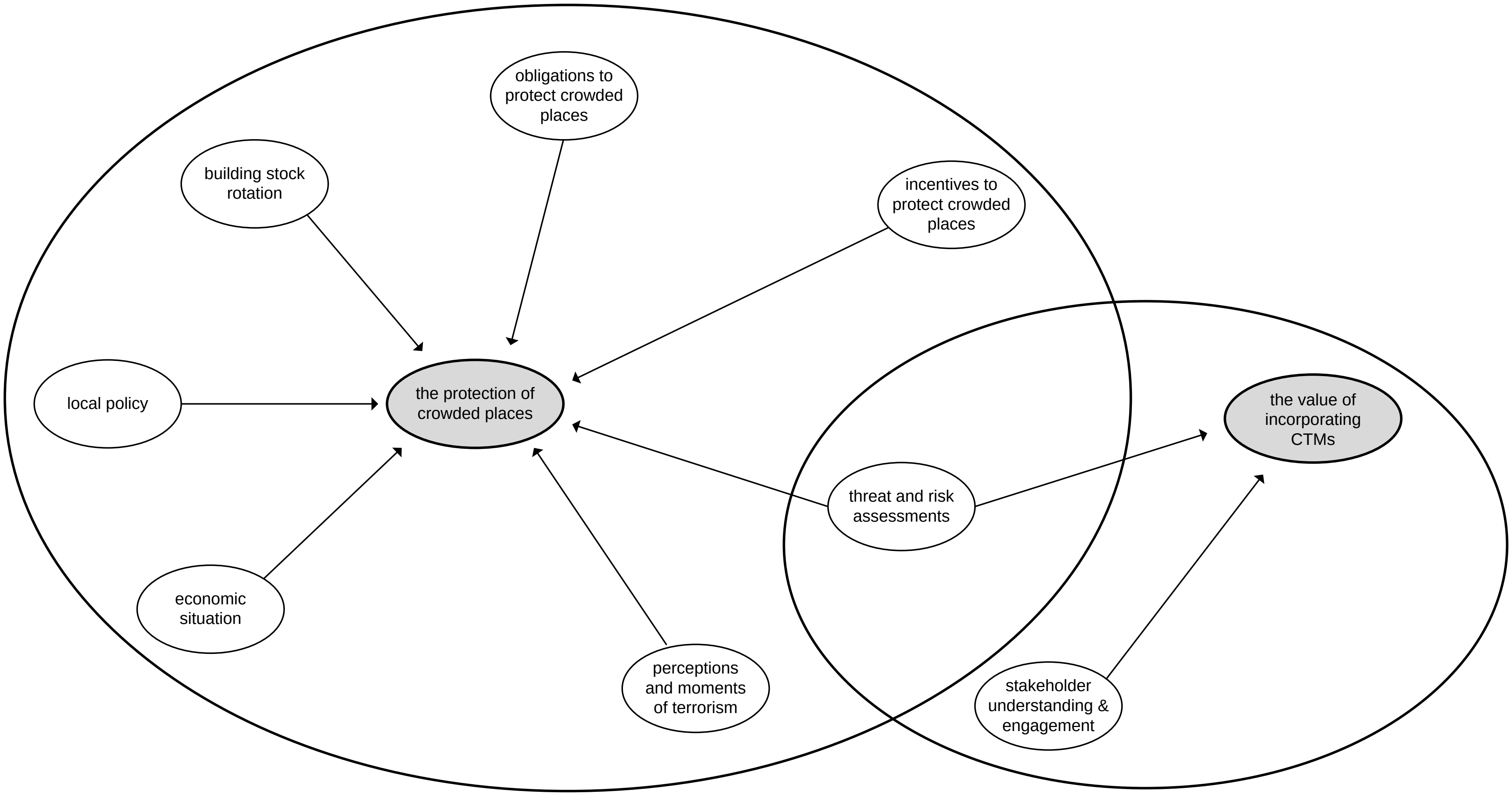
Coaffee and Bosher (*ibid*.) go on to assert that there are three key issues in relation to the above, those being proportionality, acceptability and cost, and aesthetics. The relation of the quote to the four prominent agendas that have been previously identified are clear, i.e. acceptability referring to user experience, cost relating to the costs of the CTMs themselves (as well as any return on investments), and aesthetics relating to un-impinged design and permeability. Environmental and energy concerns are also raised, with the authors debating the synergies and conflict between 'security' and 'sustainability' agendas. Whilst the aforementioned agendas appear to be at the forefront of the minds of the stakeholders who are responsible for the design, construction and operation of the built environment, seven factors have been identified that influence whether such places are protected from terrorism or not, those being obligations, incentives, threat and risk assessments (TARAs), perceptions and moments of terrorism, economic influences, local policy and building stock rotation. As well as this, two factors that influence the value of CTMs themselves were identified, those being TARAs and stakeholder engagement and understanding. To present all these influences and how they relate to the protection of crowded places and the value of CTMs, Figures 3.4 and 3.5 provide an illustrative summary of a theoretical framework, as well as the inherent relationships that result in the protection of crowded places and the influences on the value of CTMs used to protect such places. The literature behind the influences that can determine whether such places are protected is examined in section 3.4 and the influences on the value of CTMs is examined in section 3.5. As shown in Figures 3.4 and 3.5, seven influences on the protection of crowded places were evident in the literature, those being obligations, incentives, TARAs, perceptions and moments of terrorism, economic influences, local policy and building stock rotation.

3.4.1 Obligations

Whilst CONTEST and its four strands are non-statutory (Harre-Young *et al.*, 2010, p.1123; Harre-Young *et al.*, 2009, p.1289), a number of obligations are apparent in terms of legislation and insurance, as well as moral obligations to protect crowded places from terrorist attack. This section will explore and analyse the literature on each of these factors.

3.4.1.1 Legislative obligations

The legislative context in which the protection of crowded places from terrorist attack is not clear (Coaffee and O'Hare, 2008, p.178), but a number of sources infer that there are legal responsibilities to protect such places that can result in prosecution and liability if an attack occurs (CPNI, 2011, p.46; NaCTSO, 2009b, p.5; Veale, 2009, p.291), as well as the possible requirement to submit plans and procedures to inquiries after an incident occurs (British Council for Offices, 2009, p.149).



influences on the protection of crowded places

influences on the value of CTMs used to protect crowded places

Figure 3.4. The skeleton theoretical framework

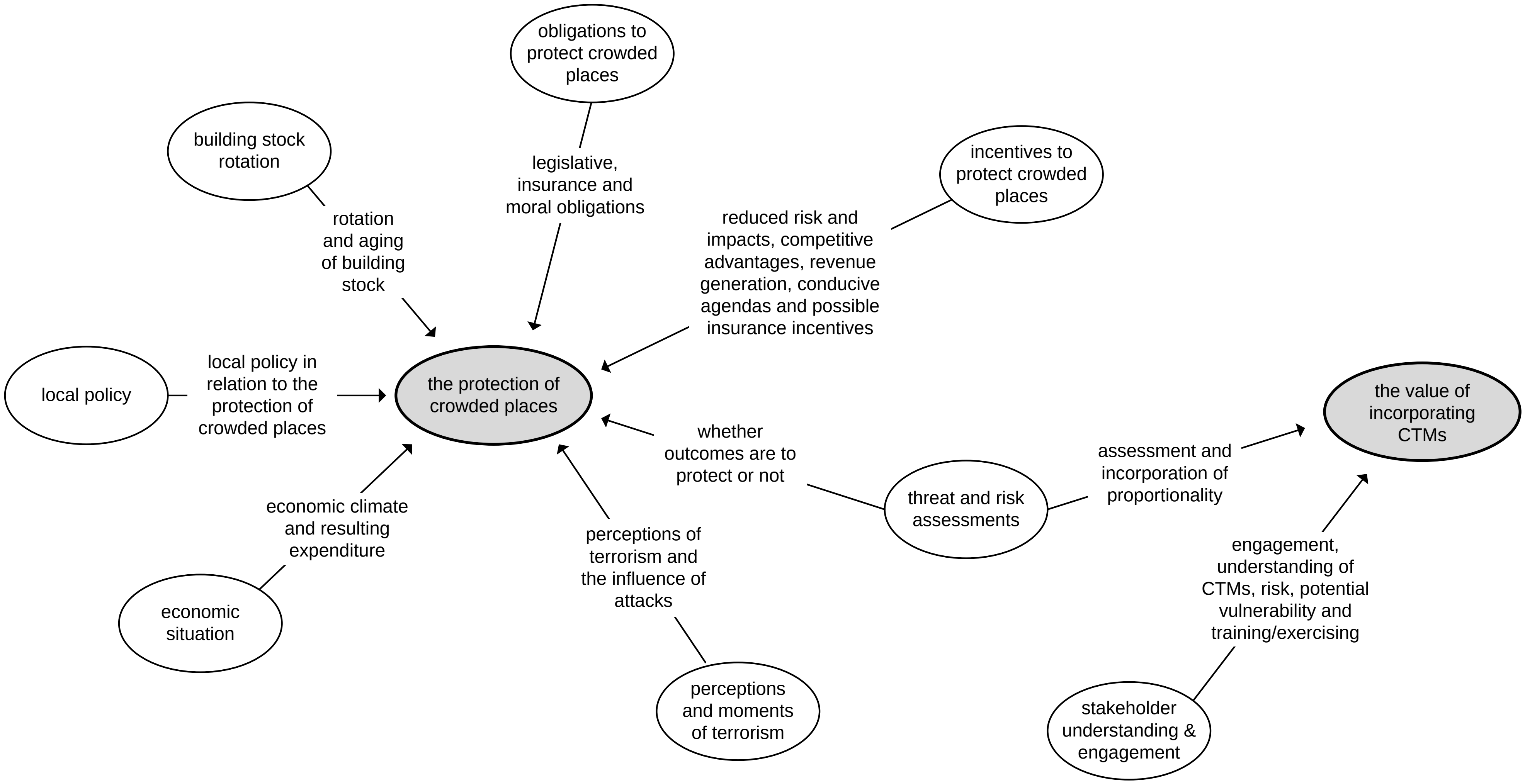


Figure 3.5. An expanded skeleton framework

The main benefit of implementing legislative requirements is the increase in resilience of a place or space (Tomlinson and Nelson, 2010, p.51; Coaffee and Bosher, 2008, p.75; Ling and Soh, 2005, p.278; Spence, 2004, p.391), an absence of any such requirements results in those who are responsible for the design, construction and operation of the built environment to avoid incorporating such resiliency measures, regardless of their perceived cost and/or benefits (Coaffee and O'Hare, 2008, p.179). However, as stated by Coaffee and Bosher (2008, p.79):

> "…the forced adoption of counter-terrorist principles within design could lead to less visibly pleasing architecture and the increased control of access to public space"

Such sentiments were also evident in Ling and Soh (2005, p.277), who asserted that such 'impositions' could present stakeholders from obtaining maximum returns on their investment. Prominent in the literature, however, are perceived legislative requirements relating to four different Acts, the two most prominent being the Management of Health and Safety at Work Act of 1992 and the Corporate Homicide and Corporate Manslaughter Act of 2007.

Management of Health and Safety at Work Act 1992

> "Current legal opinion implies that this legislation may be interpreted to include the safety of employees when there is a threat of a terrorist act or other violent act" (Veale, 2009, p.290)

The opinion that the aforementioned legislation can be interpreted to include protection from terrorist attack is also evident in Fussey (2011b, p.165), CPNI (2010, p.4), British Council for Offices (2009, p.148) and the Home Office (1999, p.8). The implication is that 'duty of care' in the legislation does encompass terrorist acts and 'appropriate procedures' include the use of CTMs (British Council for Offices, 2009, p.148). Veale (2009, p.291) provides an example of legislation used in the event of a terrorist attack, by highlighting that the New York Port Authority was found to be negligent in protecting the World Trade Center prior to the 1993 terrorist attack, after receiving advice from UK and US sources that the parking was vulnerable to attack.

Corporate Manslaughter and Corporate Homicide Act 2007

> "…companies, organisations and, for the first time, governmental bodies as a collective face an unlimited fine, a publicity order and a remedial order if they are found to have caused death due to gross corporate health and safety failures (Adams, 2009, p.70)

This Act implies that senior management within an organisation will be seen as responsible for any breaches in duty of care obligations that fall below what would be reasonably expected (*ibid*.; British Council for Offices, 2009, p.ix; NaCTSO, 2009b, p.6; Veale, 2009, p.ix). Direct legal action can have significant implications for organisations, including compensation (not covered by insurance) and reputation (NaCTSO, 2009b, p.6).

Other legislation

Veale (2009, p.291) thinks that two further items of legislation should also be considered, those being the Construction (Design and Management) Regulations 2007, which clarify risk management duties in relation to buildings throughout their lifecycle, and the Construction Products Directive of the European Community, which requires products to be fit for their intended use, including injury from explosion. The British Council for Offices (2009, p.ix) asserts that the Sustainable and Secure Building Act gave the UK Building Regulations the potential to cover security aspects in relation to building design. Future developments in relation to this will need to be monitored.

3.4.1.2 Insurance obligations

> "After IRA terrorist incidents in the early 1990s, reinsurance companies withdrew cover for claims resulting for terrorist incidents. Insurance companies then introduced a terrorism exclusion clause to their policies for commercial property" (British Council for Offices, 2009, p.143)

The exclusion of terrorism from insurance cover, which was also highlighted by Coaffee (2009a, p.142), also entailed the exclusion of other threats, such as civil war, riots and strikes (British Council for Offices, 2009, p.147). Cover was generally limited to £100,000, a figure that would be inadequate for most commercial properties and as a result, the Pool Reinsurance Company was established, consisting of private insurers who were guaranteed by the Government (British Council for Offices, 2009, p.143). Increases in insurance premiums resulting from the establishment of the PoolRe scheme were made apparent in Fussey (2011b, p.165), Coaffee (2009a, p.153) and Shillum (2008, p.35). Whilst, as with legislation, requiring buildings to incorporate CTMs would increase their resilience and reduce the impacts of an attack (Spence, 2004, p.391), where terrorism cover is established, shortcomings (or 'loopholes') in the policies are being exploited (Bleiker, 2003, p.12).

3.4.1.3 Moral obligations

> "During terrorist attacks and other disasters, peoples' safety often depends on the facilities they occupy" (Sternberg and Lee, 2006, p.1)

Where peoples' safety is dependent on an organisation, due to vulnerabilities they face, there is therefore a moral obligation to (proportionately) protect them from harm. Little (2004b, p.4060) showed that organisations who focussed on such core values and culture performed the best in high-risk environments. The Institute for Public Policy Research (2009, p.20) has advocated that Business Continuity Planning (BCP) should be promoted as an element of Corporate Social Responsibility (CSR). Furthering this, the British Council for Offices (2009, p.141) contend that:

> "Exercising the 'duty of care' by ensuring that the office environment is as safe and secure as possible is now viewed as an important facet of corporate social responsibility"

Whilst moral obligations are (or should be) a factor in the protection of crowded places from terrorist attack, numerous other factors require attention, including the incentives offered by protecting such places.

3.4.2 Incentives

> "…security does add value to the bottom line, and it is equally possible to see security as 'value-added' as it is a cost, but it means generating metrics that show that, and a commitment to proving that it provides a worthwhile Return on Investment" (Gill, 2007, p.28)

What is the value of incorporating CTMs into organisations and their premises? What return on investment is achievable? Evident in the literature are six over-arching incentives for the protection of crowded places, those being the reduced risk of being attacked, reduced impacts of an attack, competitive advantages, revenue generation, conducive agendas and possible insurance incentives. As terrorist attacks are perceived to be of relatively low frequency, building a business case for their incorporation can be difficult (Kappia *et al.*, 2009, p.630). This, coupled with the requirement for organisations to finance the incorporation of CTMs using their own resources (Grabosky, 2007, p.10), results in a reliance on the incentives and benefits of their use to be understood. However, with no literature presenting all the incentives under one, publicly available publication, it would appear such incentives are neither widely known nor understood.

3.4.2.1 Reduced risk of attack

By incorporating CTMs, the risk of an attack will reduce:

> "The intention of such measures is to manipulate the built environment to reduce the attractiveness and physical opportunities to access targets while increasing the

likelihood of apprehension and, thus, the chances that an individual will deem the offence too risky" (Fussey, 2011a, p.86)

However, the risk is reduced through displacement, which is the increased risk of an attack occurring at another location (spatial displacement), time (temporal displacement) or through different methods of attack (tactical displacement). Such displacement could occur deliberately (where displacement is an objective, as opposed to the reduction of risk), or unintentionally (Coaffee, 2009a, p.61). Spatial displacement is the most evident form of displacement in the literature, cited by a plethora of studies (Fussey, 2011a, p.89; Fussey, 2011b, p.173; Steven, 2011, p.158; Coaffee, 2009a, p.25; Stephens, 2009, p.7; Coaffee and O'Hare, 2008, p.176; Meuller, 2008, p.3; Lakdawalla and Zanjani, 2005; Coaffee, 2003c, p.74; Raco, 2003, p.1880). Temporal displacement is cited by Fussey (2011a, p.89), as is tactical displacement, which is also evident in the work of Steven (2011, p.158), Stephens (2009, p.7), Dolnik (2007, p.13) and Cozens *et al*., 2001, p.140). While a recent study has questioned the occurrence of such displacement (Kurawski, 2010, p.273), criticism of it as a consequence emerged in literature on CPTED (as referred to in section 3.3). However, as stated by Cozens *et al*. (2005, p.342), it is a consequence (and criticism) of all crime prevention strategies. Evident in the literature however is the symbolism of a potential target (Fussey, 2011a, p.93; Fussey, 2011b, p.173; Harre-Young *et al.*, 2010, p.1128) and also the notion that protecting places from terrorist attack could also increase their attractiveness as a target, as through its protection it has highlighted it has 'something to protect' (Steven, 2011, p.159; Zilbershtein, 2005, p.810), with a resulting escalation in the tactics used to attack such a place (Steven, 2011, p.159). Whilst there are cases where incorporating CTMs reduces the risk of an attack and displaces that risk (Harre-Young *et al.*, 2010, p.1124; Coaffee, 2003a, p.26), research has shown that targets can be attacked repeatedly (Andrew, 2009, p.644). Also intrinsically linked to displacement is the notion of 'invisible' CTMs (3.3.1.2), as it could be questioned whether the use of such measures would attract targeting or increase the fears of those who use the area, if they cannot see that they are protected. As stated by Zilbershtein (2006, p.810):

"This dilemma concerning visibility of security measures, perceived image and consequential responses is an area that demands much more research"

3.4.2.2 Reduced impacts of an attack

"…a small or medium sized enterprise, with a very localised market, could be permanently put out of business by a major incident, as happened to about 60 per cent of businesses affected by the 1996 Provisional IRA bombing of Manchester" (Gregory, 2007b, p.322)

The impacts of an attack, as demonstrated above, can be significant. However, business interruption and loss are just one of the impacts that can be felt, with the immediate impacts of the blast itself and the resulting debris, long-term health implications and the damage to reputation also contributing to the consequences of an attack.

Damage and debris

Upon detonation of an explosive device, there will be a blast wave, fireball, a shattering effect (also known as brisance), damage from debris (primary and secondary fragments) and ground shock (CPNI, 2011, p.8; HM Government, 2010c, p.6; British Council for Offices, 2009, p.164).

> "The most widespread cause of injuries and internal disruption from an external bomb blast is the fragmentation and inward projection of window glass" (British Council for Offices, 2009, p.169)

The lethality and potential of glazing is also evident in Be Safe Not Shattered (2011), Fussey (2011b, p.166), HM Government (2010c, p.6), RIBA (2010, p.13), Mays and Hadden (2009, p.19), Little (2004c, p.66), Jenkins (2001, p.12) and Mallonee *et al.* (1996, p.382). Consideration should also be given to structural collapse (HM Government, 2010c, p.6) and other short-term or long-term debris (HM Government, 2010c, p.6; Mays and Hadden, 2009, p.15; Park and Alderson, 2004, p.9.5). Such damage is not necessarily confined to the immediate vicinity of the explosion either, as glass can break 500m away, based on a 'car bomb' (Be Safe Not Shattered, 2011), with impacts being felt 8km away when the 'lorry bomb' exploded in Manchester City Centre in 1996 (Williams *et al*., 2000, p.296). The impact of any explosion will increase with the density of the surrounding area (Glaeser and Shapiro, 2002, p.206; Williams *et al*., 2000, p.296).

Business interruption and loss

The extent to which business interruption and loss occurs will be dependent on the size of the device itself, the effects of the explosion, the nature of buildings (as alluded to above) and the wider area that is impacted. Such impacts will occur in relation to lives lost and direct property damage (Multihazard Mitigation Council, 2005, p.2), disruption costs (Bosher and Kappia, 2010, p.1149; CPNI, 2010, p.4; British Council for Offices, 2009, p.9) and the cost of the response itself (CPNI, 2010, p.4; Multihazard Mitigation Council, 2005, p.2). As a result of the Manchester City Centre bombing, approximately 60% of businesses that were affected went out of business completely (Gregory, 2007b, p.322); loss of turnover from local businesses was estimated at £50 million and the subsequent rebuilding cost over £500 million (Williams *et al*., 2000). 1,200 properties were affected, 672 businesses were displaced and over 100,000m^2 of office and retail space was immediately decommissioned, as well as damage occurring to residential properties, local transport infrastructure (*ibid*., p.297). 2,500 workers were temporarily laid off, with "a few hundred" losing their jobs permanently (*ibid*., p.298).

Health implications

Health implications are evident, even for those who were not present or directly impacted by the attack (Schuster *et al.*, 2001), most notably due to public panic (Durodié and Wessely, 2002, p.1901), cardiac arrest (Williams *et al*., 2000, p.297), Post-Traumatic Stress Disorder (PTSD) and depression (Galea *et al.*, 2002, p.952) and resulting absenteeism for organisations (Howie, 2009a, p.51).

Reputation

> "The reputational damage of a security breach is something that will concern all senior management – the loss of trust following a failure to protect staff, clients or even data may prove difficult to recover" (CPNI, 2010, p.4)

Apparent in the literature was the value companies now place on reputation and brand, as shown above but also by Fussey (2011b, p.165), Fussey *et al.* (2011, p.136), Veale (2009, p.292), Briggs (2005, p.55), Curtin *et al*., 2005, p.x) and Spencer and Winch (2002, p.41). Reputation can be damaged prior to an attack, based on inadequate security, as well as after an attack in the procedures that were in place and how effective they were in dealing with the attack (British Council for Offices, 2009, p.141). As is evident from the above, the consequences an attack can have are profound, resulting in an incentive to ensure they do not occur or are mitigated. Literature on how reputation and brand can be enhanced and therefore provide an incentive to protect crowded places is discussed next.

3.4.2.3 Competitive advantages

The incorporation of resiliency measures (not just CTMs) as a competitive advantage is evident in Bosher *et al.* (2009a; 2007a) and Hamel and Valikangas (2003). Bosher *et al.* (2007a, p.172) assert that those in the construction sector should embrace and pre-empt regulatory change, using it as an opportunity for competition within sectors by incorporating CTMs and broader resiliency measures. Considering economic influences such as downturns, any advantage to increase proposal success would be more welcome and could simply entail the consideration of certain resiliency measures, as opposed to extensive incorporation, showing greater consideration as to the longevity and design of the places and spaces. In the following section, revenue generation from CTMs will be explored; a factor that could increase the benefits of incorporating them into proposals and seeking the aforementioned competitive advantages:

> "Threats to the built environment should not be seen as problems but as opportunities to develop and provide niche products and solutions related to hazard mitigation" (Bosher *et al*., 2009a, p.18)

Whilst the above highlights the advantages for those who design, construct and operate the built environment, the advantage for businesses to incorporate them (clients or tenants) are furthered by Briggs and Edwards (2006, p.18), who assert that security is not merely about increasing safety and/or perceptions of it, it is one of the most important sources of competitive advantage evident today. This is reinforced by Hamel and Valikangas (2003, p.63):

> "Any company that can make sense of its environment, generate strategic options, and realign its resources faster than its rivals will enjoy a decisive advantage. This is the essence of resilience. And it will prove to be the ultimate competitive advantage in the age of turbulence"

3.4.2.4 Revenue generation

Not only can the incorporation of CTMs themselves generate revenue, (see Coaffee (2005, p.462) for an example of the congestion charge incorporated around the City of London), their incorporation can lead to increases in reputation and branding (HM Government, 2010c, p.34; Coaffee *et al.*,2009a, p.215; Coaffee and Van Ham, 2008, p.192), as organisations and crowded places can become synonymous with security, enhance their reputations and as a result, increase their income through repeat business (thus also leading to possible competitive advantage). Whilst not evident in the literature, it is possible that rental premiums could be charged, due to the increased resilience of the buildings themselves, as Cozens *et al*., 2005, p.341) found that property value increases were evident in areas that had incorporated CPTED principles into their designs.

3.4.2.5 Conducive agendas

Considering other agendas that normally influence the design, construction and operation of the built environment can also be conducive to counter-terrorism, through providing opportunities and synergies to incorporate CTMs whilst enhancing buildings or areas in other ways. Pedestrianisation, regeneration, environmental enhancement and adopting a holistic approach are examples of this and are evident in the literature.

Pedestrianisation

> "it is possible to convert security zones into usable and useful public spaces" (Németh and Hollander, 2010, p.32)

Through pedestrianisation (the synergy with counter-terrorism being traffic exclusion), the safety and security of a wider area could be protected, benefitting more places (HM Government, 2010c, p.12), also possibly resulting in a more cost-effective solution. Welsh *et al*., 2010, p.301) say that through pedestrianisation and increased street usage, natural surveillance is increased. Also evident is how pedestrianisation itself can lead to regeneration; as the RIBA (2010, p.16) highlight an example of a project where pedestrianising an area for counter-terrorism purposes encouraged cafes, restaurants and bars into the area in the long-term; hence the protection of crowded places can increase footfall and the revenue of businesses in the protected area.

Regeneration

> "Many cities are now overtly linking security to urban regeneration" (Coaffee, 2009a, p.86)

Such a perspective is also adopted by Fussey *et al.* (2011, p.109), RIBA (2010, p.16), Coaffee and Rogers (2008a, p.215; 2008b, p.107) and Raco (2003, p.1870). Such regeneration can occur across varying spatial scales, with examples of the immediate vicinity surrounding crowded places being presented by RIBA (2010, p.16), through to multiple and wider spatial scales, as is evident with the merging of regeneration and security in relation to the Olympic Games that will be held in London (and elsewhere in the UK) in 2012 (Fussey *et al.*, 2011, p.109). The consequences of merging such agendas can increase the attractiveness of areas themselves, especially in relation to being able to host large-scale events (Coaffee and Rogers, 2008b, p.107).

Holistic approach

By not just focussing on the protection of individual crowded places, or even on a specific method of attack, more cost-effective solutions can be incorporated, as wider areas could be protected (resulting in potential pedestrianisation and regeneration benefits), as well as providing an increased deterrent through showing a higher level of consideration in relation to the protection of a given area (Little, 2004a, p.56). CPNI (2011, p.14) highlight the importance of adopting a holistic approach in terms of site security, to ensure that individual CTMs do not compromise other measures/initiatives.

Environmental enhancement

> "…one way to ensure that security features are embedded in an acceptable and appropriate manner within planning and design is by integrating such considerations with ideas of sustainability and reduced energy consumption" (Coaffee and Bosher, 2008, p.80)

The incorporation of counter-terrorism (as well as security more broadly) with environmental enhancements is evident in a range of literature (HM Government, 2010c, p.12; Coaffee and Bosher, 2008, p.80; Coaffee, 2003c, p.79; Marshall, 2002, p.6). Coaffee (*ibid*.) and Marshall (*ibid*.) highlight how excluding and restricting traffic from a given area can decrease pollution, a benefit that could result in an increase in users due to improved air quality (Marshall, 2002, p.6). For further information on other synergies between security and sustainability, see Coaffee and Bosher (2008).

3.4.2.6 Insurance incentives

Whilst potential obligations under insurance policies were explored in section 3.4.1.2, insurance can be used to incentivise the protection of crowded places from terrorist attack, as well as increase the resilience of buildings and areas more broadly. The insurance industry is arguably a key influence in the protection and resilience of such places, through their ability to regulate and control the incorporation of such measures (Crichton, 2008, p.130; Lakdawalla and Zanjani, 2005; Gloyn, 1994, p.12). Insurance policies cannot cover all losses, such as lost information and reputation (NaCTSO, 2010a, p.24; 2010c, p.12), but the potential for reduced insurance premiums is clear if protective measures are incorporated (Bosher and Kappia, 2010, p.1149; Marshall, 2002, p.6), as is the competitive advantages to be gained by those who incorporate CTMs through reduced excesses and premiums from insurers. Arguably however, the PoolRe scheme (as discussed in section 3.4.1.2) acts as a disincentive for such action, as loss is underwritten by the Government. However, it could also be argued it acts as an incentive, as the reputations of organisations are highly valued, therefore it arguably attracts them to protect intangible elements using their own resources. As stated by the British Council for Offices (2009, p.x):

> "On the face of it, insurers would appear to be a logical way of encouraging security because, ideally, it should reward those who adopt protective measures by reducing their insurance premiums to reflect the decreased risks… Unfortunately, the commercial insurance market does not follow this practice… However, it is worth noting that adopting additional security measures should reduce the likelihood of claims on policies and thus could reduce premiums in the long-term"

3.4.3 Threat and risk assessments

TARAs can influence whether crowded places are protected or not, as the outcome of such an assessment could be to re-locate (to a less vulnerable or attractive area), or that the risk of an attack is low enough to not warrant the incorporation of CTMs; although literature fails to highlight this. However, also evident in the literature is how TARAs can influence the value of CTMs used to protect crowded places. TARAs encompass factors in relation to the assessments themselves (section 3.4.3.1), the assessment of the terrorist threat (section 3.4.3.2), situational context (section 3.4.3.3) and proportionality (section 3.4.3.4).

3.4.3.1 The assessment

The British Council for Offices (2009, p.13) states there are seven steps to TARAs, those being:

1. Assess the threat potential
2. Quantify the threat potential
3. Assess the impact or consequences of the threat being carried out
4. Quantify the impact or consequences of the threat being carried out
5. Assess the level of risk and risk appetite
6. Allocate a management strategy
7. Decide on appropriate mitigation measures

The need for engagement between stakeholders is also apparent, as organisations will need to not just understand their own business, but also the external threats (CPNI, 2010, p.8; Tomlinson and Nelson, 2010, 51; British Council for Offices, 2009, p.13). As stated by Tomlinson and Nelson (2010, p.52):

> "The threat and risk assessment (TARA) is the foundation for all subsequent security planning and design work. It is therefore vital that a properly researched, bespoke TARA is commissioned, and done in the concept design stage"

As highlighted in section 3.4.3, the outcome of such a TARA could be to re-locate or choose another location to design the required building and should therefore be carried out before a site is chosen (British Council for Offices, 2009, p.88). Yet, it will also influence those designs, inform the CTMs (and other resiliency measures) to be incorporated, inform organisational plans and procedures, as well as influence overall resilience (British Council for Offices, 2009, p.10). Therefore, if such an assessment is not carried out properly or proportionately, the level of influence, the operational requirements and robustness of physical CTMs and the quality of plans and procedures could be inappropriate and disproportionate to the threats (and other threats and hazards) that are faced (see CPNI

(2007) for further information on processes for identifying the operational requirements of CTMs).

3.4.3.2 Situational context

The uniqueness of each crowded place and their surrounding area is commonly cited in literature; such factors influence the vulnerability and protection of those places (CPNI, 2011, p.1; Cole, 2010b, p.48; Harre-Young *et al.*, 2010, p.1121; Lavy and Dixit, 2010, p.561; Coaffee *et al.*, 2008, p.107). The nature of the occupier was also raised, as some businesses will be at greater risk than others due to their operations or the number of people that they accommodate (CPNI, 2010, p.7), as was the nature of the building itself, as historical or heritage buildings would require greater considerations in terms of security to ensure their protection (Park and Alderson, 2004, p.9.5). Adjacent and surrounding buildings was also cited, as dense or narrow streets and areas can exacerbate the impacts of blast (Mays and Hadden, 2009, p.14), glazing can provide numerous hazards for building occupants and evacuees (RIBA, 2010, p.13; Little, 2004b, 66) and the topography and layout of the area and buildings will influence the vehicle-borne threats that could be faced, as well as their consequences (Forman *et al*., 2009, p.257). Existing or planned utilities and services will also influence the value of CTMs, as certain circumstances could constrain the CTMs that could be used and how they could be installed (*ibid*., p.272), or could result in the relocation and diversion of the utilities themselves that could be achieved, albeit at a cost (Harre-Young *et al.*, 2010, p.1126). The nature of the wider area itself can influence the value of CTMs: targets of terrorist attacks (or perceived targets) could be in the vicinity, so nearby buildings could also be at risk (CPNI, 2011, p.46; HM Government, 2010c, p.3; Tomlinson and Nelson, 2010, p.54; Kemp, 2007, p.611; Briggs and Edwards, 2006, p.38; Zilbershtein, 2005, p.808).

3.4.3.3 The terrorist threat

The assessment of the terrorist threat itself can also influence the value of CTMs, as not assessing the risk highly enough can result in under-engineered CTMs and vulnerable crowded places, and assessing the risk as higher than it is could lead to over-engineered and obtrusive CTMs (Harre-Young *et al.*, 2010, p.1126). Whilst consideration should also be given to the influence that perceptions can have in the assessment of terrorist threats and decisions to protect crowded places (see section 3.4.4), how it is assessed also needs to be considered. Although commenting on the chemical, biological, radiological and nuclear threat, Littlewood and Simpson (2007, p.58) highlighted that:

> “Difficult as it may be to admit, those outside the intelligence and counter-terrorism community or without access to such information are in many cases simply guessing”

This highlights the need for GSAs and CTSAs (as discussed in section 3.2.2). While specific intelligence is unobtainable, precedence can be sought from previous terrorist attacks and plots, which have predominantly involved VBIEDs in the UK (see section 3.1). Assessing this particular threat requires understanding of different vehicle-borne threats (those being parked vehicles, encroachment of unfinished or vulnerable protection, penetrative attack, as well as the use of duress and/or deception) (Forman *et al*., 2009). By understanding the terrorist threat (as much as possible), CTMs can therefore be designed to the most appropriate and proportionate blast and impact loading (*ibid*.). As stated by Veale (2009, p.292):

> "Understanding the terrorists' intentions and capabilities – what they might do and how they might do it – is crucial to assessing the threat"

Assessing the intentions and/or capabilities incorrectly, as previously highlighted, could result in under-engineered and vulnerable or over-engineered and obtrusive CTMs (Harre-Young *et al.*, 2010, p.1126), which could undermine or nullify any value obtained through the use of CTMs.

3.4.3.4 Proportionality

> "Although many stakeholders apparently agree that these allocations should reflect the magnitude of risks to which different areas are exposed, no consensus has emerged on how this might be accomplished" (Willis *et al.*, 2005, p.vii)

This quote captures the issues in relation to proportionality. While an intrinsic connection to the assessment of risk and terrorist threats is evident, due to possible under-engineered and over-engineered outcomes, how proportionality is derived is unclear. The subjective and contextually-specific nature of each crowded place, occupiers and users, as well as adjacent and surrounding areas, results in a complex set of circumstances that must be assessed in order to achieve a proportionate outcome. As highlighted by Dainty and Bosher (2008, p.363):

> "…the way in which resilience should be built-in is entirely contingent on context"

Even though security advice asserts that crowded places should be protected proportionately (CPNI, 2011, p.5, and 2010, p.14; HM Government, 2010b, p.5, and 2010d, p.5; British Council for Offices, 2009, p.39), no processes are offered to aid those responsible for the design, construction and operation of crowded places in assessing objectively what is and what is not proportionate.

> "Because terrorist threats are not easily quantifiable, it is difficult to determine the "right" level of security. Using cost-benefit analysis as the sole criterion to determine the level of security is inadequate" (Jenkins, 2001, p.2)

Assessing the cost-effectiveness of varying approaches is more achievable on a case-by-case basis (Stewart, 2010, p.29; Elliott, 2009, p.5; Willis *et al.*, 2005, p.xv), the value put on a human life is one of many questions in determining damages and costs that an attack could incur (Stewart, 2010, p.32). Considering that the statistical likelihood of a crowded place being attacked is essentially zero and the number of targets is essentially infinite (Meuller, 2008):

> “If no real immediate threat exists, and yet nothing can ever be ruled out, how much security is enough?” (Dolnik, 2007, p.15)

What is evident is a lack of literature on the assessment of proportionality, but also an acknowledgement that the public only see the CTMs, not the threats that cause their incorporation Such gaps in knowledge contribute to the under-engineering and vulnerability, as well as the over-engineering and obtrusiveness, of crowded places (Harre-Young *et al.*, 2010, p.1126) and as a result, their influence on the value of CTMs can be significant. Further research is required in order to provide clarification on these issues, or further debate and knowledge in relation to them.

3.4.4 Perceptions and moments of terrorism

> “It is said that when Tony Blair watched the events of 9/11 unfold on CNN, he became convinced that the terrorist strike had “changed the world forever”. In one sense he has been proven right and not because it has already led to the invasion of two countries; more that the fear of further attack has been embedded in the public consciousness. People now think about terrorism in a way they simply did not before” (Regan 2006, p.22)

Statements like this in relation to the impact of 9/11 are evident in the literature (Rigakos *et al.*, 2009, p.286; Rypkema, 2003, p.9; Briggs and Edwards, 2006, p.28); as evidenced in Briggs (2005, p.10):

> “We might question whether September 11 was the point of change or the moment of realisation of what had been taking place over the last decade”

Such a perspective is also adopted by McEntire *et al.*, 2010, p.50) and Little (2008, p.1). What is evident is the sheer scale of implications of such attacks, also including the Lockerbie terrorist attack (George and Whatford, 2007, p.158), Bali bombing (McDonald, 2005, p.308), the attacks on the London Underground in 2005 (Fussey *et al.*, 2011, p.144; Coaffee, 2010, p.939; Briggs and Edwards, 2006, p.29), the attacks in Mumbai (Coaffee, 2009b, p.348) and the attempted suicide attack on an airplane in 2009 (more commonly referred to as the ‘underwear bomber’ plot) (Shenoi, 2010, p.1). Tierney and Bruneau (2007, p.14) highlighted that such implications were also evident as a result of Hurricane Katrina in

August 2005. Immediately after such events, feelings of fear were cited (Fussey *et al.*, 2011, p.138; Blalock *et al*., 2008, p.1728; Thissen, 2004, p.315; Berube and Rivlin, 2002, p.19). Such fear, or its prediction, are evident in numerous articles, with the associations of cities being under siege being evident in Catterall (2001, p.383), Friedmann (2001, p.391) and Marcuse (2001, p.394), all of which were, most notably, published in 2001. In a study on transport patterns, Blalock *et al*., 2008, p.1717) showed that due to travellers responses to the attacks of September 11th 2001, as many as 2300 road deaths were attributable to the attacks, due to fear of flying. A plethora of literature details the appearance of CTMs and security measures as a result of those attacks (Gerstenfeld and Berger, 2011; Coaffee *et al.*, 2009a, p.221; Coaffee and O'Hare, 2008, p.176; Benton-Short, 2007, p.442; Hollander and Whitfield, 2005, p.244; Little, 2004a, p.52; Coaffee, 2003c, p.64; Marcuse, 2001, p.395). However, whilst the measures literally 'appeared overnight' (Little, 2008, p.1), their use was as a result of an increase in agendas and policies that were already in existence, as opposed to being 'new' technologies to which the incident lead to their sudden implementation (Coaffee, 2009a, p.3; Janz, 2008, p.202; Manunta, 2007; Briggs, 2005, p.71; Lyon, 2003, p.666; Warren, 2002, p.614). Whilst the securitisation of space increased (Guidry, 2007, p.55), the attacks also instigated wide-ranging policy changes, although arguably, they too were little more than extrapolations of ongoing trends as opposed to 'new' political directions (Coaffee and Murakami Wood, 2006, p.507). Most prominent were changes to and creation of counter-terrorism legislation and policies (Klausen, 2009, p.403; Loukaitou-Sideris *et al*., 2006, p.727; Wulf *et al*., 2003, p.429; Lyon, 2003, p.666; Light, 2002, p.607), as well as in relation to security policies more broadly (Fowler and Sen, 2010, p.1; Coaffee and Van Ham, 2008, p.191; Thompson and McCarthy, 2004, p.2.1). The economic consequences of such acts resulted in considerable attention (Richardson *et al*., 2007; Frey *et al*., 2007, p.2; Bruck and Wickstrom, 2004), as did specific policies in relation to critical national infrastructure (Medonça and Wallace, 2006; Bunn and Bunn, 2002, p.1), transport (Cox *et al*., 2011, p.307; Elzawi and Eaton, 2010, p.278; Rigakos *et al.*, 2009; Loukaitou-Sideris *et al*., 2006, p.727) and 'mega-event' and 'sport mega-event' planning (Fussey *et al.*, 2011, p.2; Ciulianotti and Klauser, 2010, p.53; Giulianotti and Klauser, 2010, p.49; Toohey and Taylor, 2008, p.451). Returning to counter-terrorism, evident in the literature was the questioning of whether de-centralisation should occur, with debates on urban sprawl, the defensive dispersal of concentrated areas and the abandonment of building tall buildings (Ling and Soh, 2005, p.265; Wekerle and Jackson, 2005, p.40; Godschalk, 2003, p.138; Harrigan and Martin, 2002, p.107; Graham, 2001a, p.414; Lorch, 2001, p.415). As asserted by Graham (2001a, p.414):

> "The iconic power of the skyscraper that has been exposed as a flawed and arrogant building type which inevitably builds deep vulnerabilities into the cityscape"

However, as noted by Regan (2006, p.23) and Coaffee (2004b, p.208), 'tall building' policies have remained. Terrorist attacks (as well as the manifestation of other threats and hazards) can evidently have significant implications as to whether vulnerable places are protected. However, as perhaps demonstrated by the ‘tall buildings’ issue above, immediate reactions are not enduring, partially due to a short-term focus (Andrew, 2009, p.848) and the fading of memories (Gloyn, 1994, p.16). In relation to changing perceptions, Howie (2007, p.70) states:

> “As its meaning changes over time perceptions of the phenomenon take the form of its most recent and popularised occurrences”

How such occurrences are popularised is partially dependent on the media (Howie, 2009a, p.8; Wolfendale, 2007, p.86; Briggs and Edwards, 2006, p.30), with Howie (2009a, p.104) asserting the ‘everydayness of terror news’ that is now evident. However, whilst such news may appear every day:

> “There have been no attacks by international terrorist groups or individuals associated with them in the UK during the period covered by this report. This does not reflect the absence of a threat; rather it reflects the resources and capabilities put in place to deal with it” (HM Government, 2010e, p.27)

In July 2011, the UK’s threat level was lowered from ‘severe’ (where it had been since January 2010), to ‘substantial’ (Security Service, 2011). This, coupled with the death of Osama Bin Laden, the identification and targeting of other senior Al Qaeda leadership and the strategic defeat of Al Qaeda being ‘within reach’ (BBC, 2011d), will unquestionably have an influence on perceptions of the terrorist threat in the UK, although the extent and implications of the influence are yet to be seen. Rigakos *et al.* (2009, p.299) suggest that there is a ‘bipolar reaction’ to the terrorist threat, either believing it to be a serious concern or a problem confined to other cities. Whilst there is some logic in this, as an organisation could believe it is at high risk, or not, their perceptions are influenced heavily by a range of factors that have been explored above. As stated by Little (2008, p.3):

> “there can be little question that current concerns about terrorism and the risk it poses to individuals or society are shaped as much by perception as by objective risk assessments”

3.4.5 Economic influences

Whether crowded places are protected from terrorist attack is also about ability as opposed to intentions, as CTMs have cost implications, that may be unaffordable and scrutinised in times of budgetary limitation and economic downturn (HM Government, 2010a, p.21; Coaffee and Bosher, 2008, p.81; Mignone, 2007, p.5409; Wekerle and Jackson, 2005, p.141; Swanstrom, 2002, p.138; Carmichael and Gartell, 1994, p.9).

3.4.6 Local policy

Local policy can influence whether crowded places are protected, as different constituencies or even regions could have different policies in relation to whether, or how, such places are protected. Coaffee and Murakami Wood (2006) highlight how ‘rings of steel’ historically entered policy due to their use in relation to ‘defensible space’ and also through attempts of planners to ‘plan out’ terrorism in Northern Ireland. Whilst security and resilience have been increasingly embedded in urban planning and design (Coaffee, 2008b, p.4633), scepticism regarding proportionality, acceptability, cost and aesthetics are evident in the minds of those responsible for the design, construction and operation of such places (Coaffee and Bosher, 2008, p.79) and therefore influences the perspectives of other stakeholders, including local planning units and councils, and how they consider and implement acceptable solutions.

3.4.7 Building stock rotation

> “There are, however, many more existing structures – and corresponding potential terrorist targets – than there are new structures coming on line. Thus the opportunities and need for protection in existing structures is much greater in existing than in new structures” (Marshall, 2002, p.9)

The majority of terrorist targets, therefore, already exist today (Harre-Young *et al.*, 2010, p.1121). Ravetz (2008, p.4462) asserts that with a building stock rotation of 1-2% a year (the accommodation of past and current economic influences is unclear), 75% of buildings that will be present in 2050 already exist. Not only does this induce a requirement to retro-fit CTMs into crowded places (including public spaces), it also raises questions in relation to adaptability and how changing threats and users of a building can be incorporated into designs, when such factors are unknown (British Council for Offices, 2009, p.87) and therefore, by its very nature, the protection of such places will occur at a relatively slow pace. The aging and vulnerability of building stock will also influence refurbishment or decommissioning (Vora *et al*., 2008, p.602).

3.5 Influences on the Value of Counter-Terrorism Measures

As shown in Figure 3.4, there were two influences on the value of CTMs, those being TARAs (as explored in section 3.4.3) and stakeholder engagement and understanding (section 3.5.1).

3.5.1 Stakeholder engagement and understanding

Stakeholder engagement and understanding encompasses how and whether stakeholders engage with each other (and how such interactions, or a lack of them, can influence the value of CTMs), as well as their understanding in relation to CTMs themselves, risk, potential vulnerability in designs and training, testing and exercising.

3.5.1.1 Stakeholder engagement

As was raised in section 2.2.5, there is a definitive role for those who design, construct and operate the built environment to protect vulnerable infrastructure from a range of hazards, threats and major accidents, but professional fragmentation is a 'hallmark' of the construction industry (Bosher and Dainty, 2010, p.6). How engagement (or a lack of it) influences the value of CTMs will now be explored.

> "Protective counterterrorism in urban areas is no longer just a police and security services issue: many professional practice communities, and the general public, are being enrolled in the fight against terrorism…we are all counterterrorists" (Coaffee, 2010, p.953)

The emphasis here is on responsibility (whether taken on voluntarily or through imposition), with design in relation to counter-terrorism involving a plethora of stakeholders (Bosher and Kappia, 2010, p.1150; Coaffee, 2010, p.340; HM Government, 2010d, p.16; RIBA, 2010, p.3; Coaffee *et al.*, 2008, p.107; Briggs, 2005, p.20; Little, 2004a, p.56; Thompson and McCarthy, 2004, p.2.1). Furthermore, there is a particular emphasis on the need for engagement at the earliest opportunity, emphasising stakeholders being proactive in identifying the need for, as well as the design and incorporation of CTMs (RIBA, 2010, p.3; Tomlinson and Nelson, 2010, p.51; British Council for Offices, 2009, p.86; Coaffee *et al.*, 2008, p.107; General Services Administration, 2005, p.235).

> "A security department alone cannot 'do' security for a company or organisation. While all these people and entities provide valuable input, experience and structures, they are only part of the picture. In reality, security is a participatory activity; without the active engagement of the full range of actors, security is patchy and partial" (Briggs, 2005, p.20)

The value of CTMs used to protect crowded places can therefore be influenced in a number of ways; if appropriate stakeholders are not engaged, the threat could be assessed incorrectly, inadequate or over-engineered CTMs could be purchased, designed and incorporated, CTMs themselves could even be misunderstood and incorporated incorrectly, leaving vulnerable points in the protection of crowded places (see section 3.5.1.3). Those who are involved in the design, construction and operation of the built environment need to change how they perceive, plan and design, as well as incorporate CTMs (Harre-Young *et al.*, 2009, p.1289), but it is not clear how they should trade-off issues pertinent to CTMs. That said, Glass (2008, p.180) suggests that architects could invite relevant stakeholders (such as security experts) into charette-type meetings in order to enhance the quality of the design being produced, as well as enhance their own learning and understanding about designing in such measures. Arguably, such an approach would facilitate the relatively expedient identification of potential solutions and their relative value and implications, aiding in understanding how they relate to the various needs and aspirations of the stakeholders involved, of which the architect is of paramount importance in understanding (Emmitt, 2007, p.11; Lawson, 2006, p.30), thereby identifying potential issues or costs that could occur or influence a project later on in the process (Forman *et al*., 2009, p.252). Earlier identification and assessment of potential solutions could also facilitate opportunities to incorporate communal security arrangements (CPNI, 2010, p.14), potentially increasing the cost-effectiveness of the CTMs used. The need for inter-professional solutions and inter-disciplinary perspectives is clear in relation to the protection of such places (Bosher and Kappia (2010, p.1146):

> "Achieving a positive relationship between counter-terrorism and the built environment will rest on our ability to find ways of bringing together those who design spaces with those who secure it and those who use it" (Briggs, 2005, p.85)

3.5.1.2 Understanding of CTMs

The literature suggests a need for greater understanding of CTMs, most notably in relation to perceptions of 'target hardening', the relationship between CTMs and 'lesser' crime prevention measures, as well as the understanding of what CTMs can be used to protect crowded places. As will be shown in Chapter Four, the protection of crowded places involves more than just 'target hardening'; three categories of CTMs can be used, those being external to the building (hostile vehicle mitigation), as a part of the building itself (protective construction) and as a part the occupiers' business operations (planning, detection and procedures). Even within 'protective construction', whilst target hardening is evident, other CTMs can be incorporated that do not inherently involve the 'hardening' of particular assets. Yet, target hardening is cited in a plethora of sources (Silke, 2011, p.12; Fussey, 2011a, p.86, and 2011b, p.164; Steven, 2011, p.158; British Council for Offices, 2009; Stephens, 2009). Cozens *et al*. (2005, p.338) claim that excessive use of such hardening measures can create a fortress mentality, but so too could the use of the term, as well as the measures themselves. If perceptions of CTMs are that they all result in target hardening, criticisms in relation to the symbolism of, and fear emanating from, CTMs will remain.

Also evident is the assertion that measures used for crime prevention (such as CPTED or SBD, as referred to in section 3.3) are not appropriate for counter-terrorism purposes (Fussey, 2011a, p.86; Forman *et al*., 2009, p.251; Zilbershtein, 2005, p.807), most notably due to different psychological mindsets, especially when considering the threat of suicide attacks (Coaffee *et al.*, 2008, p.107; Roach *et al*., 2005, p.7; Zilbershtein, 2005, p.814). Coupled with the complexity that is inherent in the protection of crowded places (see for example, section 3.4.3.2 on situational context) is a lack of knowledge on what CTMs exist and can be incorporated into the protection of such places, which only exacerbates the potential for such places to be designed or retro-fitted in vulnerable or over-engineered ways (Harre-Young *et al.*, 2010, p.1128). A typology of CTMs is therefore required that not only identifies what CTMs can be used, but also identifies their relative value and systemic implications in order to provide and inform solutions to the aforementioned problems (*ibid*.). Such a typology is initiated in Chapter Four.

3.5.1.3 Vulnerable points in protection

> "There is also a danger that we place misguided trust in technology to deliver security, forgetting that technological 'kit' is only as effective as the socio-technical systems it is employed within, and the humans operating it" (Briggs, 2005, p.24)

Not only can such issues result in vulnerable points in the protection of crowded places, thereby potentially nullifying any value of CTMs used to perform such functions, but the design of CTMs themselves could also lead to such vulnerability, if for example, CTMs used to prevent hostile vehicles from being able to travel through to a certain area are spaced too far apart, or not at the right height, facilitating their encroachment and the overcoming of such obstacles. Literature on requirements of CTMs will be presented in Chapter Four; see also CPNI (2011) and Forman *et al*. (2009) for further information in relation to encroachment and types of vehicle-borne threat.

3.5.1.4 Training, testing and exercising

> "Too many plans are based around what the company would like to happen in a crisis rather than what might happen…On paper the plans may appear to work fine. However, the real test would be in a crisis situation. During a real crisis is not the time to be testing procedures for the first time" (Curtin *et al*., 2005, p.155)

Unless CTMs (such as those evident in the planning and procedures of organisations) are tested and tested properly, their value could be nullified (Dolnik, 2007, p.17; French, 2006, p.13). Apparent is a lack of literature on how the testing of such CTMs could influence their value, as well as the implications of not undertaking such practices.

3.5.1.5 Understanding of risk

> "…no building can ever be considered 100% secure" (Guidry, 2007, p.69)

Such a notion that 'absolute security' is impossible is present in a plethora of literature, both academic and industrial (CPNI, 2010, p.4; Howie, 2009b, p.101; Veale, 2009, p.290; Meuller, 2008, p.4; Dolnik, 2007, p.19; Wolfendale, 2007, p.76; Briggs and Edwards, 2006, p.15; Elliott, 2009, p.5), as is the notion that risk is the sum of the threat, the vulnerability and the consequences (R = T x V x C) (Tomlinson and Nelson, 2010, p.54; Cox, 2008, p.1749; Little, 2008, p.2). Its influence on the value of CTMs in terms of over-sensitivity, as such emphasis could result in over-engineered and somewhat standardised places (HM Government, 2010c, p.9). In understanding how notions of 'absolute security' relate to the terrorist threat, HM Government (2006, p.1) highlight that therefore, guarantees of attacks not occurring cannot be made, yet efforts can be (and are being) made to reduce the risk as much as possible. Its relation to perceptions is also evident (see section 3.4.4), with perceptions of risk rarely reflecting reality (Briggs, 2005, p.27). Whilst there may be risks for which mitigation would be neither practical nor realistic (Little, 2004a, p.57), the evident implication is that organisations should accept some level of risk and take those risks with a greater level of certainty (Briggs, 2005, p.40; Lorch, 2001, p.415). Briggs and Edwards (2006, p.14) offer a comment on those advising on the security of organisations:

> "…their role is to help the company to take risks rather than eliminate them, and to have contingencies in place to minimise damage when things go wrong"

3.6 Conclusion

The relationship between counter-terrorism and the built environment has been made apparent in this chapter, with a literature review highlighting how the relationship emerged and developed over time, most notably due to perceived and real changes in the nature of the terrorist threats that are faced and their mitigation through urban planning and design. Notions of fortress architecture (and 'fortress UK') and defensible space were explored and questioned, leading to recent developments in the use of CTMs the emergence of 'invisible' CTMs in protecting crowded places. Influences on the protection of such places were forthcoming, with obligations, incentives, TARAs, perceptions and moments of terrorism, economic influences, local policy, and building stock rotation each influencing whether crowded places are protected. Literature highlights the statutory duties do encompass the protection of places from terrorist attack and that, therefore, obligations exist not only under moral duties but also under legislation. Incentives to protect crowded places were presented, with reductions in risk and the impacts of an attack, competitive advantages to be gained and revenue generation through incorporating CTMs, conducive agendas, and insurance incentives cited. TARAs were noted as influencing the protection of crowded places and the value of CTMs used, as their outcomes can determine whether CTMs are incorporated, as well as their robustness and engineering. Stakeholder understanding and engagement was cited as also influencing the value of CTMs, with engagement between stakeholders themselves, understanding of CTMs and of risk, vulnerability in design, and testing, training and exercising all having the potential to undermine any benefits of the incorporating CTMs. Through such discussions, a number of design considerations and agendas have also begun to appear, with issues in relation to cost and return on investment, un-impinged design and permeability (most notably through the use of 'invisible' CTMs), user experience, and environmental concerns being evident. Influences on the protection of crowded places were also identified, as were influences on the value of CTMs that can be used to protect them. In order to fully understand how such measures relate to the aforementioned issues, a typology is required that classifies them, identifies inherent performance, and identifies consequences of their use. This typology is formed in the following chapter.

4.0 Towards a Typology of Counter-Terrorism Measures

A typology of CTMs will be formed in this chapter. As has been highlighted in Chapters Two and Three, there is a lack of knowledge on CTMs, their performance and their consequences (Harre-Young *et al.*, 2010, p.1128). Therefore, this chapter will define the boundaries of the typology, the design philosophy behind it, and classify the CTMs that can be used to protect crowded places from VBIEDs. Following this, the performance and consequences of the CTMs will be discussed, with the framework of a provisional typology being presented at the end of the chapter, prior to its development and validation as a result of the research methods used (Chapter Five).

4.1 Defining the Boundaries of the Typology

There are four factors that demarcate the boundaries of the typology, those being CONTEST, vulnerable places, terrorist methods of attack and types of security. How these factors form the boundaries of the typology is shown in Figure 4.1.

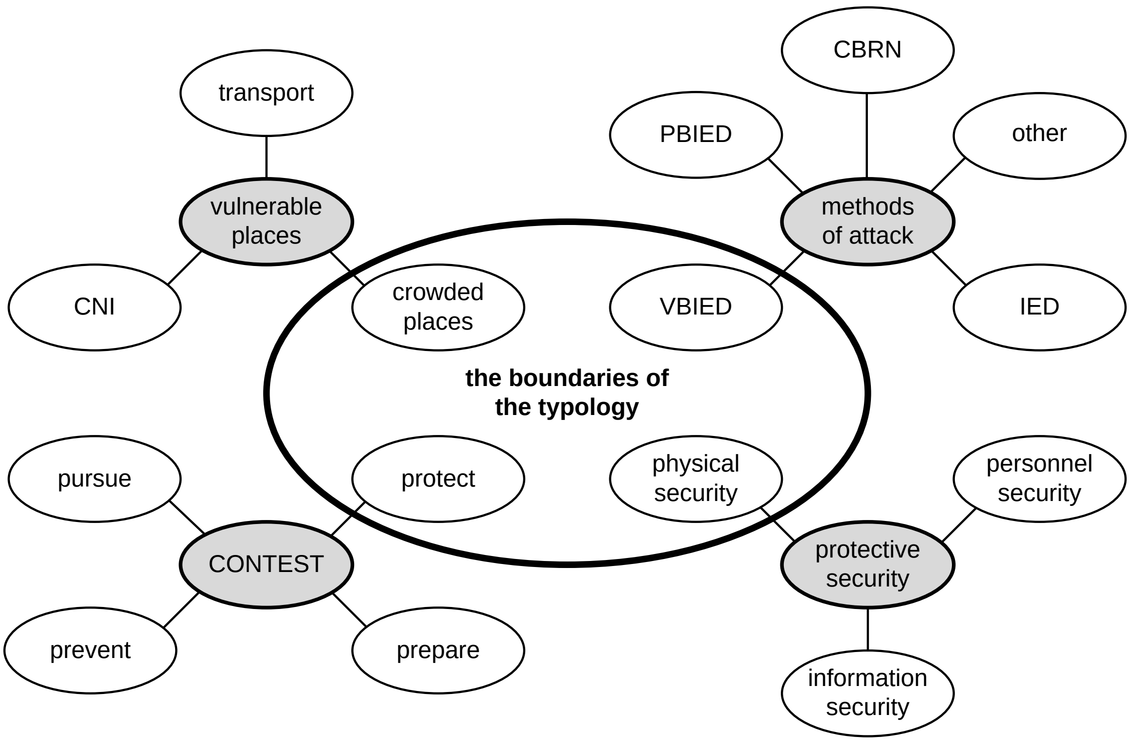


Figure 4.1. The boundaries of the typology

As highlighted in section 3.2, the 'Protect' strand of CONTEST has inherent implications for the design, construction and operation of the built environment. It has resulted in a number of areas of security enhancements and in terms of the built environment, encompasses the protection of vulnerable places, those being crowded places, transport infrastructure and critical national infrastructure. Section 3.2.1 highlighted that the use of VBIEDs was of particular concern, with recent terrorist plots and attacks concentrating on crowded places and involving the use of such devices (Clarke and Soria, 2009; Harre-Young *et al.*, 2009). The typology is based on the principle that there are five types of vehicle-borne threat, as detailed by the CPNI (2011; 2010), British Council for Offices (2009) and Forman *et al.* (2009). The CPNI (2011, p.6) detail the five types of threat as follows:

- Parked vehicles: An attack may come from a VBIED in a parking area of unscreened vehicles which may be underneath or adjacent to an intended target
- Encroachment: Incomplete or incorrectly spaced countermeasures can allow a hostile vehicle to enter an area without the need for impact. A hostile vehicle may also be able to tailgate a legitimate vehicle through a Vehicle Access Control Point (VACP)
- Penetrative attack: The use of the front or rear of a vehicle as a ram to breach a perimeter of target premises in order to get a hostile vehicle closer to the intended target
- Deception: Various forms include use of stolen or cloned ID, verbal deception or Trojan (disguised) vehicle
- Duress: Duress imposed on the occupant of a legitimate vehicle to carry a hostile payload into a protected site or duress imposed on a guard to grant vehicular access through a vehicle access control point

'Layered' attack scenarios could be an option, with a vehicle penetrating any vehicle security barriers (VSBs) and another vehicle encroaching through the resultant gap in the measures (*ibid*.). In relation to security and the mitigation of the aforementioned threats, physical security has been raised as having significant implications for the protection of crowded places from VBIEDs (Harre-Young *et al.*, 2010; 2009), which together demarcate the boundaries of the typology.

4.2 Counter-Terrorism Design Philosophy

Counter-terrorism design philosophy encompasses the design principles on which physical security is based and how those principles influence TARAs, site selection and highlight the inherent benefits of stand-off.

4.2.1 Design principles

> "Protection is not an absolute concept" (Elliott, 2009, p.5)

As was evident in section 3.5.1.5 of Chapter Three, understanding risk dictates that certainly in relation to the protection of crowded places from VBIEDs, the risk can only be mitigated, not eliminated. Nor can security ultimately be delivered to an organisation, or for an organisation; it must be an inclusive process and undertaken by all those within an organisation in order to mitigate the risk as high as reasonably practicable (Briggs, 2005, p.40). With this in mind, a set of principles (Elliott, 2009, p.7) aim to therefore mitigate the aforementioned risk through the use of design to, where possible and appropriate:

- Deflect an attack by showing that the chance of success for the terrorist is small
- Disguise valuable parts of a potential target so that the focus of an attack is centred on an area that would not have the desired impact
- Disperse a potential target so that an attack could not cover a large enough area to cause a significant impact
- Stop an attack reaching its intended target through the use of physical CTMs
- Blunt the attack should it reach its target or occurs anyway, by incorporating CTMs into the building itself

Elliott (2009, p.7) states that steps 1-3 can often be incorporated at no cost. However, this is debatable as deflection would occur through, as Elliott says, “layout, security and defences” (*ibid*.), which can have a cost as those defences would more than likely be the CTMs used to stop and blunt an attack from being successful. Whilst disguising an asset may not bear additional costs, dispersing a target could, via increases in land costs and disruption to day-to-day business operations. CTMs do not have to be physical products, as referring back to the definition of a CTM (see section 1.1.3.2), it can encompass the removal of items from a site or building, such as litter bins (see for example Cherry *et al.*, 2008, p.79; Dolnik, 2007, p.16), as well as organisational, or ‘non-structural’ measures (Harre-Young *et al.*, 2009, p.1288). The use of such CTMs, the typology of which will begin to be developed from section 4.3 onwards, should be proportionate to the threat that each individual building or site faces (CPNI, 2011, p.5; NaCTSO, 2006-2011). As put forward by Grosskopf (2006, p.1):

> “…strategies seek to change the fundamental nature of terrorist targets by lessening their real and symbolic value to terrorists while simultaneously reducing their physical vulnerability to terrorist threats”

Such reduction in real and symbolic value, as well as vulnerability, occurs through the consideration and incorporation of CTMs, based on a TARA being carried out, which will now be discussed.

4.2.2 Threat and risk assessments

TARAs are a risk management process, through which threats and vulnerabilities are identified and the measures required to mitigate them are incorporated, followed by periodical review and rehearsal, as shown in Figure 4.2. TARAs and their outcomes should consider, and where possible be adaptable to, evolving threats and the ability to increase security levels in response to heightened threats (General Services Administration, 2005, p.235; Jenkins, 2001, p.20).

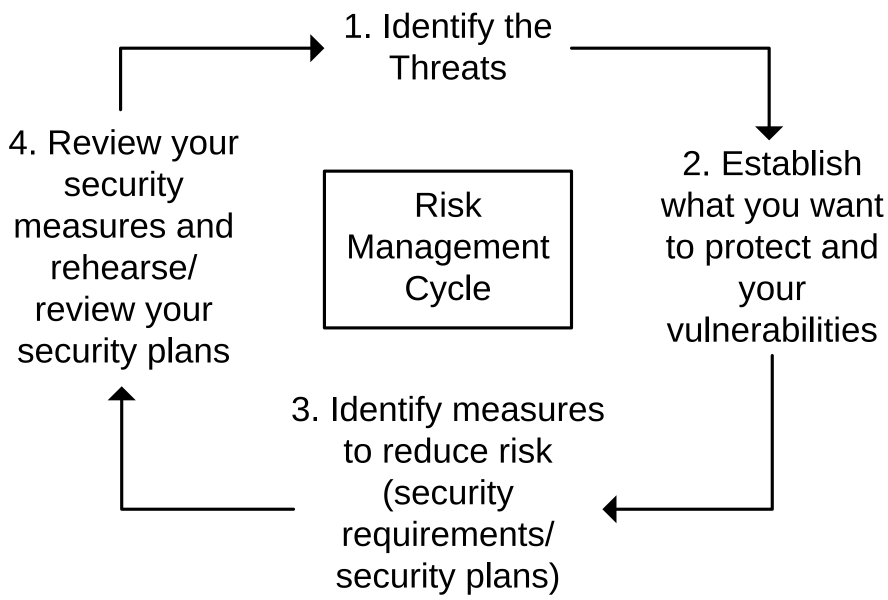


Figure 4.2. Risk management cycle (NaCTSO, 2011, p.6)

The incorporation of CTMs to reduce the risk, following the identification of proportionate solutions through a TARA being carried out, will need to be subject to a cost-benefit analysis, with the ultimate question being…

> "…is the reduction in risk worth the additional expenditure?" (Stewart, 2008, p.116)

4.2.3 The right site?

An outcome of the TARA could be that a more cost-effective solution could be to change the current location of the potential site or asset (Little, 2004a, p.55; CPNI, 2011, p.46), hence why such planning and assessments should be conducted at the earliest possible opportunity (British Council for Offices, 2009, p.87). The feasibility of such a solution being chosen is dependent on the nature of the crowded place being designed or assessed, as certain built assets may be more suited to city-centre locations, which could negate the possibility to relocate and therefore restrict the options available. The literature raises that, from a counter-terrorism perspective, the incorporation and benefits of stand-off are of particular importance As cited by Robinson (2004, p.39):

> "When we identify a site which we want to buy and develop we reach for our architect or engineer to help us explore how we can maximise its potential and minimise any drawbacks it may have"

4.2.4 Stand-off

'Stand-off' is generally defined as the distance between a bomb and a building (Lavy and Dixit, 2010, p.545; British Council for Offices, 2009, p.104; Mays and Hadden, 2009, p.12;

Little, 2008, p.3; National Research Council, 2001, p.3; Holtrop, 1993, p.237). However, if stand-off is defined as the distance between a bomb and a target (as opposed to simply 'a building'), the space plan inside a building becomes a factor, resulting in stand-off being achieved in two ways:

> "First, it is accomplished by a physical barrier, such as a ditch, a low concrete wall or bollards, that prevents vehicles driving close to a target…Second, stand-off is accomplished by rearranging the inside of a building so that valuable assets are as remote as possible from the greatest threat" (Elliott, Mays and Smith, 1992, p.296)

Whilst stand-off may be the most important factor in determining the extent of damage that could be caused by a VBIED (CPNI, 2011, p.8; Tomlinson and Nelson, 2010, p.56), it is not always an entirely controllable parameter, as city-centre locations and high value land can render its incorporation impossible or unrealistic (*ibid*.; Bosher and Kappia, 2010, p.1145; Mays and Hadden, 2009, p.12). Considering such potential restriction, specialist advice should therefore always be sought when determining localised blast impacts and their mitigation (British Council for Offices, 2009, p.163). Ideal stand-off distances are 30m for a car and at least 90m for larger vans and lorries (CPNI, 2010, p.16); an increase in distance decreases the measures required to enhance the building to mitigate the impact of a blast (CPNI, 2011, p.20; HM Government, 2010b, p.7; Lavy and Dixit, 2010, p.545; British Council for Offices, 2009, p.162; Forman *et al*., 2009, p.254). Benefits include easier surveillance of a site / surrounding area and therefore, easier detection of intruders and hostile vehicles (British Council for Offices, 2009, p.104).

Inherent consequences of stand-off involve complexity in relation to its enforcement in relation to existing utilities and infrastructure (Harre-Young *et al.*, 2010, p.1125), as well as (depending on the CTMs used to enforce it) an increase in the urban heat island effect (Coaffee and Bosher (2008, p.80; McEvoy *et al*., 2006, p.190) and lower usable floor ratios (Then and Loosemore, 2006, p.161). The internal incorporation of stand-off however, could be achieved at no additional cost (British Council for Offices, 2009, p.105; Guidry, 2007, p.69). The costs associated with hardening a building due to a lack of enforceable stand-off could be greater than installing hostile vehicle mitigation (HVM) measures at a sufficient distance (Forman *et al*., 2009, p.12). Therefore, it can be envisaged that for each project, there would be an optimum stand-off distance at which the total cost of providing the stand-off, combined with the cost of enhancing the building itself, is minimised (Mays and Hadden, 2009, p.12). Considering the variability of the aforementioned factors however, such assessments and cost-benefit analyses are entirely contingent on the site-specific context and attributes of chosen CTMs for a given project.

4.3 Classifying Counter-Terrorism Measures

A classification of CTMs is publicly available, with HM Government (2010b, p.7) classifying them under four categories, those being in relation to blast resistance, building management facilities, HVM and better oversight. Specifically in relation to the mitigation of VBIEDs, Cormie *et al*. (2009) categorise CTMs as: CTMs external to the building (HVM), CTMs incorporated into the building itself to protect it, and the organisational planning and procedures inherent in preparing for and responding to an attack. It is this classification that is adopted for the provisional typology of CTMs used to protect crowded places from VBIEDs, i.e. a pre-existing typology is used currently, although such classifications may change as a result of data collection (Chapter 6). A review of literature on CTMs will now be presented, exploring the performance and consequences of CTMs under their respective categories, those being hostile vehicle mitigation (section 4.4), protective construction (section 4.5), and planning, detection and procedures (section 4.6). Exploration of the literature in each of these areas will determine the CTMs that are evident, as well as their performance and consequences.

4.4 Hostile Vehicle Mitigation

HVM encompasses the use of traffic management, vehicle access control and traffic calming, enforced through the use of CTMs (more commonly known as vehicle security barriers (VSBs), when being used in relation to HVM). Through such planning external to a building, the need for the incorporation of protective construction CTMs can be reduced or removed (Forman *et al*., 2009, p.259; General Services Administration, 2005, p.257). CPNI (2011, p.14) state that:

> "Successful security is most effective when implemented on a number of geographical layers. In terms of HVM, layers can feature access control and vehicle management on a district level, design of approach routes, further vehicle management and stand-off distances within the local site context and finally, control of stand-off distances and secure threshold design to the immediate vicinity of the asset"

The CPNI define a 'district' as being the wider site context and of varying scale, but generally with multiple sites and land ownerships, with the 'site' being the local context that can also include multiple land ownerships and the threshold (typically the incorporated stand-off distance) being the zone immediately around the asset (CPNI, 2011, p.15). It is within the district and the site that traffic management, vehicle access control and traffic calming occur, each of which will be explored, followed by literature on VSBs. Such an approach to HVM is evident in Figure 4.3.

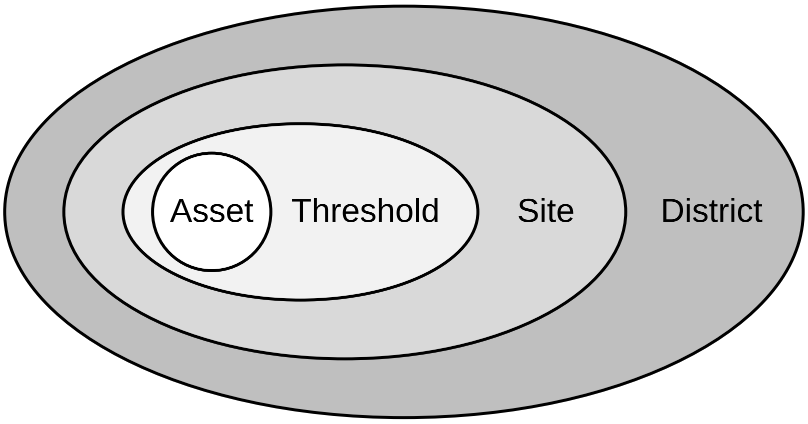


Figure 4.3. A layered approach to HVM (CPNI, 2011, p.14)

4.4.1 Traffic management

Four traffic management approaches are evident, those being traffic exclusion, traffic restriction, traffic inclusion and temporary barriers. Whilst the CPNI (2011, p.18) and Forman *et al*. (2009, p.258) classify the approaches as being exclusion (total exclusion and exclusion coupled with screening), inclusion and temporary barriers, the aforementioned four options are used to clearly differentiate between the different options. Each option has different benefits and implications, as will be described below. In relation to the selection and incorporation of a traffic management approach, Forman *et al*. (2009, p.257) put forward that accommodating an existing traffic pattern when retro-fitting is inherently less effective and more expensive. An example of such a situation could be that existing traffic routes could facilitate vehicles being able to reach high speeds, through the use of straight roads. Not changing the layout would result in the need for more robust and obtrusiveness CTMs than would be required if the route was changed to slow the vehicles down and reduce the impact they could have. Further exploration of traffic calming is presented in section 4.4.3.

4.4.1.1 Traffic exclusion

From a security perspective, traffic exclusion should be the starting point in terms of effective protection, with remote or off-site car parking resulting in extra confidence (Forman *et al*., 2009, p.258). The requirements of excluding traffic will be its enforcement through VSBs and will therefore negate the need for vehicle access control or traffic calming measures inside the threshold itself, although traffic calming measures could be incorporated external to the VSBs in order to reduce potential impact speeds (see section 4.4.3). Depending on the size of the site or district within which traffic exclusions are incorporated, such an approach can negate the need for areas of traffic restriction, traffic calming and their enforcement through the use of VSBs, thereby reducing issues in relation to traffic displacement and congestion (HM Government, 2010b, p.8). Reductions in air and noise pollution and therefore, less soiling of buildings are evident (Coaffee, 2003a, p.175; Coaffee, 2003c, p.73), as are reductions in crime and traffic accidents (Coaffee, 2003c, p.73) and reductions in workdays lost as a result of the improved air quality (Marshall, 2002, p.6). Such benefits can be applicable to wider areas, through the assessment of possible schemes being incorporated over multiple land ownership boundaries (CPNI, 2011, p.46). Consequences of excluding traffic encompass the impact on the day-to-day operations of an organisation/organisations due to increased walking time (Stewart, 2010, p.34) and elimination, restricted and/or reduced parking (Stewart, 2008, p.116) and the potential impact on disabled persons (HM Government, 2010b, p.8.). Most evident however is the displacement of traffic, with Coaffee (2003a, p.175) highlighting that levels of traffic around an area that excluded traffic may not change, implying that congestion increased in the surrounding areas, which has its own consequences in terms of increasing air and noise pollution and the soiling of buildings in that area (Coaffee, 2003a, p.176).

4.4.1.2 Traffic restriction

The restriction of traffic, which should imply that some form(s) of screening will occur, increases the likelihood of a hostile vehicle being identified. Such an approach will need to ensure that the ability to reject vehicles is incorporated, without the need to allow such vehicles past the access control point (CPNI, 2010, p.16; British Council for Offices, 2009, p.109). If less than 100% of the vehicles are screened, the risk of a hostile vehicle being successful in an attack attempt is increased, resulting in a more profound requirement for VSBs within the restricted area (Forman *et al*., 2009, p.258). The performance of traffic restriction encompasses the reduction in the consequences arising from traffic exclusion (see previous section) and therefore reduces the impact on day-to-day business operations. Coaffee (2003a, p.176) noted that public transport journey times can be reduced, depending on the size of the traffic restriction (which in this case was ‘the Square Mile’ in the City of London). Forman *et al*. (2009, p.258) have noted that off-site screening can result in the reduction of the number of vehicles that need access to a site, as well as environmental, safety and cost benefits that may also arise from incorporating such an approach. Consequences of traffic restriction would therefore encompass displacement to a lesser extent, but risk of an attack being carried out would increase, due to the ability of a hostile to potentially exploit vehicle access control point vulnerabilities.

4.4.1.3 Traffic inclusion

Traffic inclusion implies that neither exclusion nor restriction occurs and that traffic is therefore un-impinged in its movement around a district or site. However, buildings would therefore require individual protection, reducing stand-off distances and potentially resulting in the need for more robust and obtrusive VSBs (Forman *et al*., 2009, p.258). The benefits arising from such an approach therefore encompass un-impinged day-to-day business operations and vehicle permeability, however the consequences are such that the risk of an attack and its impacts are much higher.

4.4.1.4 Temporary barriers

The use of temporary barriers is also a traffic management approach, as they could be used at times of heightened threat (Forman *et al.*, 2009, p.258). A number of issues in relation to their requirements and consequences are evident. As highlighted by Forman *et al*. (*ibid*.), deployment may be intelligence based and may therefore indicate to adversaries that there is intelligence about their plans, they could be deployed too late, they may require specialist equipment to deploy and be transported from afar, they may be less effective against penetrative impact than permanent solutions, they are not always effective to use on undulating or unmade ground, their appearance may preclude their application in certain environments, their mass may preclude their use on elevated slabs, few systems incorporate active barrier elements, effective designs (from a security perspective) are not always appropriate at sites where pedestrian routes are not clearly demarcated, and the need for them to be pedestrian permeable such as at transport interchanges and shopping centres may reduce their structural effectiveness.

4.4.2 Vehicle access control

Forman *et al*. (2009, p.265) highlight three types of vehicle access control point (VACP); a single line of barriers, an inter-lock system (two lines of barriers allowing access to one vehicle at a time, whereby the second line does not open until the first line closes) and a final denial system (whereby the route a vehicle must take is enforced through the use of VSBs, with a barrier at the end being ready to stop hostile vehicles). Regardless of the VACP used, the checking of vehicle and occupant legitimacy is of importance, as is the ability to reject vehicles without their admission past the barriers (Tomlinson and Nelson, 2010, p.56). Details of deliveries and visitors should be obtained prior to arrival (with entry refused if prior notification has not been received), logged upon arrival and their status checked after a period of time, as well as searched prior to admission past the barriers themselves (HM Government, 2010d, p.21). As noted by Forman *et al*. (2009, p.258), less than 100% screening increases the risk of an attack being carried out and tailgating should be addressed (French, 2006, p.14).

Three means of access control are apparent, those being a single line of barriers, an inter-lock system, and a final denial system. Comprising of an access control method and a single line of barriers, the single-line system this is the simplest VACP. However, such a method is prone to tailgating, with hostile vehicles being able to encroach through the barriers, exploiting the inherent weakness of the system itself. An inter-lock system comprises of an additional layer of barriers (than a single-line system) and the restriction of the vehicle in between the two sets of barriers to be unable to encroach around them, enforced through CTMs. The second line of barriers must only be opened upon the closing of the first set, reducing the risk of tailgating and increasing the security of the VACP, but has inherent cost implications and reduces vehicle throughput (Forman *et al*., 2009, p.265). A final denial system can exist with or without restricting access, with the vehicle route(s) being enforced through the use of CTMs to stop vehicles being able to encroach or overcome the desired route. Whilst vehicle throughput can be un-impinged, the system is totally reliant on the guard force identifying and reacting to a hostile vehicle and lowering the final barrier, which also raises questions regarding its deterrent value (Forman *et al*., 2009, p.265).

4.4.3 Traffic calming

Traffic calming involves the reduction in speed of vehicles, so as to reduce the energy that can be transferred to a building or VSBs (BCO, 2009, p.109). The energy that can be transferred depending on different vehicle types, weight and speed is evident in Table 4.1, which shows that traffic calming has significant security benefits in reducing the impact speed and kinetic energy of hostile vehicles, therefore resulting in any CTM being less robust and obtrusive, as well as allowing any security personnel (or capable others) to act if hostile intentions are identified (Forman *et al*., 2009, p.259; HM Government, 2010, p.26). Traffic calming can be facilitated through the use of vertical deflections (speed bumps) and horizontal deflections (bends, chicanes, or off-setting routes).

Table 4.1. Kinetic energy for various vehicle types and impact speeds (Forman *et al*., 2009, p.270)

Nominal speed		Kinetic energy: kJ				
		Car	4x4	Goods vehicle		
Mph	kph	1500kg	2500kg	3500kg	7500kg	30000kg
10	16	15	25	35	74	296
20	32	59	99	138	296	**1185**
30	48	133	222	311	667	2667
40	64	237	395	553	**1185**	4741
50	80	370	617	864	1852	7407
60	96	533	889	**1244**	2667	10667
70	112	726	**1210**	1694	3630	
80	128	948	1580	2212		
90	144	**1200**	200			

Note: all values are approximate

4.4.4 Vehicle security barriers

> “A VSB provides the hard stop for penetrative vehicle attack. VSBs are structural in nature and can be either active (powered or manual) or passive” (Forman *et al*., 2009, p.261)

Within literature, VSBs are evident under eight categories, those being public art and culture, water, play, seating, street furniture, topography and levels, walls and fences, and incidental street elements (CPNI, 2011, p.26). A barrier is defined as any:

> “Symbolic, physical or electronic limits set with the purpose of creating partitions between a certain area and its surroundings” (British Standards Institution, 2006b, p.5)

In relation to physical barriers, structural elements can be incorporated into a variety of street furniture and landscaping, creating numerous opportunities in relation to the creation and incorporation of VSBs (HM Government, 2010c, p.26). Whilst the CPNI’s (2011, p.26) aforementioned categorisation of VSBs is detailed, certain categories overlap, such as ‘seating’ and ‘street furniture’. Therefore, a broader categorisation is adopted, encompassing security-explicit barriers, street furniture, and landscaping and nature. Common principles concerning the incorporation of VSBs, especially considering security-explicit barriers and street furniture, as well as trees, is the distance between and height of the VSBs themselves. The maximum clear gap between VSBs must not exceed 1200mm (measured at a height of 600mm above ground level), with the minimum height of such barriers being a minimum of 500mm (CPNI, 2011, p.23; HM Government, 2010c, p.27; Forman *et al*., 2009, p.263).

> “All barriers have advantages and disadvantages that must be considered before they are deployed” (British Council for Offices, 2009, p.160)

4.4.4.1 Security-explicit barriers

Evident in the literature is a category of VSBs that perform solely security functions and do not provide further amenity (such as street furniture) or environmental benefits (such as landscaping and nature). Drawing on the work of the CPNI (2011; 2010) and Forman *et al*. (2009), security-explicit barriers encompass barriers, blockers, bollards, fencing, gates, planters and walls. The inherent benefits of passive measures (those that are not automated or ‘active’) are that they remove the risk of attacks occurring through deception and duress, as well as removing the risk of tailgating if such measures are incorporated to exclude traffic or simply protect an individual building (British Council for Offices, 2009, p.159). Such measures can require shallow foundations or even be surface mounted, reducing the complexity and costs inherent in installing such CTMs (Forman *et al*., 2009, p.272). Their acceptability is dependent on the extent to which they restrict permeability (Kappia *et al.*, 2009, p.632), with potential consequences being raised by Harre-Young *et al.* (2010, p.1125) as to whether certain VSBs increase the risk and severity of flooding at neighbouring locations.

4.4.4.2 Street furniture

VSBs in the form of street furniture are also evident in the aforementioned literature (CPNI, 2011; CPNI, 2010; Forman *et al*., 2009), with furniture, art and bicycle racks being examples of such measures. Whilst they inherently provide additional functions and benefits, further exploration of such measures is not evident. As highlighted in the previous section, VSBs with shallower foundations have inherent benefits in terms of reduced complexity and costs involved in their installation (Forman *et al*., 2009, p.272), a factor that will also apply to street furniture. Further examination of these measures is required in order to provide a more in-depth exploration of the measures as well as their inherent attributes.

4.4.4.3 Landscaping and nature

These VSBs include bunds, collapsible areas, ditches, topography, trees and water (Collapsible areas are highlighted in Harre-Young *et al.* (2010); other VSBs are drawn from CPNI (2011; 2010) and Forman *et al*. (2009)). Other sources cited such measures because of their inherent aesthetic and environmental benefits (Lavy and Dixit, 2010, p.559; British Council for Offices, 2009, p.107). Synergies between security and other agendas, such as environmental issues, are evident (Coaffee and Bosher, 2008, p.81; Coaffee (2008b, p.4636), through not only using such VSBs to perform security functions, but also through the possible incorporation of sustainable urban drainage systems into the VSBs. Yet, complexity exists in terms of inherent consequences in relation to health and safety (British Council for Offices, 2009, p.107) and the requirements for trees, which would need to be of substantial girth (British Council for Offices, 2009, p.160; Forman *et al*., 2009, p.263).

4.5 Protective Construction

> "Protection is generally achieved through a combination of standoff, redundancy, and hardening" (Tomasetti and Abruzzo, 2004, p.22.4)

Redundancy and hardening are inherent in protective construction, the objectives of which are furthered by Little (2007, p.107), who states that it relates to the prevention of glazing and façades shattering and entering occupied space, keeping blast energy outside of the building, protecting occupants from fragmentation and by preventing structural collapse. The achievement of this has been stated to cost between 0-5% of overall construction costs (Crawford, 1995b, p.9; Elliottt *et al*., 1992, p.296). Brand (1994) highlights the layers of a building, and to categorise the CTMs inherent in protective construction, those layers are adopted, as shown in Figure 4.4.

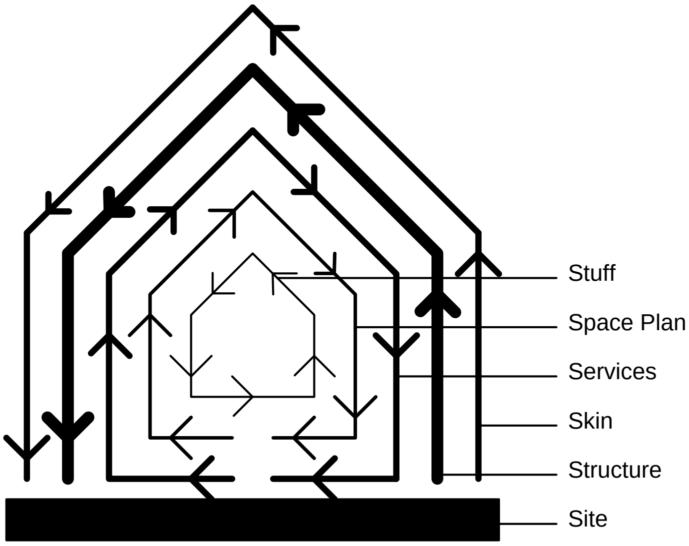


Figure 4.4. Layers of change (Brand, 1994, p.13)

Two of Brand's (1994) layers are not applicable to CTMs used within protective construction, those being 'site' (CTMs external to the building fall under HVM) and 'stuff' (the layout and enhancement of space plans are applicable, but not the 'things' that are placed within or around them). Accordingly, literature on the protection of the structure of a building is explored in section 4.5.2, the protection of the skin of a building is explored in section 4.5.1, the services in 4.6.3 and the space plan in section 4.5.3. A relationship between protective construction and HVM is evident, with sufficient stand-off negating the need for any CTMs under protective construction to be incorporated. However, as stated by HM Government (2010c, p.24):

> "Costs associated with fully hardening a building due to lack of blast stand-off can be significantly greater than installing vehicle counter-terrorism measures at a suitable distance…However, each site will need to be assessed on a case-by-case basis as land costs, ownership, available room, planning permission, business needs and re-location costs may eliminate any cost-benefit"

The protection of a building, however, has been cited as having numerous benefits, with such enhancement being synonymous with 'invisible security' as the building can appear the same as a conventional construction (Guidry, 2007, p.67) and the building will also be more resilient to other threats, hazards and major accident (Rose *et al*., 2007, p.529; Sternberg and Lee, 2006, p.16; Marshall, 2002, p.9; National Research Council, 2001, p.3). The CTMs within protective construction will now be explored, highlighting their requirements, performance and consequences where possible, including any information on their potential costs.

4.5.1 Skin

The protection of the 'skin' of a building encompasses its cladding and façades, the most notable of the latter being glazing. Cladding should be attached directly to floor slabs as opposed to perimeter columns (HM Government, 2010c, p.20; Mays and Hadden, 2009, p.10) and have easily accessible fixings and panels that can allow inspection and, if necessary, replacement after an explosion (Mays and Hadden, 2009, p.10). The British Council for Offices (2009, p.172) state that fixings should be designed to remain elastic under blast loads so that they can be re-used after an explosion, even if the panels themselves need replacing. In relation to the form of façades, the exterior geometry of a building should be convex as such a geometry facilitates the dissipation of blast loads more than other forms and no re-entrant corners or recesses should be incorporated, as these can exacerbate the effects of an explosion and provide a location to conceal smaller devices (HM Government, 2010c, p.19; British Council for Offices, 2009, p.107; Mays and Hadden, 2009, p.9).

The British Council for Offices (2009, p.169) state that there are three main types of glazing, those being annealed, toughened and laminated, although the use of heat-strengthened glazing is also evident. Also applicable is the use of anti-shatter film (ASF) and bomb blast net curtains (BBNC). The purpose of protecting glazing is to reduce or eliminate its fragmentation (Mays and Hadden, 2009, p.19) and the blast pressures which could enter the interior of the building (Smith and Cormie, 2009, p.178). Glass is the weakest part of the exterior façade and can be damaged from greater distances than any other façade material (Little, 2004b, p.66; Elliott *et al*., 1992, p.297). Whilst it has been stated that open-able windows in the façade should be avoided, outward-opening windows are generally more robust (to external explosions) than inward-opening ones (Mays and Hadden, 2009, p.10). Glazing that does not fail or shatter will inherently be of benefit in the event of any explosion, not just one emanating from a terrorist attack (Marshall, 2002, p.9). Annealed glass, when unprotected, results in elongated shards that can be angular and jagged, resulting in an immediately hazardous environment for any occupants nearby such glazing (Be Safe Not Shattered, 2011; Mays and Hadden, 2009, p.19; Smith and Cormie, 2009, p.180). ASF is a transparent adhesive film that is applied to the inside surface of glazing panes and can also be anchored under frames, in order to hold any fragments together, regardless of whether the pane becomes detached from the frame itself (Be Safe Not Shattered, 2011; Smith and Cormie, 2009, p.184; Holtrop, 1993, p.237). Although ASF can reduce transparency (British Council for Offices, 2009, p.171) and is relatively less effective than laminated glazing (Smith and Cormie, 2009, p.185), it reduces risk of injury by 50% (compared to no protection), can be installed during working hours (reducing disruption), can provide energy-saving benefits and last over 10 years (Be Safe Not Shattered, 2011).

BBNCs are used to capture glass fragments (although annealed shards can penetrate the curtain itself) and panes, and allow blast pressures to flow through, removing any airborne threats to building occupants (Smith and Cormie, 2009, p.185; Carmichael and Gartell, 1994, p.11). As with ASF, they suit retro-fit situations and can allow existing window frames to remain, which can be of particular benefit to heritage buildings (British Council for Offices, 2009, p.171). However, they have inherent consequences in terms of reduced visibility, light permeability, ventilation and aesthetics (British Council for Offices, 2009, p.171; Smith and Cormie, 2009, p.185). They are also less effective than laminated glass (Smith and Cormie, 2009, p.185). Smith and Cormie (2009, p.183) state that the strength of this glass is between that of annealed and toughened, the difference being that this glass will break into larger, but fewer, sharp-edged fragments compared to annealed glazing. Whilst toughened glass offers a four- to six-fold increase in strength compared to annealed glass (Smith and Cormie, 2009, p.181), it will still shatter when it breaks, resulting in fragmentation that will be smaller than that of annealed glass (Be Safe Not Shattered, 2011; Mays and Hadden, 2009, p.19).

> "…the safest type of glass to use" (Be Safe Not Shattered, 2011)

Laminated glass, consisting of two or more plates of glass held together by a flexible plastic layer (PVB layer), has the capability to retain its integrity as it deforms, resulting in little or no fragmentation, and shorter repair times (Be Safe Not Shattered, 2011; Mays and Hadden, 2009, p.19). The PVB layer should be not less than 0.76mm and should be secured into the frame (HM Government, 2010c, p.21). Smith and Cormie (2009, p.183) assert that an essential part of the design of such glazing is the detailing of the edge retention and the supporting of the glass in its frame and fixings, which should allow it to absorb strain. Smith and Cormie (*ibid*.) also state that the performance of such glazing is superior to annealed and toughened glass in a number of ways and that as a result, it should be considered to be the minimum baseline standard for new buildings:

1. The excellent bond between glass and pvb, which substantially remains active after the glass cracks
2. The large strain energy capacity of the pane after the glass piles have cracked
3. A ductile failure mechanism in which highly hazardous conditions do not immediately occur when the pvb reaches its limit of tearing, but which increase only gradually beyond this point. This gives an added built-in margin of safety, although this is difficult to quantify
4. An in-built resistance to physical attack

Additional benefits are cited by Crawford (1995b, p.6):

> "Safety and security are not the only benefits of laminated glass – it absorbs 99.5 per cent of ultraviolet rays, to the benefit of staff, furniture and fittings. Additionally, the interlayer absorbs high- and low- frequency noise, particularly when used in a double-glazed unit. This is currently the best form of protection against blast, but can be the

> most expensive, however, on large projects, if performance criteria are taken into account, it can be the most cost-effective”

4.5.2 Structure

Evident in the literature is the protection of three particular structural components, those being columns and frames, floors, and stairwells. Whilst detailed literature on the design of element in various structures can be found in Cormie *et al*. (2009), the construction and layout of columns and frames is widely cited as pertinent to the structural integrity of a building, most notably in order to ensure a building does not disproportionately or progressively collapse (British Council for Offices, 2009, p.165; Mays and Hadden, 2009, p.22), which according to HM Government (2010c, p.19), can be achieved through using (as a minimum) the measures for robustness against such collapse for Class 2B building as described in Part A3 of the current Building Regulations. As stated by Mays and Hadden (2009, p.24):

> “…the principal measure to ensure robustness is to design a structure which can develop alternate load paths”

Mays and Hadden (2009, p.10) assert that an essential requirement for a structure is that it is well tied together and sustains localised damage without widespread collapse, which requires tensile capacity and ductility in the design of the elements and their connections. Evident in the literature is a preference for steel or reinforced concrete frames (HM Government, 2010c, p.19; British Council for Offices, 2009, p.164; Cormie, 2009, p.218; Mays and Hadden, 2009, p.10), with appropriate connections and ties (see HM Government, 2010c, for information on such requirements). In relation to floors, Mays and Hadden (2009, p.11) say they should be tied into structural frames and be able to withstand load reversal, as the impact of a blast and the resulting uplift pressures will overcome gravity loads on the floor itself. Also, particularly on lower floors where the blast impact will be highest, there should be continuity of floor spans and their reinforcement in both of the slab faces should be incorporated (*ibid*.). Regarding stairwells, at least two should be incorporated and designed so that they are spaced no more than 50m apart, are orientated toward different escape routes (HM Government, 2010c, p.21).

4.5.3 Services

Services will need to be protected, as damage can disrupt services over both the short-term and long-term (Taylor, 2009, p.275). Their ability to improve air quality and therefore reduce occupant sickness and increase productivity is cited (Marshall, 2002, p.9). Further exploration of the protection of services is required, especially to identify further benefits and consequences of their protection.

4.5.4 Space plan

Also inherent in the protection of crowded places is the space plan (circulation design) that can be designed and incorporated internally. Evident in the literature is the use of evacuation routes, internal partitions, protected spaces and sacrificial design. Guidry (2007, p.69) asserts that when designing-in such measures, they can be incorporated at no or little cost and can provide an 'invisible' means of protecting a building. Evacuation routes should resist the impacts of any blast and fragmentation, with exit routes being at least duplicated (HM Government, 2010c, p.20). Whilst providing means of egress from a building, they should also lead to protected spaces if applicable (see section 4.5.4). Lightweight internal partitions can cause secondary fragmentation in the event of an explosion, however if designed properly, they can act as barriers for fragmentation, through dividing up internal areas of a building, therefore reducing loss of life, injury and damage to the internal areas of a building (HM Government, 2010c, p.21; Mays and Hadden, 2009, p.11; Holtrop, 1993, p.237). Protected spaces are internal, structural core areas, that are preferably reinforced and large enough to accommodate the occupants of the building (Mays and Hadden, 2009, p.11; HM Government, 2010c, p.20; NaCTSO, 2009b, p.33). A minimum clear floor space allowance of $0.6m^2$ per person is recommended, although $0.8m^2$ is advised (Mays and Hadden, 2009, p.26). Whilst, as with all structurally-based CTMs, their design and construction should be done in consultation with specialist advice, Mays and Hadden (2009, p.26) assert that such spaces should:

- be clearly identified as a protected space; clear signage directing people to the nearest Protected Space is recommended
- be located remote from windows, external doors and walls
- be located remote from structural bays and from areas prone to structural collapse
- be located away from areas exposed to high blast and fragment hazards
- be surrounded by full-height reinforced concrete walls; fire stairs and lift lobbies should preferably not be used where there are alternatives, but may provide practical solutions
- be away from areas with additional hazards, e.g. hazardous stores, fuel
- accommodate people with impaired mobility
- be located on each and every floor
- be located in similar positions on each floorplate
- be located in areas that will not disrupt normal escape routes
- be designed for at least 3 hours occupancy

Such spaces could be used to invacuate occupants, when the location of an explosive device is unknown or known to be outside (NaCTSO, 2009b, p.33; Jenkins, 2001, p.12). They should also, ideally, have toilet and drinking water faciltiies, as well as reliable communication links (including a public address system) and adequate ventilation (British Council for Offices, 2009, p.179). Sacrificial design is presented in the literature, through the use of the layout (or re-organisation) of rooms and services. Reorganising such facilities can prevent their exposure to vulnerable areas (British Council for Offices, 2009, p.113) and where glazing is used, it should face areas that do not have open access, such as internal courtyards (British Council for Offices, 2009, p.177). Secondary layers of glazing could also be used, providing an internal stand-off distance (Carmichael and Gartell, 1994, p.11).

4.6 Planning, Detection and Procedures

Planning, detection and procedures (PDP) encompasses the use of procedures and competent staff to deal prevent, prepare for and respond to terrorist attacks. The need for competency is highlighted by NaCTSO (2011, p.5) and HM Government (2010d, p.21), which places emphasis on the training, testing and exercising of plans and procedures, although it may not be practical to carry out regular tests or exercises, especially in public buildings (Proulx, 1999, p.335); it may be costly in terms of resources required to run such events and in terms of disruption to day-to-day activities (Maestas *et al*., 2007, p.529). There are three elements to PDP, those being security culture, people and technology, and planning and procedures, which will now be explored.

4.6.1 Security culture

The security culture an organisation adopts is an essential part of counter-terrorism planning (CPNI, 2010, p.36). The encouragement of staff to adopt ‘security first’ habits theoretically impacts the effectiveness of all CTMs, especially those which rely on human interaction, as a poor willingness to participate or lack of interest could lead to CTMs being left in vulnerable positions etc.

> “How the organisation engages and communicates with staff reflects its commitment to security” (CPNI, 2010, p.37)

Evident in incorporating and facilitating a security culture are staff communications, management support, line management relations and employee welfare, with such initiatives as a security hotline being usable to encourage participation and awareness (*ibid*.). As stated by Briggs and Edwards (2006, p.13):

> "…security is achieved through the everyday actions of employees right across the company. It is not something that the corporate security department can do to or for the company on its behalf".

4.6.2 People and technology

'People and technology' encompasses capable guardians, closed circuit television cameras (CCTV), communication systems, intruder detection alarms, lighting and security guards. The term 'capable guardian' refers to any person who is able to identify suspicious behaviour and act on it (British Standards Institution, 2006b, p.7), meaning that users of crowded places (not just staff), can aid in the protection of the place they are at (Welsh *et al*., 2010, p.315; Smith, 2009, p.239). Therefore, appropriate procedures for staff to deal with such incidents should be developed. Regarding CCTV, whilst studies have questioned its effectiveness in reducing crime (Briggs, 2005, p.24), specifically in relation to the mitigation of VBIEDs, its effectiveness is dependent on the method of attack, as a suicide attack would not be impacted by deterrence, but the abandonment of a device might be impacted by such means (Cherry *et al*., 2008, p.87). Its performance is dependent on the abilities of those using it, as cameras could be left in positions that leave vulnerabilities in a scheme (see section 3.5.1.3 for further information 'weak points'), but has multiple uses in terms of monitoring and detection, as well as post-incident investigations (Regan, 2006, p.22; Graham, 2001b, p.237). Communication systems could be incorporated and/or used for emergency situations, benefitting a range of situations (HM Government, 2010c, p.26; British Council for Offices, 2009, p.179). Intruder detection alarms are cited as being of importance in integrating security systems, so that CCTV, lighting and alarm systems are all interconnected (*ibid*.). They benefit a range of threats and aid in both deterrence and detection.

> "External lighting provides an obvious means of deterrence as well as detection" (NaCTSO, 2011, p.13)

Whilst lighting benefits a range of situations, its use must be carefully considered, as it could disrupt and disturb adjacent buildings and occupiers, and could interfere with other CTMs, such as CCTV (*ibid*.). Security guards have an inherent impact on deterrence and are therefore also able to identify and potentially prevent an attack from occurring (Mahoney, 1994, p.16), as a result of disrupting hostile reconnaissance or an attack itself. Coaffee (2003c, p.71) showed that when such visible deterrents were reduced, crime levels began to increase.

4.6.3 Planning and procedures

Planning and procedures encompasses awareness, Business Continuity Planning (BCP), contingency planning, evacuation and invacuation planning, housekeeping and search planning. Awareness of staff to hostile reconnaissance and suspect packages and/or vehicles reduces the likelihood of an attack from occurring (HM Government, 2010d, p.21; Lavy and Dixit, 2010, p.558; NaCTSO, 2009b, p.15; Dolnik, 2007, p.17; Prenzler, 2007, p.35). Ensuring that staff have the confidence and procedures in place to act on suspicions is pertinent (CPNI, 2010, p.39; NaCTSO, 2009b, p.15), although other users of the building or space could also report activity to staff, for which appropriate procedures should be in place (Welsh *et al*., 2010, p.315). As raised in section 3.2.2.2, awareness can be raised through Project Argus and Griffin events, schemes developed to heighten safety, responses and continuity in relation to terrorist attacks (Coaffee *et al.*, 2008, p.107). A relevant point is the identification of hostile reconnaissance, which is undertaken to assess the vulnerability of a target and to practice its attack (NaCTSO, 2009b, p.51; Stephens, 2009, p.7; Elliottt *et al*., 1992, p.288). Identifying such practices and therefore stopping an attack from occurring is therefore a highly effective solution.

BCP encompasses the planning arrangements that ensure the organisation and its assets are able to cope with an incident and return to normality (albeit a new one) as soon as possible following an incident (Veale, 2009, p.291). It should be constantly updated as organisations change, with regular testing to ensure staff competency and plan validation (CPNI, 2010, p.28). BCP is beneficial in mitigating limitless disruptions and is therefore a cost-effective measure, especially where it is already being undertaken. Contingency planning encompasses the arrangements made to respond to various incidents, with plans being activated as part of BCP, or in response to specific situations and the need to recover from an incident (British Council for Offices, 2009, p.152; Mays and Hadden, 2009, p.25; Veale, 2009, p.292). As stated by Veale (2009, p.295):

> "A post-event contingency plan is essential for business survival. It is not only necessary for dealing with terrorist outrages but also for many other forms of disaster, from flooding to fire and from a major communication failure to a plane crash"

As with BCP, such arrangements are usable in a variety of situations and are not explicit to counter-terrorism. Evacuation and invacuation planning is a very pertinent issue here. Of particular importance was invacuation (the 'inward evacuation' of building users), which would be required if the location of a bomb was unknown or known to be external to the building (CPNI, 2010, p.17; HM Government, 2010d, p.21; British Council for Offices, 2009, p.192; NaCTSO, 2009b, p.31). As stated by Maestas *et al*. (2007, p.530):

> "Evacuating large crowds of people under any circumstance is a challenge…Determining the most effective evacuation plan for a large public facility

> requires in-depth analysis of multiple factors. Determining the best routes, foreseeing potential problems, addressing the chaos/panic factor, and orchestrating the evacuation are all crucial aspects that should be evaluated" (Maestas *et al*., 2007, p.530)

In relation to such planning, communication systems can be used to aid in the facilitation of the evacuation or invacuation (Williams *et al*., 2000, p.302; Proulx, 1999, p.335). Escape routes should be diverse, so that the risk of routes being impaired by an attack are reduced (Mays and Hadden, 2009, p.11); they should be regularly checked and checked prior to any commencement of evacuations or invacuations, as should pre-arranged muster points (CPNI, 2010, p.35; Mahoney, 1994, p.18). The inter-related nature of the CTMs is evident in relation to evacuation and invacuation planning, as lighting can assist in aiding building users in their movements (Ling and Soh, 2005, p.279) and CTMs could obstruct or impinge evacuation (British Council for Offices, 2009, p.39). The use of 'grab bags' can aid in ensuring vital information and equipment are taken when evacuating or invacuating (NaCTSO, 2011, p.15), with orderly and efficient evacuations being shown to save lives, as was evident in the terrorist attacks of September 11th, 2001, in the USA (Maestas *et al*., 2007, p.529). Evacuating users of a building may expose them to further risks, such as injury from debris (Mays and Hadden, 2009, p.25). The British Council for Offices (2009, p.151) states that when evacuating, assembly points should be remote from the evacuated building and be not less than 500m away, with consideration also needing to be given to alternative assembly areas and the avoidance of tall and heavily-glazed buildings. Whilst the implications of testing such arrangements would result in disruptions to businesses and productivity reductions (Then and Loosemore, 2006, p.161), analyses would need to consider whether the long-term implications of not testing such arrangements and the implications this could have in the event of an attack would be worth the avoidance of such disruption.

Housekeeping is seen as an important factor in protecting crowded places from terrorist attack, as it facilitates the easier identification of suspicious packages (and persons), as well as inherently benefitting the tidiness and aesthetic appearance of buildings and areas (HM Government, 2010d, p.23; NaCTSO, 2009b, p.19). Linked to housekeeping is search planning, which should be undertaken as part of ongoing routines and heightened in times of increased or specific threat (CPNI, 2010, p.35; NaCTSO, 2009b, p.29). As previously stated in relation to evacuation and invacuation planning (section 4.6.3), this is relevant to the security and safety of evacuation and invacuation routes and assembly points, as well as prior to re-occupation of buildings by staff (CPNI, 2010, p.35). NaCTSO (2009b, p.30) state that there are seven key instructions:

1. Do not touch suspicious items
2. Move everyone away to a safe distance
3. Prevent others from approaching

4. Communicate safely to staff, visitors and the public
5. Use hand-held radios or mobile phones away from the immediate vicinity of a suspect item, remaining out of line of sight and behind hard cover
6. Notify the police
7. Ensure that whoever found the item or witnessed the incident remains on hand to brief the police

4.7 Attributes of Performance and Consequences

The literature on CTMs that can be incorporated to protect crowded places has been examined and a provisional classification and categorisation of CTMs has been presented. In order to develop a typology of CTMs, attributes of performance and consequences need to be identified, from which a provisional framework of the typology that can be developed to be populated by data obtained from adopted research methods. Evident in the previous sections have been attributes in relation to the requirements of CTMs, their resulting performance, consequences and additional information, such as how they can reconcile agendas. It is these attributes that are now explored and validated, in order to form the aforementioned framework.

4.7.1 Requirements

Requirements of CTMs are evident in terms of their construction, installation and management operations. Examples of the importance of the construction requirements of CTMs are evident in section 3.5.1.2, where it was shown that CTMs need to be appropriately constructed to ensure they are sufficiently robust. The installation requirements of CTMs can vary, as for example, foundation depths of VSBs are influenced by a number of factors, including the location of local utilities (Harre-Young *et al.*, 2010, p.1126). Management requirements have been typically shown to be pertinent to CTMs that inherently require human interaction, such as with the operation of CCTV or the maintenance of landscaping and nature. One example is the maintenance requirements inherent in the use of trees as VSBs, where maintenance must ensure that limbs do not provide means of access over perimeters, or foliage does not obscure surveillance or other CTMs (Forman *et al*., 2009, p.263).

4.7.2 Performance

The performance of CTMs encompasses their visual and functional performance. Aesthetics and permeability are evident in terms of visual performance, with functions entailing not just their impact in the event of a blast, but any environmental benefits, the ability to escalate and de-escalate levels of security, the mitigation of other threats, hazards and major accidents, permeability in relation to people and vehicles, public amenity and revenue generation.

Visual performance encompasses aesthetic issues in relation to CTMs, which are a pertinent issue within the literature, both in terms of symbolism and in terms of aesthetic performance. Examples of both include Coaffee and Bosher's (2008, p.79) assertion that incorporating CTMs could lead to less visibly pleasing architecture, and the relatively poor aesthetic performance of BBNC, due to the resulting reduction in visibility, light and ventilation (British Council for Offices, 2009, p.171; Smith and Cormie, 2009, p.185). Visual permeability encompasses surveillance opportunities, user experience and the aesthetics of a given area, as well as the visual permeability of the CTMs, with the British Council for Offices (2009, p.171) highlighting that ASF can reduce such visibility (Guidry, 2007, p.67). It could also be argued that bollards could allow greater visual permeability compared to planters for example, due to their relatively smaller dimensions.

Functional performance includes environmental benefits, with examples including the potential for sustainable urban drainage systems to be incorporated into VSBs (Coaffee and Bosher, 2008, p.81; Coaffee, 2008b, p.4636) and reductions in pollution and soiling of buildings that occurs by excluding traffic from a given area (Coaffee, 2003c, p.73) and the resulting reduction in sick days from improvements to air quality (Marshall, 2002, p.6). The ability to escalate and de-escalate CTMs was also raised, in order to adapt to evolving and heightened levels of threat (General Services Administration, 2005, p.235; Jenkins, 2001, p.20). The mitigation of other threats, as well as hazards and major accidents was widely cited, with protective construction mitigating the impacts of all the aforementioned risks (Rose *et al*., 2007, p.529; Sternberg and Lee, 2006, p.16; Marshall, 2002, p.9; National Research Council, 2001, p.3).and VSBs mitigating a range of threats, not just terrorist attack (Forman *et al*., 2009, p.264). Permeability in terms of pedestrian and vehicle movement was also evident, with examples including the differences in permeability inherent in the incorporation of traffic exclusion, restriction or inclusion, and how this can influence acceptability (Kappia *et al.*, 2009, p.632). Public amenity was also raised as being an aspect of functional performance, with CTMs inherently being able to provide such amenity, such as the enhancement of street furniture to become VSBs. Revenue generation was also cited as a performance benefit of CTMs and resulting from their incorporation, through such means as improving the quality of an area and acting as a catalyst for regeneration.

4.7.3 Consequences

Inherent consequences of CTMs encompass whether their incorporation creates risks, whether they impact the day-to-day operations of a business, the impact they have on vehicles and any trade-offs that have to be made in order to accommodate them. The creation of risk could be a consequence of incorporating CTMs, as queues could be increased and therefore become a target themselves (Fussey *et al.*, 2011, p.138; Coaffee *et al.*, 2008, p.105) and CTMs could potentially increase the risk of flooding (Harre-Young *et al.*, 2010, p.1125). Day-to-day impacts on business could entail increased walking time due to traffic exclusions or restrictions (Stewart, 2010, p.34) and the productivity implications of testing and exercising CTMs themselves (Then and Loosemore, 2006, p.161). Linked to the impact on day-to-day operations is the impact on traffic that could result from the use of CTMs, most notably in relation to the exclusion or restriction of traffic, which will result in reduced throughput and potential delays (Forman *et al*., 2009, p.258).

> "Tradeoffs are inevitable" (Ellig *et al*., 2006, p.6)

Evident in the literature is the assertion that in order to incorporate CTMs, trade-offs will need to occur (Forman *et al*., 2009, p.251; Kappia *et al.*, 2009, p.630; Coaffee and Bosher, 2008, p.80; Then and Loosemore, 2006, p.161). An example of a trade-off is the incorporation of stand-off, which if incorporated within a site, could result in lower usable floor ratios (Then and Loosemore, 2006, p.161).

4.7.4 Additional information

Whilst each CTM has inherent requirements, visual and functional performance, and consequences, it is important to consider the need for capturing additional information during the course of the research. Such information could encompass cost data, how cost relates to the design stage in which they are incorporated and how certain CTMs or broader solutions can reconcile seemingly disparate or conflicting agendas.

> "…early inclusion of such measures at the design and pre planning stage are often cost neutral and highly desirable" (Construction Industry Research and Information Association, 2008, p.28)

The capturing of such information will therefore help to verify or dispel such statements as those above, which are reaffirmed by a number of sources (RIBA, 2010, p.3; British Council for Offices, 2009, p.86; Thompson and McCarthy, 2004, p.2.13), with no literature presenting an informed and evidenced case as to why costs will be less when CTMs are incorporated at the earliest opportunity, although such a statement may appear logical.

4.8 A Provisional Framework for the Typology

A provisional framework for the typology can therefore be established, as CTMs that can be used to protect crowded places have been identified (shown in Table 4.2), as have inherent attributes they can possess (shown in Table 4.3).

Table 4.2. The CTMs identified in the literature

Hostile Vehicle Mitigation	Protective Construction	Planning, Detection and Procedures
Security-Explicit Barriers	***Skin***	***Security Culture***
Barriers	Cladding	Security Culture
Blockers	Façades	
Bollards	Glazing	***People and Technology***
Fencing		Capable Guardians
Gates	***Structure***	CCTV
Planters	Columns and Frames	Communication Systems
Walls	Floors	Intruder Detection Alarms
	Stairwells	Lighting
Street Furniture (examples)		Security Guards
Art	***Services***	
Bicycle Racks	Services	***Planning and Procedures***
Furniture		Awareness
	Space Plan	Business Continuity Planning
Landscaping and Nature	Evacuation Routes	Contingency Planning
Bunds	Internal Partitions	Evacuation and Invacuation
Collapsible Areas	Protected Spaces	Housekeeping
Ditches	Sacrificial Design	Search Planning
Topography		
Trees		
Water		

Table 4.3. Example attributes of CTMs within a provisional framework for the typology

Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Construction requirements	***Visual***	Day-to-day business operations not restricted	Creation of a new risk	Cost
Installation requirements	Aesthetics		Disruption to day-to-day business operations	Participant comments
Management requirements	Permeability	Reduction in damage		Reconciliation information
		Reduction in risk	Increased damage to neighbouring buildings	Relationship to other CTMs
	Functional			Trade-offs
	Blast impact			
	Environmental benefits			
	Escalation and de-escalation			
	Mitigation of hazards, threats and major accidents			
	Permeability			
	Public amenity			
	Revenue generation			

4.9 Conclusion

This chapter has begun to develop the typology of CTMs that can be used to protect crowded places, as well as provide indications of their relative performance and consequences. Through the undertaking of an extensive literature review, the boundaries of the typology were formed, encompassing the protection of crowded places from VBIEDs, through incorporating physical security measures, all of which is directly relevant to the 'Protect' strand of CONTEST (as well as elements of 'Prepare'). Design philosophy was explored, with the choice of site and incorporation of stand-off noted as important factors in the protection of vulnerable places. A classification of CTMs was presented that encompassed all the means by which crowded places (and their occupiers) can protect themselves from a vehicle-borne terrorist attack, through the use of HVM, protective construction, and planning, detection and procedures. Literature on CTMs was then presented, from which attributes of the typology have been formed and can be used to assess the relative performance and consequences of them.

> "The questions of whether counter-terrorism measures are cost-effective, what value they bring, to whom and if they can contribute to increased sustainability by mitigating the impacts of more than just the particular threat are of vital importance" (Harre-Young, 2009, p.8)

The research methodology and design that was adopted, in order to develop and validate the typology and answer the aforementioned questions will now be explored in the following chapter, with the results of the research itself being presented in Chapter Six.

5.0 Research Methodology and Design

Understanding and adoption of research methodology, strategy and methods is discussed in this chapter, firstly by identifying methodological paradigms and the research strategies and methods that are traditionally used in conjunction with them, and how the resulting data can be analysed. Each of these discussions will also highlight the adopted design of the research itself, which will then be followed by the presentation of the plan for the research and the schedule that was undertaken. The development and undertaking of preliminary and main studies, as well as the creation of a scenario-based research instrument, will then be explored and the chapter will culminate in discussions on the validity and reliability of the methodology and research itself. It is important to highlight that during the course of the research, sensitive information was divulged by a number of participants and evident in a number of site visits. Such information was shared with (and already known by) the appropriate authorities (see section 5.2.6 for ethical considerations in relation to this). Its publication would be of use to those intent on causing harm, so whilst such information or observations are referred to in the thesis, details that would nullify their anonymity are omitted, but replaced with as much context as possible in order to provide, as far as is practicable, an open and evidenced account. The withholding of such information is also evident in a number of discussions that occurred over the course of the research. The occasional quoting of, or referral to, an ‘un-attributable source’ is therefore evident within the thesis. Such withholding is a result of confidentiality as well as security, with each participant given the option to be completely un-attributable, as opposed to being anonymous yet coded

5.1 Research Methodology, Strategy and Methods

Research methodology in social enquiry refers not just to the research methods adopted, but also to the philosophical assumptions that a study is based on, which themselves influence the actual research methods used to collect, analyse and interpret data; the research methods cannot be viewed in isolation from the ontological and epistemological positions that are adopted by a researcher (Dainty, 2008, p.3). Emanating from and evident in the literature on research methodology are a plethora of such frameworks, all of which encompass three distinct yet inter-related elements (as referred to above), those being philosophical assumptions regarding knowledge and reality (methodological paradigms), general approaches to research (research strategies) and their resulting procedures for data collection (research methods). An overview of these elements and their key components are highlighted in Figure 5.1, each of which will be explored in greater depth, in order to ascertain an in-depth understanding of their nature and prominence in order to develop a valid and reliable research design.

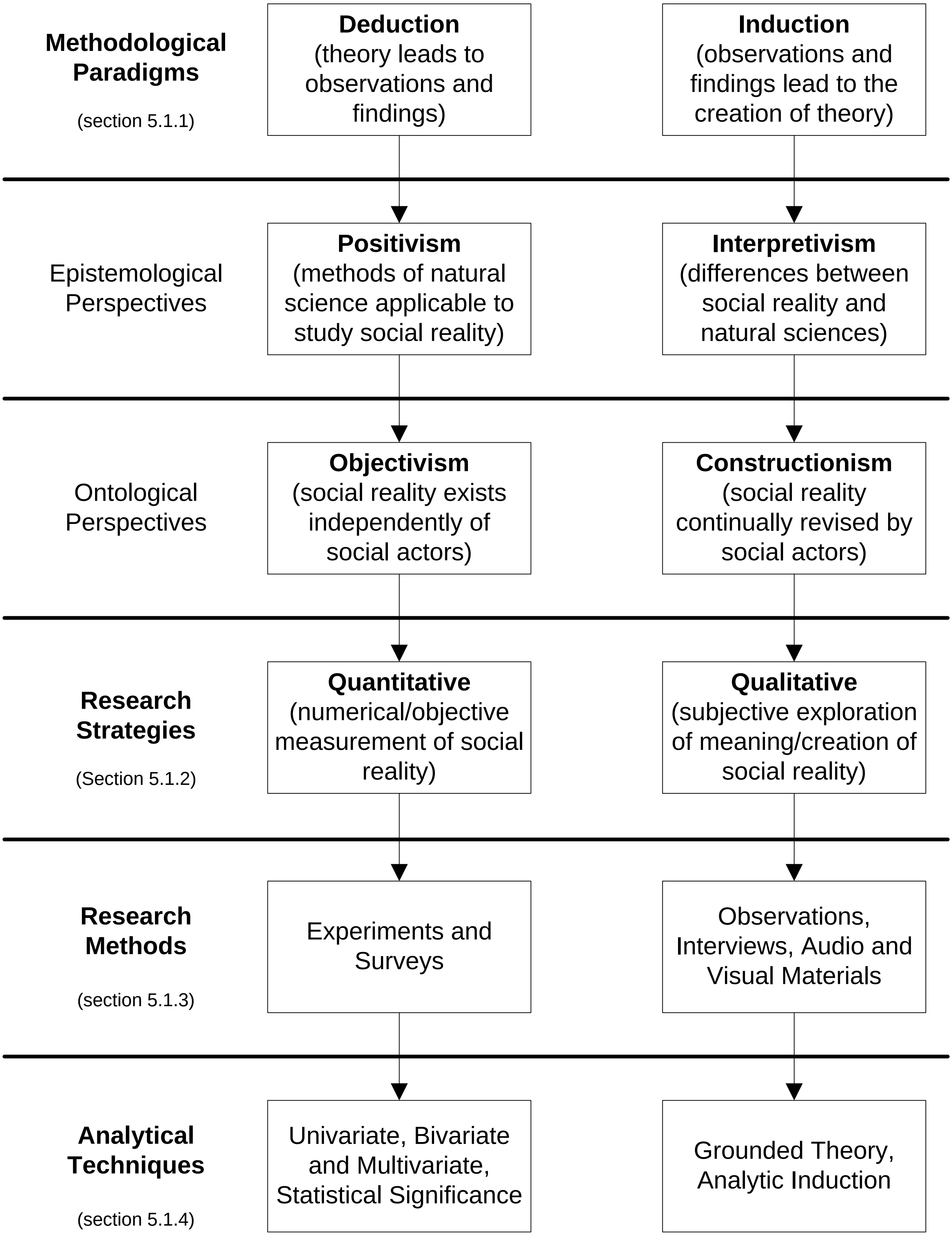


Figure 5.1. An overview of research methodology, strategy, methods and analytical techniques

5.1.1 Methodological paradigms

A paradigm can be seen as a theoretical framework, or lens, through which events can be viewed (Fellows and Liu, 2008, p.17). The creation of theory can be viewed as being deduced from observations and findings, known as deduction, or as emerging from observations and findings, known as induction (Bryman and Bell, 2007, p.35). These two perspectives encapsulate the two methodological paradigms that dominate research methodology, both of which entail their own philosophical assumptions regarding knowledge and reality (epistemology and ontology, respectively).

5.1.1.1 Epistemology and ontology

Epistemology is concerned with the nature and acceptability of knowledge and how we acquire it (Knight and Turnbull, 2008, p.65; Runeson and Skitmore, 2008, p.75; Bryman and Bell, 2007, p.16; Walliman, 2006, p.15). Knowledge can be acquired two ways, through sensory experience using inductive reasoning, known as empiricism, and through deductive reasoning, known as rationalism (Knight and Turnbull, 2008, p.68; Walliman, 2006, p.15). Ontology is concerned with the nature of reality and whether social phenomenon and their meanings exist independently of social actors (Dainty, 2008, p.3; Runeson and Skitmore, 2008, p.76; Bryman and Bell, 2007, p.22; Walliman, 2006, p.15). Both induction and deduction are traditionally associated with their own epistemological and ontological assumptions, as well as their own research strategies, methods and analytical techniques. It is these two paradigms (and their interconnectivity) that will now be explored.

5.1.1.2 Deduction

Deduction encompasses observations and findings being derived from theory, through the deduction of a hypothesis or hypotheses that are based on existing theory and then empirically investigated (Robson, 2011, p.18; Bryman, 2008, p.9; Bryman and Bell, 2007, p.11), as shown in Figure 5.2.

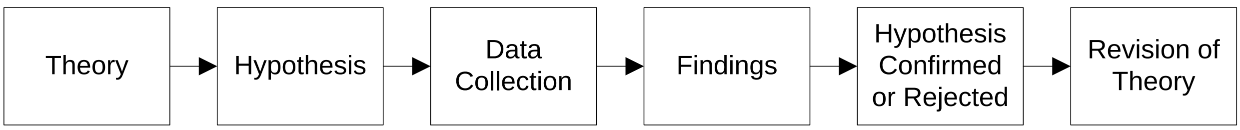


Figure 5.2. The process of deduction (Bryman, 2008, p.10)

Epistemologically, deduction is associated with positivism, which asserts that the methods used to study the natural sciences can be used to study social reality (Robson, 2011, p.21; Bryman, 2008, p.13; Bryman and Bell, 2007, p.16; Walliman, 2006, p.15) and that therefore, the researcher can remain independent of and uninfluenced by their observations and methods (Fellows and Liu, 2008, p.17; Silverman, 2006, p.409). Ontologically, deduction is associated with objectivism, which posits that social phenomenon and their meanings exist independently of social actors (Bryman, 2008, p.19; Bryman and Bell, 2007, p.22; Walliman, 2006, p.15). Deduction also traditionally encompasses the use of a quantitative research strategy and research methods (Bryman and Bell, 2007, p.14), which are explored in sections 5.1.2.1 and 5.1.3.1 respectively.

5.1.1.3 Induction

Conversely to deduction, induction posits that theory is the outcome of observations and findings (Robson, 2011, p.19; Bryman, 2008, p.11; Bryman and Bell, 2007, p.12), with the difference between induction and deduction emphasised in Figure 5.3.

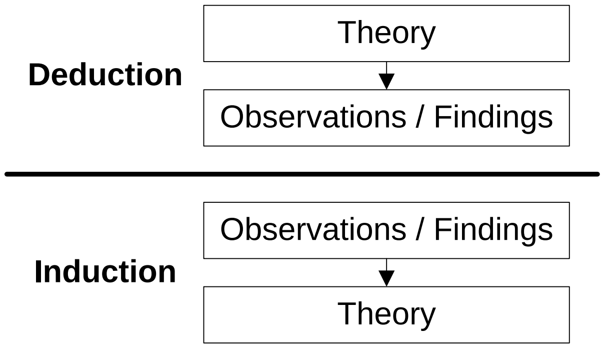


Figure 5.3. The difference between deduction and induction (Bryman, 2008, p.11)

Epistemologically, induction is associated with interpretivism, which asserts that the social sciences are fundamentally different from the natural sciences and that subjective meaning is needed to understand them (Bryman, 2008, p.16; Fellows and Liu, 2008, p.18; Bryman and Bell, 2007, p.19; Walliman, 2006, p.15). Ontologically, induction is associated with constructionism, which posits that social phenomenon and their meanings are continually accomplished and revised by social actors themselves (Bryman, 2008, p.19; Bryman and Bell, 2007, p.23; Silverman, 2006, p.400; Walliman, 2006, p.15). Induction is therefore also associated with the use of a qualitative research strategy and the use of qualitative research methods (Bryman and Bell, 2007, p.14), which are discussed in sections 5.1.2.2 and 5.1.3.2 respectively. Whilst the two paradigms could be perceived to be dichotomous, as apparent in Figure 5.1, their inter-relatedness and ability to both be used in terms of methodological pluralism is a matter of growing precedence.

5.1.1.4 Iterative or dichotomous paradigms?

> "The basic principle of methodological pluralism is that the use of multiple theoretical models and multiple methodological approaches is both legitimate and desirable if established models and understandings are to be questioned and knowledge furthered" (Dainty, 2008, p.8)

Whilst Dainty (*ibid*.) asserts that methodological pluralism is achievable and even desirable, it could be argued that such pluralism is inherent in the paradigms themselves, with deduction entailing elements of induction and vice versa; they are iterative processes that 'weave' back and forth between data and theory (Bryman and Bell, 2007, p.14). The distinction between the two paradigms is therefore questionable, with the terminology themselves purporting to there being two dichotomous paradigms, a factor Bryman and Bell (2007, p.15) argue is a reason to think of deduction and induction as methodological tendencies as opposed to 'hard and fast distinction'. Robson (2011, p.31) argues that the task of science is to create theory that explains reality and to test those theories using rational criteria, implying an inherently iterative process of induction and deduction, an approach also known as realism (also critical realism), a reconciliatory approach whereby a natural order is recognised as existing in social phenomena (positivism), yet the understanding of this is subjective and requires interpretation (interpretivism) (Walliman, 2006, p.20).

5.1.1.5 The inductive nature of the research

As previously highlighted, a fundamental question confronting those undertaking social research is the adoption of philosophical positions in relation to their enquiries (Dainty, 2008, p.1). The nature of the research is inductive, as demonstrated by the creation of a theoretical framework that captures the influences on the protection of crowded places and the influences on the CTMs that can be used to protect such places (Chapter Three), as well as the development of a provisional typology of the aforementioned CTMs (Chapter Four). Whilst, therefore, the research was also somewhat deductive in the sense of validating and furthering the 'created theory' regarding the protection of crowded places, subjective understanding of and insights into stakeholder perspectives and action was required, ideally suiting a qualitative research strategy and the use of qualitative research methods. Epistemologically, the research adopts an interpretivist stance due to the aforementioned subjective meaning needing to be understood, with the theoretical framework identifying constant and variable influences, and the typology presenting the performance and consequences of CTMs. The research adopts an ontological stance of critical realism, as it aims to understand (and therefore change or influence) the social world through the identification of the 'structures at work' (Bryman and Bell, 2007, p.18), as aforementioned; the research aims to explain the reality of the situation, create theory as a result of that understanding, and to test said theory. Therefore, the research is iterative in nature due to being inherently inductive and deductive, and requires the adoption of a reconciliatory stance and approach in order to adhere to that. In doing so, the order within the social phenomen being studied can be appropriately examined and understood, recognising that such understanding is subjective and requires interpretation (Robson, 2011, p.31; Walliman, 2006, p.20).

5.1.2 Research strategies

Viewed as iterative or dichotomous and as previously highlighted by Dainty (2008, p.3), the philosophical assumptions made regarding research methodology inherently influence and determine the quantitative and/or qualitative research strategies that are adopted, strategies that will now be explored.

5.1.2.1 Quantitative research

> "Quantitative approaches tend to relate to positivism and seek to gather factual data, to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously" (Fellows and Liu, 2008, p.27)

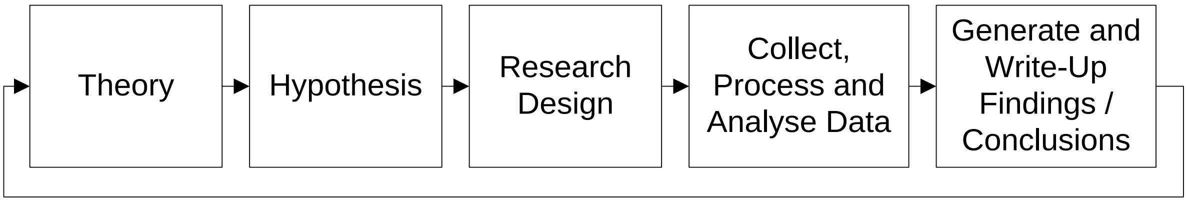


Figure 5.4. The process of quantitative research (Bryman and Bell, 2007, p.155)

Qualitative research, as shown in Figure 5.4 above, is inherently deductive, embodying the positivist view that social reality is an external, objective (and therefore measureable) reality (Bryman and Bell, 2007, p.28). Four preoccupations of quantitative research are apparent, those being measurement, causality, generalisation and replication and that as a result of these factors, a number of criticisms of such research have been raised, those being that social phenomenon and their meanings are not distinguished, the measurement process possesses an 'artificial and spurious sense of precision and accuracy', the reliance on instruments and procedures hinders the connection between the research itself and everyday life, and a static view of social reality is evident in the analysis of relationships between variables (Bryman and Bell, 2007, p.174).

5.1.2.2 Qualitative research

> "Qualitative research begins with assumptions, a worldview, the possible use of a theoretical lens, and the study of research problems inquiring into the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2007, p.37)

The distinction between qualitative and quantitative research is the subjective nature of the assumptions being made, emphasising words as opposed to quantification, as well as the rejection of positivism for interpretivism and the resulting need for subjective meanings to be understood (Bryman and Bell, 2007, p.28). The difference in the process of qualitative research is shown in Figure 5.5. Whilst qualitative research is associated with the generation of theory, it can also be used to test them (Bryman and Bell, 2007, p.29) as for example, the research question could be to investigate all or part of an existing theory, highlighting the inter-related nature of induction and deduction further. As with quantitative research, apparent preoccupations and criticisms attributed to qualitative research have been put forward, with qualitative research seeing through the eyes of the participants, therefore describing and emphasising context and process, with the resulting concepts and theory being grounded in the collected data (Bryman and Bell, 2007). Criticisms of qualitative research encompass the subjective nature of the research and the resulting complexity inherent in trying to replicate and generalise it, as well as potential lack in transparency (*ibid*.).

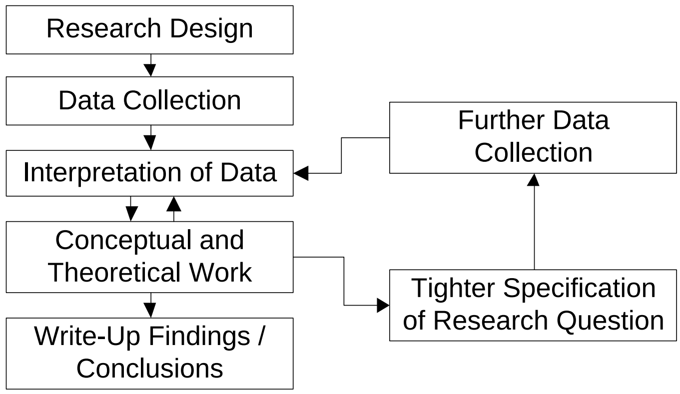


Figure 5.5. The process of qualitative research (Bryman and Bell, 2007, p.406)

Creswell (2007) asserts that there are five qualitative approaches, those being narrative research (reporting the life of a single individual), phenomenological research (the meaning for several individuals of their lived experiences), grounded theory research (the generation or discovery of a theory through an abstract analytical process), ethnographic research (the examination of shared patterns in a cultural group) and case study research (the study of an issue explored through one or more cases within a bounded system). Whilst case study research can be as a qualitative research design in which a 'case' or 'bounded system' is investigated using research methods, it can also be understood as a unit of analysis (Stake, 2005, cited in Creswell, 2007, p.73). Therefore, use of term 'case study' should be carefully considered, as such terminology can have multiple meanings and resonances (Robson, 2011, p.156; Proverbs and Gameson, 2008, p.99). Grounded theory is also seen as a qualitative research design (Robson, 2011, p.146; Hunter and Kelly, 2008, p.86), whereby theory is generated through a systematic process of data collection and analysis and is therefore grounded in the data. However, as posited by Bryman and Bell (2007, p.29):

> "Whilst it is useful to contrast the two research strategies, it is necessary to be careful about hammering a wedge between them too deeply"

5.1.2.3 Multi-strategy research

As with the inter-related nature of research methodologies, research strategies themselves are inter-connected and can be used in conjunction with each other and as asserted by Robson (2011, p.29), such combined use is becoming increasingly popular as the appreciation that such multi-strategy designs can be undertaken without 'dire consequences'. In a study into the construction industry's use of, and adherence to, research methodology, strategy and methods, Dainty (2008, p.10) highlighted that there was "an apparent reluctance to embrace paradigmatic change", with an evident reliance on positivist (deductive/quantitative) methods and open-ended interviews when qualitative research methods were used. Dainty (*ibid*.) argued that such reluctance to embrace paradigmatic change results in insights into industry practice lacking richness that a greater appreciation of qualitative strategies and methods could provide.

5.1.3 Research methods

Whilst research methods are not only individual tools or techniques in their own right, but representations of a researcher's philosophical assumptions regarding knowledge and reality (Bryman and Bell, 2007, p.4), they are able to be broadly classified and explored, in order to gain an understanding into how they are used to collect quantitative and qualitative data.

5.1.3.1 Quantitative research methods

Evident in the literature on research methods is prominent use of experiments and survey as quantitative data collection techniques. Experiments and quasi-experiments (studies that do not fulfil all the internal validity requirements of experiments) seek to manipulate variables in order to ascertain causal relationships and dependent variables (Bryman and Bell, 2007). Surveys, which can be carried out through a variety of means (such as face-to-face, postal and internet-based, or through structured interviews) aim to record data on variables from which patterns of association can be detected (Bryman and Bell, 2007, p.56).

5.1.3.2 Qualitative research methods

Semi-structured and un-structured interviews are widely used in qualitative research (Robson, 2011; Bryman and Bell, 2007; May, 2001), as are observation and audio/visual materials (Silverman, 2006). Surveys can also be used (Robson, 2011), with their qualitative use allowing additional probing of responses from participants. Interviews can occur face-to-face, over the telephone or via the internet, and encompass one-on-one situations as well as with multiple participants, more commonly referred to as group interviews or focus groups. Whilst the two terms are used interchangeably (Robson, 2011, p.293), herein a focus group is defined as a form of interview in which multiple participants interact, moderated by the researcher, in order to construct meaning in relation to a specific and defined topic (Bryman and Bell, 2007, p.511). A group interview is therefore defined as a form of interview in which multiple participants construct meaning in relation to a number of topics, with less emphasis on moderation (*ibid*.).

5.1.3.3 Mixed-methods research

Mixed-methods research encompasses the use of qualitative and quantitative research methods in a single project, with capitalisation of strengths and the offsetting of weaknesses being a key attraction in relation to their combined use (Bryman and Bell, 2007, p.643). For example, a semi-structured interview could be conducted, exploring a participant's perspective of a given area (qualitative), yet then content analysis of the interview transcript could be used to objectively measure patterns and associations in relation to specific words or phrases (quantitative). Two prominent arguments against the use of such methods are that research methods themselves entail epistemological commitments (note here the use of the commitments, as opposed to them being seen as tendencies, as previously discussed) and the view that qualitative and quantitative research are separate paradigms themselves (*ibid*.). Criticism of such an approach arises as a result of questioning the reliability and validity of the research if mixed-methods are used, yet potential to enhance such attributes is also evident, through triangulation. Triangulation is the use of more than one method or source of data in order to enhance the reliability and validity of the findings (Robson, 2011, p.158; Bryman and Bell, 2007, p.412). Denzin (1988, cited in Robson, 2011, p.158) asserts that there are four types of triangulation, those being data triangulation (the use of more method of data collection), observer triangulation (the use of more than one observer during a study), methodological triangulation (the use of multi-strategy research) and theory triangulation (the use of multiple theories or perspectives). Of pertinence in the debate for and against the use of qualitative versus quantitative research methods is the issue of generalisation; how applicable is the research to those outside of its scope. A key issue in relation to this is sampling (the methods used to recruit a representative (or not) group of participants from a certain population, which will now be explored.

5.1.3.4 Using a qualitative strategy and qualitative research methods

As previously stated, Dainty (2008, p.10) asserts that qualitative research can provide rich insights into practice, an outcome that is pertinent to the aim and objectives of this research. With the research also adopting an interpretivist and constructivist stance through its inductive nature, the need for a qualitative strategy to explore the meanings given to various factors and the interpretation of them was prevalent. Whilst there was a deductive element to the research, the use of a quantitative strategy would have entailed significant challenges, as no prior research had been undertaken in relation to the specific scope of the research and complexity was inherent in terms of sampling (discussed in forthcoming section 5.2.5), resulting in such a strategy not being used. In relation to the qualitative research methods that were used, these entailed the use of focus groups and interviews, discussions (defined as 'informal interviews', whereby the same data collection protocol was adhered to, but the interviews occurred either as a result of a pre-arranged meeting or alternative reason, yet participation in the research was requested), as well as observations during site visits and the collection and analysis of documents received during one interview. The use of such qualitative research methods allowed the probing and exploration of participants' perspectives in order to validate and further the theoretical framework and typology.

5.1.3.5 Sampling

> "The objective of sampling is to provide a practical means of enabling the data collection and processing components of research to be carried out whilst ensuring that the sample provides a good representation of the population" (Fellows and Liu, 2008, p.159)

Sampling encompasses the probability sampling (random selection) or non-probability sampling (non-random selection) (Robson, 2011; Walliman, 2006) of a target population. Traditionally, non-random sampling, such as systematic, stratified or cluster sampling (Fellows and Liu, 2008, p.161), is associated with quantitative research due to its inherent preoccupation with generalisation and statistical significance, ensuring representativeness and the ability to make broader inferences (Silverman, 2010, p.139). Sampling in relation to qualitative research is purported to be less important, as such research generates in-depth analysis of a specific context and is thereby grounded in data (Bryman and Bell, 2007, p.497; Silverman, 2000, p.105). Such sampling methods include theoretical sampling, where the researcher contacts potential participants who are perceived to contribute positively to the research (Walliman, 2006, p.79); snowball sampling, which is where the researcher contacts a number of potential participants who then provide further participants for the researcher (*ibid*.); and convenience sampling, which is where the researcher contacts participants due to the nature of their accessibility (Bryman and Bell, 2007, p.197).

The role of three stakeholders was most evident in the literature, those being architects, developers and engineers. Architects were targeted due to their growing importance in contributing to the resilience and security agendas (Coaffee, 2010, p.340; Malagoda, Amaratunga and Pathirage, 2010, p.429; Crichton, 2008, p.117; Regan, 2006, p.23; Ling and Soh, 2005), through the making of design decisions, conveying of information to clients (Glass, 2008, p.174; National Research Council, 2001, p.3) and by delivering value to their clients, building users and community (Emmitt, 2007, p.1; Robinson, 2004, p.39). Developers were targeted due to perceived centrality in positively or negatively contributing to the aforementioned agendas (Bosher *et al.*, 2009a, p.16; British Council for Offices, 2009, p.105; Bosher *et al.*, 2007a, p.173), most notably due to perceived inappropriate motivations (Bosher *et al.*, 2007a, p.174) and lack of understanding regarding what CTMs can be used (Harre-Young et al., 2010, p.1126). Engineers are of importance in assessing the potential implications of an attack (British Council for Offices, 2009, p.13), designing and incorporating appropriate CTMs (Malagoda, Amaratunga and Pathirage, 2010, p.429; Clarke, 2004, p.303), conveying information to clients and end-users (National Research Council, 2001, p.3) and again, as with architects, maximising value through their designs and resulting decisions (Robinson, 2004, p.39). The role of insurers was also raised as they have the ability to regulate or incentivise the use of CTMs and therefore aid in the adaptation to and mitigation of such risks (Crichton, 2008, p.130), although uncertainty surrounds the extent to which the incorporation of CTMs is obligated or incentivised. The targeting of Local Authorities was also made, due to their role in ensuring the safety and security of public places (Ling and Soh, 2005) and because of the identified local policy issues (section 3.4.6) that can influence whether such places are protected.

As raised in section 5.1.3.4, the objective of sampling is to provide a means of data collection that provides a good representation (Fellows and Liu, 2008, p.159). Fixation with sampling in relation to qualitative research is due to the in-depth analysis of specific context (Bryman and Bell, 2007, p.497; Silverman, 2000, p.159). Considering the targeting of specific stakeholders, as well as the research requiring those with understanding of CTMs, theoretical sampling and snowball sampling methods were used. Theoretical sampling was chosen so that, as alluded to above, positive contributions could be made to the research (Walliman, 2006, p.79), reducing the risk of participants being engaged with who could not contribute to the typology or the understanding of the CTMs that can be used. Snowball sampling was also used in conjunction with the above, taking the opportunity to engage with recommended contacts, who again, were known to be able to positively contribute to the research. Arguably, whilst random-sampling would have resulted in greater representativeness, specific information on CTMs was required that would only be obtainable by those who have carried out such work previously, or during the course of the research itself. By being informed by the literature on this particular area, and needing specific information in relation to the objectives of this research, it was felt that such a strategy was appropriate and valid.

5.1.4 Data analysis

The methods through which the data will be analysed are also of importance, in order to ensure the reliability and validity of the research and its findings. Whilst quantitative data analysis encompasses univariate analysis (one variable at a time), bivariate analysis (two variables at a time) and multivariate analysis (three or more variables) with statistical significance validating findings (Bryman and Bell, 2007), qualitative data analysis is cited as being considerably more complex due to the need for filtering, sorting and other manipulations of what is often large quantities of data (Fellows and Liu, 2008, p.27; Groat, 2002, p.174). The aim of such analysis is therefore to organise, reduce and present the findings of the research, with the coding of the data in the aforementioned themes being a key component (Creswell, 2007, p.148; Walliman, 2006, p.132). Literature on qualitative data analysis often depicts two techniques, those being grounded theory, and analytic induction (as expressed in Figure 5.1). However, as previously highlighted, grounded theory can be seen as a qualitative research strategy in its own right, due to the specific and systematic process through which theory is created by the collection, coding and analysis of data (Robson, 2011, p.489; Bryman and Bell, 2007; Creswell, 2007, p.160; Strauss and Corbin, 1998, p.12). Analytic induction, however, as shown in shown in Figure 5.6:

"…is an approach to the analysis of data in which the researcher seeks universal explanations of phenomena by pursuing the collection of data until no cases that are inconsistent with a hypothetical explanation (deviant or negative cases) of a phenomenon are found" (Bryman and Bell, 2007, p.583)

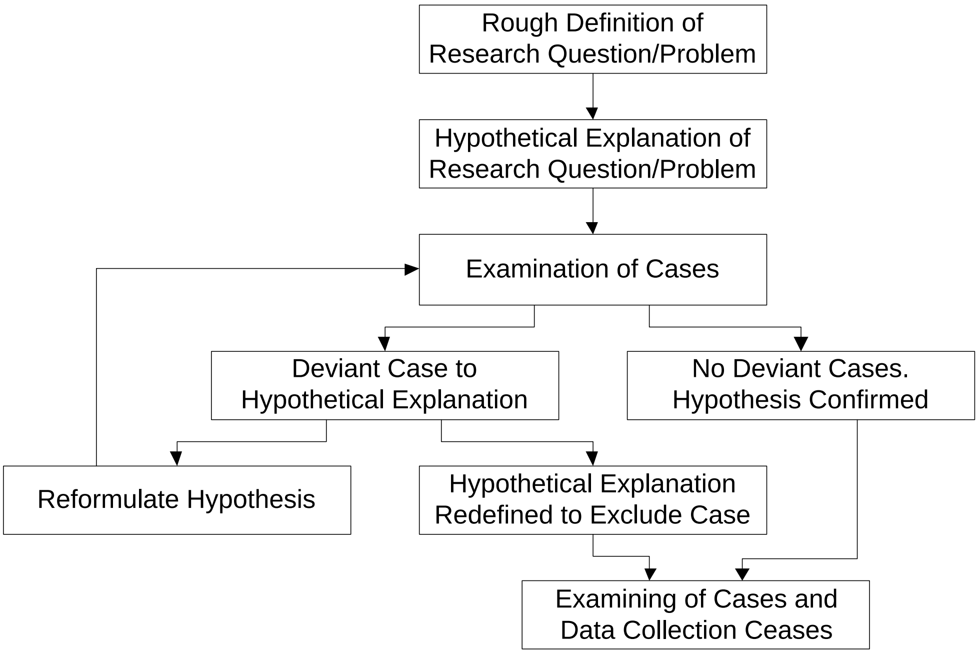


Figure 5.6. The process of analytic induction (Bryman and Bell, 2007, p.582)

Whilst quantitative data analysis can require the use of computer software, its use in relation to qualitative data analysis is questionable. The process through which data is analysed is the same, whether conducting such analysis 'by hand' (through a paper-based system or standard word processing software), or by using specialist analysis software, as the organisation and coding of data is carried out by the researcher (Creswell, 2007, p.164). The use of specialist software will also more than likely require the researcher to gain an enhanced understanding of it, which will have time implications and will also put a layer, or barrier, between the researcher and their data, potentially increasing the amount of time taken to modify the organisation and/or coding of their data as the research progresses (Robson, 2011, p.472; King, 2008, p.137; Creswell, 2007, p.165). The use of specialist software could also instil complacency within the researcher, who could assume that the software will analyse the data for them (Robson, 2011, p.472). Whilst the choice of whether to use such software should be made on a case by case basis, as purported by Silverman (2010, p.257), not using such software could actually be better.

5.1.4.1 Analytic induction and the analysis of data

Analytic induction was used in order to seek verified explanations of the theoretical framework and of the typology, by pursuing the collection of data until no cases that were inconsistent with the theoretical framework and typology were found. The process through which this occurred was presented in Figure 5.6. The construction of the framework, as shown in Chapter 3, enabled the expression of, through illustrations and narrative, influences that are applicable to this study (Miles and Huberman, 1994, p.18, cited in Robson, 2011, p.67). Through developing the framework and the typology, it ensured that the research was explicitly understood and that the analysis and coding of data was as relevant and accountable as possible. In accordance with the features of qualitative data analysis, as asserted by Robson (2011, p.469), such an approach facilitated the labelling of elements of interest, incorporation of comments and reflections, using the constructed and emerging themes and patterns to influence further data collection, gradually elaborating sets of generalisations, and the linking of those generalisations back to the literature. The construction of the provisional framework and typology also facilitated the incorporation of a coding frame into the design of the questions and scenario-based research instrument, ensuring the coding of data was as simple and consistent as possible during the analysis stages of the research (Walliman, 2006, p.91). Thematic coding analysis was then used as the primary means of structuring data, as outlined above and as alluded to by Robson (2011, p.469), yet it incorporated the use of the themes and the summaries of them to supplement and illustrate the explorative nature of the research in line with the theoretical framework (Robson, 2011, p.467). The following phases of thematic coding analysis were used, quoted from Robson (2011, p.476):

1. *Familiarizing yourself with your data*. Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas
2. *Generating initial codes*. May be done by first devising a framework or template or inductively by interaction with the data. Extracts from the data are given codes in a systematic fashion across the entire data set, with similar extracts being given the same code
3. *Identifying themes*. Collating codes into potential themes, gathering all data relevant to each potential theme. Checking if the themes work in relation to the coded extracts and the entire data set. Revising the initial codes and/or themes if necessary
4. *Constructing thematic networks*. Developing a thematic ‘map’ of the analysis
5. *Integration and interpretation*. Making comparisons between different aspects of the data using display techniques such as tables and networks. Exploring, describing, summarizing and interpreting the patterns. Demonstrating the quality of the analysis

As purported by Fellows and Liu (2008, p.187), the analysis of qualitative data can be laborious and difficult, with the data requiring systematic management to ensure reliability and at least two ‘passes’ or ‘rounds’ of the data to ensure that emerging concepts or themes identified towards the end of the first ‘round’ are checked for in the previous data during the second ‘round’. Such an approach was therefore adopted to ensure the accuracy and reliability of the data. Whilst the process of coding itself can result in the context in which the data was collected being lost (Bryman and Bell, 2007, p.597), the theoretical framework facilitated the capturing of the context, framing the circumstances in which the data was given. The receiving of documents from interview participants and the resulting analysis of data within them was also considered, due to the subjective aspects that are apparent in such material (Fellows and Liu, 2008, p.234), most notably the authenticity of those materials, their credibility, representativeness, and their meaning (Scott, 1990, p.6, cited in Bryman and Bell, 2007, p.555). Referring to Figure 5.5, the adopted qualitative strategy and analytical techniques resulted in the following process:

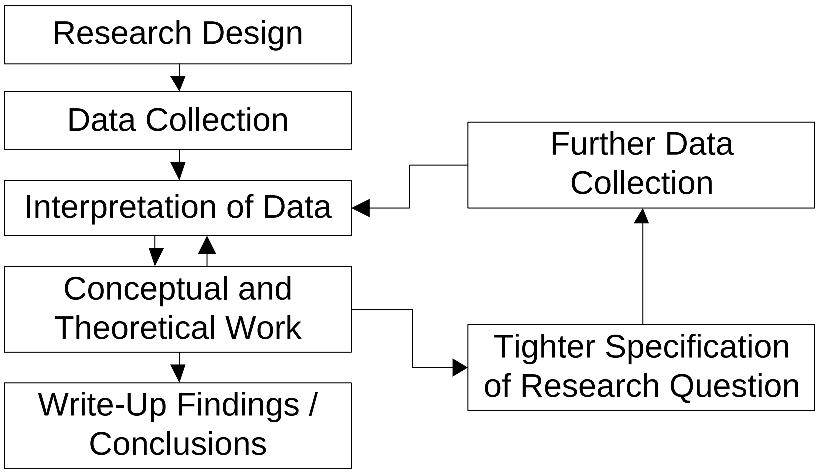


Figure 5.7. The process used to carry out the data collection and analysis

The above process was therefore used to analyse the data that was collected for the research. Upon the completion of the interviews and discussions (the distinction between them having been defined in section 5.1.3.4) and in line with Robson's (2011, p.476) phases of analysis, familiarisation with the data was developed, which lead to the generation of initial codes. Constructing networks and interpretation of the codes resulted in three over-arching categories of data forming, those being influences on the protection of crowded places, influencing on the value of CTMs used to protect crowded places, and CTMs and their attributes within the typology of measures that can be used to protect such places. Themes within these categories therefore emerged (such as TARAs, auditing, and stakeholder understanding and engagement each influencing the value of CTMs) and the data from the study could be re-analysed to ensure all applicable data was appropriately coded. These developments in the analysis of data therefore aided in the research design for the main study and the narrowing of the questions asked during the discussions and interviews, ensuring that participants were asked the questions whilst adopting a semi-structured interview structure, so that the significance of issues according to stakeholders could be captured. Once all the interviews and discussions had been carried out and initially analysed, they were all analysed for a second time, to ensure that any emergent issues towards the end of the data collection process were analysed in conjunction with interviews and discussions that were carried out earlier in the process.

5.1.5 The role and potential bias of the researcher

> "…there is a growing recognition that it is not feasible to keep the values that a researcher holds totally in check" (Bryman, 2008, p.24)

Bryman (*ibid*.) asserts that there are several areas where such influences can be apparent, those being the choice of research area, the formulation of research question, the choice of methods, the formulation of research designs and data collection techniques, the implementation of data collection, the analysis of data, the interpretation of data and in relation to the conclusions of the research. The potential bias of a researcher can influence every component of a research project itself, as well as its design. Such perspectives are also evident in Bryman and Bell (2007, p.30) and May (2001, p.51). Preventing bias, therefore, seems impossible, at the very least insurmountable. Therefore, a reflexive approach seemed prudent, being aware of personal values and their potential to influence the aforementioned components of the research. As asserted by Creswell (2007, p.206), researchers interact with the subject matter to co-create derived interpretations. Bias in relation to interpretations seems most apparent, with the researcher framing their research in a particular way, interpreting the interpretations of their participants, as well as then interpreting that data in relation to the reviewed literature (Bryman and Bell, 2007, p.21). Such considerations were not solely dealt with prior to undertaking the research, reflection of the personal input of the researcher was a constant factor in the collection and analysis of data, as personal values or perspectives, such as sympathies or disagreement, can occur during such processes (Bryman and Bell, 2007, p.30) or even afterwards, influencing the findings of the research itself and the prominence given to them. Through clearly stating the process that was taken to carry out the research, being reflexive yet thorough and using informed and appropriate protocols and frameworks, any incursion of values was identified and visible (see section 5.5.2.1 for more information).

5.1.6 Ethical and confidentiality considerations

> "The value of research depends as much on its ethical veracity as on the novelty of its discoveries. How can we believe in the results of a research project if we doubt the honesty of the researchers and the integrity of the research methods used?" (Walliman, 2006, p.147)

Whilst culturally bounds (Fellows and Liu, 2008, p.249), such considerations most notably encompass the potential for harm, informed consent, invasions of privacy and the use of deception (Bryman and Bell, 2007, p.132; Silverman, 2006, p.317) and are therefore crucial in recognising and responding to 'human issues' involved in undertaking research (Silverman, 2006, p.315) and the adherence to a moral behaviour (May, 2001, p.59). The adherence to data protection legislation is also apparent, through ensuring that personal data is processed fairly and lawfully, be obtained and used lawfully in relation to a given purpose, not be excessive in relation to said purpose, be accurate and up-to-data, be secured so as to not allow unlawful process or accidental loss or damage, and not be transferred outside of the European Economic Area (Fellows and Liu, 2008, p.258; Bryman and Bell, 2007, p.143). Data that was collected therefore adhered to the aforementioned principles and will be kept until the need for its use, most notably through the cessation of the project and its publications, has ceased (Fellows and Liu, 2008, p.256). Loughborough University required an ethical approval form to be undertaken prior to permission being given to conduct the research. Once approval was granted, a participant information and ethical consent form was created (see Appendix C5.1), with copies being signed by participants and the researcher undertaking the interview.

As referred to at the beginning of Chapter Five, occasions occurred during the course of the research where sensitive information was divulged to the interviewer, by participants. A procedure was put in place to deal with such situations, which encompassed the matter being brought to the attention of the interviewer's supervisor and also to the attention of the interviewer's contact at NaCTSO. The supervisor was part of the project team and was therefore allowed to see the specific details of the interview, as the project team members were identified in the participant information and informed consent form (Appendix C5.1). The NaCTSO contact, however, was not included in such a way, so the specific details of the interview and participants were not divulged.

5.2 The Research Plan and Schedule

As a result of the aforementioned understanding of research methodology and the formulated research design, a research plan was formed, as shown in Figure 5.8. The schedule of research that was undertaken is shown in Figure 5.9. As is evident from the aforementioned Figure, the sources of data used were 27 interviews, 8 discussions, three site visits, two received sets of documents, three telephone calls and four emails. Also evident in Figure 5.9 and in line with the sampling methods adopted (see section 5.2.4), architects, developers, engineers and Local Authorities were engaged with, as were academics, design consultants, NaCTSO and urban designers.

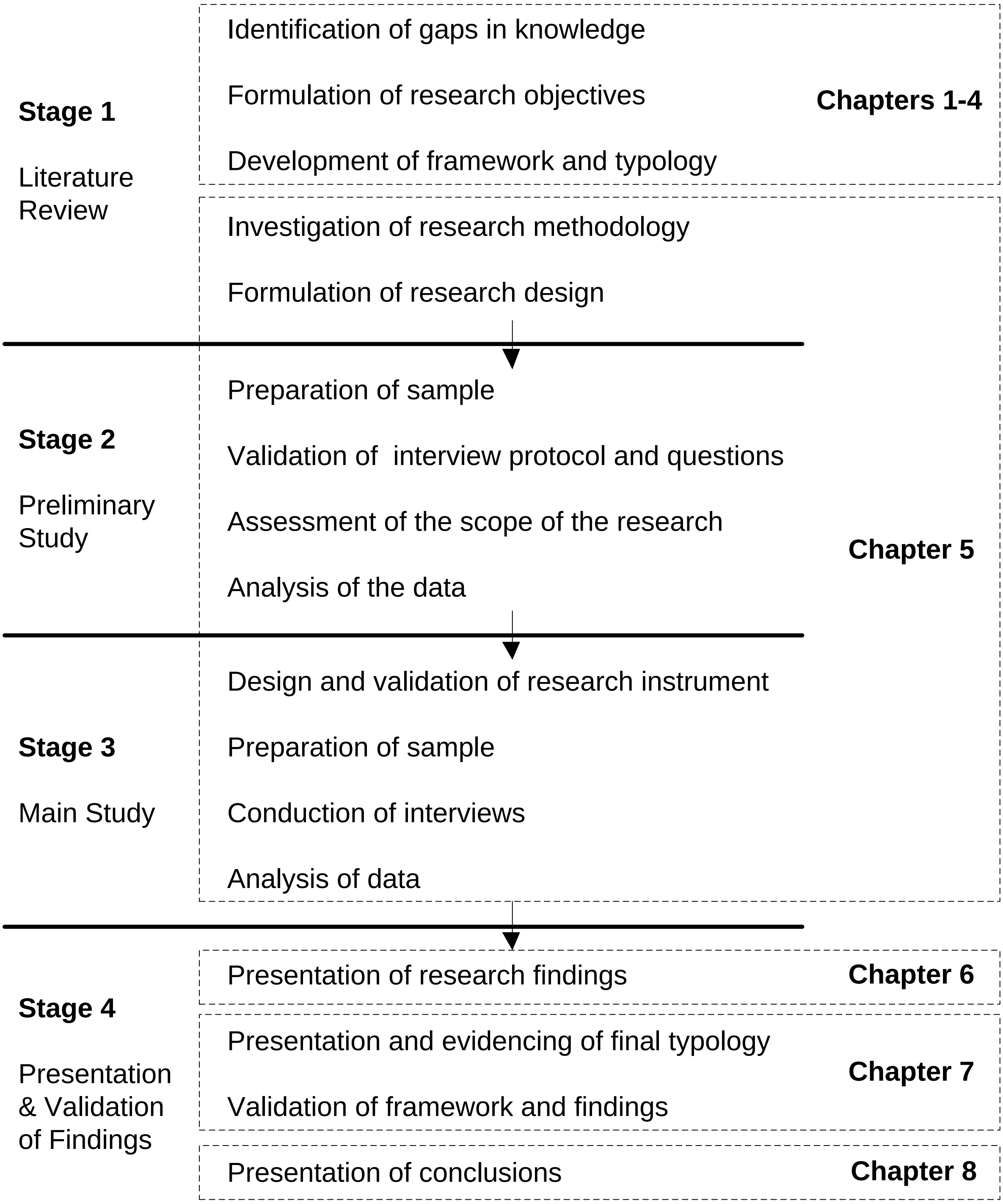


Figure 5.8. The research plan

2009 Q3	2009 Q4	2010 Q1	2010 Q2	2010 Q3	2010 Q4
3 Discussions Acad. CT NaCTSO Rep. Acad. Constr'n.	**3 Interviews** Acad. Terrorism 2 Design Cnslt's 3 CTSAs	**1 Discussion** NaCTSO Rep. + 1 Document	**1 Email** Architect **2 Discussions** NaCTSO Rep. Crime Mgr. **7 Interviews** Engineer Architect Urban Dsgnr. 3 Design Cnslt's & 1 Cost Conslt. Architect Architect **1 Site Visit** **1 Email** Design Cnslt.	**2 Emails** 1 Engineer 1 Ex-Practitioner **1 Discussion** Un-attributable **6 Interviews** Engineer Engineer Engineer 2 Engineers 3 Developers Engineer **1 Telephone Call** 1 NaCTSO Rep. **2 Interviews** Engineer Engineer **1 Discussion** Un-attributable	**8 Interviews** Engineer Architect Engineer, Architect & 3 Documents 2 CTSAs 2 Engineers 3 CTSAs Planning Dir. Engineer & Site Visit **1 Telephone Call** Un-attributable **1 Interview** CTSA & Site Visit **1 Telephone Call** NaCTSO Rep.

Preliminary Study

Figure 5.9. The schedule of research that was undertaken

5.3 Research Studies and Instrument

This section will now explore the creation of the preliminary and main studies that were used to carry out the research, as well as the development of a scenario-based research instrument that was used during a number of the interviews. Table 5.1 provides information on the participants who contributed to the research, in line with ethical, data protection, and anonymity arrangements that were put in place and agreed on prior to the collection of data.

Table 5.1. An overview of participant information

Source No.	Participant No.	Stage	Role / Tag	Organisation	>5 years' CT experience?
D1	1	Q3 2009	Academic, Urban Planning	University	Yes
D2	2		NaCTSO Representative	NaCTSO	Yes
D3	3		Academic, Construction Mgt	University	No
I1	4	Q4 2009	Academic, Terrorism	University	Yes
I2	5		Design Consultant A	Design Consultancy	Yes
	6		Design Consultant B	Design Consultancy	No
I3	7		CTSA A	Police Force	Yes
	8		CTSA B	Police Force	No
	9		CTSA C	Police Force	Yes
D4	2	Q1 2010	NaCTSO Representative	NaCTSO	Yes
D5	2	Q2 2010	NaCTSO Representative	NaCTSO	Yes
E1	10		Architect	Architects	No
D6	11		Crime Specialist	Police Force	Yes
I4	12		Director	Construction Company	Yes
I5	13		Architect	Architects	No
I6	14		Urban Designer	Local Authority	No
I7	15		Strategic Consultant A	Design Consultancy	No
	16		Cost Consultant	Construction Company	No
	17		Strategic Consultant B	Design Consultancy	No
	18		Associate Director	Design Consultancy	No
I8	19		Architect	Architects	Yes
I9	20		Director	Design Consultancy	Yes
E2	17		Strategic Consultant B	Design Consultancy	No
I10	21		Architect	Construction Company	No
E3	22	Q3 2010	Associate Director	Construction Company	Yes
E4	23		PhD Student, Crime Reduction	University	No
D7	24		Un-attributable source		Yes
I11	25		Director	Construction Company	Yes
I12	22		Associate Director	Construction Company	Yes
I13	26		Design Manager	Construction Company	No
I14	27		Director A	Construction Company	Yes
	28		Director B	Construction Company	Yes
I15	29		Director	Developers	Yes
	30		Executive Director A	Developers	Yes
	31		Executive Director B	Developers	Yes
I16	32		Director	Construction Company	Yes
T1	2		NaCTSO Representative	NaCTSO	Yes
I17	33		Director	Construction Company	Yes
I18	34		Director	Construction Company	Yes

D8	24		Un-attributable source		Yes
I19	35	Q4 2010	Principal Consultant	Construction Company	Yes
I20	36		Architect	Architects	Yes
I21	37		Technical Director	Construction Company	Yes
	38		Architect	Architects	No
I22	39		CTSA A	Police Force	Yes
	40		CTSA B	Police Force	Yes
I23	41		Director A	Construction Company	Yes
	42		Director B	Construction Company	Yes
I24	8		CTSA A	Police Force	No
	43		CTSA B	Police Force	Yes
	44		CTSA C	Police Force	Yes
I25	45		Assistant Director	Local Authority	Yes
I26	46		Engineer	Local Authority	No
T2	24		Un-attributable source		Yes
I27	47		CTSA	Police Force	Yes
T3	2		NaCTSO Representative	NaCTSO	Yes

5.3.1 The preliminary study

The preliminary study ran from July 2009 to June 2010, the objectives of which were to ascertain the extent to which the aim and objectives of the research itself were justified, valid and appropriate given the state of the art, to test data collection and analysis techniques, and to collect data, where possible, in relation to the fulfilment of the objectives themselves. The study was conducted during the literature review into counter-terrorism and the resilience of the built environment, as well as that of research methodology and design. As shown in Figure 5.10, of those stakeholders engaged with, a number of participants were recruited through known contacts of colleagues who work in the Department of Civil and Building Engineering, in line with the adopted sampling methods.

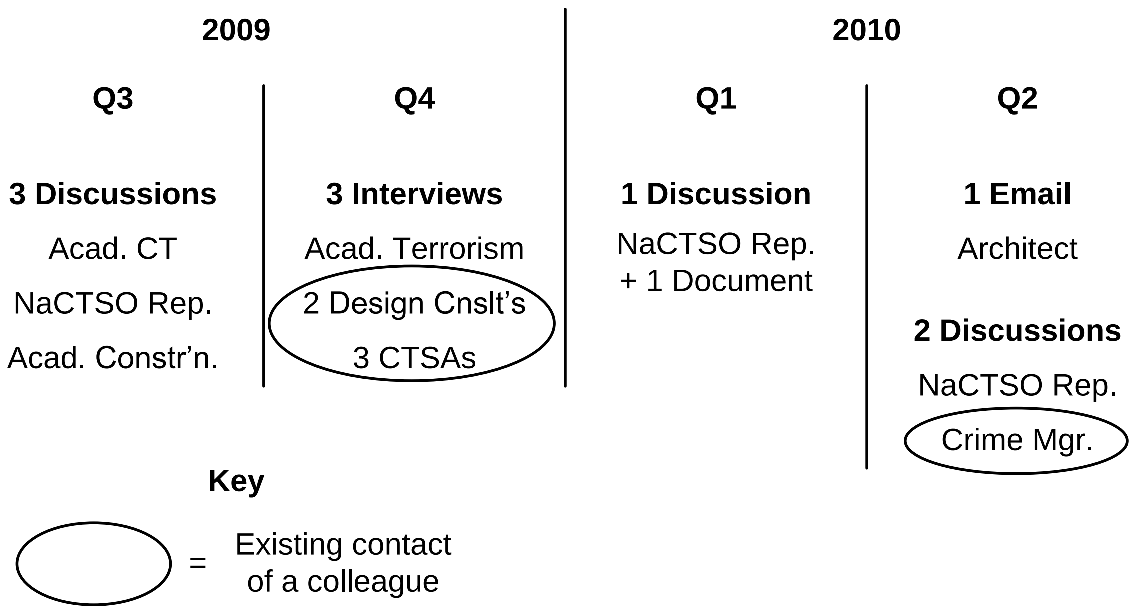


Figure 5.10. The sample and schedule of the preliminary study

5.3.1.1 Data collection protocol

When the participants were contacted, a pre-interview letter was sent (appendix C5.2). The letter detailed the nature of the research itself and what the participants could expect from being interviewed, as well as outlining the questions that would be asked. The study also acted as a means of testing the interview questions, ensuring that the use of ambiguous or technical terms were avoided, overly long or general questions were avoided (Bryman and Bell, 2007) and to see if a research instrument would be needed to aid in extracting the required information. It also facilitated the use of cognitive mapping to record participants perspectives (Bryman and Bell, 2007, p.431) and the testing of the interview protocol more generally, in terms of introductions, the main body of the interview and closures (Robson, 2011, p.284). Post-interview letters were then sent to participants (Appendix C5.3), to thank them for their time and reflect on the individual contributions that were made.

5.3.1.2 Influences of the preliminary study

The study determined that no amendments were needed to the existing interview questions and protocols themselves. However, emanating from the participants were a range of influences on the protection of crowded places, as well as influences on the value of CTMs that can be used to protect such places. Therefore, a theoretical framework was formed (in conjunction with returning to the literature following the interviews), in order to construct such a framework and inform the future questioning of participants. This influence is evident through the nature of the thesis itself, with the literature review being framed around the theoretical framework itself (see Chapter Three for the provisional framework determined by the literature itself and Chapter Eight for the validated framework). Such influences highlight the inductive nature of the research and the influences that can result from them, as well as the need to be able to accommodate such developments in relation to the collection and analysis of data. As previously noted, the length of the preliminary study was approximately 12 months, most notably due to the accommodation of these influences and the creation of a research instrument. Whilst all the participants who were engaged with had prior or current knowledge of counter-terrorism in relation to the protection of crowded places (as a result of the theoretical and snowball sampling methods that were adopted), the expression of potential implications of CTMs, for example spatially in terms of traffic displacement, resulted in the need to create a visual and usable research instrument, to aid in resolving these issues. The study resulted in the following process.

5.3.2 The research instrument

In order to aid in capturing the aforementioned attributes of crowded places and CTMs, a realistic scenario was required.

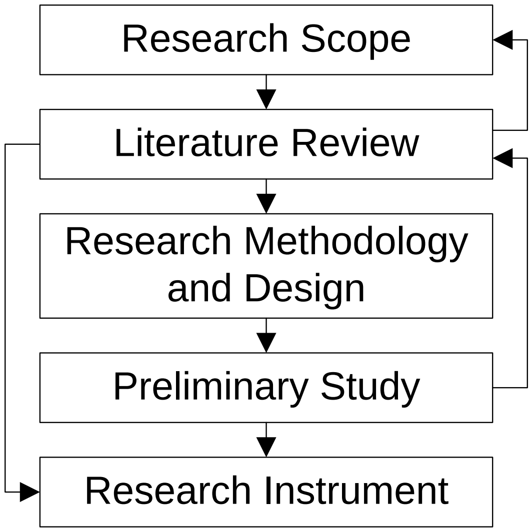


Figure 5.11. The influences of the preliminary study

The city of Nottingham hosts the second largest square in England (Nottingham City Council, 2009, p.5) and the square itself, surrounded by varying infrastructure, provided an ideal setting upon which to base the instrument. Therefore, research was undertaken (in the form of observation and photography of the area, as well as the use of on-line map resources), in order to graphically map the area and develop the instrument itself. Two documents published by Nottingham City Council were also used (Nottingham City Council, 2009; 2005), as they explored the Council's policies in relation to master plans and urban design, and also provided information on Old Market Square, which was the focus of the research instrument. Google SketchUp software (version 7) was used in order to create a two-dimensional and scaled construct of the area surrounding plot (Old Market Square), as shown in Figure 5.12.

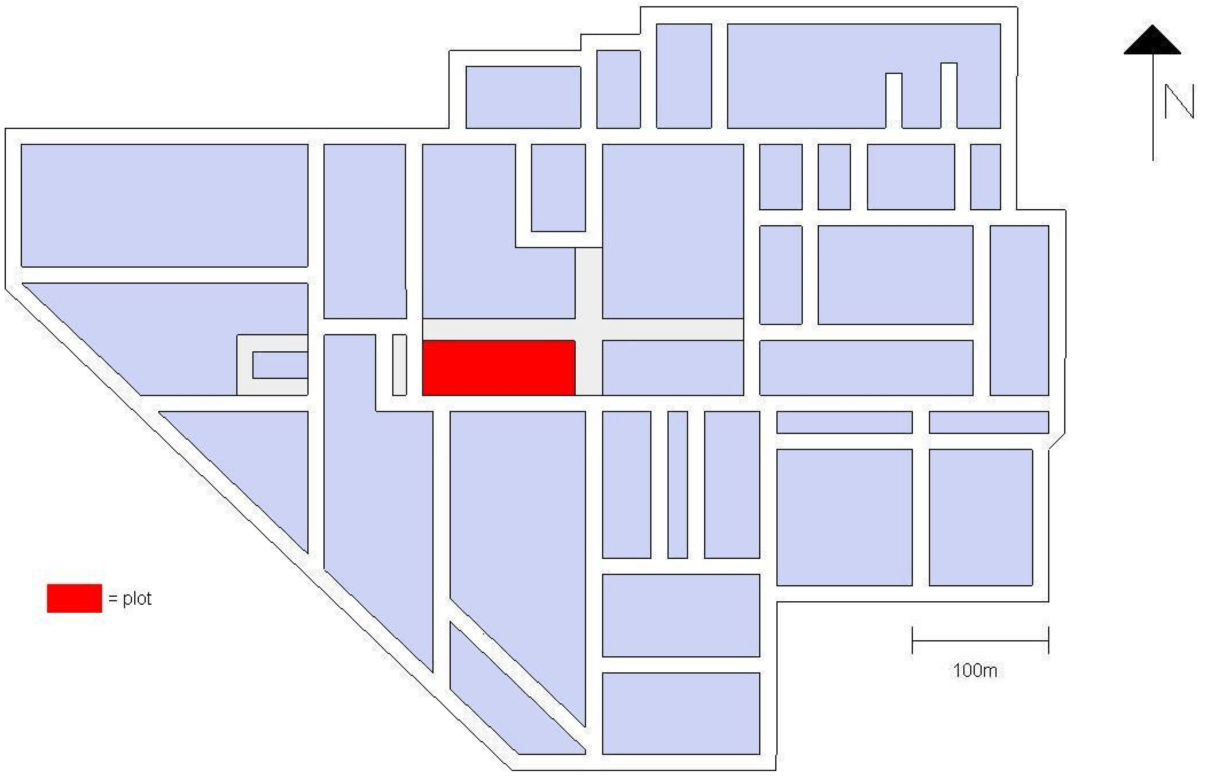


Figure 5.12. The scenario-based research instrument

The site was chosen due to the plethora of factors that are inherent in the situational context that crowded places can be located within, as transport infrastructure, historic and modern buildings, outside dining facilities and existing CTMs were evident, as shown in Figure 5.13. Blank handouts of the research instrument were printed on A3 paper, in order to allow room for participants to illustrate examples freely and within plenty of space. It was envisaged that the coding of any data would be done so against the existing framework and typology. Two interviews were used to test the scenario-based research instrument, with one participant highlighting its potential benefit, but not requiring it themselves, with the other participant using the handout to sketch out ideas and highlight points that they were making; using the instrument as an aide-memoire as well as a platform on which to illustrate points. The illustrations were coded against the existing analytic framework, with no problems or modifications required to it. The instrument was then used as it was, when required, for the main study.

5.3.3 The main study

The main study ran from June to November 2010, the objectives of which were solely to collect data in relation to the aim and objectives of the researcher, as the testing and validation of the interview protocol and research instrument had been undertaken within the preliminary study. As is evident in Figure 5.14, a number of participants were recruited through snowball sampling, through being contacts of colleagues, or of a participant. The study was conducted during the literature review into counter-terrorism and the resilience of the built environment, as well as that of research methodology and design. As shown in Figure 5.10, of those stakeholders engaged with, a number of participants were recruited through known contacts of the researcher’s supervisors, in line with the adopted sampling methods.

5.3.3.1 Data collection protocol

The same data collection protocol used during the preliminary study was also used during the main study. All but two of the interviews carried out during quarter two of 2010 were carried out in New York City, in the USA. Funding was received by the IMCRC to conduct research, which also required no additional or modified protocols. Instead of posting post-interview letters, which was done to participants in the UK, electronic versions were sent.

5.3.3.2 Encountered barriers to the collection of data

A significant barrier to the collection of data was the inability to obtain all the desired monetary costs of the CTMs themselves, with relatively few being given ranges.

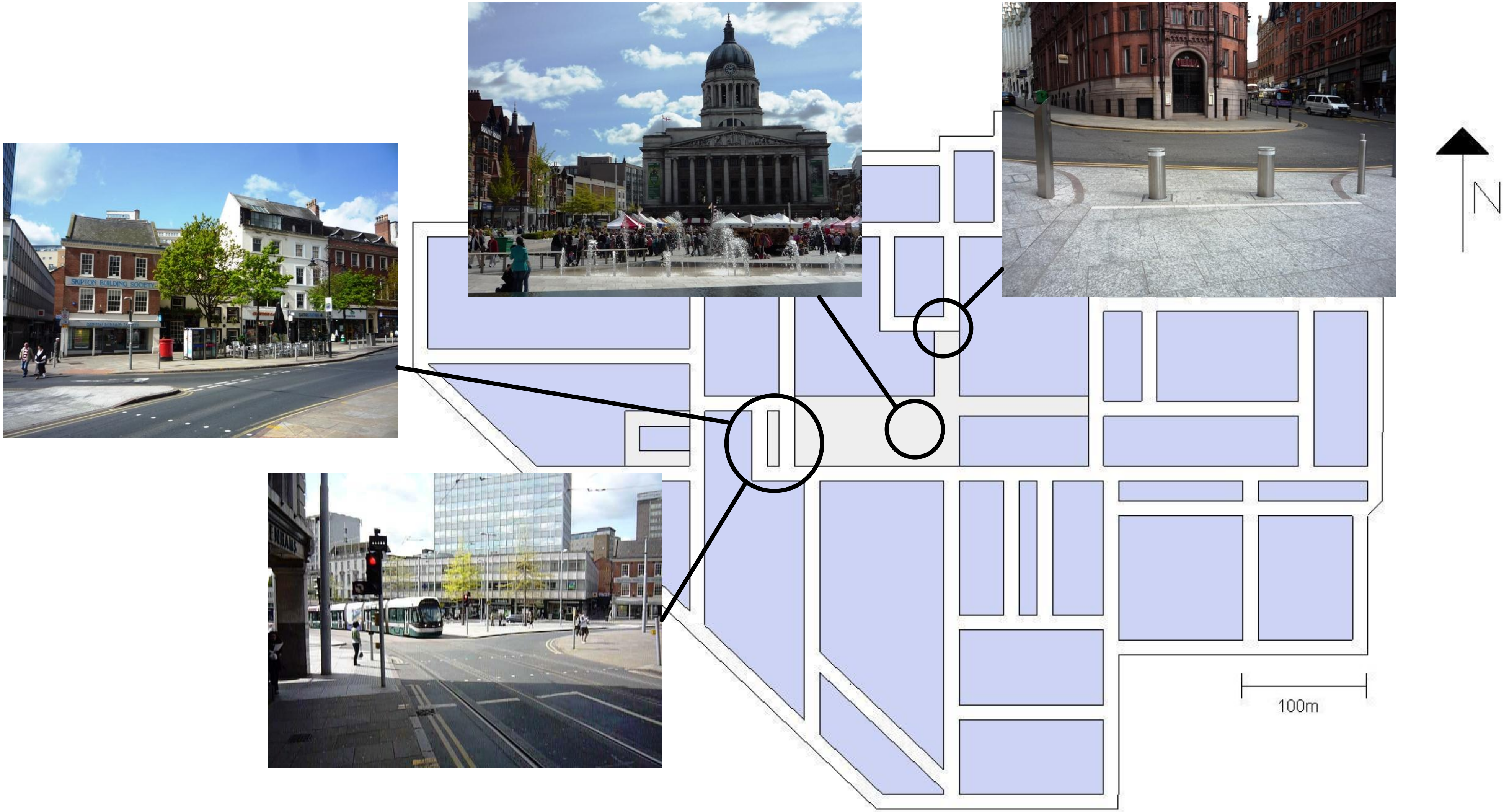


Figure 5.13. Examples of situational context at Old Market Square

Participants felt that obtaining such Figures, or 'rules of thumb', was not possible, due to the inherent variables that exist within projects that make each place or space unique. This is of considerable detriment considering part of an objective was to identify the cost-effectiveness of CTMs.

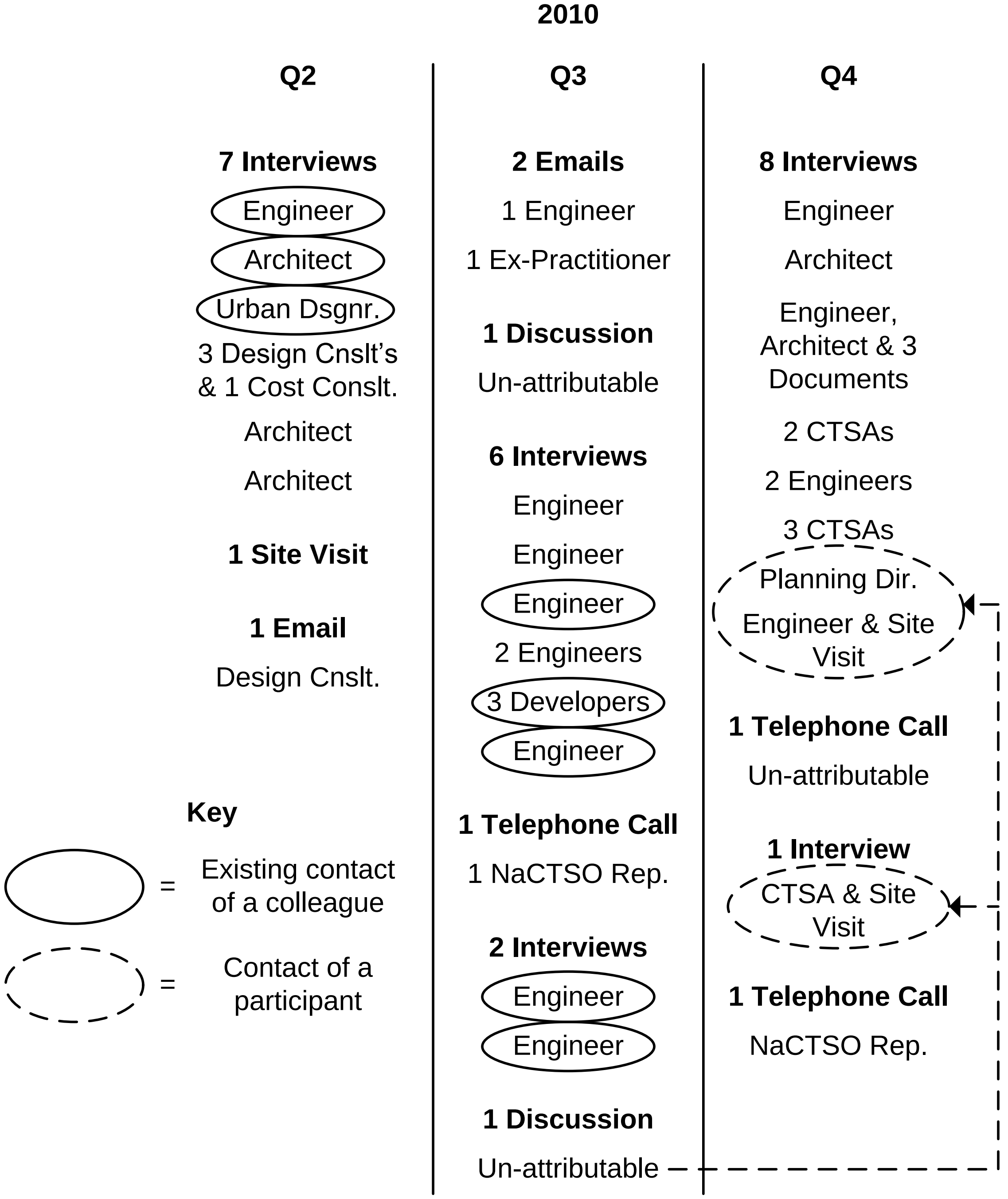


Figure 5.14. The sample and schedule of the main study

However, data on the requirements, performance and consequences of CTMs was collected, resulting in the research still being able to analyse and present findings in relation to those factors and contributing to knowledge in those ways. Not being able to obtain specific cost data nonetheless highlights the complexity that is inherent in protecting crowded places, and as will be shown in Chapter Six, aids those who are responsible for the protection of crowded places to be able to identify scenarios that can contribute to the cost of projects.

5.4 Research Validity and Reliability

Reliability and validity are two significant terms in relation to research and the methodology, design and methods used to collect and analyse data. Reliability can be seen as the extent to which the study is repeatable, through the presentation and rigour of the processes used to carry out the research (Bryman, 2008, p.31; Bryman and Bell, 2007, p.40). Validity can be seen as another word for ‘truth’ (Silverman, 2010, p.275), as research presents findings that may or may not reflection the ‘actual’ circumstances that were investigated, if incorrect or inappropriate methods were used (Bryman and Bell, 2007, p.41) and therefore may or may not research or present findings on what the aims and objectives said it would.

5.4.1 Reliability of the research

The reliability of the research has been demonstrated through the informed discussion and use of, as well as presentation of illustrations showing, the processes that were used to conduct the research. The examination of literature on research methodology and design lead to the choosing of a qualitative research strategy in order to explore and understand the subjective nature of the topic being researched, with set processes identified for the collection and analysis of the data. As the analysis of data occurred through the use of a provisional theoretical framework and typology, how they were formed was also made apparent. It was noted that the formation of the framework was as a result of the preliminary study, whereby participants had raised a number of influences on the protection of crowded places and on the value of CTMs themselves. How that particular output of the preliminary study related to the literature review, research methodology and design, and future study was made clear. The sampling methods that were used were documented, with the use of analytic induction and theoretical saturation denoting when data collected ceased. It is therefore argued that in terms of reliability and the ability of a researcher to replicate this study, as much clarity that could be presented, has been, and is sufficient in itself to replicate such an inductive and qualitative study as is possible.

5.4.2 Validity of the research

The validity of the research has been demonstrated through the appropriate selection of research methods and reflexivity surrounding potential bias, in order to ensure that the research methods used (and how they were used) resulted in valid data that was directly related to the aim and objectives of the research. Two factors are pertinent in this instance, those being methodological constraints and the role and potential bias of the researcher.

The inductive nature of the research led to the adoption of a purely qualitative research strategy and the use of qualitative research methods to understand and probe the subjective responses of participants. The use of such a strategy resulted in significant findings early on in the research, with the preliminary study identifying that whilst the CTMs evident in the typology were valid each had inherent requirements, performance and consequences, a range of factors were identified that influenced whether crowded places were protected or not, as were factors that influenced the value of the CTMs themselves. Therefore, the literature review was re-visited and a theoretical framework was constructed in order to capture and analyse data that had been obtained and would be in the future. As was raised, the complexity surrounding the identification of monetary costs of incorporating CTMs was raised and inhibited the researcher from being able to collect the desired data in relation to this. Whilst it could be argued that with the formation of the typology, time could have been spent on creating an objective research instrument that, for example, identified ranges of costs that stakeholders thought could be an accurate reflection of the costs of such measures, the inductive nature of the research (and arguably, the values of the researcher) lead to the pursuit of data on the influences that determined whether CTMs were incorporated or not. The role and potential bias of the researcher also influences the validity of the research, as pre-existing or emergent values of a researcher could incur on a number of stages of the research process, as was made evident in this chapter. It's argued that two such incursions occurred during the research process, to which the awareness of reflexivity prior to the data collection occurring aided in their identification and relative resolution.

5.4.2.1 Personal values of the researcher

Personal motivations and perspectives of participants (why they were in the job that they were and how they felt about this topic) were raised in a number of interviews. During two interviews where such matters were addressed, participants stated that money was their sole purpose, and/or the morality of protecting crowded places was not a value they held. This impacted the researcher's personal values and, whilst responses were recorded objectively, impinged the researcher's chain of thought, due to the personal differences in values that had been made apparent. However, it's argued that through the recognition of such issues occurring prior to the data collection being started, the use of cognitive mapping to understand participants and the adherence to and exploration of pre-set (yet semi-structured) questions, facilitated the data collection to carry on un-impinged.

5.4.2.2 Perceived importance of the findings

The preliminary study resulted in the identification of a number of factors that influenced whether crowded places were protected, as well as the value of CTMs themselves (as previously highlighted). Coupled with the complexity and questioned possibility of collecting data on the monetary costs of CTMs, such a situation presented two possible routes that the research could have traversed. Either an objective research instrument was constructed that facilitated the collected of cost data through ranges, thereby requiring a quantitative approach, as well as qualitative methods to understand reasoning and interpretations, or, a purely qualitative research instrument was constructed to further investigate the influences on the protection of crowded places and on the value of CTMs themselves. Such circumstances reflect the need for a decision that had to be made and it is apparent that the value judgements and bias of the researcher partially influenced the decision itself. It was decided that as opposed to creating a research instrument to explore one attribute of CTMs (the success of which was questionable due to participants feeling the collection of such data was not achievable in any case), the findings of the preliminary study should have been followed. The inductive nature of the research had lead to provisional, yet significant, findings that the researcher felt indicated the reality of the area more than the pursuit of specific cost data would have done. Therefore, it is argued that the research that was conducted was valid, as it represented the reality of the situation in which it is positioned, and used appropriate methods to collect and analyse the data.

5.5 Conclusion

This chapter has presented the methodological position that was adopted in order to undertake the research and the resulting qualitative research strategy and methods that were used in order to fulfil the objectives of the inductive research. It has presented a short literature review and understanding on research methodology, strategy and methods, which was followed by the presentation and reasoning of the research design that was adopted for the research itself. The schedule that was undertaken was also presented, and the research instrument and studies themselves were explored, identifying how the research design informed the valid and reliable collection and analysis of data. Reflections on the validity and reliability of the research methodology and design were then purported, which highlighted the impact of the researchers own personal values on the research, as well as how those values and the perspectives of participants shaped and informed the direction of the research itself. The direction that the research took resulted in the identification of a number of influences on the protection of crowded places, as well as on the value of CTMs themselves. The results of the research, presented in the following chapter, therefore explore these influences, as well as the data that was obtained on the CTMs themselves, their value, and their implications.

6.0 Results of the Research

This chapter presents and discusses the substantive analysis of the data that was collected from the preliminary and main studies of the research. As was raised in the previous chapter, the preliminary study highlighted that a number of factors influenced the protection of crowded places and the value of CTMs themselves, which were explored and incorporated into the research design, given the inductive and interpretative nature of this research. The analysis of data from the main study furthered the influences (that were incorporated into the theoretical framework), highlighting that eight high level influences that can determine whether crowded places are protected (or not) and that three factors can influence the value the CTMs used to protect them, either by nullifying and voiding or positively impacting any perceived or actual value of the CTMs themselves. How the participants (an overview of whom was presented in Table 5.1) contributed to the collection of data in relation to those influences is presented in Table 6.1. Evident from Figure 6.1 is that TARAs, as well as stakeholder understanding and engagement, can influence both the protection of crowded places, as well as the value of the CTMs used to protect them. These influences, as well as the performance, requirements and consequences of CTMs will now be explored.

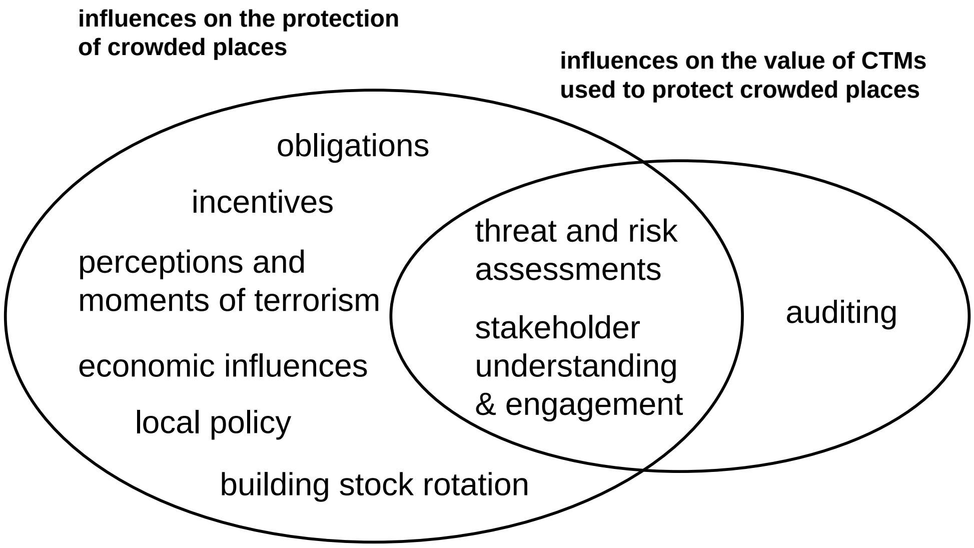


Figure 6.1. Influences on the protection of, and value of protecting, crowded places

6.1 Influences on the Protection of Crowded Places

There are eight factors that can influence the protection of crowded places, as shown in Figure 6.2. The results in relation to obligations, incentives, threat and risk assessments, perceptions and moments of terrorism, stakeholder understanding and engagement, economic influences, local policy, and building stock rotation will now be explored.

Table 6.1. Data contributions made by participants

	Preliminary Study										Main Study																																Total
	D1	D2	D3	I1	I2	I3	D4	D5	E1	D6	I4	I5	I6	I7	I8	I9	E2	I10	E3	E4	D7	I11	I12	I13	I14	I15	I16	T1	I17	I18	D8	I19	I20	I21	I22	I23	I24	I25	I26	T2	I27	T3	
Influences within the framework																																											
Obligations	#	#		#	#	#					#	#			#	#		#	#			#	#			#	#	#	#	#		#			#	#	#	#	#	#	#	#	**28**
Incentives			#							#	#		#		#							#	#		#	#			#	#		#	#	#	#		#	#	#		#		**19**
TARAs		#	#	#	#	#	#		#		#	#	#	#	#	#		#			#	#	#	#	#	#	#		#	#		#	#	#	#	#	#	#	#		#		**32**
Perc’s and Moments of Terrorism				#	#	#			#		#	#	#		#	#							#	#	#	#	#		#	#		#	#	#	#		#		#		#		**23**
Economic Influences						#					#														#		#			#						#							**6**
Local Policy																										#																	**1**
Building Stock Rotation																										#																	**1**
Stakeholder Und’g and Eng’t		#		#	#	#		#		#	#	#	#	#	#	#	#	#	#	#		#	#	#	#	#			#	#		#	#	#		#	#	#	#		#	#	**32**
Auditing					#																						#																**2**
CTMs within the typology																																											
Hostile Vehicle Mitigation			#	#	#	#	#				#	#	#	#	#	#		#	#	#	#	#	#	#	#	#				#	#		#	#				#	#		#		**27**
Protective Construction					#	#	#	#			#	#	#	#	#	#		#	#			#	#		#	#	#		#	#		#				#	#	#	#		#		**25**
Planning, Detection & Procedures			#		#	#	#				#			#	#	#		#	#			#	#	#	#	#				#		#	#		#	#	#		#				**22**

\# = Contribution

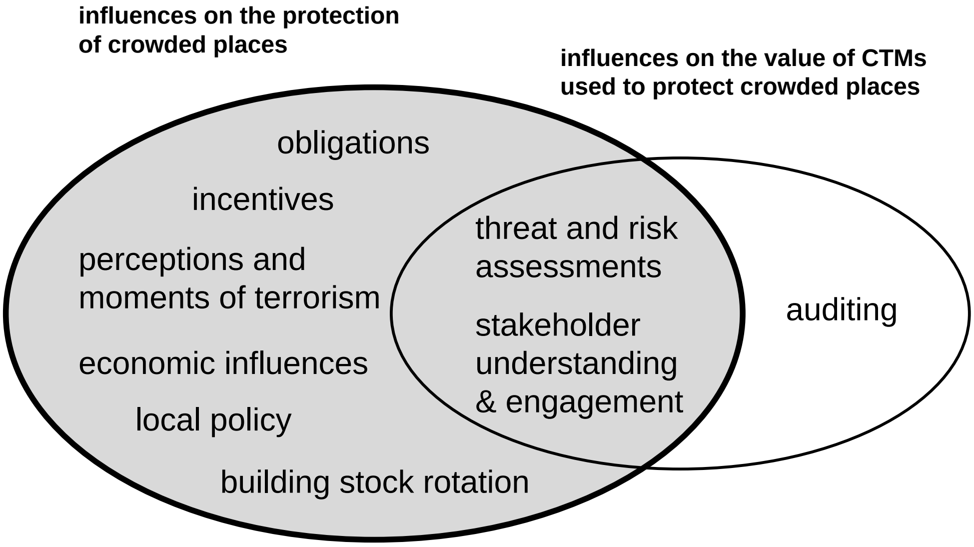


Figure 6.2. Influences on the protection of crowded places

This section will show that whilst influences that contain elements of confusion have resulted and can result in the protection of crowded places, such as the extent to which existing legislation encompasses the incorporation of CTMs, more often than not, the confusion and uncertainty is exploited or directly results in the protection of crowded places not occurring. This is expressed in Figure 6.3, which presents a fish-bone diagram to show such influences on the protection of crowded places.

6.1.1 Obligations

Obligations encompass legislation, insurance policies and organisational values, all of which were raised as influencing the protection of crowded places.

6.1.1.1 Legislation

> "…as soon as people find out it's not mandatory, you've got a battle on your hands" (I2. Design Consultant A, Design Consultancy)

This sentiment was echoed by 12 other participants, all from security-orientated positions. In particular, it was raised that interpretations of the Health and Safety at Work Act are varied and as a result of no clear policy, this circumstance is exploited, resulting in the protection of crowded places not occurring. Two participants felt that existing legislation could be used and that obligations exist under duties of care, through the aforementioned Act (I4. Director, Construction Company; I12. Associate Director, Construction Company). Any potential for stakeholders to be prosecuted under existing legislation highlights incentives to incorporate CTMs (not necessarily physical measures) into buildings and sites, through the reduction in risk of being prosecuted (I4. Director, Construction Company).

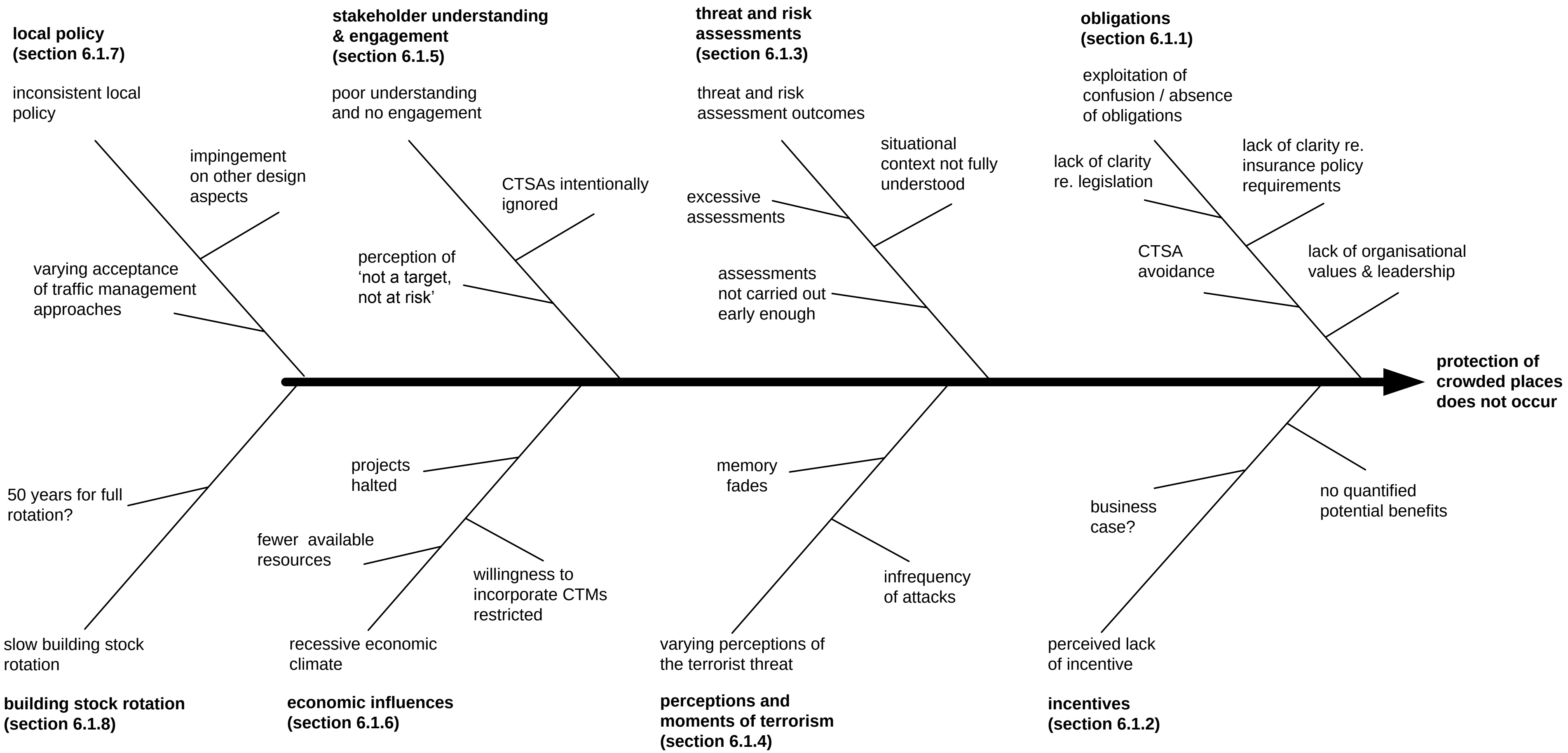


Figure 6.3: A fish-bone diagram expressing the negative influences on the protection of crowded places

The reduced damages to reputation and the retention of business that could occur as a result of not incorporating such measures are also worthy of consideration in such situations. Corporate manslaughter was also raised, with prosecutions being feasible in the event of an attack where lives were lost and injuries caused, and where CTMs had not been incorporated (I17. Technical Director, Construction Company; I18. Director, Construction Company; I27. CTSA). Liability is the emanating issue surrounding this, with the following quote summarising the thoughts of numerous participants:

> "…if your assessment is that that is a true statement of risk and you don't follow it, could you then be taking on liability; the fact that you were aware of it and you chose to ignore it" (I5. Architect)

Considering the confusion and varying perspectives, it was highlighted by one participant that it will need to be tried and tested in court in order for the 'real' answers to emerge (I18. Director, Construction Company). The potential for existing legislation to be used seems to have significant implications for the protection of crowded places, yet this issue seems to be 'down-played' by those in Government, with CTSAs being instructed not to refer to possible legislative implications when consulting with stakeholders (T3. NaCTSO Representative). Regarding governmental or other authoritative perspectives in relation to legislation, the following was raised:

> "I don't see an appetite from the top, down and then that allows the people in the middle, the developers, to wriggle like mad and get out of as much as they possibly can" (I25. Assistant Director, Local Authority)

The amount of 'wriggling' that organisations will do to avoid incorporating CTMs into buildings was highlighted by one CTSA during a site visit, who stated that three employees had been fired from their jobs for recommending spending money on CTMs and that, despite the current employee having made progress and incorporating some CTMs, at every opportunity, cheaper alternatives had been sought and purchased (I27. CTSA; Site Visit 3). The majority of these CTMs were found to not be fit-for-purpose, requiring their removal and replacement with new, fit-for-purpose measures, thus costing the organisation more money than it would have had the advice been followed initially (further exploration of the reproduction of CTMs can be found in section 6.2.2.2). This all took place at an internationally renowned crowded place who had been targeted in terrorist plots, information which is publicly known and has been reported in the media. Similar, although not as extreme, examples were given in other regions, with one CTSA reporting the following during part of an interview regarding the avoidance of incorporating CTMs:

> "Certainly big companies know that and they use it to their advantage, because I certainly know on two occasions where a company in **** kept the ALOs at a distance until actually, the plans had been approved by the council" (I24. CTSA C)

Without enforceable legislation (or evidenced benefits of CTMs that inspire changes in culture and industry), how these issues influence the protection of crowded places, as well as the reconciliation of differing priorities and agendas, was summarised by this CTSA:

> "what it means is, if and when an attack does take place, then there'll be a lot more casualties than would have otherwise been the case" (I24. CTSA B)

6.1.1.2 Insurance obligations

Issues in relation to insurance revolve around existing systems and responses in the event of an attack. Regarding existing systems, the PoolRe scheme was raised as detrimentally influencing the protection of crowded places. The PoolRe scheme results in any loss being underwritten by the Government in the event of a terrorist attack, which it was argued acts as a disincentive to release expenditure incorporating CTMs over and above current statutory obligations (I11. Director, Construction Company). A link between insurance and legislation was made clear by one participant, who stated that if the incorporation of CTMs was made a statutory obligation, then insurers would take a much more active role (I4. Director, Construction Company). However, as with legislative obligations, the uncertainty is facilitating the protection of crowded places not occurring, which in itself poses questions that require further investigation…

> "…we know we're a target, but if we don't do anything, will the insurance companies still pay out?" (I18. Director, Construction Company)

It is this thought that emanated from several participants. Again, liability seems the prominent issue, with the need for clarification only being solved through a court case that occurs (I18. Director, Construction Company). The PoolRe scheme was also raised as influencing the value of protecting crowded places, as occupiers can recoup certain losses without the need to insure themselves for those losses (I11. Director, Construction Company). However, such a perspective fails to consider that the scheme only covers *certain* losses, with losses through damage to reputation, diminished retention of business etc being un-reimbursable. It could be argued that where CTMs have purposefully not been incorporated, especially after CTSA advice, damage to reputation and revenue will be even more profound, highlighting the benefits in incorporating such measures.

6.1.1.3 Moral obligations

> "It's our people, it's important, so we've got to do whatever we need to do to ensure the protection of our people" (I17. Technical Director, Construction Company)

The above quote demonstrates a moral obligation to protect crowded places, especially considering the aforementioned lack of clarity surrounding legislation and possible liability. It was raised that in such circumstances, action is made on the basis of the values and leadership of the specific organisations themselves (I16. Director, Construction Company).

> "…there's a moral obligation if nothing else, but again, a moral obligation, what value do you put on it?" (I18. Director, Construction Company)

Whilst it was argued that counter-terrorism seems a part of Corporate Social Responsibility (CSR) (D3. Academic, Construction Management), the current tendency is for occupiers to protect their own building and not consider the performance and consequences of protecting a wider area (I4. Director, Construction Company) and construct places and spaces that honour the broader goals of society (I8. Architect). What's not clear is how counter-terrorism can further CSR and contribute to those broader goals. However, it was raised that 'economics' often trumps such moral or broader societal perspectives, due to the absence of clarity regarding legislation:

> "Why should a developer spend an extra 5% if they don't have to? If what they do is totally legitimate, why should they have to spend it? And if you're there taking the moral high-ground saying 'you should be doing this', they're going to say 'why? Do I need to do it? Is there a statutory requirement for me to do it?'. If there isn't, then they won't do it, it's as simple as that. It's economics" (I4. Director, Construction Company)

So, in the absence of legislation, there is a need for the incentives of protecting such places to be examined, an exploration which is presented in the following section.

6.1.2 Incentives

> "What is the incentive for a company to actually put in security?...there's a business case there, that actually, we want to ensure people keep coming here. There's then the consequence of resilience and continuity in the event, if something happens. But has this all been quantified in a potential benefit? I'm not aware of it" (I18. Director, Construction Company)

Six overarching incentives, as presented in Figure 6.4, are the reduction in the risk of being targeted, reduced impacts of an attack, competitive advantages, revenue generation, conducive agendas and insurance incentives.

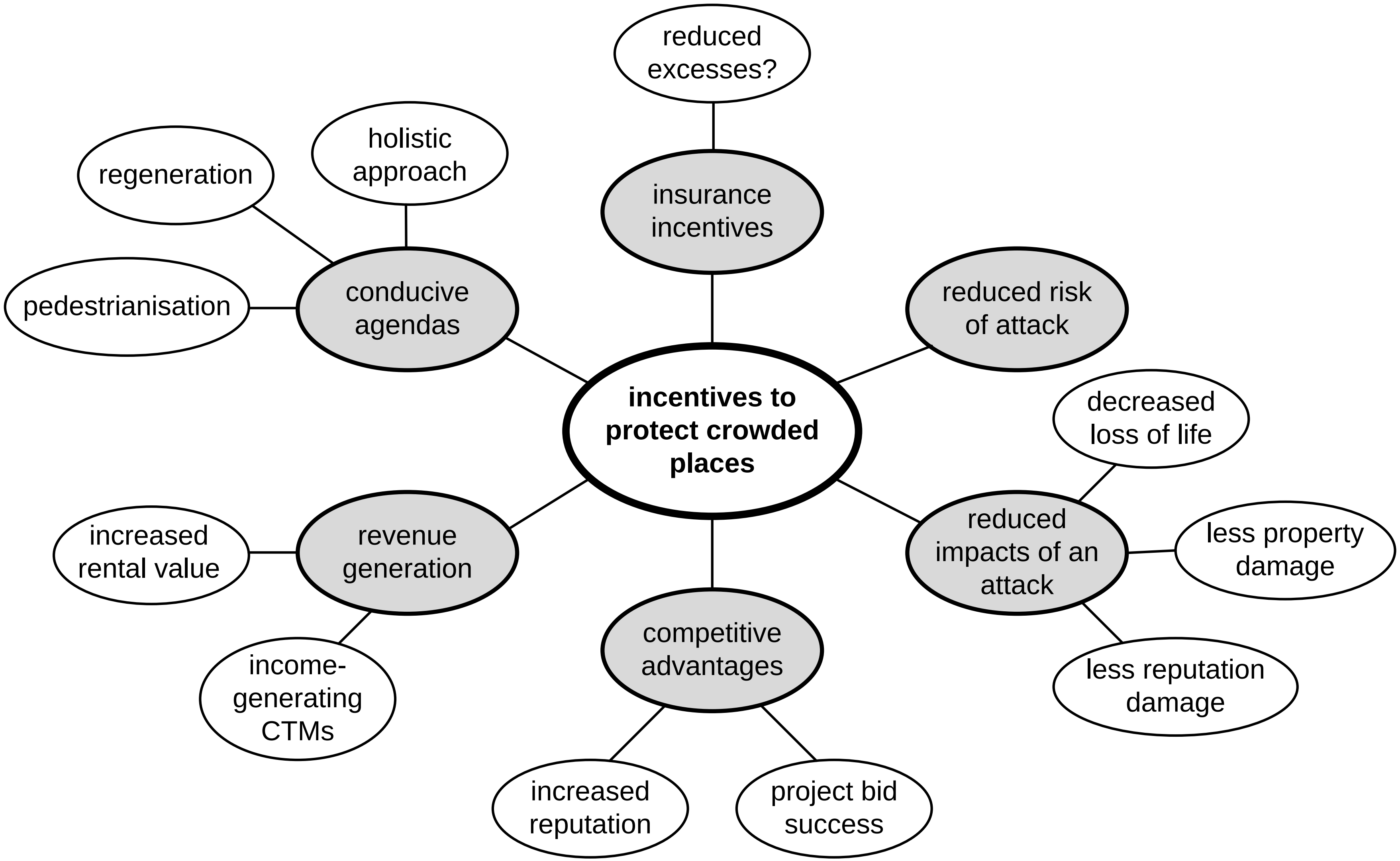
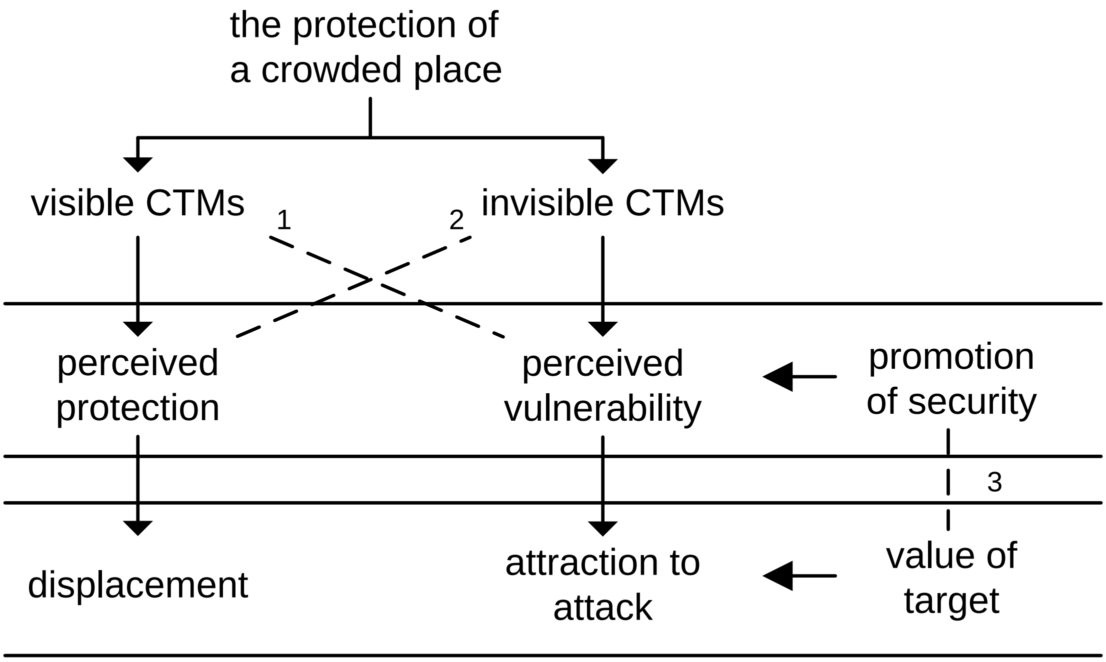


Figure 6.4. A concept map of the incentives to protect crowded places

6.1.2.1 Reducing the risk of being targeted

Firstly, it is important to note that any reduction in risk occurs because the terrorist threat is displaced (as shown in Figure 6.4). Displacement, therefore, is a consequence of the use of incorporating CTMs to protect crowded places. Emerging from the participants was a clear sense of visible CTM's leading to a perception of protection and therefore displacement, yet the use of invisible measures would result in a perception of vulnerability and the attraction of an attack. Intrinsically linked to this is the public promotion of incorporated CTMs and the significance of the target itself. If the incorporation of CTMs had been publically promoted, this would influence perceived notions of protection and vulnerability. However, the significance of a crowded place could result in its repeated targeting, regardless of any incorporated CTMs. Such influences are expressed in Figure 6.5 below.



1 Visible CTMs could still be perceived as vulnerable if surmountable, exploitable etc

2 Invisible CTMs could be recognised through hostile reconnaissance and 'trained eyes'

3 The promotion of incorporated CTMs could attract attention and increase the risk of being targeted

Figure 6.5. Perceptions regarding displacement

Interestingly, all three participants who commented on the *visibility* of CTM's were in security-specific positions and cited its importance in terms of security, whereas all five participants who commented on the *invisibility* of CTM's were architects or designers, in non-security-specific positions and spoke about it in relation to design and aesthetics, resulting user experiences, as well as security. The stated aim of such 'invisible' designs would be to create places that would 'look like they would have looked without incorporating any CTM's'. However, as raised by one designer:

"…half the value of a camera is knowing the camera's there…if you don't make it foreboding enough, then maybe you're actually encouraging threats". (I7. Associate Director).

Whilst there appears to be a dichotomy between the 'security' and 'design' agendas in relation to displacement and the use of visible/invisible measures, the reduction in the risk of an attack occurring is an incentive for any (perceived or real) 'at risk' organisation, although what remains unclear is the impact of invisible CTM's in terms of perceptions of security, from the perspective of potential offenders as well as end users.

6.1.2.2 Reducing the impacts of an attack

Such impacts encompass the physical results of an attack in terms of loss of life and damage to property and other assets, as well as the impacts on business reputation and the retention of business. Less loss of life and damage was cited by numerous participants, with assessments at each site needed to fully gauge, in conjunction with the proposed or incorporated CTMs, damage estimations. Disproportionate collapse and primary/secondary fragments were seen as the most important aspects from which protection will reduce impacts (I12. Associate Director, Construction Company; I17. Technical Director, Construction Company; I19. Consultant, Construction Company). Incentives to protect in terms of the protection of reputation were cited by numerous participants, with the loss in revenue from this aspect alone being perceived by participants to potentially far exceed the cost of incorporating any CTMs (I4. Director, Construction Company; I11. Director, Construction Company; I18. Director, Construction Company). An example of a company who incorporated CTMs into their site due to fears over potential harm to their reputation was cited during one interview, however, as also stated by the CTSA, such examples organisations "are very much in the minority" (I24. CTSA B).

6.1.2.3 Competitive advantages

Competitive advantages were only raised by one participant. As part of a bid for the design and construction of a crowded place, the participant and their colleagues researched the occupier and surrounding area, resulting in their decision to consider counter-terrorism and flood mitigation measures in their proposal. Such considerations were not presented in any other proposal that the occupier received and was a part of the decision to award the bid to the participant's proposal (I21. Technical Director, Construction Company). Therefore, the consideration and incorporation of CTMs can be seen as uncommon practice, especially considering the aforementioned legislative and insurance policy issues. This provides developers, designers and planners with an incentive to consider and where appropriate, incorporate, CTMs and other mitigation measures, resulting in relatively higher success in being awarded bids and an increase in reputation. Therefore, turnover and revenue could increase.

6.1.2.4 Revenue generation

Revenue generation encompasses certain CTMs being able to generate revenue themselves, as well as the increase of rental values that can be achieved as a result of the increased protection and resilience of a building and/or site. CTMs can generate income, as advertising boards or measures where surfaces can be used for such advertising purposes, can be structurally enhanced to fulfil counter-terrorism purposes (I2. Design Consultant A, Design Consultancy; D7. Un-attributable Source; I23. Director A, Construction Company). An example of such an advertising board was observed during site visit 1, as shown in Figure 6.6. Whether they were incorporated as HVM measures (and were constructed for that purpose) is unknown, however it provides a visual example of the street furniture that can be used to protect crowded places. A further example was given by one participant, where ASF had advertising printed on it (I2. Design Consultant A, Design Consultancy). As certain CTMs can generate revenue, it can therefore be argued that over time, they would 'pay for themselves' and therefore also have the potential to return the costs incurred for an entire protection scheme and thereby after, generate further revenue and profit. It was raised that incorporated protection into a building could enable tenants to be charged higher rents, due to the increased security and the decreased costs being incurred in the result of an attack or other similar event (I11. Director, Construction Consultancy). How the incorporation of CTMs can generate revenue via regeneration and subsequent increases in property and rental values was also raised, and is discussed in section 6.1.2.5.

Figure 6.6. Advertising boards in Lower Manhattan, New York

6.1.2.5 Conducive agendas

Pedestrianisation and regeneration are discussed within this section, as participants raised these two agendas as being conducive to counter-terrorism (and vice versa). These agendas, more often than not incorporated into building and urban design separately, highlight the benefits and implications of adopting a holistic approach to the mitigation of hazards and threats, as well as incorporating the needs resulting from other policies and agendas, such as environmental enhancement and de-cluttering of the built environment.

Pedestrianisation

Whilst it was argued that pedestrianisation is the ‘only way’ that the exclusion of all vehicles within any given area will be facilitated (I21. Technical Director, Construction Company), a range of perspectives and experiences were raised. Of importance, however, was the need for pedestrianisation to occur in areas where there is a constant ‘energy’ or use of that space, otherwise such places can become desolate (I6. Urban Designer, Local Authority) and it could be argued, attract crime. In an interview in New York (I6. Urban Designer, Local Authority), it was raised that pedestrianisation has not worked well in some areas, due to buildings closing after office hours, with no other amenities available there. In relation to the implications of pedestrianisation, traffic displacement was raised (I4. Director, Construction Company; I6. Urban Designer, Local Authority) as well as the prevention of vehicles being able to physically reach buildings, for delivering goods or dropping off/collecting people (I6. Urban Designer, Local Authority). Whilst traffic displacement was raised as an issue, it was highlighted that a key issue is where traffic is only restricted, not excluded, as queues can form and congest areas (I6. Urban Designer, Local Authority).

The benefits of pedestrianisation were cited by numerous participants, with increases in footfall (and therefore increases in revenue for businesses within the pedestrianised areas) being raised most often (I4. Director, Construction Company; I6. Urban Designer, Local Authority; I15. Director, Construction Company; I21. Technical Director, Construction Company; I25. Assistant Director, Local Authority; T2. Un-attributable Source). Environmental and pollution-related benefits were also raised as benefits of pedestrianisation (I4. Director, Construction Company; I25. Assistant Director, Local Authority), as were reductions in injuries and deaths resulting from incidents involving vehicles and pedestrians (I4. Director, Construction Company). It was raised by two participants that where pedestrianisation was being incorporated for counter-terrorism purposes, often there was an existing conflict between traffic and pedestrians (I25. Assistant Director, Local Authority; I26. Engineer, Local Authority). A reduction in crime was also noted in areas where pedestrianisation had occurred, as had better access provisions for disabled persons, due to the nature of pedestrianisation itself, as well as (in some cases) the additional use of high-quality materials (I25. Assistant Director, Local Authority). The benefits and implications of pedestrianisation are not widely recognised however, as evidence of misconceptions emanated from projects where pedestrianisation was being incorporated into certain areas. Some businesses objected to pedestrianisation, due to fears of downturns in footfall and revenue (I4. Director, Construction Company; I6. Urban Designer, Local Authority), however after the pedestrianisation occurred (and as demonstrated in the previous paragraphs), footfall and resulting revenues increased, due to perceived increases in the quality and comfort of the space (I6. Urban Designer, Local Authority). Despite the benefits of pedestrianisation (in relation to counter-terrorism), one participant noted:

> "…but obviously, you can't pedestrianise everywhere" (I15. Director, Development Company)

Regeneration

The protection of crowded places was also raised as being conducive to regeneration, with an example given of a project where the exclusion of traffic and the pedestrianisation of an area resulted in landlords increasing rents (due to the increase in the quality of the area), which lead to their tenants (existing low-quality outlets) being effectively forced out, for new and higher-quality outlets to take their place, who in turn invested in their properties to increase their attractiveness and use, which in turn increased footfall to the area and revenues for those businesses (I25. Assistant Director, Local Authority). The following quote is taken from part of an interview whereby counter-terrorism and its conduciveness to regeneration and pedestrianisation (and vice versa) was being discussed:

> "…for every pound you spend on street enhancement, you can usually equate it to five pounds increase in value and so if it's a £1 million project, it releases £5 million in value to premises and I think that's probably a similar kind of thing that would happen with counter-terrorism and the way that we implement street enhancement projects as well" (I25. Assistant Director, Local Authority)

Whilst somewhat anecdotal, the 1:5 ratio, which relates specifically to monetary value, is based on experience of numerous projects and offers some insight into the benefits that can arise when incorporating CTMs. Further research is needed however, in order to provide objective and substantiated findings in relation to this.

A holistic approach

The need for a holistic approach, not just in terms of security but in regard to protection from other threats, hazards and major accidents, as well as the incorporation of other agendas, was raised by numerous participants. In terms of why such an approach is rarely taken, one participant felt the cause was because of:

> "…fiefdoms. People are very precious about their knowledge. You've got this inner circle of consultants that make their money selling man hours…people try and make it more complicated than it really is" (I18. Director, Construction Company)

The consequences of this are summarised by another participant:

> "…it's about community and it's about holistic vision of place and I think that as soon as you start fracturing and breaking down that, you end up with divided communities" (I20. Architect)

In the context of the interview, 'communities' was meant in terms of people, however not taking a holistic vision of any project can result in fractured, redundant and more complex infrastructure. An example of a project where numerous technological systems were incorporated, as opposed to joined-up thinking being able to result in more inclusive and refined systems, was highlighted by one participant who called the consequences of such action as "counter-terrorism acne" (I15. Executive Director A, Development Company). The benefits of adopting such an approach were highlighted through three projects that had been completed. At one site, a critical national infrastructure site, a construction company reduced planned counter-terrorism expenditure by 60%, simply by adopting a holistic approach to the site, albeit only from a security perspective (I14. Directors A and B, Construction Company). By enforcing a perimeter to the site, less obtrusive CTMs (if required at all), were installed further into the site itself. An example of specific CTMs entails blast-resistant glazing having been recommended for all of the buildings, yet due to the aforementioned perimeter protection, the need for such CTMs on every building was significantly reduced. An even more inclusive project was cited, with the exclusion of traffic for counter-terrorism purposes being furthered to exclude traffic from a wider area, pedestrianising routes to local parks and increasing the attractiveness of the area, as well as benefitting from reduction in air and noise pollution (I21. Technical Director, Construction Company). Another project was raised whereby a crowded place was being protected, so the opportunity was taken to pedestrianise a wider area, in order to tackle abuses of existing traffic orders in the area (I26. Engineer, Local Authority). However, in this instance, an adjoining building had an inadequately protected underground area (with the occupier exploiting the lack of obligations to protect crowded places), which ran underneath the protected crowded place itself, which left the scheme vulnerable to attack, undermining the work carried out (and money spent) to date.

These examples, whilst highlighting the benefits that can be gained from adopting a holistic approach in relation to security, do not reflect a completely holistic approach to the design of crowded places and surrounding areas in terms of the consideration and reconciliation of other agendas. Projects seem to be undertaken with a somewhat 'silo' mentality. As highlighted above, there are benefits to be gained from adopting a holistic approach, but this, as well as the protection of crowded places from VBIEDs specifically, seem dependent on stakeholder understanding and engagement and their awareness of the inherent benefits and available opportunities.

6.1.2.6 Insurance incentives

Whilst previous discussions have centred on how uncertainty in relation to insurance policies influences the protection of crowded places, a minority of participants raised that insurance acts as an incentive to protect, as current perceptions are that while premiums will not be reduced if CTMs are incorporated, excesses will be (D5. NaCTSO Representative; I18. Director, Construction Company). Whether the reduction in excesses, depending on the damage caused and the cost of the CTMs incorporated, could cover the cost of the CTMs themselves, was not highlighted by any participant. As an incentive to protect, this seems an attractive proposition and one which requires further research, along with the other, aforementioned, issues in relation to insurance, as well as the competitive advantages that could be gained by those seeking to be insured through incorporating CTMs and insurers competing to insure them at the reduced risk.

6.1.3 Threat and risk assessments

The data that was collected on TARAs revolved around the influence those assessments can have on the value of the CTMs used to protect crowded places, through proportionate, under-engineered and vulnerable, or over-engineered and obtrusive, responses. However, it should not be overlooked that such assessments can determine whether crowded places are protected, as the result of such an assessment could be to relocate or not build in a particular location, due to inherent, adjacent or nearby (potential) targets. The issues that emerged from the participants encompassed the assessments themselves, situational context, threats and proportionality, all of which influence the value of the CTMs used as a result. Issues in relation to TARAs, or specific components of them, were raised in 34 out of the 42 sources of data collection. These issues also feature heavily in the set of project documents given during an interview. Influence on the value of protecting crowded places is not only made by the carrying out of, contents and interpretation of the TARA itself, but on the situational context that inherently determines the assessment, the terrorist threat faced and issues in relation to proportionality. It is these influences that this section considers.

6.1.3.1 The assessment itself

The TARA is fundamental in assessing the situational context (i.e. the nature of the occupier/tenant, the design of the building and site, adjacent or nearby threats, the level of protection required), the national and localised terrorist threat, and the proportionate solutions available to mitigate the assessed risks. When considering the protection of a crowded place and the incorporation of CTMs, the first task is to carry out a TARA, as the result of the assessment may be to relocate, whether designing a new building or retro-fitting an existing one (I11. Director, Construction Company; I23. Director A, Construction Company). Emanating from participants were three clear issues in relation to the assessments, those being their inclusion of future scenarios, their inclusion of all affected stakeholders and their transparency. The issues surrounding future scenarios are highlighted in the following quote:

> "You might not be a target today, but if you're putting up a structure, who are the occupiers of this structure going to be in 5-10 years time? What are the terrorist threats going to be? It's got to be in your interest to make a reasonable design, to take reasonable steps to protect the structure. The extent to which you do that, that's the difficult one" (I11. Director, Construction Company)

Such potential change could result in the tenants being in a building that is over-engineered (in counter-terrorism terms) for their needs and is therefore, dis-proportionate. Whilst they will reap the inherent benefits of those CTMs, the impact they have on permeability and user experience is unclear. Further research is needed into the longevity of crowded place occupancy and how their incorporation of CTMs relates to this. The importance of including stakeholders in the assessment and its recommendations was made apparent by one participant, who gave an example of a project where bollards has been incorporated into a site, but were removed and relocated due to executives wanting to drive through areas that had been protected, incurring additional and unintended costs (E4. Ex-Practitioner, Crime Reduction). Issues in relation to stakeholder engagement are explored further in section 6.2.2.1. The transparency of TARAs carried out by CTSAs was also raised, with participants being 'told' what level of threat they faced (high, medium or low) without the reasoning being explained to them (I21. Architect; I21. Technical Director, Construction Company) and that this can cause difficulties in discussing protection with clients, when contractors are not told the reasoning either (I25. Assistant Director, Construction Company).

6.1.3.2 Situational context

Situational context encompasses the nature of the occupier themselves, their symbolism and iconography and that of their buildings, the topography surrounding the building, surrounding infrastructure (both above ground and under-ground), the density of the space in which it is posited and the ‘adjacency risk’. Adjacency risk was cited by one participant in terms of the proximity of potential targets to an existing or potential occupier (I19. Consultant, Construction Company). Two scenarios are incumbent in regard to adjacency risk. Firstly, an occupier may be adjacent or nearby to a perceived target, which would increase their own risk of being impacted by a terrorist attack. Secondly, a neighbouring building to a protected building is also at increased risk, due to blast waves reflecting off the protected building more than would have occurred if the building was not protected, worsening the damage to surrounding buildings (I17. Technical Director, Construction Company).

6.1.3.3 The terrorist threat

It was raised that the protection of crowded places from vehicle-borne terrorist attack was the most important, due to the impacts that it can cause and the numerous plots and attacks that have involved their use (I3. CTSA A). The situational context will determine the vulnerabilities faced in terms of approach speeds and access routes, yet the likely method(s) of attack also determine the charge size of an explosive device (based on an attack using an IED), which will have consequences for any CTMs in regard to their robustness. The TARA should therefore breakdown the likelihood and impact of each type of attack, identifying vulnerabilities to each and potential solutions (I19. Consultant, Construction Company). Based on the situational context (of which the threat is a part), a proportionate solution can then be determined.

6.1.3.4 Proportionality

> “It’s what you don’t do, as much as what you do do” (I2. Academic, Terrorism Studies)

The above quote captures the essence of proportionality, yet determining what to incorporate and what not to was the prominent issue raised by participants. Proportionality was known to be the stance adopted by Government and NaCTSO, yet how proportionate assessments are carried out and solutions designed was questioned repeatedly. An example of a project was given where a crowded place was to be constructed in a city-centre location and a CTSA had advised the designers that monster trucks could be used to travel up any steps and that ditches would be required to prevent this method of attack from occurring (I21. Architect). Examples were also given of occupiers who had hired consultants to carry out TARAs to verify those conducted by CTSAs. Considering what has just been presented and the issues in relation to transparency that have been discussed previously, there is an apparent need for further research and development in this area, as whilst the proportionality ‘stance’ is clear, how it is assessed and determined in relation to solutions is not evident and as highlighted above, is causing scepticism surrounding the expertise of CTSAs. However, whilst the ‘monster truck’ example highlights interesting issues, that was the only such example given during the course of the research. As noted by one CTSA:

> “Proportionality only comes with experience” (I22. CTSA A)

Yet, considering the above comments, it appears that proportionality might also arise through more transparent assessments, but could also only be truly assessed at the end of the building’s life. However, it must also be noted that the ‘true picture’ surrounding terrorist threats will never be known, due to the necessary secrecy surrounding intelligence; a factor that must also be acknowledged.

6.1.4 Perceptions and moments of terrorism

Perceptions and moments of terrorism were raised in just under half of the interviews, discussions and communications as an influence on the protection of crowded places. The most significant influence emanating from the data was ‘moments of terrorism’, most notably the terrorist attacks of September 11th 2001 in the USA and July 7th 2005 in the UK.

6.1.4.1 Perceptions of terrorism

> “There is always going to be some level of threat and there’s ‘real threat’ and ‘perceived threat’, because if something hasn’t happened for two years, they think the threat is reducing” (I18. Director, Construction Company)

How perceptions of terrorism can influence the protection of crowded places is summarised by the above quote. Where perceptions of terrorism are low and/or perceived to be less than the ‘real’ threat, CTMs are not incorporated into crowded places as it is felt that they are not needed. However, it became clear over the course of the research study that there is a lack of awareness, specifically outside of security-focussed departments and/or organisations, regarding the threat that is faced, which is demonstrated through this quote, taken from an interview in the midst of discussions surrounding the change and expenditure that has occurred as a result of terrorist attacks:

> “How many incidents have there actually been since 9/11, apart from the 2005 events here, how many have actually affected the UK, in a big way, apart from the Glasgow thing, really, there hasn’t been anything” (I16. Director, Construction Company)

The literature review highlighted a plethora of terrorist attacks and plots (section 3.1.2) that demonstrate that whilst the number of attacks that have been carried out have been sparse, the number of attempts have been numerous. It would therefore appear that there is a need for those who encounter counter-terrorism practices to be more informed of the threat, especially considering the perceived changing nature of the threats that is occurring (and therefore, the changing nature of the planning for those threats). Most notably, participants highlighted that planning for Mumbai-style attacks is increasing (I26. Engineer, Local Authority; I27. CTSA). An example was given of a crowded place that had incorporated CTMs to enforce a stand-off distance around the building, only for future stages of the scheme to be called into question due to worries regarding Mumbai-style attacks. It was envisaged that the funding for the remaining HVM would then be used elsewhere, leaving the building vulnerable to attack due to the 'unfinished' HVM scheme. What became clear through the research study however, was the influence that individual attacks, or 'moments of terrorism', can have and how they shape and inform broader perceptions.

6.1.4.2 Moments of terrorism

> "…there are always going to be events" (I1. Academic, Terrorism)

It is these 'events', these moments of terrorism, that influence a person's overall perception of the terrorist threat and act as catalysts for action on a plethora of scales, including whether and how crowded places are protected. Examples were given of how the terrorist attacks of September 11th 2001 in the USA and attacks on London's transport network on the 7th July 2005 and Glasgow International Airport in 2007 caused a plethora of responses; the responses to the attacks of September 11th 2001 could not be over-emphasised by participants. It has been seen as the "marker in the ground" (I4. Director, Construction Company), the moment which transcended international policies and discourse, through to the policies and security responses of individual buildings. It was highlighted that a completely new environment exists, an environment in which the threat of terrorism, both nationally and internationally, has been completely re-assessed (I16. Director, Construction Company) and that as a result of this, counter-terrorism has been thrust into the realm of building and urban design (I9. Director, Design Consultancy). After the attacks themselves, it was raised that a range of 'makeshift' and 'haphazard' responses were made, not necessarily because of a perception that other attacks were imminent, but because organisations had to be 'seen to be doing something' (I6. Urban Designer, Local Authority), responses such as those demonstrated through the following quote:

> "You couldn't even walk on the streets because there's people standing outside trying to get into a building, or you'd walk into a building lobby and there'd be very long lines just to get in the building and so, if you had a 2 o'clock meeting, you'd better get there by 1.30, otherwise you weren't going to be on time" (I9. Director, Design Consultancy)

Moments of terrorism also reduced ignorance to the threat of terrorism, with numerous examples given of such events bringing terrorism to the forefront of peoples' minds again (I3. CTSA B) and how it takes such an event to get people to incorporate and request CTMs (I22. CTSA A; I24. CTSA C). This was highlighted as being the case with the attack on Glasgow

International Airport and the responses made by airports afterwards (I2. Design Consultant A, Design Consultancy; I3. CTSA C). How these perceptions and moments of terrorism directly influence the protection of crowded places is demonstrated through the following quote:

> "After 9/11, whoosh, straight up! After the London bombings, whoosh, straight up! It's cyclic. If a bomb goes off now, my phone won't stop ringing tomorrow, all the projects I've got on hold will be in the pipeline" (I18. Director, Construction Company)

6.1.5 Stakeholder understanding and engagement

Two evident influences on the protection of crowded places were the intentional 'sidelining' or ignoring of CTSAs and Architectural Liaison Officers/Crime Prevention Design Advisers whilst planning and designing crowded places (I24. CTSAs B and C), as well as stakeholders whose businesses were neighbouring and adjacent to crowded places perceiving their property to not be at risk because they were not going to be the specific target of an attack (I24. CTSAs A and C). While such places may not be the intended target of an attack, a blast will still impact their property, the extent to which will be dependent on the nature and location of the blast itself and its proximity to the neighbouring properties. A greater understanding of risk is therefore required (see section 6.2.2.5 for further details).

6.1.6 Economic influences

Economic influences were raised as influencing the protection of crowded places, as the current economic climate reduces willingness to spend on CTMs (I15. Executive Director B, Development Company; I18. Director, Construction Company). An example was also given by a CTSA who highlighted that a company wanted their staff to attend Project Argus and Griffin events, but the staff couldn't get cover to attend due to cut-backs (I3. CTSA A). This highlights that there are circumstances where even though the CTMs are 'free', releasing staff to get the benefits are not feasible, despite the value of those specific events. Considering the current economic climate, such influences are particularly pertinent and therefore increase the strain on the need for cost-effective CTMs, if they have to cost anything at all.

6.1.7 Local policy

Local policy was highlighted in a focus group with a development company, who articulated that within and around the City of London, different constituencies have different approaches to the protection of buildings and how such policies can be at odds with other policies and objectives.

> "…putting buildings on the backs of footpaths, we have to put in this deep concrete wall, which was effectively a metre high and about 500mm deep, anchored back to the buildings and we're supposed to have a retail environment. Now, you know, having this big bunker around the building is exactly counter to the other policies that City have, in terms of actually attracting high-quality retail" (I15. Director, Development Company)

It was raised that not only does such a situation result in CTMs no longer being considered (due to the exploitation of no apparent legislation), but also that in terms of excluding vehicles from an area, thereby removing the need to enhance the structure of a building as described in the previous quote, some constituencies are more open to this approach than others. How influential and renowned tenants and occupiers were was also raised in relation to this, in being able to exclude traffic from a wider area, despite reservation from the local authority. Whilst results in relation to the performance and consequences of the different traffic management approaches are presented in section 6.4.1, it appears that local authorities need to be more aware of the performance and consequences of the different approaches in order to ensure that differing objectives and policies are consistent and reconciled wherever possible, informing decision-making and not developing or enforcing them in an ad-hoc manner.

6.1.8 Building stock rotation

Building stock rotation was raised by one participant, a Director of a development company, who highlighted the longevity of the process of protecting all the at-risk places and how standards can change over such a period of time:

> "The relative change in building stock is about 2% a year…so if you want to get the standards we're doing now across all the buildings in the City…it'll take you 50 years to get there" (I15. Director, Development Company)

Whilst such a perspective does not take into consideration that not all the buildings may require protection, and the aging (and resulting vulnerability) of such places, it raises a relevant point regarding the longevity of the process and the issue of proportionality and how current versus future threats are incorporated into designs. Such discussions and supporting data in relation to proportionality are presented in section 6.1.3.4.

6.2 Influences on the Value of Counter-Terrorism Measures

As shown by Figure 6.7, there are three factors that each influence the value of CTMs used to protect crowded places, those being TARAs, stakeholder understanding and engagement, as well as auditing.

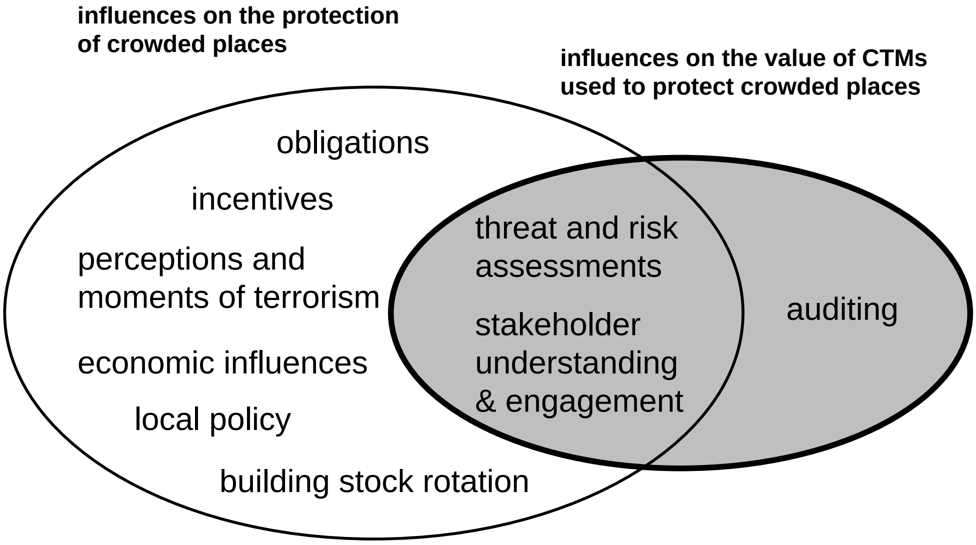


Figure 6.7. Influences on the value of protecting crowded places

TARAs also influence the protection of crowded places and will be discussed in section 6.1.3.

6.2.1 Stakeholder understanding and engagement

This section explores how stakeholder engagement and understanding influences the value of the CTMs used to protect crowded places and encompasses engagement between stakeholders themselves, their understanding of CTMs, vulnerable points in protection, understanding of risk and training, testing and exercising. Figure 6.8 displays these influences and their key components.

6.2.1.1 Stakeholder engagement

Stakeholder engagement encompasses the different requirements and wishes of stakeholders, their sharing of information, the design stage in which they're engaged with, the importance of the end-user and as raised by one participant, how they can be 'a voice in the wilderness'.

Differing requirements and wishes

> "…stakeholders are at odds with each other because they have different needs" (I6. Urban Designer, Local Authority)

It is this factor that is most pertinent to issues in relation to stakeholder engagement. Examples were given by participants on how different needs and wishes impacted projects, where those differing perspectives had not been recognised and accommodated.

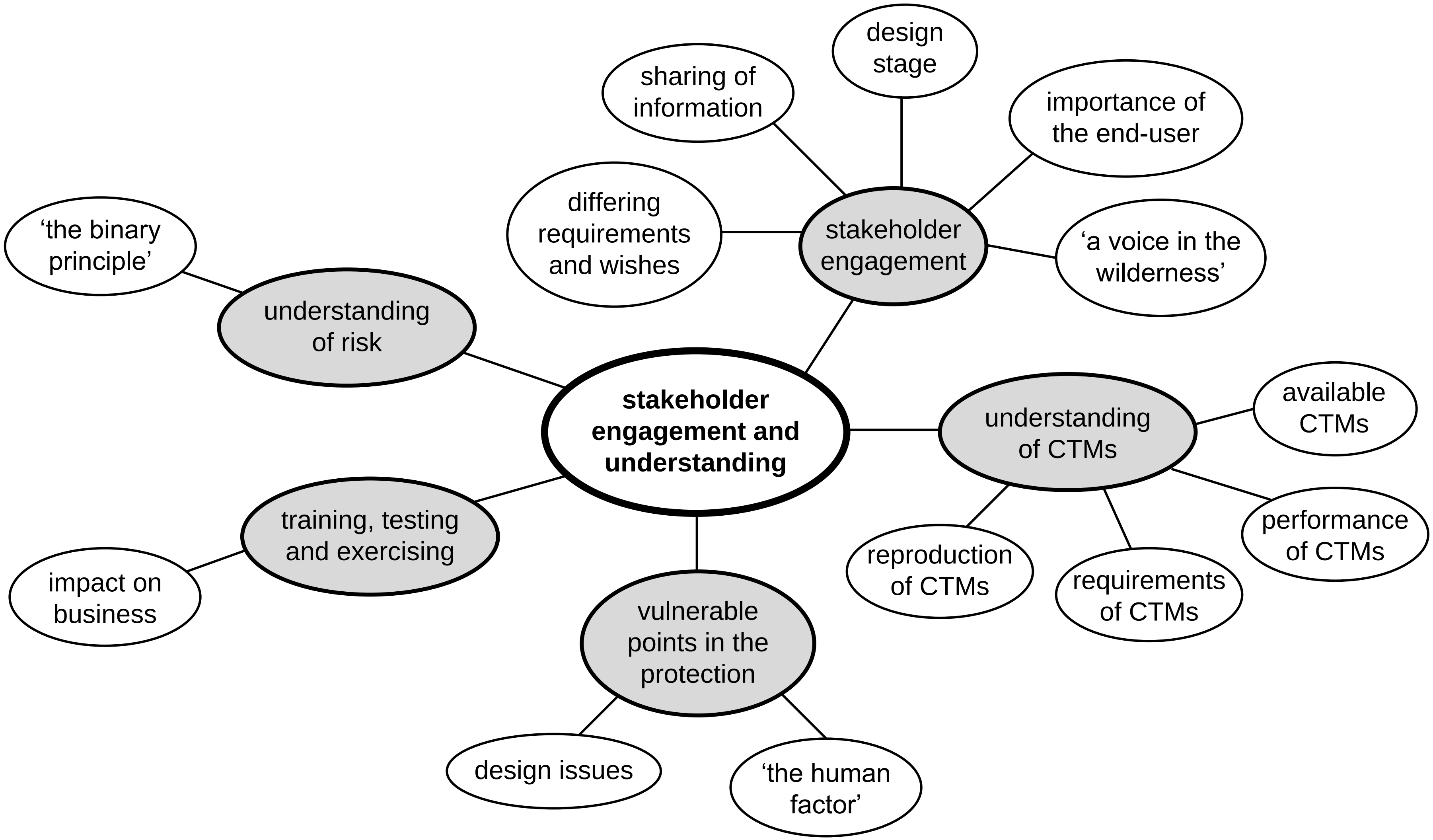


Figure 6.8. A concept map presenting the issues in relation to stakeholder engagement and understanding

Where such issues had not been recognised and addressed, CTMs were incorporated that blocked access routes for certain employees and resulted in the measures being removed and replaced at additional expense (E4. Ex-Practitioner, Crime Reduction), or impinged on the end-user and the time it took them to carry out routine tasks (I14. Director B, Construction Company). Where the different needs and wishes had been recognised, engagement with those issues resulted in solutions that were better for everyone, with examples given of planned blast-resistant glazing being changed to accommodate staff within a building being able to open windows, as the contractor knew of products that fulfilled both functions (I14. Director B, Construction Company) and the engagement of a Local Authority with commercial companies who would be affected by traffic restriction and the creation of memorandum of understandings to minimise disruption (I26. Engineer, Local Authority). Whilst stakeholders will always have different needs and wishes, what's clear is that through engaging with them, the most accommodating solution can often be developed and even if such accommodations cannot be made, the fact that those stakeholders have been consulted and engaged with, with attempts made to accommodate certain needs and wishes, will result in them being more receptive to any consequences or trade-offs (I14. Director, Construction Company).

Sharing of information

The sharing of information was raised as being an issue in relation to stakeholder engagement, with participants repeatedly stating that it does not occur amongst organisations, due to them being protective over the information that they own/have and/or the size of the organisation itself (D6. Crime Specialist, Police Force; I18. Director, Construction Company; I21. Technical Director, Construction Company; I27. CTSA; T3. NaCTSO Representative). An example was also raised of an emergency service organisation who was unable to participate in planning arrangements for a high-risk site due to not having the facilities to store restricted information (I27. CTSA). Participants felt that the best way to share information, as well as engage with and understand the involved stakeholders, was to 'get everyone around the table' (I13. Design Manager, Construction Company), with the benefits of organising such a feat being the involvement and input of all those stakeholders who will use or be affected by the CTMs, as well as less 'hassle hours' later on (I13. Design Manager, Construction Company). It was raised by one participant that unintended consequences, such as bollards being removed and replaced due to stakeholders wishing to have access to certain areas (as previously raised), are simply a consequence of bad planning (I17. Technical Director, Construction Company); a consequence that can be avoided by the sharing of information and engagement with all affected stakeholders.

Importance of the end-user

The importance of the end-user was cited by six participants, with the consequences of not engaging with or addressing the needs of end-users bearing additional costs later on, due to the replacement or modification of incorporated CTMs. The majority of examples that were raised highlighted where CTMs had to be replaced or removed due to impingement on essential or routine working practices (E4. Ex-Practitioner, Crime Reduction; I11. Director, Construction Company; I14. Director, Construction Company; I17. Technical Director, Construction Company). However, an example was raised of a project where end-users of a protected scheme were engaged with and the solution being developed was modified to accommodate their wishes. The project, involving traffic restriction in a certain area, modified the CTMs (rising/lowering bollards) so that the restricted area could be accessed or exited from either side of the CTMs, benefitting emergency service (as well as any other) access and egress (I26. Engineer, Local Authority).

Design stage

> “You see it all the time, people coming in far too late in the development process” (I25. Assistant Director, Local Authority)

Whilst in this instance the participant was talking about end-users who were requesting the incorporation of bollards around their building, aforementioned examples have raised the same issue in relation to CTSAs and security consultants. The design stage in which stakeholders incorporate CTMs can have major implications on a project, with one example being highlighted by a participant who showed that stand-off distances impact the appropriate sizes of glazing and windows, so identifying this at the earliest opportunity will allow parameters for the design to be set, whereas if this occurred later on in the project, costs in relation to re-designs and modifications will only increase (I8. Architect). As summarised by one participant:

> “You need to get those sorts of things agreed, bottomed out, very early on because it does have big implications” (I21. Architect)

‘A voice in the wilderness’

“A voice in the wilderness” (I11. Director, Construction Company) is a quote from a participant who used it to reflect their perspective on what it is like to promote the benefits of stakeholder engagement and incorporate a solution that benefits more than just one stakeholder or organisation.

> "…all bollards do and stand-off distances, what do they protect? They protect a particular asset and they'll protect the people in that particular asset, but you've got the adjacent assets…" (I4. Director, Construction Company)

As highlighted in section 6.1.3.2, buildings that incorporate particular CTMs are more robust and blast-resistant, increasing the damage that adjacent buildings can incur due to the increased reflection of blast waves. The link between this issue and above point is the benefits of traffic exclusion (or at least restriction), in order to protect those adjacent buildings and reduce their risk. However, the benefits of these approaches, as well as the benefits of CTMs more generally, remain 'lost in the wilderness' and unengaged with by stakeholders, emphasising the need for publicly available information on these issues.

6.2.1.2 Understanding of CTMs

This section encompasses stakeholder understanding of the CTMs that are available, their performance, their requirements and issues in relation to their reproduction.

Available CTMs

> "…we have our bollards" (I9. Director, Design Consultancy)

> "…what else can you do?" (I6. Urban Designer, Local Authority)

The aforementioned sentiments were consistent when discussing associations with counter-terrorism and what can be done to protect crowded places. Examples were given of stakeholders assuming that sufficient stand-off distances cannot be created when dealing with existing buildings (I23. Director B, Construction Company), protecting crowded places encompasses incorporating layer after layer of CTMs (E4. Ex-Practitioner, Crime Reduction; I14. Director A, Construction Company) and stakeholders choosing products purely because of their appearance in brochures (I14. Director A, Construction Company). Awareness of the range of CTMs that can be used was inconsistent, however, as stated by one participant:

> "…there's all sorts of way to secure a building" (I23. Director B, Construction Company)

Performance of CTMs

Whilst data on the performance of individual CTMs is presented in their respective and forthcoming sections, broader understanding of the performance of such measures was inconsistent. It was stated by one participant that CTMs are not seen as adding value to projects currently (I15. Director, Development Company). Although this concurs with aforementioned and forthcoming presentations of data that highlight a widespread lack of awareness regarding what CTMs can be used, as well as their benefits and consequences, the following was raised by one participant…

> "…if you look at it purely as a product cost, you won't see the benefit" (I14. Director A, Construction Company)

Forthcoming sections and chapters will demonstrate where value is inherent and obtainable in the protection of crowded places, yet such understanding of CTMs was not consistent, with the perception that such value is not evident yet, otherwise further progress would have been made in protecting such places (I15. Director, Development Company). The following quote highlights the general consensus:

> "…there are not really any synergies with security and anything…it's an entire additional overlay that you have to add to a project" (I8. Architect)

Requirements of CTMs

Four examples of stakeholders not understanding the requirements of CTMs were evident and raised, encompassing the security of CTM infrastructure itself, the frames and fixings required for enhanced glazing, stand-off and air gaps between VSBs. An example of a project was given whereby a cabinet which contained control systems for an automated VSB was secured using a lock and key available from local hardware stores (I2. Design Consultant A). Whilst this also highlights the potential weaknesses that can be exploited (see section 6.2.2.3 for further information), it indicates a lack of understanding surrounding the requirements and supporting infrastructure of CTMs, as well as the aforementioned lack of understanding surrounding the CTMs themselves. Understanding in relation to the enhancement of glazing itself, as well as the frames and fixings it requires was also raised, with one participant stating that they were dealing with projects where millions of pounds worth of glazing had failed, because the supplier had supplied glazing that was not specified, the frames and fixings were insufficient to support the load of the enhanced glazing and potential issues in relation to thermal stress were not understood (I2. Design Consultant A). Potential implications of such errors are profound and do not just encompass issues in relation to cost. If enhanced glazing is not supported properly, in the event of a blast, the impact will simply propel the intact glazing inwards, causing a major hazard for occupants. An example of a project where 30m of stand-off had been incorporated was also raised, with the occupier then wanting to put retail outlets in the protected distance to sell amenities such as coffee (I2. Design Consultant A). Whilst this was raised as creating a new risk and diminished the effectiveness of the stand-off, the level of risk posed to any users of that space will be significantly less than if no stand-off distances were incorporated, as the building would be completely vulnerable to vehicle penetration and more likely to be targeted.

The ability to incorporate mobile or relatively small outlets/amenities therefore acts as reconciliation between enforcing stand-off and restricting user experience. The importance of the air gap between VSBs was also raised as not being fully understood, with an example of a project being raised where two bollards were going to be incorporated, to block a potential access route between two buildings. However, the occupier did not understand the importance of the maximum gap between such VSBs and only wanted one to be installed for aesthetic reasons (I26. CTSA). Such errors would leave the crowded place vulnerable to the encroachment of their CTMs and again highlights the impact that weaknesses in designs can have, as raised in section 6.2.2.3.

Reproduction of CTMs

Two participants gave examples of numerous projects where stakeholders they consulted and advised either constructed their own versions of CTMs using individual components that were obtained cheaper than if a recommended CTM was used (I2. Design Consultant A), or where a CTM was simply chosen because it was cheaper than the recommended ones (I27. CTSA). One example that was given highlighted that at every opportunity, the occupier of a crowded place would go against CTSA advice and incorporate a VSB that was not recommended, which upon inspection was found to be insufficient and ineffective, resulting in the need to remove it and replace it with an appropriate VSB, negating any saved costs (I27. CTSA).

6.2.1.3 Vulnerable points in the protection

Stakeholder understanding in relation to vulnerable points in protective schemes was also raised, with issues regarding passive versus active VSBs, human error and unreliable or inappropriate CTMs being relied upon. Two participants raised that they had much more ‘faith’ in passive CTMs, as human error could not negate their effectiveness (I12. Associate Director, Construction Company; I13. Design Manager, Construction Company). Human error was raised by several participants, with examples of CCTV cameras being moved and left in positions that facilitated undetected access. Reliance on inappropriate products or activities was also raised, with examples given of occupiers placing parking bays at the ends of car parks, assuming parked cars would be able to stop hostile vehicles and that any parked cars in those places would not be hostile themselves. The following quote also demonstrates the consequences of vulnerable points in designs, although it should be noted that the vulnerability exists at an adjoining scheme to the crowded place that has enforced a standoff:

> “The most damage can be done by going in the undercroft. Apparently, there’s a column under here that a suitable blast would bring the entire ground floor down in the ****…If you wanted to have a walk around all of this later, you would see just a single barrier arm there with a bloke standing there and it would be very, very easy to get in there. All the deliveries to the shops come in and out of the undercroft and then go upstairs, so there’s all sorts of vehicle movements. Members of the public go in there to pick their telly up as well, so it is just not secure” (I26. Engineer, Local Authority)

6.2.1.4 Training, testing and exercising

> “…whilst they might have the paperwork, how good are the individuals?” (I4. Director, Construction Company)

Whilst only being raised by two participants, the influence of such planning can detrimentally impact preparedness for and responses to a terrorist attack, as well as a range of other scenarios that can result in the evacuation or invacuation of users. An example of a crowded place was given by one participant, who stated that in relation to emergency planning, they would not test their procedures ‘live’, i.e. actually conduct an evacuation, as they would not be generating any income during that time (I27. CTSA). Whilst day-to-day activities would stop, occupiers and business owners would need to evaluate the potential implications of not testing their procedures and the costs and other implications that would occur as a result of their untested procedures.

6.2.1.5 Understanding of risk

> “You’ll mitigate the risk, you’ll never eliminate the risk” (I4. Director, Construction Company)

This idea was raised by a further three participants, who stated that clients often assume that by incorporating CTMs into their buildings or sites, the risk of a terrorist attack will be zero. However, as outlined in the aforementioned sections, the risk is only reduced and/or displaced, with impacts of a blast still being possible if adjacent or nearby buildings are targeted. Also evident, as raised previously (section 6.1.5), was a lack of understanding on the part of occupiers being adjacent to larger or more renowned crowded places; they felt that they were not at risk because they would not be the target of an attack, although in practice they would incur major implications in terms of potential loss of life and damage (I24. CTSAs A and C). Assessing the likelihood in terms of risks manifesting themselves was also raised, with the assessment of this one factor having significant implications in terms of the extent to which CTMs are incorporated. As stated by one participant:

> "…we try and take it back a step or two, just to see what is the genuine likelihood?...the big bit that really tends to sort the wheat from the chaff is normally likelihood" (I19. Consultant, Construction Company)

This is also influenced by the identification and assessment of 'real' versus 'perceived' risks and threats, which was raised by three participants. An example was given by one participant who stated that if the threat of terrorism was not evident in a community risk register (a risk register compiled by local authorities, emergency services etc of risks faced in their conurbation), then they would not feel duty-bound to incorporate CTMs (I10. Architect). However, such a perspective and course of action fails to address that the risk registers are a regional assessment of risks and may not therefore identify local or individual threats, and that secondly, the construction of a new crowded place or other at-risk building could itself influence the register and cause it to be updated in the future. Risk registers will always be a past reflection of perceived risks and relying on them to decide whether certain buildings are protected is not wholly reliable.

Also evident was a binary perception of risk, with participants perceiving that risks would either happen, or they would not (I15. Director, Development Company; I18. Director, Construction Company). The same principle was also raised as being applicable to security and how secure a building was, i.e. it is either secure, or it isn't (I8. Architect). Previous discussions have identified that there the likelihood of varying risks will vary considerably and in this instance, protecting crowded places from VBIEDs will reduce the likelihood and mitigate the impact of attack occurring, not eliminating the risk entirely.

6.2.2 Auditing

> "…millions of pounds worth of glass going wrong, because the supplier supplied glass that was not what he said he would. Consequentially, it's got to be replaced…If there was an attack, it would fail and it would fail dangerously" (I2. Design Consultant A, Design Consultancy)

Although only raised by two participants, auditing (or the lack thereof), as demonstrated above, has the potential to significantly influence the value of protecting crowded places. There are two elements to the above quote. Firstly, the sheer scale of what can potentially go wrong even without a terrorist attack having occurred. The design consultant highlighted that the glazing was failing regardless of any catalyst, such as an explosion, which has aforementioned cost implications. Secondly, in the event of an attack, the incorporated measures would be worthless, the implications of which would be profound. It was stated by the other participant that the value of the effort is in saving money (I16. Director, Construction Company), however this perspective fails to reflect the wider cost implications, in terms of lives, damage to the skin, structure and services of the building, as well as costs in terms of reputation and retention of business.

6.3 The Classification of the Counter-Terrorism Measures

Having presented the data on the influences on the protection of and value of protecting crowded places, data on the performance and consequences of the CTMs that can be used will now be explored. The basis of the typology is the underlying classification and organisation of the CTMs themselves, which was initially presented in section 4.3, using a pre-existing typology. The classification of CTMs was not changed as a result of the data collection, as participants found the classification appropriate, as it classifies the purpose and location of the CTMs themselves, e.g. Hostile Vehicle Mitigation measures clearly identify their purpose and location, which would be external to any building or space. The final typology is therefore based on the classification of CTMs that is expressed in Figure 6.9. The Figure expresses the overarching structure in which the CTMs reside. Individual CTMs are identified in their respective sections, with data on the performance and consequences of hostile vehicle mitigation being presented in section 6.4, protective construction in section 6.4 and planning, detection and procedures in section 6.5.

6.4 The Performance and Consequences of Hostile Vehicle Mitigation

This section will now present data on the performance and consequences HVM, with components of HVM being raised in just over half of the sources of data collection. HVM encompasses the management, access/egress and calming of traffic, through the use of VSBs (as shown in Figure 6.9).

6.4.1 Traffic management

As identified in the literature review, there are four approaches to traffic management, those being total traffic exclusion (section 6.4.1.1), the restriction of traffic (section 6.4.1.2) and screening), the inclusion of traffic (section 6.4.1.3) and temporary barriers (section 6.4.1.4).

6.4.1.1 Traffic exclusion

Participants had a fixed perspective on the benefits and implications of traffic exclusion. In terms of benefits, the public reclamation of streets was cited by four participants, with areas of traffic exclusion and pedestrianisation enabling those within and those who use said areas to use them how they wish, returning an amenity to the area.

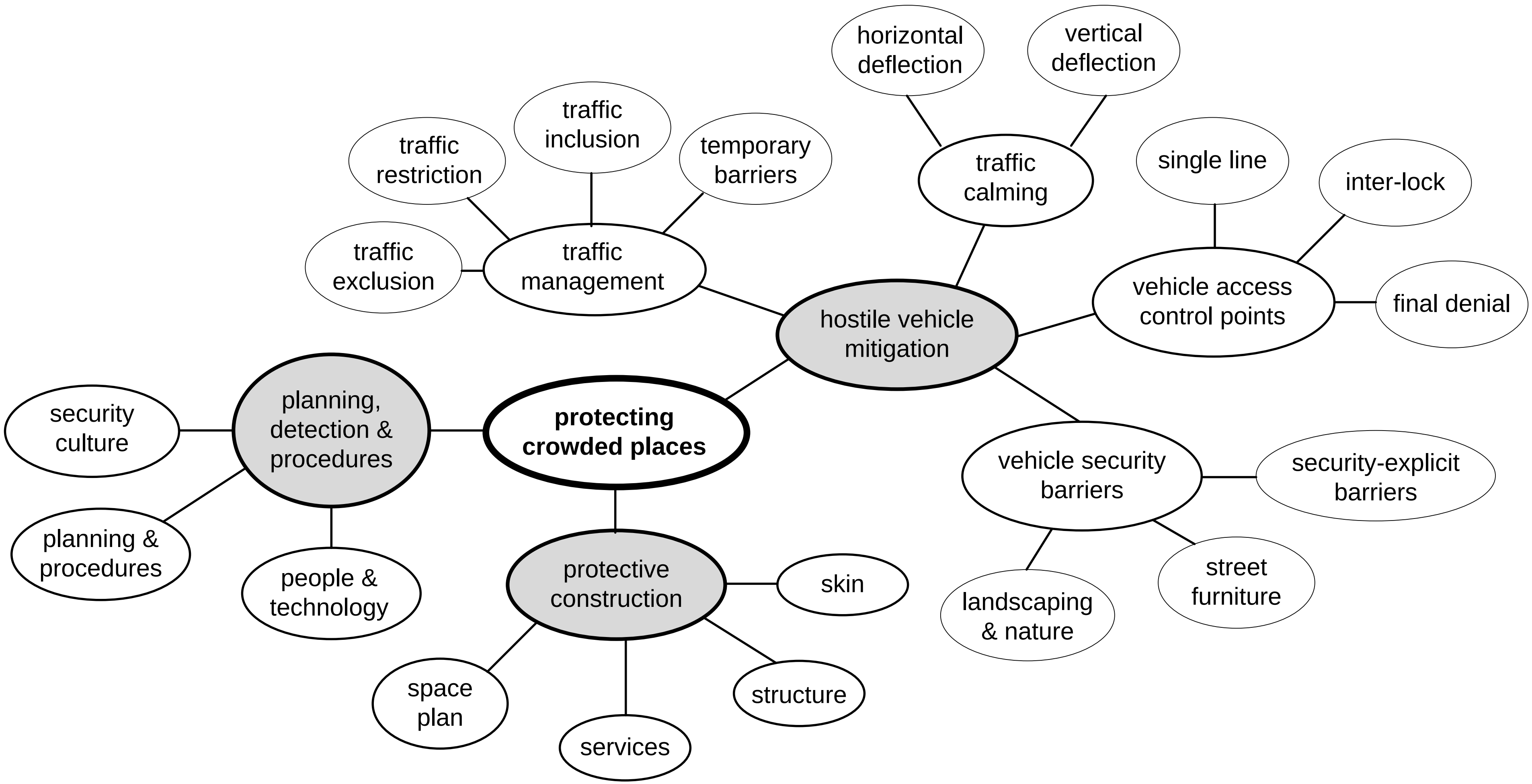


Figure 6.9. The classification of CTMs used to protect crowded places

The increased safety of pedestrians through reductions in accidents and deaths was cited (I4. Director, Construction Company; I25. Assistant Director, Local Authority), as was the reduction in vehicle emissions and noise pollution (I4. Director, Construction Company). It was also raised that traffic exclusion has ideally suited areas where vehicle and pedestrian movement already conflicted (I25. Assistant Director, Local Authority) and where existing traffic regulations were being abused (I26. Engineer, Local Authority). However, as raised by one participant after discussing the range of benefits in relation to traffic exclusion and pedestrianisation:

> "…for me that's then all heading in the right direction because you're seeing some improvements to the streets, seeing some amenity and it's doing a function as well and it's finding mechanisms that try to find the 'win win', but obviously, you can't pedestrianise everywhere" (I15. Director, Development Company)

The only implications raised by participants were the inability of vehicles to get close to buildings, impacting commercial viability though the inability of delivery vehicles and users of the buildings to get to their destinations (I4. Director, Construction Company; I6. Urban Designer, Local Authority; I21. Received Documentation) and the potential need for the existing road networks surrounding the excluded area to be upgraded (I4. Director, Construction Company). There are also parking implications for disabled users of buildings (I10. Architect) and able-bodied users of buildings, as highlighted by this participant:

> "…your shopping centre wants a car park next door. They're all the same. They want people to travel there, that's why they built a car park next door. They don't want people to walk there" (I3. CTSA C)

During interviews with participants on traffic exclusion, two projects where traffic exclusion had been incorporated were explored further, with an example in London (UK) and one in Lower Manhattan, New York (USA). In Lower Manhattan, traffic exclusion had been successful due to it being constantly busy (no 9-5 working, resulting in a desolate area outside of these hours) and because, despite fears that business would decrease, footfall and revenues increased due to the safer and 'more comfortable' space (I6. Urban Designer, Local Authority). A project in London where traffic exclusion had been incorporated was also seen as successful, as it was a catalyst for regeneration of the area (see section 6.2.2.5) and aided in the use of the area, with users of the buildings in the protected area frequently visiting nearby buildings (again, within the protected area), which decreased the time it took them to travel to meetings and increased their safety and enjoyment of the area, especially considering the regeneration that occurred as a result of the exclusion (I25. Assistant Director, Local Authority). What is evident above is a notion of the benefits and implications of traffic exclusion, however the benefits seem poorly publicised, as misconceptions surfaced during the interviews, as it was made clear that businesses within the exclusion zone feared for losses in footfall and therefore revenue. Yet, where traffic exclusions were incorporated, footfall and revenue had increased. The restriction of traffic, therefore, could aid in the reconciliation of the implications raised during the interviews.

6.4.1.2 Traffic restriction

Traffic restriction was raised by two participants and observed in each of the three site visits. It is used to restrict access to a particular area, site or part of a site, through the incorporation of vehicle access control points, as shown in Figure 6.10.

Figure 6.10. Enforced traffic restriction in Lower Manhattan, New York

As noted in section 6.4.1.1, traffic exclusion was shown to result in no or limited impact in relation to traffic flow, yet traffic restriction was raised as potentially causing such disruption on a larger scale (depending on design, planning and staged arrivals), due to the need to search vehicles and therefore increase the amount of time it takes vehicles to gain access, resulting in queues and the disruption of traffic flows external to the site (I6. Urban Designer, Local Authority). This implication was observed during Site Visit 1, where the number of vehicles wishing to gain access to the restricted area exceeded the amount of space available to accommodate waiting vehicles, so vehicles were forced to wait on the main road, disrupting one lane of traffic and causing congestion.

> "…somebody tried to escape a robbery and they actually ended up going down the wrong lane and actually being tangled up in the closure" (I25. Assistant Director, Local Authority)

Traffic restrictions were also observed during site visits 2 and 3, where CTMs had been incorporated to restrict access to specific parts of an area. During Site Visit 2, it was highlighted that the area where traffic restriction was being incorporated was partially influenced by the abuse of existing traffic regulations and the restriction would therefore aid in its resolution (I26. Engineer, Local Authority). During Site Visit 3, it was observed that traffic restriction was used to restrict access to delivery areas only.

6.4.1.3 Traffic inclusion

Traffic inclusion was not directly referred to by any participant as a CTM. However, the benefits and implications of it can be drawn from data (and its subsequent analysis) regarding traffic exclusion (section 6.4.1.1.), traffic restriction (section 6.4.1.2) and in relation to stand-off (section 6.4.5). Section 6.4.1.1 on traffic exclusion highlighted misconceptions, with business fears of decreased footfall and revenue being proved incorrect, with increases in footfall and revenue occurring and the only implication being the inability of users of places and spaces being unable to drive or be driven ‘to their doorsteps’. The benefits of traffic exclusion in relation to counter-terrorism were clear, with greater potential for no protective construction CTMs needing to be incorporated. In relation to traffic inclusion, the possibility of incorporating such stand-off is significantly reduced, with traffic being within short distances of places and spaces. Therefore, traffic inclusion is less desirable from a security perspective and a public perspective (due to the aforementioned increases in footfall gained through traffic exclusion), yet from a business perspective, it allows such users of buildings to travel undisrupted, directly to the buildings themselves.

6.4.1.4 Temporary barriers

Temporary barriers were mentioned by two participants, each highlighting a different factor in relation to them. While they were seen as an inconvenience, the inconvenience is a trade-off for not incorporating permanent CTMs into the site or building (I8. Architect), therefore having a cost incentive and also, it was argued, can contribute to sustainability and environmental agendas, as they can be re-used and last for at least 200 years (I18. Director, Construction Company). It was also noted that temporary barriers will move upon impact, so the ‘final’ stand-off distance needs to be taken into consideration in determining their placement (I18. Director, Construction Company).

6.4.2 Vehicle access control points

Vehicle access control points (VACPs) were raised by two participants, evident in received documentation and observed during all three site visits. The participants who commented on VACPs, an architect and an urban designer, felt that any impediment to access is ‘not wanted’ (I10. Architect) and that the restriction of traffic causes queuing and impacts the flow of traffic (I6. Urban Designer, Local Authority). Whilst restricting access has permeability and traffic implications, from a security perspective, it allows the movement of vehicles on-site (after screening) and can therefore reduce the risk of being targeted. It also reduces the impacts of an attack, should a VBIED detonate at the VACP itself, a certain distance away from the building, rather than directly outside (or in a worst-case scenario, inside), the building. Figures 6.11 and 6.12 were taken during Site Visit 1.

Figure 6.11. A vehicle being searched inside a VACP

Figure 6.12. The searched vehicle leaving the VACP

Here, a vehicle and driver's credentials were checked prior to be allowed to pass through the first set of bollards (which were on a rotating turntable). However, as shown in Figure 6.11, once 'trapped' between the two sets of bollards, the vehicle was then searched (no rejection lanes or anticipation for a scenario involving the discovery of an explosive device or suspicious material). Once the vehicle had been approved to pass through, the second set of bollards were rotated and the vehicle progressed to its destination (Figure 6.12). While this VACP highlights how they can be incorporated into dense and urban settings, how the security staff would respond to a vehicle that was found to have explosives inside, or be suspicious, are unclear. The only 'rejection' route possible was for the vehicle to be reversed back through the first set of bollards. However, the vehicle had been 'trapped' and would not be able to reach its intended target or make its intended impact.

6.4.3 Traffic calming

Traffic calming was raised by three participants, who each highlighted that through reducing the speed vehicles can reach in attempting to penetrate CTMs, through such means as chicanes, the potential size, robustness and obtrusiveness of the CTMs can be reduced (D4. NaCTSO Representative; I11. Director, Construction Company; I27. CTSA).

6.4.4 Vehicle security barriers

The vehicle security barriers (VSBs) that were commented on, evident in received documentation or observed during the research are highlighted in Figure 6.13. Data on the benefits and implications of VSBs will now be presented, with three overarching categories of measures, those being security-explicit barriers (section 6.4.5.1), street furniture (section 6.4.5.2) and landscaping and nature (section 6.4.5.3).

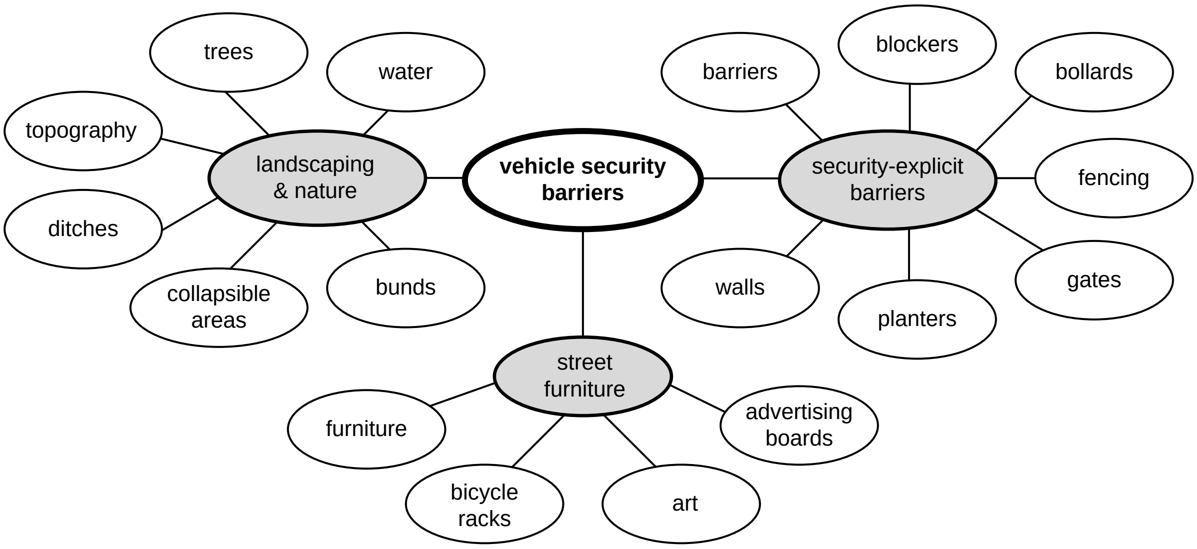


Figure 6.13. Vehicle security barriers cited in documentation or observed during the research

In relation to the benefits and implications of VSBs generally, one participant raised that they had much more faith in passive, physical CTMs than in people- and/or more technology-orientated CTMs, due to the potential for such measures to be overcome or left in vulnerable/ineffective positions (I12. Associate Director, Construction Company).

6.4.4.1 Security-explicit barriers

Security-explicit barriers are those CTMs that only fulfil security purposes; they include barriers, blockers, bollards, fencing, gates, planters and walls.

Barriers

Barriers were cited by one participant, observed during all three site visits and were evident in documentation received during one interview. Documentation cited barriers as being required to aid in demarking the boundary between public and private space whilst ensuring secure access/egress (I21. Received Documentation). This function was also evident during the interview and site visits (Site Visits 1-3). Barriers (and any other traffic-restricting CTM) increase the amount of time taken to process vehicles. During one site visit, it was highlighted that the barriers were kept raised, in order to negate this issue, with a trade-off having been made in terms of security. The barriers' safety systems were switched on when the national threat level was at 'Substantial' or below, whereas if the threat level was at 'Severe' or 'Critical', the safety systems were switched off. The implications of this are that vehicles failing to adhere to warning signs to stop prior to the barrier will go underneath the barrier and be crushed by the arm lowering (due to the removed safety systems). It was highlighted that the likelihood of such an incident occurring was minimal, with the trade-off ensuring CTMs were incorporated (I27. CTSA; Site Visit 3). The cost of such a barrier (the product cost of a raising-arm barrier) was thought to be approximately £30,000.

Blockers

Blockers, as pictured in Figure 6.14 (a photograph taken during Site Visit 3), were cited by two participants and evident in one site visit. As with barriers, blockers are used to demarcate boundaries and facilitate access/egress. One participant said that a potential limitation with blockers (and any automated CTMs) is that the technology controlling them also needs to be secured properly in order to avoid being overcome. An example was given of an automated blocker whose control cabinet had been secured with a lock and key that was available from any hardware store (I2. Design Consultant).

Figure 6.14. A blocker in Lower Manhattan, New York

Bollards

Bollards were discussed by numerous participants and were evident in all three site visits. The benefits of automated bollards (also known as rising/lowering bollards) were cited by two participants, with the facilitation of access and egress to and from the protected area (I13. Design Manager, Construction Company; I26. Engineer, Local Authority). The permeability of bollards was thought to be relatively high compared with other CTMs, such as planters (I6. Urban Designer, Local Authority; I26. Engineer, Local Authority). However, as with blockers, their management needs consideration. One participant said that a memorandum of understanding was being drawn up with the local Police to operate the bollards, however it was feared that in the long-term, operators would become complacent and simply lower the bollards whenever they saw a vehicle waiting (I26. Engineer, Local Authority). Such CTMs also need their own infrastructure to supply and operate the movement of the bollards, which has to be within a certain distance of the CTMs themselves. Retro-fitting such measures was also cited as requiring a 1m wide, 2m deep hole for each bollard, with such CTMs costing approximately £1,000 each (product cost) (I26. Engineer, Local Authority). The green and red lamps often installed with such measures are not officially recognised as a legitimate traffic signal by Highway Authorities under the Traffic Signs Regulations, resulting in the need for exemption by the Department of Transport (I26. Engineer, Local Authority).

Evident in Site Visit 1 was the incorporation of bollards into a turntable, as shown in Figure 6.15. Whilst the benefits of such a device were the access and egress of vehicles into and out of the protected area, the design itself did not incorporate the ability to reject vehicles that failed a screening process, a process that only occurred once the vehicle was confined between two sets of the rotating bollards. How the vehicle would be dealt with if explosives were found or it was deemed suspicious were unclear.

Figure 6.15. Bollards on a turntable in Lower Manhattan, New York

Fencing

Fencing was raised by five participants and evident in one site visit, with the demarcation and broader security functions cited the most. One participant highlighted a project where a fence had incorporated bollards into its structure, an incorporation that was not visible, portraying the image of a ‘normal’ fence (I8. Architect). Whilst there are aesthetic benefits to this, consideration should be drawn to the implications of visible/invisible CTMs (see section 6.1.3.4).

Gates

Gates were evident in documentation received during an interview, documentation which highlighted that (at the time) there was no crash rating for vehicle access gates, due to their bespoke design (I21. Received Documentation).

Planters

Planters were noted by two participants, evident in documentation received during an interview and observed during two site visits. The most prominent factor raised in relation to planters (an example of a non-enhanced planter can be seen in Figure 6.16) was the need for their considered management. One participant spoke of ‘half-dead plants’ and ‘cigarette butts’ being constantly visible (I6. Urban Designer, Local Authority) and documentation noted that the species of planting inside would be chosen so as to ensure that surveillance was not compromised (I21. Received Documentation).

Figure 6.16. Planters in Lower Manhattan, New York

Walls

Walls were raised by three participants as being a CTM, with no benefits or implications raised. Aesthetically and in relation to movement, their permeability is relatively poor compared to other CTMs, such as bollards. However, there is potential for advertising to be positioned on the walls themselves, facilitating the generation of income.

6.4.4.2 Street furniture

Street furniture that was evident or observed during the research included advertising boards, art, bicycle racks and furniture. These perform counter-terrorist/security functions provide another, non-security-explicit, function.

Advertising boards

Advertising boards were observed during one site visit (as shown in Figure 6.6). Whether they had been constructed as VSBs was unclear, however they demonstrate that such street furniture can be used and have benefits, herein being the ability to generate income and therefore, have the potential to (over time) recoup the costs of the measures themselves and generate profit by taking into consideration their management.

Art

Art was raised by one participant, who highlighted a project where Figures of soldiers had been constructed as replacements for bollards (I6. Urban Designer, Local Authority). Whilst in this instance, the ‘soldiers’ were constructed to demonstrate political motives, their use demonstrates the ability of such constructed items to be used as VSBs and therefore provide aesthetic and cultural benefits, as well as in some instances providing additional amenity through seating etc.

Bicycle racks

The use of bicycle racks as VSBs was raised by two participants and evident in documentation received during an interview. Both the participants stated that bicycle racks had been used because they were less obtrusive than other CTMs (such as bollards and planters) and because they provided a public amenity (I6. Urban Designer, Local Authority; I26. Engineer, Local Authority). The information within the received documentation also made these points.

Furniture

Furniture as VSBs was raised by three participants, as well as providing public amenity (I6. Urban Designer, Local Authority; I13. Design Manager, Construction Company; D8. Un-attributable Source), the implications being the need for the foundations of the furniture, as well as the seating itself, to be more robust and potentially deeper (than ‘normal’ furniture).

6.4.4.3 Landscaping and nature

Landscaping and nature encompasses bunds, collapsible areas, ditches, topography, trees and water, all of which can be used to protect crowded places from VBIEDs through their use to enforce traffic management, traffic calming and vehicle access control points.

Bunds

Bunds were raised by two participants; if incorporated during the planning and design phases, bunds could be constructed using spoil from the site where they are being incorporated, saving money (D7. Un-attributable Source; I11. Director, Construction Company). Despite this clear monetary advantage (in the right circumstances), incorporating bunds is dependent on the size of the site. Therefore, it is a CTM that is not feasible for city-centre or densely populated areas.

Collapsible areas

Collapsible areas were raised by one participant, with their construction resulting in their ability to accommodate the weight of pedestrians, but not that of a vehicle, so if a vehicle traverses the area, it collapses and traps the vehicle (see section 6.1.3.4 for the perceived implications of invisible CTMs). *Note: Prior to the final submission of this thesis, the technical viability of collapsible areas was called in to question (un-attributable source), as lighter vehicles than that which the area is designed to collapse under can still traverse the area. Therefore, collapsible areas are not referred to in the remainder of the thesis*.

Ditches

The use of ditches was raised by two participants. It was highlighted that they are rarely used in crowded places, due to more aesthetic CTMs being desired (D8. Un-attributable Source). Their use was offered by a CTSA who was giving advice to designers of a building, despite the building being in a city-centre location (I21. Architect). ‘Health and Safety’ issues seem somewhat pertinent in relation to ditches, other CTMs also easily accommodating aesthetic or environmental benefits, such as through the use of topography or water.

Topography

Topography was raised by two participants, with the ability of topography for traffic management and calming functions, enforcing stand-off distances through creating a terrain that is not traversable (D4. NaCTSO Representative). Spoil from a site could also be used to create the topography, reducing costs through recycling (I11. Director, Construction Company).

Trees

The use of trees was only raised by one participant, during a discussion on the use of landscaping and nature to create stand-off distances and mitigate the impact of VBIEDs. It was raised that, whilst feasible, the trees need to be of a certain girth, rooting and space between one another, often resulting in their use being rarely achieved or found (D8. Un-attributable Source).

Water

The use of water was not raised by any participant and was only observed during one site visit, where due to the size of the site, large-scale water features had been incorporated into surrounding parts of the building in order to enforce stand-off distances, as well as providing aesthetic and environmental benefits (Site Visit 3).

6.4.5 Stand-off

The majority of participants with little or no experience of design in relation to counter-terrorism (and a minority of those who do have such experience), viewed stand-off as the enforced distance between an explosive device and a building; it is *external*. However, there was growing recognition of the need for, as well as the performance and consequences of, *internal* stand-off that can be created through the design of internal space. In terms of 'external stand-off', its essence is captured through the following quote:

> "…the closer the stand-off distance is, the stronger the building has to be" (I6. Urban Designer, Local Authority)

This was stated by several participants and captures the implications of being unable or unwilling to incorporate sufficient stand-off distance around a building. The 'sufficient distance' was highlighted by numerous participants as being approximately 30m (I11. Director, Construction Company; I12. Associate Director, Construction Company; I17. Director, Construction Company; I19. Consultant, Construction Company). 'The 30m rule' exists due to analysis of blast dissipation, yet should not be solely relied on, as unique factors at each location (such as distance between buildings) can affect blast dynamics and loads, as does the size of the device itself (I12. Associate Director, Construction Company). Specific assessment of each individual site and set of circumstances is always required.

The difficulty in achieving such distances was emphasised by an architect (I8), principal consultants, associate directors and directors of construction companies (I12; I18; I19; I23), a director of a development company (I15) and project documents given during an interview (I21). The difficulty surrounds the density of urban spaces and being physically unable to find or incorporate sufficient stand-off distances into new or existing locations. As previously raised, this then results in the need for protective construction measures to be incorporated. An example of a project in this situation was raised during an interview. The building, in construction at the time of writing and already internationally renowned for its architectural design and use of materials, has only been able to incorporate limited stand-off, so the structure of the building was designed so that it can withstand the loss of two columns (I11. Director, Construction Company). However, stand-off can be incorporated in such circumstances, as raised by one participant:

> "…the only way you're going to do it is to pedestrianise places" (I21. Technical Director, Construction Company)

Where stand-off cannot be incorporated in an individual site and especially considering the heightened threat considering the nature of the building in question, pedestrianisation of a wider area could have been incorporated, which would have resulted in the benefits (and implications) of pedestrianisation itself (see section 6.2.2.5) and less or no protective construction measures being incorporated. When such stand-off distances are incorporated, the implications of this for the occupier of the building are lower usable site and floor space ratios (I5. Architect; I15. Executive Director B, Development Company), which as highlighted by one participant, comes at a cost:

> "…that has a significant impact on value, because you're using up site area, which is of premium value in places like the City" (I15. Executive Director B, Development Company)

Some projects were mentioned that, in an attempt to reconcile such costs, incorporated revenue-generating assets into the area between the building and the vehicle security barriers, which can create new risks in itself and therefore, potentially undermining the effectiveness and use of the stand-off distances. Examples included mobile refreshment outlets (I2. Design Consultant) and private events hosted by the occupier, an issue of even more prominence in this particular example due to the building being protected through public funds (I6. Urban Designer, Local Authority). When external stand-off distances cannot be incorporated, or are not sufficient to warrant little or no protective construction measures being installed, the internal layout and structure of the building can be designed to enforce an ‘internal stand-off’ distance, with other measures including moving people away from windows (I17. Director, Construction Company) and from where potential devices could detonate (I18. Director, Construction Company). Data on the measures involved, with, as well as the performance and consequences of, internal space and layout are presented in section 6.5.4. The relationship between HVM and protective construction is clear; incorporating stand-off has benefits in terms of better blast protection for the individual site (and wider approaches to stand-off offer benefits for wider areas) and results in no or less need to modify the design and structure of the building itself. The implications of insufficient stand-off, however, result in the need for protective construction measures to be incorporated, which can have significant implications for the design and structure of the building itself, and which will be explored in the following section.

6.5 The Performance and Consequences of Protective Construction

This section presents data on the performance and consequences of protective construction, which encompasses the skin, services, structure and space layout of buildings (as shown in Figure 6.17).

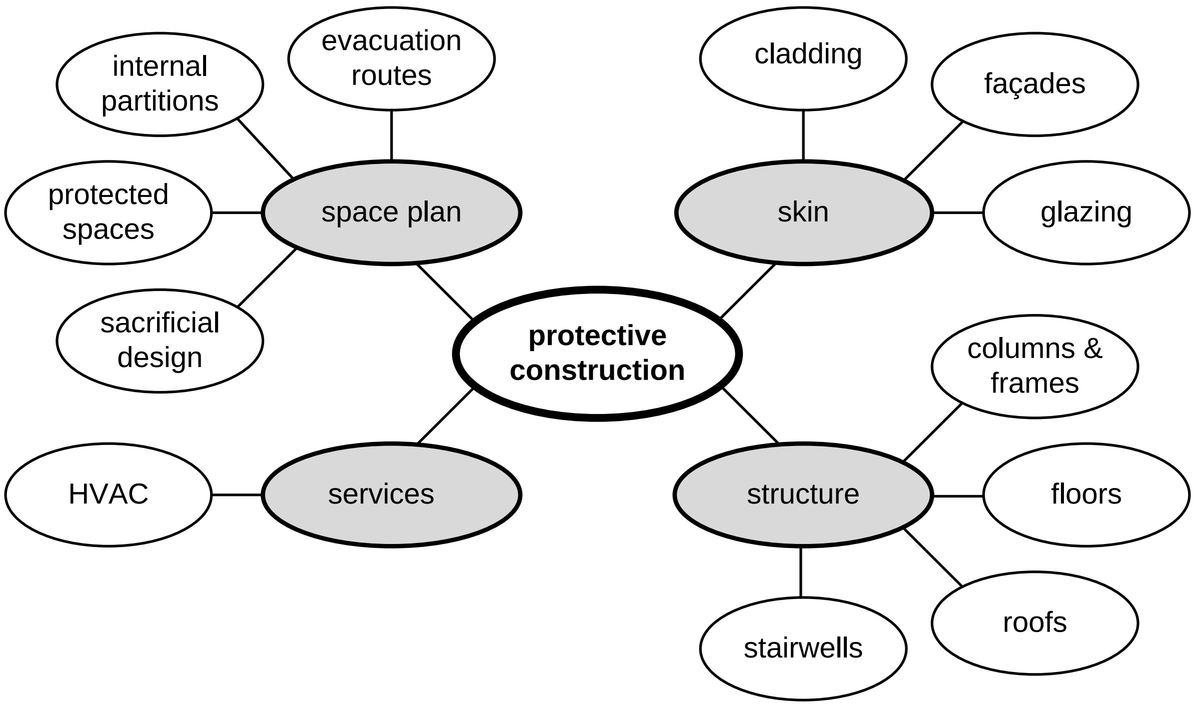


Figure 6.17. Protective construction CTMs evident in received documentation or observed during the research

In terms of the cost of protective construction, where sufficient stand-off cannot be incorporated to result in no protective construction measures needing to be incorporated, this participant highlighted the following:

> "…relatively small amounts. It usually has very, very little impact on the structural design, a few percent. So, the cost, a lot of the cost turns out to be in the cost of the glass, so if you've got a building with not very much glass, you're talking 4-5%. If you've got a lot of glass, 10-15%. It can be quite a big penalty (I17. Technical Director, Construction Company)

When retro-fitting, however, perceived cost implications that were raised by one participant lead to them stating that the 'economics' results in window replacement and creating protected spaces (I23. Director B, Construction Company). The implications of protective construction can be detrimental to adjacent or nearby buildings, as by enhancing the robustness of the structure and the blast-resistance of the skin of a building, this will result in the increased reflection of blast waves from an explosion, resulting in increased damage to those surrounding the protected building (I17. Technical Director, Construction Company). This issue adds to the benefits of traffic exclusion from an area that encompasses adjacent and nearby buildings to a high-risk or prominent target, as adjacent occupiers (if they are even aware of this issue) will not wish to be put in such a position.

6.5.1 Skin

Cladding, facades and glazing (including the frames and fixings) are discussed in this section. Whilst it is acknowledged that glazing is part of a façade, here it has been distinguished separately due to the particular importance of glazing, as will be explained.

6.5.1.1 Cladding

> "Cladding to be robust as possible (preferably two layers of masonry or pre-cast concrete panels) and tied to frame to resist positive and negative loading" (D4. Received Document)

The above is taken from a document used by the CPNI, which details construction requirements in terms of counter-terrorism. As with all of the protective construction measures, it was raised that sufficient stand-off can result in the need to not incorporate such measures in relation to cladding (I11. Director, Construction Company). Concern was raised over the extent to which cladding can be safe after an attack, despite it appearing relatively undamaged or safe, highlighting the importance of formal assessments after an attack, regardless of perceived minimal damage (I4. Director, Construction Company).

6.5.1.2 Façades

The façade was seen as the 'last line of defence' where blast loads had (or had not) been reduced through HVM (I12. Associate Director, Construction Company). The construction of façades should ensure that they do not become shrapnel in the event of an explosion (I19. Principal Consultant, Construction Company) and should be designed as to not 'trap' blast, through overhangs and deep recesses (D4. Received Document). In relation to the cost of enhancing façades, the following was raised:

> "the sort of rule of thumb that we've been working on with facades is in effect, if you take an extra 2% on the façade budget, you can do a lot with that" (I12. Associate Director, Construction Company)

This participant went on to discuss how glazing is the most important of the façade materials, in relation to counter-terrorism, due to it being "the most fragile of the façades" (I12. Associate Director, Construction Company).

6.5.1.3 Glazing

Whilst it is possible for annealed glazing to be used, with no protective action taken with the glazing or its framing and fixings, the stand-off required would be in excess of 100m (I11. Director, Construction Company). The importance of ensuring the protection of glazing is due to the damage it can cause, as the vast majority of deaths and injuries are caused by flying glass (I17. Technical Director, Construction Company; I24. CTSA B), a hazard which can be made worse in the context of tall buildings, due to glass falling faster the further it travels (I12. Associate Director, Construction Company). The benefit of protecting glazing is therefore to reduce the loss of life and the causation of injuries in the event of an explosion, especially when considering that annealed glazing can be damaged from explosions 400m away (I12. Associate Director, Construction Company). An example was given by one participant of the relationship between the distance from a blast and the type of protection, with high-hazard damage not occurring beyond 50m when using annealed glass, 40m when using anti-shatter film (ASF) and 25-30m for laminated glazing, based on a 100kg car bomb; the participant went on to say the following:

> "It is nigh on impossible to get, in any built-up area, a stand-off from a lorry bomb that means you don't have to do something about your glazing" (I12. Associate Director)

It was suggested that there are a number of trends and no single answer (I12. Associate Director, Construction Company), but a number of general principles emerged from participants, which add to the complexity and potential unreliability in providing 'rules of thumb' to potential costs of such CTMs. Principles specified in advice from the CPNI are to avoid atria and use minimal glazing, ensuring that glazing is as low down as possible and panes are no larger than $3m^2$, as these are more resilient (D4. Received Document). The size of the device matters, as does the size of pane, as for example, longer duration blasts (such as from lorry bombs) are worse for large panes, but better for car bombs, as they have relatively less longer blast durations (I12. Associate Director, Construction Company). The frames and fixings are of equal importance to the protection of the glazing itself (I2. Design Consultant A; I18. Director, Construction Company; I19. Consultant, Construction Company), with numerous examples of projects given by one participant where the glazing had been protected, but the frames and fixings had not been designed for the increased weight, so the glazing itself failed, causing major costs for the occupiers (I2. Design Consultant A). It was raised that the protection of glazing will result in less damage in the event of crime, civil unrest and protests (I10. Architect); there are also products available that can be opened and still retain a level of blast resistance due to auto-close mechanisms (I14. Director B, Construction Company). Low-level walling systems can be used on ground floors, to allow glazing yet stop vehicles from being able to penetrate the façade and it was also noted that, subject to blast analysis, protection of glazing can lessen as the height of the building increases, due to the dissipation of blast loads (I18. Director, Construction Company).

In relation to costs (generally), 2-5% of the façade budget when designing in glazing was highlighted as being the norm, whereas the cost when retro-fitting was cited as being double, excluding any operational and disruption costs (I17. Technical Director, Construction Company). However, specific data was obtained on each type of glazing protection, which will now be explored. Relatively, ASF and bomb-blast net curtains (BBNC) were cited as being the cheapest forms of glazing protection, although unless anchored into the frame and fixings, glazing protected through ASF can then becomes a single projectile (I18. Director, Construction Company) and BBNC restrict visibility to the outside (I15. Director, Development Company; I23. Director B, Construction Company), although they remove any air-borne hazards and allow blast pressures to move through the building (I23. Director B, Construction Company).

In relation to laminated glass, the minimum thickness for it to be classed as blast resistant was given as 7.5mm (I21. Received documents, quoting CPNI specifications). Environmental benefits of laminated glazing were raised by participants from a design consultancy, construction company and development company, indicating a level of awareness regarding the additional benefits of such protection. Examples were given whereby energy costs were reduced due to the reflection of UV light (I15. Director, Development Company), as well as museums using such glazing, primarily for protecting their artwork from UV light, not from blast (I7. Associate Director, Design Consultancy). An example of laminated glass being used at a heritage site was also given, whereby stained-glass windows were present and to prevent their modification, a secondary layer of (laminated) glazing was incorporated behind the stained-glass, retaining the appearance of the building from the outside (I13. Design Manager, Construction Company). When retro-fitting, a sacrificial approach to the skin of the building could be more cost-effective than replacing existing glazing, frames and fixings. Data on this approach is in section 6.5.4.4.

6.5.2 Structure

The structure of the building encompasses the columns, floors, roofs and stairwells of buildings. As with issues in relation to building services, points were made on principles of protection, with only one example of such performance being raised, which was in relation to the design of the columns of a particular building.

6.5.2.1 Columns

The essence of protective construction in relation to columns is the robustness of the building, with specifications given by the CPNI encompassing the use of framed reinforced concrete or framed structural steel, allowing for positive and reverse loading and the spreading of shear stability throughout (D4. Received Document). HVM has a direct relationship with the columns of a structure, as with sufficient stand-off, the need for such measures diminishes. An example of a project where such stand-off could not be incorporated was highlighted by one participant, with redundancy in the structure being incorporated so that, in the event of a blast, the structure could withstand the loss of two columns (I11. Director, Construction Consultancy).

6.5.2.2 Floors

Floors were raised by one participant, who stated that their construction needs to be considered due to the impacts of blast (I18. Director, Construction Company), with specifications encompassing floors being tied continuously with beams and columns, with mechanical connections, allowing for positive and reverse loading (D4. Received Document). Such specifications will have implications for the structure of the building itself under blast loading, contributing further to the need for individual analysis of the affects of blast on the proposed or constructed building itself.

6.5.2.3 Roofs

Roofs were highlighted by one participant, who stated that, as with floors, their construction requires attention due to the impacts of blast (I18. Director, Construction Company). Roofs and components of roofs should be 150mm thick reinforced concrete, with additional benefits of protection from mortar attacks (D4. Received Document). Such materials will have implications for the structure of the building itself, due to the support required by the reinforced roof, and again furthers the need for individual analysis of the building itself.

6.5.2.4 Stairwells

Stairwells have everyday functions, as well as use as evacuation routes and protected spaces, if designed sufficiently for those purposes (I9. Director, Design Consultancy). CPNI specifications detail that there should be at least two staircases, with preferably no more than 50m between them (D4. Received Document).

6.5.3 Services

Issues in relation to the protection of services were only raised by one participant, and evident in one document that was received. Only principles in relation to their protection were mentioned, with essential services needing to be placed away from vulnerable façades (D4. Received Document). Heating, ventilation and air conditioning (HVAC) systems should be at least three storeys above ground level, stopping persons from throwing in materials (I19. Consultant, Construction Company), as well as avoiding any direct penetration from vehicles. Such systems should also have the ability to be rapidly shut-off (D4. Received Document).

6.5.4 Space plan

Space layout encompasses the design and construction of the internal space of a building, through the incorporation and use of evacuation routes, internal partitions, protected spaces and sacrificial design.

6.5.4.1 Evacuation routes

The essence of protective construction involves the protection of a building, to facilitate the safe evacuation (or invacuation) of building users at the time (I19. Consultant, Construction Company), with the need for evacuation routes to be sufficiently protected to withstand the impact of a blast (D4. Received Document). Evacuation routes are beneficial not just in terrorist attack scenarios, but can be used in response to a variety of hazards and threats.

6.5.4.2 Internal partitions

Whilst no participants contributed any perspectives in relation to internal partitions specifically, it was noted how sacrificial design and such internal layouts can impact productivity (I7. Associate Director, Design Consultancy). As will be seen in the following section on protected spaces, their construction must prevent penetration of fragmentation. Such requirements are also evident in relation to partitioning, however any physical 'barrier' will affect fragmentation in relation to velocity. Further research is required into the implications of CTMs on staff productivity.

6.5.4.3 Protected spaces

As will be demonstrated in an upcoming section on evacuation and invacuation planning (see section 6.6.3.4), not every response to a real or potential attack, or other applicable scenario, will result in the evacuation of a building. At times, the invacuation of the users of the building will be necessary, invacuation to protected areas of a building (I15. Executive Director A, Development Company; I19. Consultant, Construction Company). These areas should be positioned deep within buildings, with no glazing (I9. Director, Design Consultancy; I12. Associate Director, Construction Company) and be based on a minimum of $0.66m^2$ per person, in relation to building occupancy (D4. Received Document). Such spaces can be incorporated at no cost when designed in (I23. Director B, Construction Company; I24. CTSA B).

6.5.4.4 Sacrificial design

Sacrificial design, as with structural measures, encompasses the incorporation of redundancy into the layout of a building, protecting the critical or important (human and other) assets of a building, by placing them further away from where a blast could occur, thereby limiting any damage. The following analogy was given by one participant:

> "It's like a car isn't it. You crash a car and it's got crumple zones. You're not actually worried about the shape of the boot at the end of the crash, but you are very worried about the passenger and yourself" (I5. Architect)

Through moving persons or other assets away from vulnerable façades (I17. Technical Director, Construction Company; I18. Director, Construction Company) or simply moving assets inwards (I6. Urban Designer, Local Authority; I12. Associate Director, Construction Company), the risk of death and injury is reduced, as is the level of damage to other assets that were relocated. Such relocations could be achieved with only minimal disruption costs being incurred (I12. Associate Director, Construction Company), although by moving a workforce away from windows/glazing, productivity could reduce, thereby reducing revenue (I17. Technical Director, Construction Company). Examples were given of buildings where a secondary layer of (laminated) glazing was incorporated into the internal layout, thus removing the need to do any work on the 'skin' of the building, benefitting existing buildings

(I12. Associate Director, Construction Company), most notably heritage sites (I13. Design Manager, Construction Company). By incorporating such sacrificial design and in the event of an attack (dependent on the blast loads), business could continue whilst repair work was carried out, reducing costs and other impacts of an attack, or the impacts of the manifestation of other threats and hazards (I12. Associate Director, Construction Company).

Internal partitions are also important in terms of limiting the penetration of fragmentation occupancy (D4. Received Document). Despite measures that can be incorporated at no cost and applicable to many other hazardous events, the impact on workplace interaction and productivity is of concern (I7. Associate Director, Design Consultancy) and is therefore a potential trade-off, which requires further investigation.

6.6 The Performance and Consequences of Planning, Detection and Procedures

The performance and consequences of planning, detection and procedures seemed underemphasised and largely unknown by participants, despite all of the CTMs within this category being applicable to the mitigation of other forms of threats and hazards. Security culture, which influences the effectiveness and management of the individual CTMs as well as the management of the whole strategy (as expressed in Figure 6.18), was not even commented on by one participant. Planning, detection and procedures encompasses the aforementioned culture of an organisation (here, in relation to security and counter-terrorism), the people and technology that can identify and respond to hostile reconnaissance and attacks, as well as the planning and procedures that goes hand-in-hand in facilitating said responses.

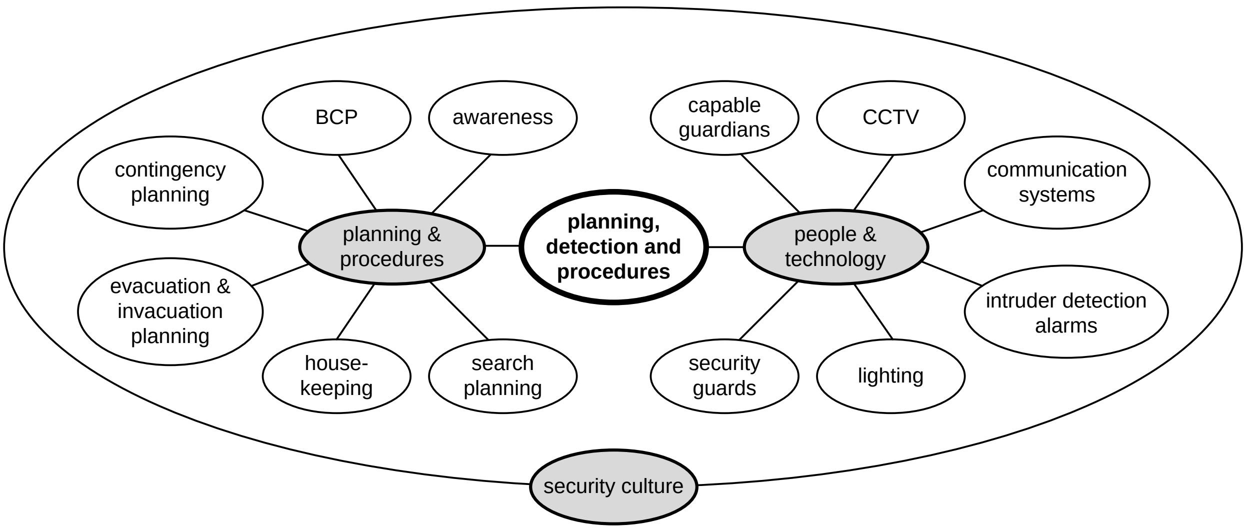


Figure 6.18. CTMs relating to planning, detection and procedures

6.6.1 Security culture

None of the participants raised the importance of security culture in relation to counter-terrorism. Whilst such culture influences and is influenced by the values of an organisation and therefore, in relation to counter-terrorism, how such security is valued and incorporated within an organisation is of significance in embedding measures involving users of the buildings.

6.6.2 People and technology

> "It's easier to raise and lower security levels with people than technology" (I10. Architect)

Although people and technology mutually benefit one another, there is a clear additional benefit of the 'people' side of the partnership, as demonstrated above, through the easier ability to escalate and de-escalate human provisions than technological ones. Both are of value when considering they are relatively easier to incorporate once a building is constructed, as opposed to other CTMs in terms of HVM and protective construction (I10. Architect). In terms of such provisions, this section covers capable guardians and security guards, with technological measures consisting of closed circuit television cameras (CCTV), intruder detection alarms and lighting.

6.6.2.1 Capable guardians

'Capable guardians' encompass anyone who is able to observe and act on anything suspicious and therefore encompasses the identification and reporting of hostile reconnaissance and possible attacks, as well as other forms of crime. Whilst the term includes staff, it suggests that any users of places have a role. Although only raised by two participants, the benefits in facilitating this, through such means as clear lines of sight and open areas, is obvious (D4. NaCTSO representative; I7. Associate Director, Design Consultancy).

6.6.2.2 CCTV

Whilst it was argued that CCTV is "more about deterrence than about real prevention" (I12. Associate Director, Construction Company), this perspective does not fully capture the use of such technology, as attacks can be prevented through the identification of hostile reconnaissance. Their effectiveness varies in relation to the threat that is faced, as the IRA were concerned with being caught, whereas suicide bombers are not discouraged by CCTV (I12. Associate Director, Construction Company). CCTV also allows for off-site observation

(I10. Architect), yet its effectiveness is influenced by two distinct factors. Firstly, human error was raised, as with movable, or pan-tilt-zoom, cameras, the operator can leave them in a position that does not cover the area it should, allowing this weakness to be exploited (I13. Design Manager, Construction Company; I19. Consultant, Construction Company). Secondly, their effectiveness can be impaired by other CTMs, street furniture or technology. Examples were given of a project whereby the placement of CCTV and lighting caused problems, due to the brightness of the lighting and the need for small number of discrete cameras (I13. Design Manager, Construction Company). There seems to be a growing trend for such technology to replace security guards, with a pan-tilt-zoom camera noted as costing £5,000 fully installed and a security guard for 365 days a year costing £100,000; as quoted by the participant, “technology, that will always win” (I11. Director, Construction Company).

6.6.2.3 Communication systems

Communication systems, despite only being raised by three participants, can benefit responses to a range of attacks, and incidents resulting from other threats and hazards, through informing those affected by such events on how to proceed, including aiding in directing such users as to whether to evacuate or invacuate, which is of particular interest due to the complexity involved in facilitating such arrangements (see section 6.6.3.4).

6.6.2.4 Intruder detection alarms

Alarm systems were only raised by two participants, most probably due to their disassociation with perceived notions of ‘counter-terrorism measures’, i.e., their association with petty crime and ‘security’ more generally. It was raised, however, that they contribute to deterring threats, as well as aiding in preventing and responding to the other threats (I12. Associate Director, Construction Company).

6.6.2.5 Lighting

As with intruder detection alarms, lighting was only mentioned in two sources of data, with its potential to impair CCTV being raised by one participant (I13. Design Manager, Construction Company) and its benefits in deterring and identifying crime more generally, increasing perceptions of safety and security, as well as aiding in surveillance for counter-terrorism purposes, being documented in project information.

6.6.2.6 Security guards

As with the other CTMs in this category, security guards are able to aid in the deterrence, identification of and response to a variety of threats. Benefits were cited as including their ability to be escalated and de-escalated (I10. Architect), as well as providing a reassuring presence to places (I23. Director A, Construction Company).

> "…there are downsides to using security guards though. Number one, they're not the brightest of people, otherwise they wouldn't be a security guard. They're not the best paid people, again, otherwise they wouldn't be a security guard. Having said that, the cost of having a security guard for a 35 year period is a million quid, so it's a damned expensive piece of resource" (I15. Executive Director A, Development Company)

Their effectiveness can be undermined through a lack of appropriate management (e.g. avoiding static positions that could be spotted by hostile reconnaissance) (I15. Executive Director B, Development Company).

6.6.3 Planning and procedures

Planning and procedures encompass the measures that need to be incorporated in order to effectively prevent, mitigate and respond to an attack. It encompasses awareness within organisations, Business Continuity Planning (BCP), contingency planning and procedures, evacuation and invacuation planning, housekeeping and search planning.

6.6.3.1 Awareness

> "…the awareness side is the easier battle, it's cheap" (I3. CTSA A)

The CTSA perspective on and experience of incorporating and encouraging awareness is clear, a perspective that was echoed in all interactions with CTSAs, due the 'quick wins' it produces, at low costs (I22. CTSA A). It was awareness, most notably being raised through the Project Argus and Griffin initiatives, that were raised by CTSAs and participants from within industry (I4. Director, Construction Company). Awareness covers not just VBIED types of attack, but a range of other methods, predominantly through the identification of hostile reconnaissance (I24. CTSA A). In relation to the Project Argus and Griffin events, it was raised that more could be done in terms of engaging with the management of national and international organisations who own crowded places in the UK; CTSAs put forward that NaCTSO could engage more with such organisations; where such engagement has occurred, attendance at the events increased significantly (I24. CTSAs B and C).

6.6.3.2 Business Continuity Planning

Business continuity planning (BCP) was seen as being of significant benefit to organisations, due to its use and effectiveness for a range of other risks (D3. Academic, Construction Management; I3. CTSA A). BCP incorporates measures to prepare for and mitigate the impacts of such risks, as well as aiding in the response to and recovery from said risks. CTSAs are increasingly adopting this perspective, through promoting counter-terrorism in terms of business continuity:

> "When you think about that, think about terrorism…it's another in, it's another way to spread awareness of terrorism" (I3. CTSA A)

An example of how CTMs aid in business continuity was offered by one participant, who highlighted that a sacrificial stance was taken in terms of the building itself, with a secondary layer of enhanced glazing being incorporated and set back from the original (and unprotected) glazing, with business being able to carry on in the event of an attack (or other hazard or threat causing damage) (I12. Associate Director, Construction Company).

6.6.3.3 Contingency planning

Although the following quote is taken from a discussion within the context of the identification of a person-borne improvised explosive device (PBIED), it highlights the importance of the procedures that are intrinsically linked and of vital importance to such other CTMs as awareness, housekeeping and search planning:

> "The problem with that is, what next? So you've got somebody in a crowd with explosives, you've got this knowledge, what are you going to do with it? How do you separate him from the crowd or do you say, actually, the crowd are going to be sacrificial, what we won't do is let him into the building, where the effects of the bomb and the consequences of the bomb would be worse" (I12. Associate Director, Construction Company)

The circumstances easily relate to a VBIED or hostile reconnaissance. The importance of CTMs like awareness and search planning is not in question, but there is a need for contingency planning and procedures to be raised as being of equal importance. By ensuring procedures are in place and are understood, then the correct action will be taken in any of these events. Such procedures could include communication networks between organisations in the same area, to aid in prevention, through the identification of suspicious behaviour etc, as well as in responding to events (I15. Executive Director A, Development Company).

6.6.3.4 Evacuation and invacuation planning

The potential complexity and confusion involved in evacuation and invacuation planning was raised by four participants. Typical reactions in the event of any incident are to evacuate, however it may be safer to invacuate (I15. Executive Director A, Development Company; I19. Consultant, Construction Company). Issues with evacuation planning stem from the risk of secondary explosive devices being positioned at or nearby evacuation points or routes. During a site visit to an internationally renowned crowded place (Site Visit 3), it was raised that this location did not have any signage directing people to evacuation points, specifically to minimise the risk of secondary devices being positioned at those locations (I27. CTSA). This highlights the importance of housekeeping (section 6.5.2.5) and search planning (section 6.5.2.5), but also the need to consider invacuation, although as raised by one participant, this has its own complexities:

> "If you're in a shopping centre and somebody's telling you to run into it, you might say 'sod off mate', and he can't physically stop you" (I4. Director, Construction Company)

This point highlights that even if sufficient protected spaces are present in a building and can accommodate invacuations, human instinct may override any of those precautionary measures, especially with those unfamiliar to the building or organisation. Solutions are therefore dependent to the individual and unique context of each site, building and organisation, solutions being compounded by possible layered attack scenarios, as demonstrated through this quote:

> "How far do you take it? If you look at ****, you've got a number of cinemas there. If you had a co-ordinated attack, some incendiary devices go off in the cinema and then you have a larger device in the Square, if an incendiary device goes off in the cinema, what are you going to do, you're going to evacuate. The only place they can evacuate is out into ****, how do you deal with that?" (I4. Director, Construction Company)

Planning arrangements at one site were highlighted during a visit, whereby in the event of a bomb alert, a small section of the surrounding area will be cordoned off whilst investigations occur (depending on the size of the package), in order for business to carry on (I27. CTSA). While no live training or exercising of the arrangements have been carried out at this location, due to daily business not wanting to be impinged upon, the management envisaged that due to the sheer number of fire exit doors around the building, it would be clear that people would be dispersing over a large area and planning the position of a secondary device (or devices) would be problematic (I27. CTSA). The importance of planning lies in the preparation and having a plan in place (I4. Director, Construction Company), so that arrangements are made to aid in the safe evacuation or invacuation of people.

6.6.3.5 Housekeeping

Housekeeping was only raised by one participant. From a classification of CTMs perspective, this is not of particular interest, as housekeeping was present in the provisional typology; the participant noted that "cleaners are more likely to see things than the security guard" (I3. CTSA C). Primary or secondary devices could be positioned on CTMs, amongst or nearby crowds and/or at evacuation points. Housekeeping, therefore, is of importance in aiding the identification of any suspicious or real devices and is inextricably linked to awareness, as well as search planning.

6.6.3.6 Search planning

As with housekeeping, search planning was only commented on by one participant, who highlighted its importance in relation to not only being aware of suspicious packages, but suspicious persons or vehicles as well (I3. CTSA A). Search planning is intricately linked to evacuation planning, as primary and/or secondary devices could be left at or nearby evacuation points and routes. This was not raised by any of the participants.

6.7 Conclusion

The results of the research have highlighted that whilst there are inherent requirements, performance and consequences of each CTM that can be used to protect crowded places (as presented in the typology of CTMs in Appendix C7.1), a number of influences that determine whether such places are protected are also evident, as are influences on the value of CTMs themselves. Uncertainty surrounding legislative requirements to incorporate CTMs emanated from participants, although a range of incentives were highlighted that aid in forming a business case for the incorporation of such measures. The importance of TARAs, and stakeholder understanding and engagement were noted, with their ability to both influence the protection of crowded places and the value of CTMs themselves. Perceptions of terrorism, economic influences, local policy, and building stock rotation were also raised, most pertinent in the current climate being the influence that the economy can have on the protection of crowded places, one example being the inability of organisations to spare employees to attend free Argus Professional events, simply because of cut-backs.

A lack of specific data in relation to the monetary costs of CTMs, the examination of which was a component of one of the objectives of the research (objective three), as was made apparent and discussed in the previous chapter. Although this therefore influences the ability of the research to purport findings in relation to the cost and cost-effectiveness of the majority of CTMs, the findings of the literature review and of the results of the research have nonetheless helped to form a typology of such measures. The typology, which presents information on the requirements, performance and consequences of the CTMs that can be used to protect crowded places, is presented and evidenced in the Appendix C7.1. Further exploration of the identified influences, as well as discussions on the emanating design considerations and agendas, is presented in Chapter Seven. The implications of the apparent lack of cost-based data, as well as other potential issues in relation to the findings, reliability and validity of the research, are reported in Chapter Eight.

7.0 The Protection of Crowded Places from VBIEDs

The performance and consequences of CTMs used to protect crowded places from VBIEDs is discussed first in this chapter; the typology of CTMs itself is presented in Appendix C7.1. Discussion of the relative attributes of CTMs are presented first, followed by the explorations of the theoretical framework and two pertinent design considerations that were evident through the research, those being designing-in and retro-fitting CTMs, and sufficient versus insufficient stand-off. Also apparent throughout the research has been the presence of four agendas, those being cost and return on investment, un-impinged design and permeability, user experience, and environmental and energy concerns; these agendas are discussed, followed by the presentation of a design that reconciles those four agendas. The boundaries of the typology (and therefore the results and discussions of the research) were set in Chapter Four (see Figure 4.1). Following the creation of the typology and its inherent relevance, an updated version is presented in Figure 7.1, highlighting the boundaries and relevance of the research.

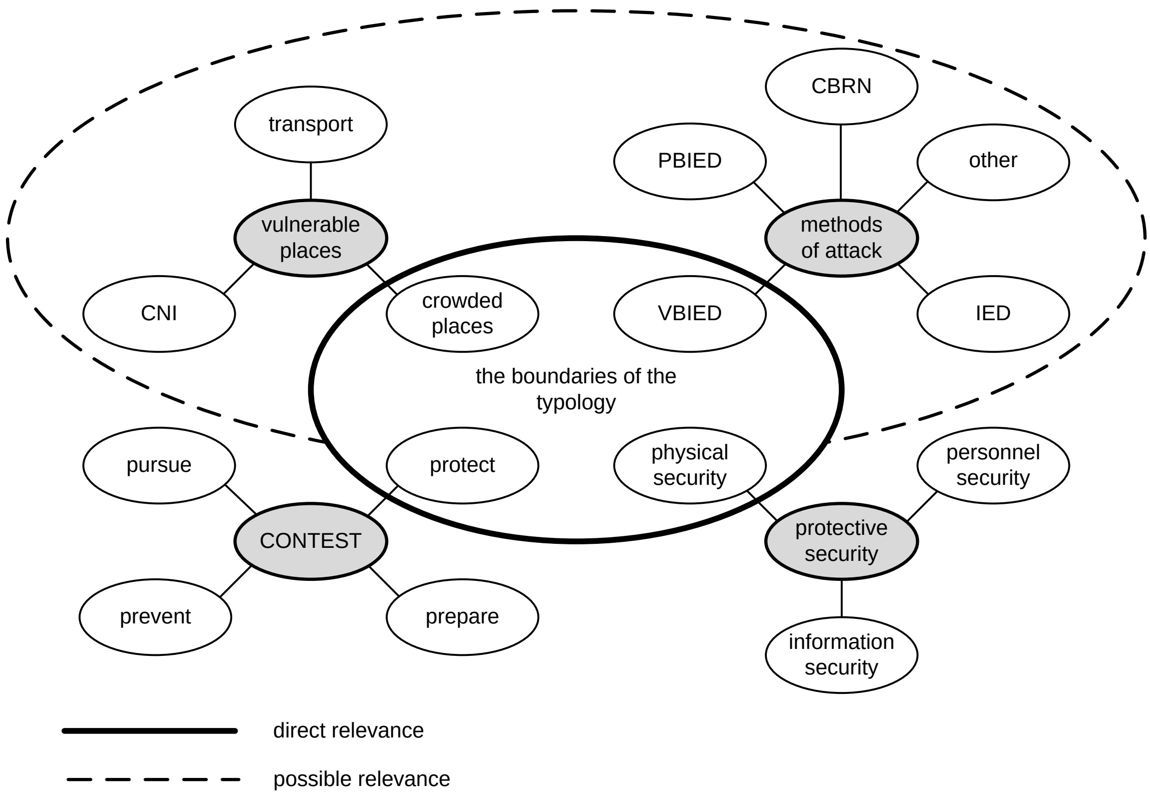


Figure 7.1. The updated boundaries and relevance of the typology and research

Whilst the direct relevance is unchanged, the potential relevance of the typology extends beyond the remit of the research. In relation to methods of attack, the typology has shown that CTMs can mitigate other forms of attack, as for instance, evacuation and invacuation planning is applicable to the detonation of IEDs, CBRN attacks and other forms of threat, such as the use of firearms. The typology is however only applicable to physical security and the ‘Protect’ strand of CONTEST. Whilst the typology should not be understood to contain all the CTMs that can be used to protect transport infrastructure and critical national infrastructure (as this was neither the remit of the research nor evident from the data), the CTMs within the typology are applicable to those places.

7.1 The Relative Performance and Consequences of CTMs

The typology of CTMs that can be used to protect crowded places from VBIEDs, which highlights the relative performance and consequences of the CTMs, is presented in Appendix C7.1. The components of the provisional framework of the typology were established in Chapter Four (see Table 4.2), with a classification of CTMs made evident in that chapter also. No changes were made to the classification of the CTMs themselves, with the results of the research concurring with the findings of the literature review. All the components that were identified in the aforementioned table were also evident in the results of the research, with no additions being made. The only difference that became apparent was the need to distinguish between positive and negative consequences, as their very nature was different. The identified attributes of such consequences did not change however, only the intentionality of their occurrence. An example is the unintentional creation of a new risk, which was identified in the literature review, as for example, reflection of blast waves from enhanced and protected buildings detrimentally impacts neighbouring buildings. This also therefore affirms the definitions of performance, requirements and consequences that were originally presented in section 1.1.3.1; the use of the terms was incorporated in order to capture all the attributes of CTMs themselves, rather than conform to the prevalent use of ‘cost’, ‘cost-benefits’ and ‘cost-effectiveness’, as they did not fully encompass all potential attributes of CTMs. Also, as sufficient cost data was not collected from which to reliably base any theories on such matters as cost-effectiveness, the adherence to the above terms enabled all possible subjective opinion of CTMs and their attributes to be collected.

7.1.1 Hostile vehicle mitigation

The relative performance and consequences of HVM will now be explored in relation to such attributes of traffic management, VACP, traffic calming and VSBs. Literature on HVM can be found in section 4.4 and the results on HVM can be found in section 6.4.

7.1.1.1 Traffic management

In terms of performance and benefits, the relative performance of traffic exclusion is greater than any other option. The increases in footfall and revenues of businesses, increases in safety, reductions in pollution and the soiling of buildings, as well as its influence on regeneration and conduciveness to broader schemes of pedestrianisation result in it being the most effective traffic management option. A case study example is provided by Lu *et al.* (2010, p.16) where the exclusion of traffic and incorporation of pedestrianisation is resulting in regeneration of the area as the area becomes a more attractive location for the public and retail outlets. The most notable negative consequence of excluding traffic however, is the disruption to businesses (in terms of deliveries, cars being able to get to the building itself etc), a consequence that is overcome through traffic restriction and traffic inclusion. However, whilst traffic restriction facilitates the ability of vehicles to get onto sites and near buildings (albeit following minor disruption in the form of access control), the benefits experienced above diminish. Whereas traffic exclusion, if enforced at a sufficient distance away, can result in no requirements for protective construction, traffic restriction will. A necessary reconciliation and assessment is therefore required, to subjectively analyse (in each unique instance) whether the benefits of on-site traffic (which can result in incorporating HVM and protective construction measures) outweigh the benefits of excluding traffic (arguably enforced through a relatively small number of VSBs). Traffic inclusion, however, results in greater risk of attack and would require HVM and maximum levels of protective construction, due to the ability of vehicles to get within a small number of metres to buildings. Whilst traffic is un-impinged, the cost of protective construction was raised as potentially reaching 15% of budgets, again resulting in the importance of the subjective assessment of values and requirements of stakeholders, in order to evaluate and incorporate the best suited option for them. The use of temporary barriers, inherently having the capacity to be escalated and de-escalated, is dependent on the timely assessment of the terrorist threat and therefore increases the risk of an attack. Relative cost benefits would need to be reconciled against its relatively lower effectiveness, as a result of its low aesthetic performance and permeability, as well as its performance on impact. The consideration of traffic management, and the different approaches within it, is evident in publicly available guidance that has been published by the Royal Institute of British Architects (Lu *et al*., 2010), where case studies have been given to show how different approaches and CTMs have been used; traffic exclusion has been incorporated at the National Assembly in Wales, Cabot Circus in Bristol (shopping centre), and at an undisclosed location in London where an international headquarters of a corporation is based, in order to allow those locations to be accessible by the public, but be relatively more secure and less vulnerable to attack.

7.1.1.2 Vehicle access control points

In terms of security, the inter-lock system performs the highest, as it removes the risk of tailgating, although it has the most severe negative consequences, as a result of the increased disruption to vehicle throughput and will be more costly than a single line of barriers, which may relatively cheaper, but is inherently more vulnerable to encroachment through tailgating. However, of more cost and also of increased risk is the use of a final denial system, as VSBs are used to line the route to ensure vehicles cannot traverse elsewhere, but the ability to stop vehicles is completely reliant on guard force reactions. The same vulnerability can be said for each form of VACP, as the vehicles and their occupants have to be searched and checked prior to their admission to a site. If this is not done appropriately, VACPs could be overcome. Where traffic is only restricted, the increased cost and risk of incorporating VACPs is evident.

7.1.1.3 Traffic calming

Traffic calming results in the reduction in speed of vehicles, thereby reducing the potential impact energy they could exert on a VSB, which in turn reduces the robustness (and potentially obtrusiveness) of the VSBs themselves. Relatively minor disruption to traffic, in the form of reduced speeds, would be reconciled against these benefits, however the complexity involved in incorporating chicanes needs to be acknowledged, especially when maintaining two-way traffic flow.

7.1.1.4 Vehicle security barriers

The intended (and positive) consequence of any VSB is the mitigation of an attack, however the relative performance and consequences of the different types of VSBs, as well as the individual VSBs, vary considerably. SEBs mitigate the impacts of a range of threats, however compared against street furniture and the use of landscaping and nature, offer little benefit elsewhere, with the least aesthetic performance and visual permeability. Street furniture offers public amenity as well as the potential for revenue generation, whereas the use of landscaping and nature most notably has environmental benefits and provides amenity, although there could be potential health and safety risks in relation to some CTMs.

Security-explicit barriers

Bollards, the most commonly associated CTM, offer the most permeability of all the SEBs. Whilst planters could be construed as having a relatively higher aesthetic performance, they are less permeable and significantly larger in size, and therefore arguably perform less well in relation to aesthetics. Measures more commonly associated with broader crime prevention and the demarcation of property boundaries (walls, fences and gates), therefore mitigate more than just terrorism, as is the case with all the SEBs, but offer less aesthetic performance when used in dense, urban settings, due to their relatively low aesthetic performance and permeability. This therefore provides insight into the prominence of bollards and planters in urban settings, due to their performance in terms of aesthetics and permeability.

Street furniture

The relative performance of street furniture, however, is higher than that of SEBs, as the furniture provides public amenities and higher aesthetic performance. Whilst the cost implications of the measures arguably vary more than those of SEBs (especially in relation to art and its sheer uniqueness), their performance lends themselves to offer more benefits than the aforementioned SEBs. Whilst a number of street furniture were addressed, the opportunities are potentially limitless, with all forms of ‘street elements’ being able to be structurally enhanced and made fit-for-purpose in relation to counter-terrorism. Their inherent benefits of providing amenity and in some cases generating revenue, results in their higher relative performance than SEBs and arguably landscaping and nature too, although the latter measures offer greater environmental benefits that could lead to increased quality of space. The use of street furniture is prevalent in publicly available guidance (Lu *et al*., 2010), with the incorporation of such measures evident in a number of locations.

Landscaping and nature

The inherent environmental benefits of VSBs within landscaping and nature result in their relative performance being higher than that of SEBs in relation to the additional benefits. Cost savings can be accrued through the recycling of spoil, with general aesthetic performance also being, arguably, the highest of all the VSBs. However, as with street furniture, their benefits in terms of user experience (in relation to counter-terrorism) is unknown, with further research being required. Whilst negative consequences are evident in the form of increased health and safety risks for users of the protected places and spaces, they increase the quality of space, which as highlighted in the literature review, is a factor in the increased usage of such areas. However, the space required to incorporate such VSBs is relatively higher than what is required for the incorporation of SEBs and street furniture, resulting in them being conducive to larger sites than are evident in dense, urban settings. Nonetheless, and as with street furniture, they provide the same security benefits as all the other VSBs, yet with additional benefits. The use of landscaping and nature is evident in case studies published by Lu *et al*. (2010, p.12), where staircases have been incorporated to exclude vehicle access to a building, and where stand-off has also been incorporated to enforce stand-off distances at the National Assembly in Wales.

7.1.2 Protective construction

The relative performance and consequences of protective construction will now be explored, through discussions on such attributes of the skin of a building, its structure, services and space plan. The literature on protective construction can be found in section 4.5 and the results on HVM can be found in section 6.5.

7.1.2.1 Skin

The protection of the cladding, façades and glazing of a building all have inherent benefits in their ability to mitigate the impacts of hazards, threats and major accidents. However, in relation to the mitigation of blast, a negative consequence of such protection is the detrimental impact it has on the vulnerability of the built assets that surround such a building, as they will be more badly affected due to the increased reflection of blast waves. Aesthetic performance is not impinged, as all the CTMs (with the exception of BBNCBs) can appear as if they are unprotected, although literature indicates ASF does reduce transparency slightly. The environmental benefits offered by ASF and laminated glazing offer incentivise their incorporation, with ASF being cited as the least expensive option (and ideally suiting retro-fitting) and laminated glazing being the most cost-effective if designed in from the outset.

7.1.2.2 Structure

The structural CTMs all mitigate the impacts of hazards, threats and major accidents, enhancing the robustness of a building to ensure it does not disproportionately collapse. The most revered methods of achieving this are through the use of steel or reinforced concrete frames. There are evident cost implications as a result of the increased robustness of the structural elements and their connections, but such expenditure would be reconciled against the reductions in damage that would occur as a result of a blast or other such event.

7.1.2.3 Services

The protection of services most notably occurs through the protection of the skin and structure of a building. When considering the potential for chemical or other such threats to occur, the location of HVAC systems at least three floors above ground level (which can be achieved at no additional cost if designed in from the outset) results in the mitigation of such threats and combined with filters for such threats, increases the internal air quality of the building, arguably reducing absence through sickness.

7.1.2.4 Space plan

Evacuation routes, protected spaces and the location of offices (sacrificial design) can be incorporated at no additional cost and aid in the mitigation of and response to hazards, threats, major accidents and other disruptive events. While these also have no negative consequences, the same cannot be said for internal partitions and the use of secondary layers of glazing (sacrificial design). Internal partitions can exacerbate the effects of a blast, by increasing the amount of fragmentation. The location and organisation of offices can also, arguably and as with internal partitions, influence workspace productivity. However, the incorporation of a layer of protected glazing and/or the re-location of offices or personnel can be the most cost-effective CTMs in retro-fit situations, due to the cost and disruption implications of replacing existing glazing, frames and fixings.

7.1.3 Planning, detection and procedures

The relative performance and consequences of planning, detection and procedures will now be explored, through discussions on such attributes of a security culture, of people and technology, and of planning and procedures. The literature on such CTMs can be found in section 4.6 and the results on HVM can be found in section 6.6.

7.1.3.1 Security culture

Management, support and communications infrastructure are typically already incorporated into organisations, resulting in the need for an inclusion of security into such practices, to the extent required for counter-terrorism purposes. A negative consequence of such a culture could be the disproportionate fear of a terrorist attack occurring (or other crime), but its importance is demonstrated through the effectiveness of awareness and the inherent vulnerability of CTMs that require human interaction. Raising awareness can be one of the most cost-effective CTMs, especially if conducted through Project Argus and Griffin events, which only require staff attendance (the events themselves are free to attend). Such a culture would embrace and require awareness, which can aid in the identification of hostile reconnaissance and suspicious behaviour, potentially interrupting plots prior to their manifestation. Where human interaction is required in relation to the use of CTMs, a security culture would ensure that adequate training for and monitoring of such interactions results in CTMs not being left in vulnerable positions, which could potentially undermine all other incorporated CTMs and nullify any value from their use.

7.1.3.2 People and technology

All the CTMs within ‘people and technology’ typically already exist in crowded places, albeit for other crime prevention functions. Capable guardians and security guards could physically stop an attack from occurring, but no such measure can mitigate the impacts of an attack on the structure of a building itself, should an attack occur. Rather, security guards who had been trained in the appropriate plans and procedures would aid in the response to such an event, potentially alleviating some of the others issues inherent in the aftermath of an attack, most notably evacuation and invacuation, as well as first aid. Negative consequences of such CTMs could be the impingement of one CTM on another (such as lighting on CCTV, placement of VSBs in lines of sight) and as previously highlighted, CTMs being left in vulnerable positions.

7.1.3.3 Planning and procedures

The aforementioned benefits of awareness are evident and are a cost-effective solution to aiding in the identification and mitigation of an attack (especially when considering that training programs are free and the skills learnt within them could stop an attack from occurring). BCP, contingency planning, evacuation/invacuation planning and housekeeping all typically exist in crowded places, requiring certain additions when dealing with terrorist attacks, as for instance, search planning needs to be incorporated into arrangements to ensure that IEDs are not left at rendezvous points and/or along routes to them. Such arrangements are arguably relatively cost-effective too, as one such check could identify an IED and result in evacuees being lead away from that route, instead of being lead to it and having the impacts of the blast that would occur in that instance. BCP is arguably the most cost-effective, as it not only aids in the preparation and mitigation of, response to and recovery from hazards, threats and major accidents, but a range of other risks and disruptive events that can impede organisations.

7.2 A Theoretical Framework of the Protection of Crowded Places

Derived from the literature review and the results of the research are eight factors that influence whether crowded places are protected and three factors that influence the value of CTMs. These inherent components of the theoretical framework are shown in Figure 7.2. The skeleton framework and its expanded contents are shown in Figures 7.3 and 7.4.

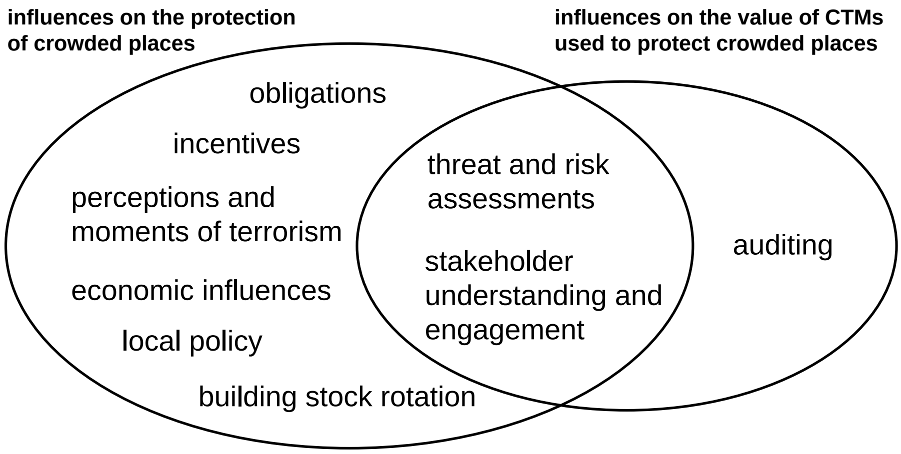


Figure 7.2. The inherent components of the theoretical framework

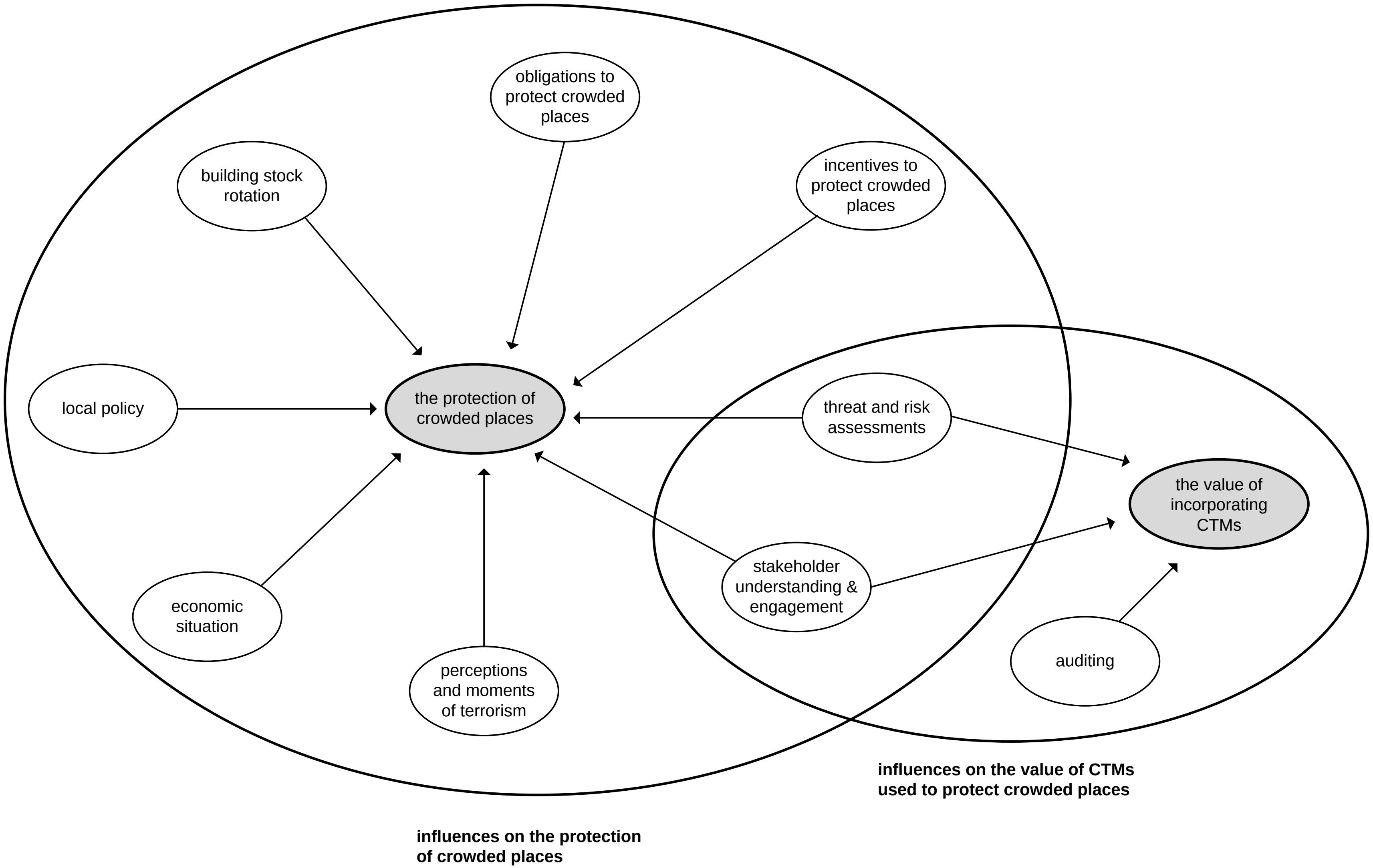


Figure 7.3. The skeleton theoretical framework

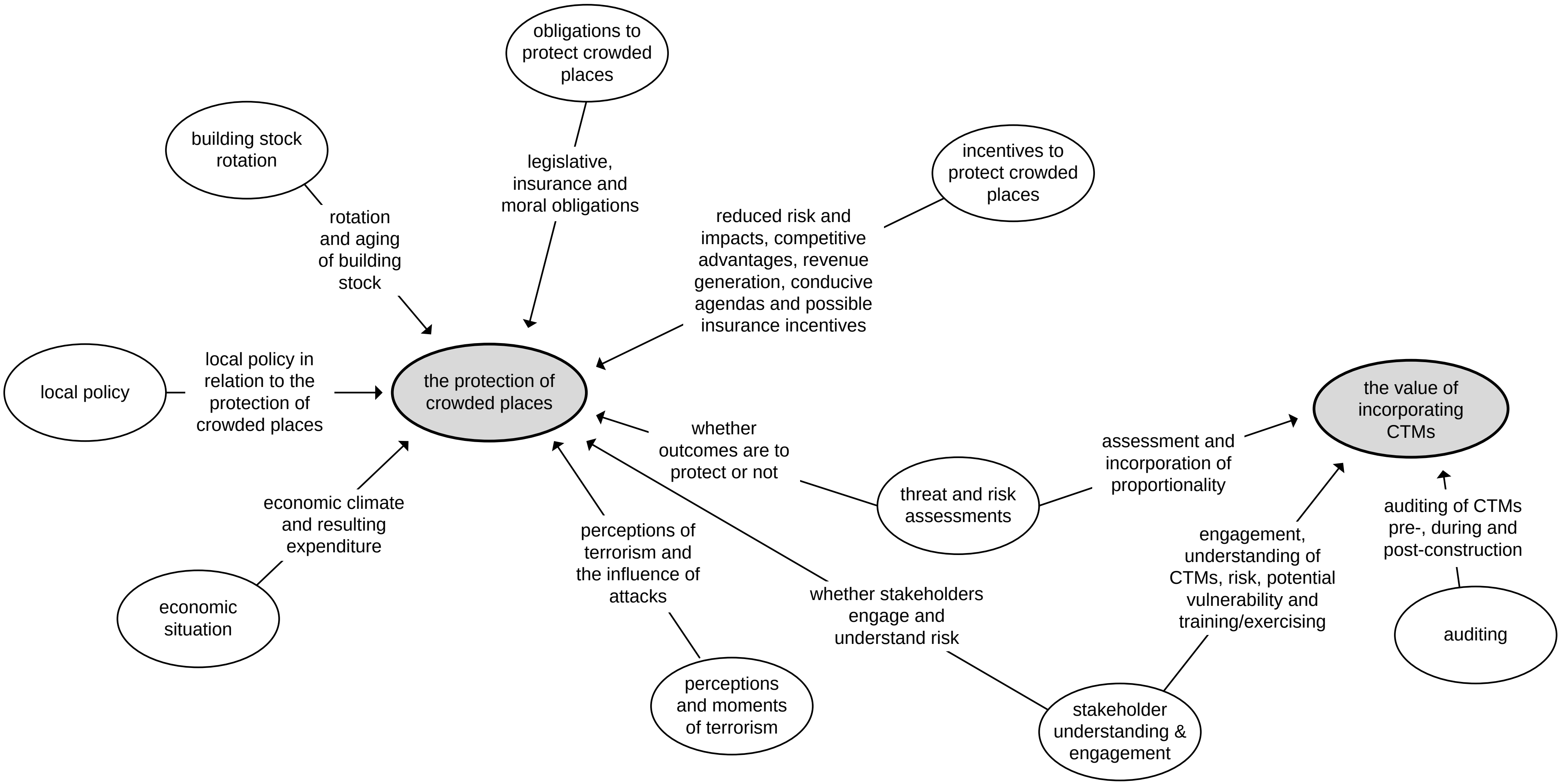


Figure 7.4. The expanded contents of the theoretical framework

7.2.1 Influences on the protection of crowded places

Eight influences on the protection of crowded places are apparent, those being obligations, incentives, TARAs, perceptions and moments of terrorism, stakeholder understanding and engagement, economic influences, local policy, and building stock rotation. Discussions on each of these influences will now be presented, drawing on the appropriate literature and results of the research.

7.2.1.1 Obligations

Obligations in terms of legislation, insurance policies and the values and leadership of organisations were evident in both the literature and the results of the research.

Legislation

Whilst the literature was relatively clear in stating that interpretations of existing legislation were such that 'duties of care' did encompass terrorist acts (Fussey, 2011b, p.165; CPNI, 2010, p.4; British Council for Offices, 2009, p.148; NaCTSO, 2009c, p.4; Home Office, 1999, p.8), only two of the participants held such assertive opinions (in relation to the Health and Safety at Work Act). All other opinions suggested an uncertainty surrounding interpretations, which most notably allowed developers and other stakeholders to not incorporate CTMs. Such uncertainty is also apparent considering CTSAs have been instructed not to state that there seems to be potential for prosecution, a factor which appears at odds with published guidance and other literature. Veale (2009, p.291) asserted that existing legislation has been used to prosecute where advice had been received, yet was not acted on. This has potential ramifications for all of the crowded places that have been assessed by CTSAs, as in the event of an attack, the assessments can be used as evidence, although it should be noted that legislation involves *gross* negligence. The dichotomy between published advice and given advice is resulting in crowded places not being protected.

> "What it means is, if and when an attack does take place, then there'll be a lot more casualties than would have otherwise been the case" (I24. CTSA B)

Insurance policies

Lack of clarity is also evident in relation to insurance, with liability being of key concern in the event of an attack. A link was also made between CTSA advice and liability, with one participant posing the following question:

> "…we know we're a target, but if we don't do anything, will the insurance companies still pay out?" (I18. Director, Construction Company)

Emanating from the results was the perspective that excesses would be reduced in the event of an attack, therefore creating an incentive for organisations to incorporate CTMs, especially if the excesses cost less than the incorporation of CTMs themselves. As with the apparent lack of clarity regarding legislation, the same is evident in terms of insurance, with no perceived obligations resulting in the incorporation of CTMs being avoided.

Organisational values and leadership

> "…there's a moral obligation if nothing else, but again, a moral obligation, what value do you put on it?" (I18. Director, Construction Company)

With the perceived lack of clarity regarding legislation and insurance (and the exploitation of it), protection could occur as a result of the values and leadership of the organisation. Duties of care are increasingly seen as integral parts of corporate social responsibility (British Council for Offices, 2009, p.141) and it could be argued that by engaging with wider areas and not just focussing on individual buildings, such efforts would justifiably contribute to such social responsibilities.

7.2.1.2 Incentives

> "If you want to account for the value of architecture to companies, what you actually talk about is value to business" (Rouse, 2004, p.64)

What are the benefits of incorporating CTMs, what are the incentives?. Emphasis on incentives seems more apparent considering the lack of clarity regarding the aforementioned obligations. Six over-arching incentives were evident in the literature, albeit not contained in one publication, and were concurred with and further informed through the results of the research, yet public knowledge of them appears sporadic. This is especially apparent given the emphasis on avoiding obligations, as opposed to capitalising on incentives. The incentives to protect crowded places, those being the reduced risk of attack, reduced impacts of an attack, competitive advantages, revenue generation, conducive agendas and possible insurance incentives, are summarised in Figure 7.5. Evident are factors that provide substantial incentives for organisations to consider the use of and incorporate CTMs.

Reduced risk of attack

The intention of incorporating CTMs is to reduce the risk of an attack occurring, by reducing the attractiveness of the target and the opportunities to attack it (Fussey, 2011a, p.86). However, the reduction of risk could result in displacement; a consequence of all crime prevention strategies (Cozens *et al*., 2005, p.342).

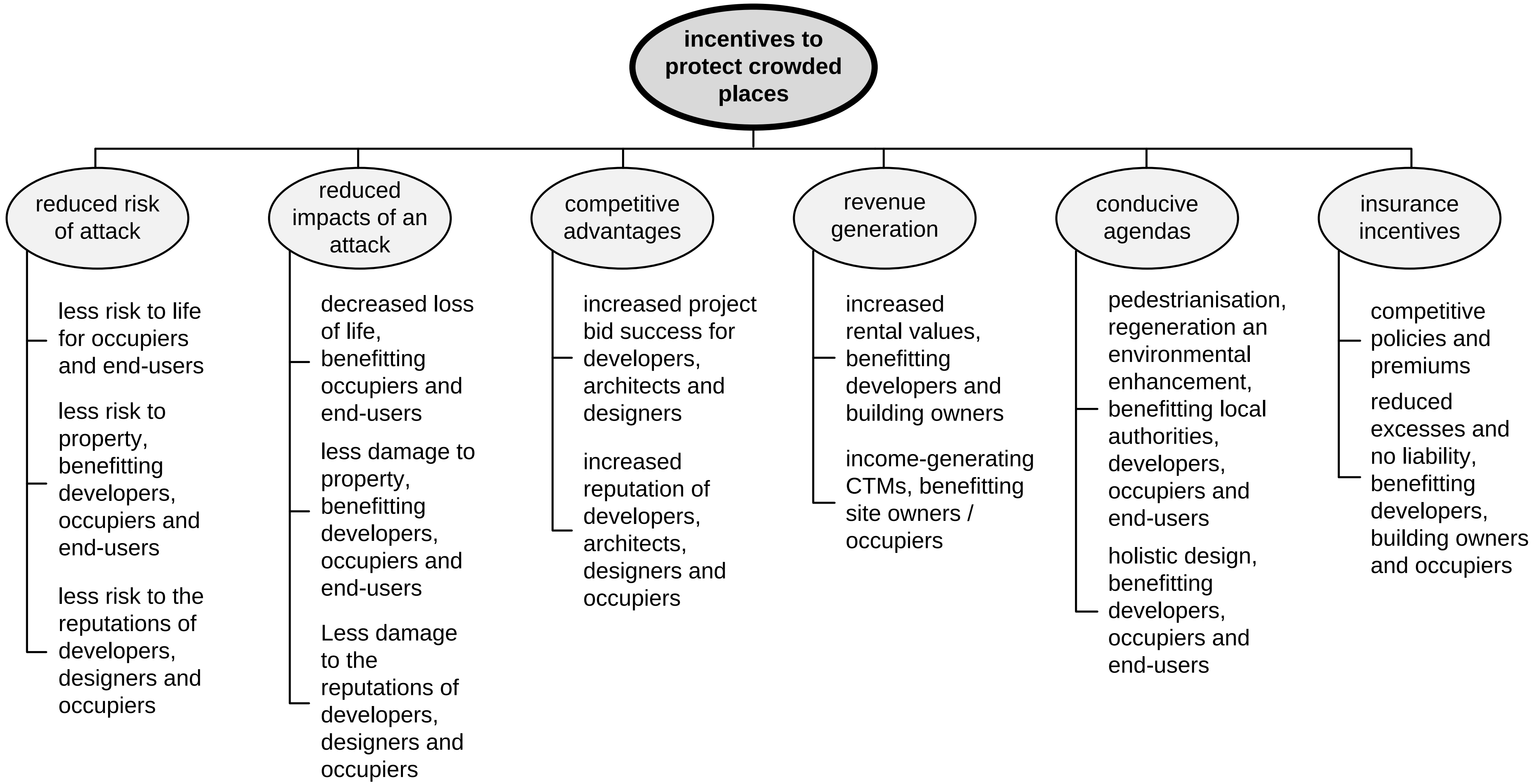


Figure 7.5. The incentives to protect crowded places

Yet, displacement might not occur, even if CTMs are incorporated, as the symbolism of a particular place and any promotion of its security (as highlighted in Figure 6.4) may result in its targeting regardless of any incorporated CTMs. The results of the research highlighted that security professionals emphasised the visibility of CTMs, whereas those within design professions emphasised the importance of their inconspicuousness or 'invisibility'. While it can be argued that 'invisible' CTMs do not increase the risk of an attack, as hostile reconnaissance or 'trained eyes' will be able to identify that vehicle-borne methods are not physically possible (if such CTMs were incorporated to this effect), the impact on user experience is relatively unknown. Such perceptions of security and insecurity and how the incorporation of CTMs relates to user experience remain unclear and require further research.

Reduced impacts of an attack

Impacts in relation to damage and debris, business interruption and loss, health, and reputation were all evident in the literature. Depending on the size of the organisation and the nature of an attack, the cost of just one of those factors could far outweigh the cost of incorporating CTMs, most notably when considering reputation, the importance of which was evident in both the literature and the results of the research. Reputation can be damaged prior to an attack, due to inadequate security, as well as after an attack, based on the procedures and CTMs that were in place and how effective they were (British Council for Offices, 2009, p.141). Although such instances are 'very much in the minority', an example of a project was given whereby a company incorporated CTMs over fears of damage to their reputation (I24. CTSA B).

Competitive advantages

The literature suggests that competitive advantages are available to those who pre-empt regulatory change (Bosher *et al.*, 2007a, p.172) and embrace hazard and threat mitigation (Bosher *et al.*, 2009a, p.18); most evident here was the competitive advantage available through incorporating resilience:

> "Any company that can make sense of its environment, generate strategic options, and realign its resources faster than its rivals will enjoy a decisive advantage. This is the essence of resilience. And it will prove to be the ultimate competitive advantage in the age of turbulence" (Hamel and Valikangas, 2003, p.63)

Whilst existing legislation is interpreted as encompassing the mitigation of terrorist attacks, meaning that such regulation needs to not be pre-empted, but recognised, the obtaining of competitive advantages was also evident in the results of the research. During one interview, it was highlighted that a construction company had carried out research indicating that the proposed project was at risk from terrorism and flooding, and therefore considered those risks in their proposals. The company was successful in winning that bid, which was partially due to their identification of potential risks to the building that no other proposal had identified. Whilst this indicates that the incorporation of threat and hazard mitigation into buildings is not common practice, it also highlights the advantages of considering and, where deemed appropriate, incorporating such resiliency measures. Developers and those involved in the design of crowded places could therefore expect greater success in the awarding of bids and increases in their reputation, which in turn will increase their revenues.

Revenue generation

Whilst the incorporation of CTMs (and other resiliency measures) can lead to increases in revenue for those who design vulnerable places, such benefits can also be obtained by those who occupy and/or own such places. Whilst the literature highlighted that this can occur through congestion charging as a part of wide-scale traffic restriction (Coaffee, 2005, p.462) and through increased reputation and branding (HM Government, 2010c, p.34; Coaffee *et al.*,2009a, p.215; Coaffee and Van Ham, 2008, p.192), the results of the research highlighted that CTMs themselves can generate revenue and can lead to increased property values and the ability to charge higher rent (of benefit to those who lease or own such places). Advertising boards have the capacity to be structurally enhanced in order to provide HVM functions, resulting in the ability of CTMs to be able to generate long-term income streams. An example was also given of advertising being printed on ASF, providing another instance of the ability of CTMs to generate revenue. Also evident in the results of the research was the increase in property and rental values of protected buildings, due to their increased security and reduced impact that would be incurred in the event of an attack or other damaging event. This is a benefit to those who own and lease such places (as well as those who occupy them, as arguably they are at less risk of being disrupted and incurring damage), and such gains are also influenced by conducive agendas.

Conducive agendas

The conducive nature of pedestrianisation to counter-terrorism was evident in both the literature and in the results of the research. The literature argued for a potential increase in footfall and revenues for local businesses, which was confirmed by the results of the research. In areas where traffic exclusion and pedestrianisation had been enforced, footfall increased and revenues of businesses in those areas did increase, contrary to their perceptions prior to the traffic exclusions being incorporated. Reductions in pollution and evident increases in safety were also cited, although a consequence of such measures is the displacement of traffic and the increased congestion in surrounding areas. The exclusion of traffic and resulting pedestrianisation can also act as a catalyst for the regeneration of areas. Literature highlighted that the incorporation of such an approach, in the long-term, will attract higher retail offer to the area and increase the footfall and revenue of businesses (RIBA, 2010, p.16). Such assertions were concurred with in the results of the research, as examples were given of similar projects, where the exclusion of traffic gradually resulted in regeneration and increased use of protected areas. A ratio of expenditure and return on investment was given, in relation to the increased quality of areas that can result from such protection. It was stated that for every £1 that was spent on enhancement that could be equated to a £5 increase in value (I25. Assistant Director, Local Authority). Although somewhat anecdotal, the ratio is based on experience of numerous projects and offers some insight into the benefits that can arise when incorporating CTMs. Further research is needed however, in order to provide objective and substantiated findings.

Environmental enhancement was raised in the literature as being a means through which the incorporation of CTMs could be encouraged (Coaffee and Bosher, 2008, p.80). Coaffee (2003c, p.79) and Marshall (2002, p.6) highlighted how excluding and restricting traffic from a given area can decrease pollution, a benefit that could result in a reduction in absence of users of such protected places due to the improved air quality. Such enhancement was also evident in local planning considerations, where the incorporation of CTMs typically resulted in enhancements to areas, whether through environmental enhancement or simply by increasing the quality of the construction materials used (I25. Assistant Director, Local Authority). For further information on other synergies between security and environmental issues, see Coaffee and Bosher (2008). The need for a holistic approach to the design of vulnerable places was also evident in both the literature and the results of the research. Literature asserted that through adopting such an approach (as opposed to silo mentalities and the consideration of individual agendas), deterrence would be increased through having shown a higher level of consideration in relation to the protection of such an area (Little, 2004a, p.56). It was also highlighted how such an approach aids in ensuring resiliency measures do not compromise others (CPNI, 2011, p.14). This research supports such statements; examples of numerous projects were given where by taking a holistic approach, significant cost savings were gained and benefits accrued through considering multiple agendas (see section 6.1.2.5 for further information on the aforementioned projects). Adopting such an approach would require greater stakeholder engagement, which is explored further in section 7.2.1.5.

Insurance incentives

> "On the face of it, insurers would appear to be a logical way of encouraging security because, ideally, it should reward those who adopt protective measures by reducing

> their insurance premiums to reflect the decreased risks… Unfortunately, the commercial insurance market does not follow this practice… However, it is worth noting that adopting additional security measures should reduce the likelihood of claims on policies and thus could reduce premiums in the long-term" (British Council for Offices, 2009, p.x)

The reduction in premiums in the long-term and the reduction of excesses immediately after an event, where CTMs had been incorporated, was also evident in the results of the research. The incentivising of such practices, whilst an attractive proposition, is intrinsically linked to the perceived obligations under policies and potential liability issues that have been previously cited. Such issues in relation to insurance therefore require greater clarity in order to further understanding and promote the possible benefits that can be gained from protecting crowded places. Competitive advantages that can be gained through the incorporation of CTMs, resulting in insurance companies offering competitive premiums and policies, also incentivises the incorporate of such measures by businesses.

7.2.1.3 Threat and risk assessments

It was questioned in the literature review (section 3.4.3) that despite no supporting literature, the outcome of such an assessment could be to not protect, or to re-locate so as to not require protection. The results of the research highlighted the importance of undertaking a TARA at the beginning of any project, due to the possibility of such implications, most notably influencing the consideration and selection of appropriate sites. TARAs, as highlighted in the literature review and results of the research, also influence the value of CTMs in relation to four aspects, those being the assessments themselves, situational context, the terrorist threat, and proportionality. Emanating from the participants were three clear issues on content, those being their inclusion of future scenarios, their inclusion of all affected stakeholders and their transparency. The assessments themselves determine whether, and the extent to which, crowded places are protected, yet no one guidance document provides detailed guidance on their undertaking and attributes. The transparency of TARAs carried out by CTSAs was raised, with participants being 'told' what level of threat they faced without the reasoning being explained to them, which results in problems discussing such matters with clients and contractors.

Situational context also influences TARAs, as the nature of the crowded places and occupiers influences the risk they face, as does existing or planned utilities and services, the topography of the built environment and the nature of surrounding buildings. Such factors were evident in both the literature and the results of the research. Most notable however, was what one participant termed 'adjacency risk'; denoting the risk buildings and businesses may face by being adjacent or near to potential targets. This also relates to previous discussions of buildings near protected places that incur more severe impacts of an attack due to the increased reflection of blast waves, resulting in an additional aspect in relation to 'adjacency risk'. Also apparent is the importance of understanding the terrorist threat, particularly in relation to the specific threats that could be apparent at each crowded place. As stated by Veale (2009, p.292):

> "Understanding the terrorists' intentions and capabilities – what they might do and how they might do it – is crucial to assessing the threat"

Assessing the intentions and/or capabilities incorrectly could result in under-engineered and vulnerable, or over-engineered and obtrusive CTMs and crowded places (Harre-Young *et al.*, 2010, p.1126), which could also undermine or nullify any value obtained through the use of CTMs themselves. The vehicle-borne threat was raised as the one requiring the most consideration, due to the impacts that such attacks can have, yet there was evidence of changing perceptions, with examples of projects being given that are increasingly planning for Mumbai-style terrorist attacks (the use of firearms and hostage taking), with funding for HVM measures at one project being questioned and potentially diverted for use to prepare for such an attack. Commenting on the CBRN threat, Littlewood and Simpson (2007, p.58) highlight the difficulty in accurately assessing such threats:

> "Difficult as it may be to admit, those outside the intelligence and counter-terrorism community or without access to such information are in many cases simply guessing"

This places emphasis and importance on the need for and engagement with CTSAs and GSAs, as they have access to such information and will be able to offer advice on appropriate threats and on incorporating proportionate solutions. Evident in the literature was a lack of guidance in relation to the assessment and incorporation of proportionality, with such absences also being raised by participants during the research itself, as was the need for experienced CTSAs. An example of a project was highlighted where a CTSA had carried out an assessment of designs for a new city-centre office building, yet had argued that terrorists could use monster trucks to traverse steps and that ditches would be required to prevent such a method from being achievable. Such an example highlights the influence CTSAs have on the perceptions and assessments of proportionality, and ultimately, the design of the built environment. What is evident is a lack of literature on the assessment of proportionality. Such a gap in knowledge contributes to the under-engineering and vulnerability, as well as the over-engineering and obtrusiveness, of crowded places (Harre-Young *et al.*, 2010, p.1126) and as a result, their influence on the value of CTMs can be significant. Further research, debate and knowledge is required in order to provide a solution to these issues.

> "Although many stakeholders apparently agree that these allocations should reflect the magnitude of risks to which different areas are exposed, no consensus has emerged on how this might be accomplished" (Willis *et al.*, 2005, p.vii)

7.2.1.4 Perceptions and moments of terrorism

Section 3.4.4 presented a wealth of literature on the significance of perceptions of terrorism and how those perceptions are influenced by terrorist attacks. As stated by Little (2008, p.3):

> "…there can be little question that current concerns about terrorism and the risk it poses to individuals or society are shaped as much by perception as by objective risk assessments"

The most notable 'influence' that was evident in the literature was the terrorist attacks in the USA of September 11th, 2001 and its wide-ranging implications and reactions. Evident was how such influences acted as catalyst for the protection of crowded places. Such effects were also evident in the results of the research, which concurred with the impetus given to those attacks and others, most notably the attacks on London's transport infrastructure in July 2007, as well as the attack on Glasgow Airport. Whilst it was argued that such actions were partially as a result of 'needing to be seen doing something', the fading of memories and ignorance towards the threat was also raised as an influence, with attacks bringing the threat of terrorism to the forefront of peoples' minds and increasing their perceptions of its severity, influencing whether vulnerable places were protected. Such influences were stated by one participant (a Director of a construction company who was responsible for the security and counter-terrorism department), who highlighted that after the terrorist attacks of September 11th 2001 and July 7th 2005, the amount of requests they received for their products dramatically increased (I18. Director, Construction Company).

7.2.1.5 Stakeholder understanding and engagement

Whilst the potential for stakeholder understanding and engagement to influence whether crowded places were protected was not evident in the literature, but two related factors were made apparent through this research. Firstly and in relation to engagement, it was raised that CTSAs and ALOs have been intentionally ignored and 'left out' of the design process for some projects until the designs have been given approval and changes could not be incorporated (I24. CTSAs B and C). This indicates that stakeholders are aware of the terrorist threat and the services that are available in relation to its mitigation, but also highlights the exploitation of the perceived absence of legislated requirements. Secondly and in relation to understanding, it was raised that businesses that were adjacent to crowded places (whether they were crowded places themselves or not is irrelevant) would not consider incorporating CTMs as they were not potential or likely targets of a terrorist attack. This highlights a lack of understanding regarding risk and the potential implications of a terrorist attack (or other incident that can result in an explosion); whereas neighbouring businesses may not be the intended target of an attack, their properties will more than likely suffer the implications of the blast and incur the impacts of an attack. Efforts need to be made, therefore, in order to enhance the understanding of not just crowded places themselves, but businesses that surround such places, in order to ensure they take such matters into consideration.

7.2.1.6 Economic influences

Evident in the literature was the influence that economic downturn can have on the ability of organisations to incorporate CTMs, as well as the prioritisation of other agendas over the incorporation of such measures (HM Government, 2010a, p.21; Coaffee and Bosher, 2008, p.81; Mignone, 2007, p.5409; Wekerle and Jackson, 2005, p.141; Swanstrom, 2002, p.138; Carmichael and Gartell, 1994, p.9). Such influences were also evident in the results of the research, which also highlighted examples of organisations who wanted to further their understanding of the terrorist threat through attendance at Project Argus events hosted by their local CTSAs, but couldn't due to not having adequate staff cover due to cut backs (I3. CTSA A).

7.2.1.7 Local policy

Counter-terrorism has become increasingly embedded into local policy, most notably through the incorporation of 'rings of steel' in Northern Ireland and London and how such policies have transcended into the more permanent protection of crowded places in urban areas. Evident in the results of the research was the influence of local policy in relation to what CTMs are incorporated and how they align (or not) with different agendas that such authorities encourage. As noted by one participant:

> "…putting buildings on the backs of footpaths, we have to put in this deep concrete wall, which was effectively a metre high and about 500mm deep, anchored back to the buildings and we're supposed to have a retail environment. Now, you know, having this big bunker around the building is exactly counter to the other policies that City have, in terms of actually attracting high-quality retail" (I15. Director, Development Company)

Examples were also given of different local authorities who preferred different traffic management approaches. While the nature of the crowded place was notably a factor in such decisions (how much of a target they were perceived as being or how much influence they had due to their size), varied preferences in relation to the protection of such places was evident.

7.2.1.8 Building stock rotation

The influence of building stock rotation was apparent in both the literature and the results of the research. Due to the nature of such rotation (cited as being between 1-2% a year), the vast majority of terrorist targets therefore exist today and as noted by Ravetz (2008, p.4462), 75% of buildings that will be present in 2050 already exist. The aging of such places and their resulting increased vulnerability is also a factor that influences whether such places are protected, all of which highlights the longevity of ensuring the protection of such places not just from terrorism, but in relation to the mitigation of all hazards, threats, major accidents and applicable risks.

7.2.2 Influences on the value of counter-terrorism measures

Three influences on the value of CTMs are evident, those being TARAs, stakeholder understanding and engagement, and auditing. Discussions on each of these influences will now be presented, drawing on the appropriate literature and results of the research.

7.2.2.1 Stakeholder understanding and engagement

The value of CTMs can also be influenced by stakeholder understanding and engagement, which encompasses the engagement between stakeholders themselves, their understanding of CTMs, vulnerable points in protection, training, testing and exercising, and understanding of risk.

Stakeholder engagement

The literature review highlighted that whilst there is a definitive role for those who design, construct and operate the built environment to protect vulnerable infrastructure from a range of hazards, threats and major accidents, professional fragmentation is a 'hallmark' of the construction industry itself (Bosher and Dainty, 2010, p.6) and that where stakeholders do not engage and interact, crowded places could be under-engineered and vulnerable, or over-engineered and obtrusive, if they are protected at all. The results of the research highlighted that stakeholders will always be at odds with each other, due to their different requirements and wishes, which puts an impetus on requirements to engage and share information at the earliest opportunity, as participants raised that design decisions occurring later on in projects can have major implications (see section 7.3.1 for further information on the importance of the design stage). Most notably, interactions with the end-users of the projects was raised, a factor which as previously highlighted, is somewhat lacking in relation to counter-terrorism and perceptions of security and insecurity. Proving the benefits of protecting crowded places would incentivise stakeholders changing their working practices and engagement with one another, but current perceptions of such benefits are relatively unknown, with one participant stating that trying to highlight such benefits was like being 'a voice in the wilderness' (I11. Director, Construction Company). The findings of this research, therefore, could aid in evidencing the benefits of protecting crowded places and provide incentives for those who design, construct and operate the built environment to interact more effectively. However, such interaction is currently not occurring. As highlighted in section 3.5.1.1, Glass (2008, p.180) highlights that a potential solution to such issues is through the use of charette-type meetings, where architects could invite relevant stakeholders (such as security experts) to work through ideas and potential solution in order to enhance the quality of the design being produced, as well as enhance their own learning and understanding about designing in such measures. Arguably, such an approach would facilitate the relatively expedient identification of potential solutions, their performance and their consequences.

Understanding of CTMs

How understanding of CTMs influences the value of CTMs was evident in the literature review, with gaps in understanding of what CTMs are available and associations with those methods, and the ability of 'lesser' crime prevention measures to double-up as CTMs. Guidance does not exist on the CTMs that can be used to protect crowded places, which is arguably exacerbating current perceptions of 'target hardening' and 'fortress mentalities'. The results of the research highlighted that knowledge of what CTMs were available was lacking, as was information on their performance and requirements, and consequences of attempting to reproduce CTMs. Participants questioned what else could be done except incorporate bollards, whereas others recognised that there were numerous ways to 'secure a building'. Examples were also given of businesses who tried to reproduce CTMs in order to save money. In the instances given, the reproduced CTMs were not fit-for-purpose and resulted in their removal and replacement with appropriate CTMs, costing more money than would have otherwise been spent if the recommended CTMs had originally been incorporated. Understanding of CTMs therefore influences the value of CTMs themselves in a number of ways, issues that will be resolved through the identification of the potential requirements, performance and consequences.

Vulnerable points in protection

> "There is also a danger that we place misguided trust in technology to deliver security, forgetting that technological 'kit' is only as effective as the socio-technical systems it is employed within, and the humans operating it" (Briggs, 2005, p.24)

Such notions (whilst having broader meaning than solely counter-terrorism) were evident in the results of the research, as well as the literature, with participants emphasising having greater faith in 'passive' CTMs than in 'active' ones. VSBs left in open positions, CCTV cameras being left in positions that facilitate 'blind spots' that can be exploited and the insecure protection of supporting infrastructure were all cited examples of the inherent vulnerability in 'active' CTMs. Also, the design of places themselves was raised, with examples of buildings surrounded by VSBs, enforcing stand-off distances, yet at the rear of buildings were plastic barriers that could easily be penetrated, so a VBIED could get underneath the building and undermine the value of the CTMs themselves.

Training, testing and exercising

> "Too many plans are based around what the company would like to happen in a crisis rather than what might happen…On paper the plans may appear to work fine. However, the real test would be in a crisis situation. During a real crisis is not the time to be testing procedures for the first time" (Curtin *et al*., 2005, p.155)

Such an emphasis on training, testing and exercising was also apparent in the results of the research. Occupiers and business owners would need to evaluate the potential implications of not testing their procedures and the costs and other implications that would occur as a result of their untested procedures, against the time and disruption that would be incurred as a result of running such exercises. The influence of such planning can detrimentally impact preparedness for and responses to a terrorist attack, as well as a range of other scenarios that can result in the evacuation or invacuation of users, which again can undermine the value of other CTMs that have been incorporated.

Understanding of risk

The importance of understanding that risk can only be mitigated and not eliminated was raised in the results of the research with binary perceptions (i.e. it will either happen, or it won't; it is either secure, or it isn't) being questioned, and the importance of aiding organisations in accepting and taking risks being of importance. Attempting to eliminate risks, which in relation to counter-terrorism would be attempted through the incorporation of overly robust and obtrusive CTMs, results in a disproportionate solution. As has been previously highlighted, understanding of risk was also evident in relation to potentially being impacted by a terrorist attack, regardless of whether such places were targets or not, and that by protecting buildings, damage to neighbouring properties can be increased due to the increased reflection of blast waves. Although such a factor incentivises the protection of wider areas (which has its own benefits in terms of traffic exclusion and pedestrianisation), it indicates a greater understanding of the risks involved in relation to terrorist attacks and the protection of crowded places.

7.2.2.2 Auditing

Evident from the results of the research was the importance of auditing and how the process can influence the value of CTMs themselves and the protection of crowded places. Whilst only raised by one participant, its importance was made clear by the participant who gave examples of projects where millions of pounds worth of glazing had failed because it was the wrong type, which would have failed badly in the event of an attack and which had to be replaced at additional cost. If auditing of the protection of crowded places is not undertaken, not only can inappropriate CTMs be incorporated that will have to be removed and replaced (at a cost), but in the event of an attack, the CTMs themselves would fail and in some instances therefore, exacerbate the impacts of an attack. Auditing, therefore, can have significant influences on the value of CTMs themselves and the protection of crowded places. Considering such influences are not apparent in the literature and were only raised by one participant, greater awareness of the process seems vital.

7.3 Two Pertinent Design Considerations

Throughout the literature review and the results of the research, two design considerations are consistently evident, those being designing-in versus retro-fitting CTMs, and sufficient versus insufficient stand-off. Literature and several participants asserted that designing-in CTMs is cheaper, retro-fitted CTMs are less effective, and incorporating sufficient stand-off is the most effective CTM, evidenced arguments have not been forthcoming. It is the aim of this section, therefore, to explore these design considerations, utilising the scenario-based research instrument where appropriate, to provide an evidence-based account of the relative performance and consequences of the different approaches.

7.3.1 Designing-in and retro-fitting

> “Designing-in such measures at the pre-construction phase is vital, as retrofitting will be much more costly and reduce the effectiveness of the measures” (Coaffee, 2008b, p.4637)

Such a perspective is evident in a number of other works (RIBA, 2010, p.3; Forman *et al.*, 2009, p.257; British Council for Offices, 2009, p.86; Thompson and McCarthy, 2004, p.213). Yet whilst the perspective is evident, it is not evidenced. However, Thompson and McCarthy (2004, p.213) offer more of an insight into the reasons as to why the stage in which incorporation of CTMs matters:

> "The importance of planning ahead cannot be overemphasized – entire building systems, site planning, floor layouts, room sizes, adjacencies, construction materials, and project schedules may be impacted by security design decisions. In new construction or major renovation projects, architectural solutions are often the most cost effective".

This insight offers potential implications, yet a systematic and evidenced account of how the design stage influences the design process itself, the requirements of the CTMs and the performance of the CTMs, is not offered. It is these factors that will now be explored through the use of the scenario-based research instrument. The scenario utilises the same plot that was used during the research, and is based on the occupiers of an office block (that is positioned in the aforementioned plot) requiring protection for their premises. The plot, as is evident in Figure 7.6, is a dense, city-centre environment, which rules out traffic exclusion solutions due to their impracticality considering the surrounding infrastructure.

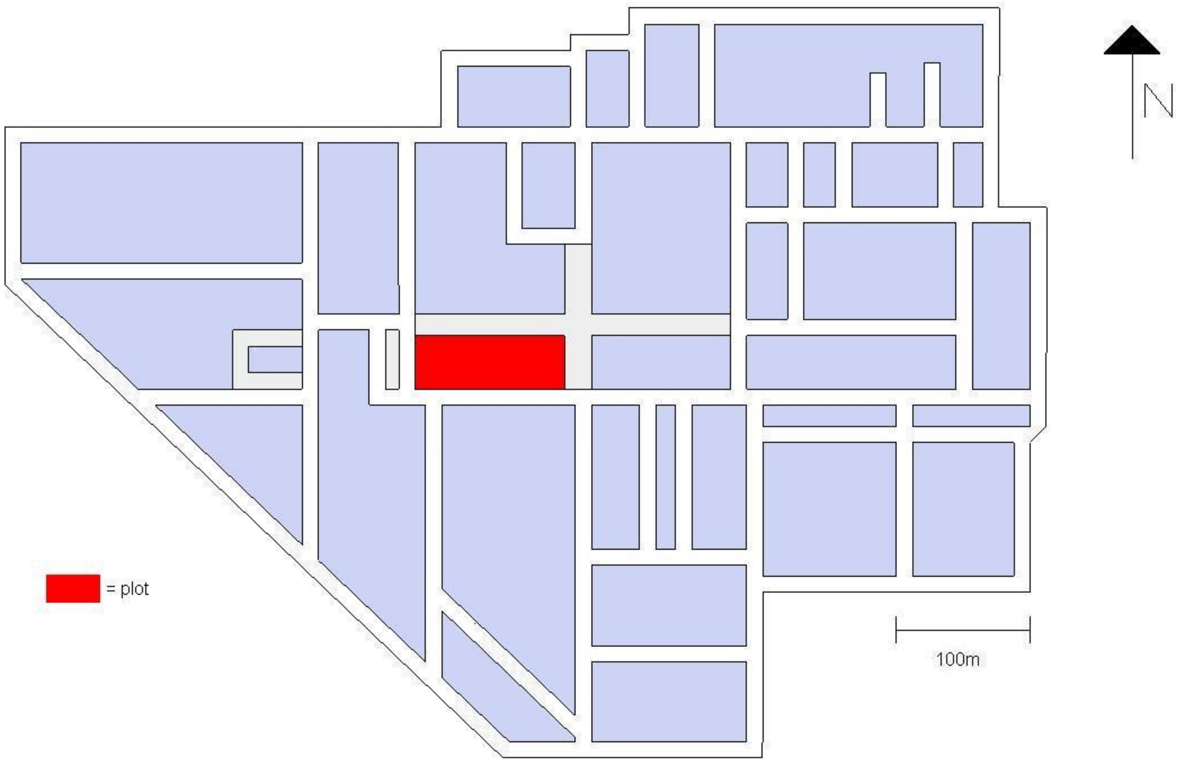


Figure 7.6. The location of the office block in the scenario

The scenario encompasses the occupier requesting HVM measures to be incorporated, reducing the vehicle-borne threat and the impacts of an attack should one occur, or any damage from a nearby attack.

7.3.1.1 A retro-fit scenario

As previously mentioned, HVM measures were requested. In order to prohibit vehicles from being able to park alongside or penetrate the building itself, passive bollards and street furniture were chosen to line the two sides of the building running parallel to roads (as evident in Figure 7.6) and active bollards were chosen to be located at each of the four entrances to the pedestrianised area surrounding the other two sides of the building. Although bollards already existed, they were not sufficiently robust to perform the requirements now that vehicle-borne threats were being considered. This resulted in the original bollards being removed and were replaced with the new, appropriate bollards. Existing utilities and services also had to be diverted, in order to install the foundations for the passive bollards and the infrastructure required to operate the systems for the active bollards. Where utilities could not be diverted, the robustness of the passive bollards had to be increased, due to the inability to obtain the required foundations.

7.3.1.2 A designing-in scenario

When considering the same specifications, but being designed-in prior to the construction of the building, there are less inherent implications. Firstly, the replacement of any existing street elements with CTMs is not required, reducing time requirements on contractors, costs, and disruption to the users of the building and the public. Secondly, the diversion of existing utilities is also no longer required, as the incorporated CTMs and utilities are designed around one another, which again reduces time requirements of contractors, costs, and disruption. Thirdly, more robust (and potentially obtrusive) CTMs are avoided through the removal of the need to locate them on top of utilities, reducing the cost of the CTMs themselves. Designing-in CTMs therefore has significant advantages when compared to retro-fitting such measures, through reductions in time and costs, as well as disruption to building occupants and neighbouring premises. However, the design stage does not solely influence the time, cost and disruption considerations, but also the feasibility of CTMs that can be used. Taking protective construction as an example, if laminated glazing (and the required frames and fixings) were being considered, retro-fitting such CTMs would be unfeasible, due to the need to replace all the existing frames and fixings, which may not be possible in some buildings. It therefore forces less effective CTMs to be incorporated, increasing vulnerability to an attack. Designing-in CTMs can therefore have a number of advantages over retro-fitting such measures, through reductions in the time, cost and disruption implications of:

- stakeholder engagement and deciding on appropriate courses of action;
- removal, making safe, and replacement of existing street elements or inappropriate CTMs with the required, fit-for-purpose CTMs;

- diversion of existing utilities;
- robustness (and potential obtrusiveness) of CTMs; and
- nullifying restrictions in relation to the feasibility of incorporating CTMs that could be used.

Based on guiding principles that they have been given, CTSAs assert that retro-fitting is ten times more expensive than designing-in CTMs (I22. CTSA A). However, it is not possible here to make evidenced judgements on the scale of time, cost and disruption implications that are inherent in retro-fit situations, informed and evidenced judgement as to whether such assertions are accurate is not possible. Rather, the highlighted implications verify the assertions that retro-fitting CTMs will be more costly and, in certain situations, less effective, as suggested in literature (RIBA, 2010, p.3; Forman *et al*., 2009, p.257; British Council for Offices, 2009, p.86; Coaffee, 2008b, p.4637; Thompson and McCarthy, 2004, p.213). The highlighted implications should be considered as indicating the scale of the challenges involved in retro-fitting CTMs and be used as benchmarks from which to work out cost estimations on a case-by-case basis.

7.3.2 Sufficient and insufficient stand-off

Evident in the literature and the results of the research (most notably from non-security professionals) were associations with stand-off being external, whereas internal stand-off distances can also be incorporated, in order to protect vulnerable assets within the building itself. Elliott *et al*. (1992, p.296) assert that there are, therefore, two phases of stand-off:

> "First, it is accomplished by a physical barrier, such as a ditch, a low concrete wall or bollards, that prevents vehicles driving close to a target…Second, stand-off is accomplished by rearranging the inside of a building so that valuable assets are as remote as possible from the greatest threat"

Considerable emphasis is placed on the importance of stand-off, due to the extent of damage that a blast can have on a building (CPNI, 2011, p.8; Tomlinson and Nelson, 2010, p.56), although there is recognition that in locations such as city-centres, high value land can render its incorporation impossible or unrealistic (Bosher and Kappia, 2010, p.1145; Mays and Hadden, 2009, p.12). Where sufficient stand-off can be incorporated, the extent to which protective construction measures are required decreases (CPNI, 2011, p.20; HM Government, 2010b, p.7; Lavy and Dixit, 2010, p.545; British Council for Offices, 2009, p.162; Forman *et al*., 2009, p.254). As expressed by one participant:

> "…the closer the stand-off distance is, the stronger the building has to be" (I6. Urban Designer, Local Authority)

Evident in the literature and the results of the research was the specification of such 'sufficient' stand-off being 30m, when considering a VBIED in the form of a car. The '30m rule' exists due to analysis of blast dissipation, but should not be solely relied upon, as the situational context of each building varies, influencing blast dynamics and requiring subjective assessments at each site to determine the required distances. Whilst Forman *et al*. (2009, p.12) purport that the cost of protective construction measures due to insufficient stand-off could be greater than incorporating HVM measures, the implications of incorporating such distances (and the feasibility of doing so in dense, urban settings), is unclear. Scenario-based discussion will therefore explore the incorporation of sufficient and insufficient stand-off.

7.3.2.1 Sufficient stand-off

30m of stand-off is mapped on to the scenario-based research instrument in Figure 7.7. Its enforcement through traffic exclusion (or restriction) requires the use of numerous VSBs and traffic calming measures, as shown in Figure 7.8. The benefits of incorporating such stand-off to the occupier of the main building are in not having to expend 4-15% of building costs on protective construction measures (depending on the extent of glazing within the building; figures based on interview data), but the consequences are profound.

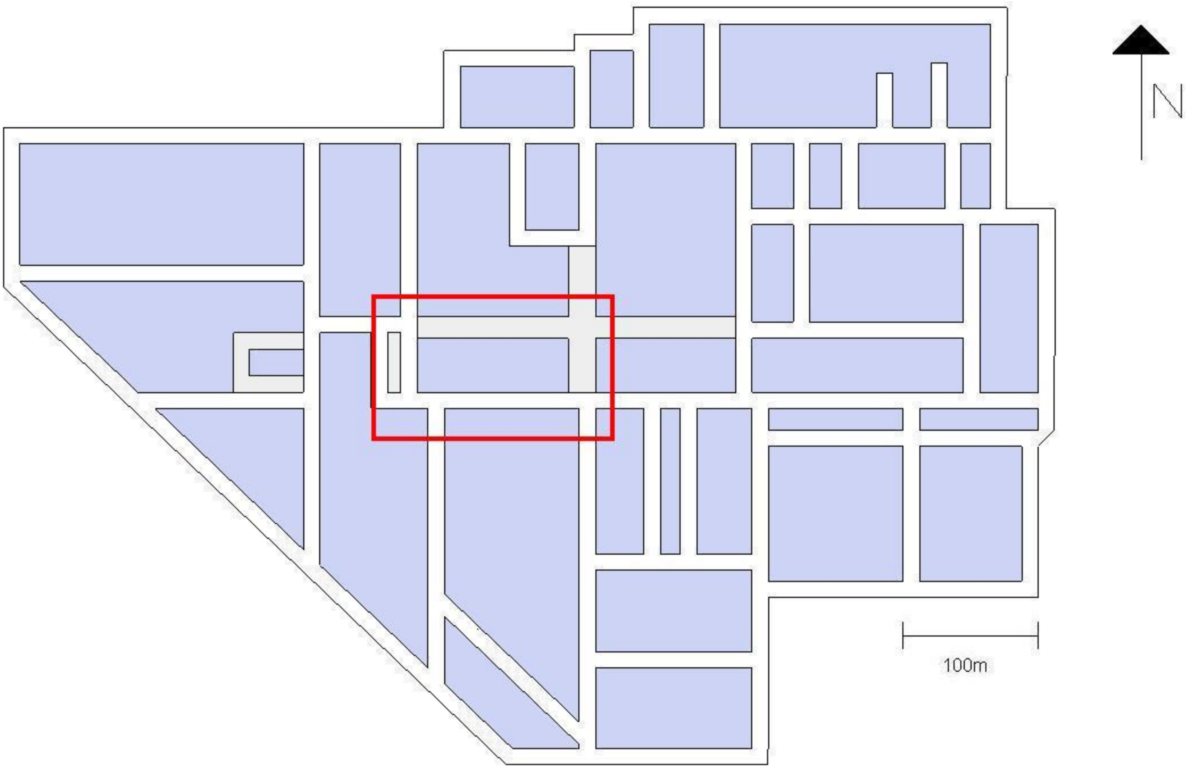


Figure 7.7. Sufficient stand-off mapped on to the scenario

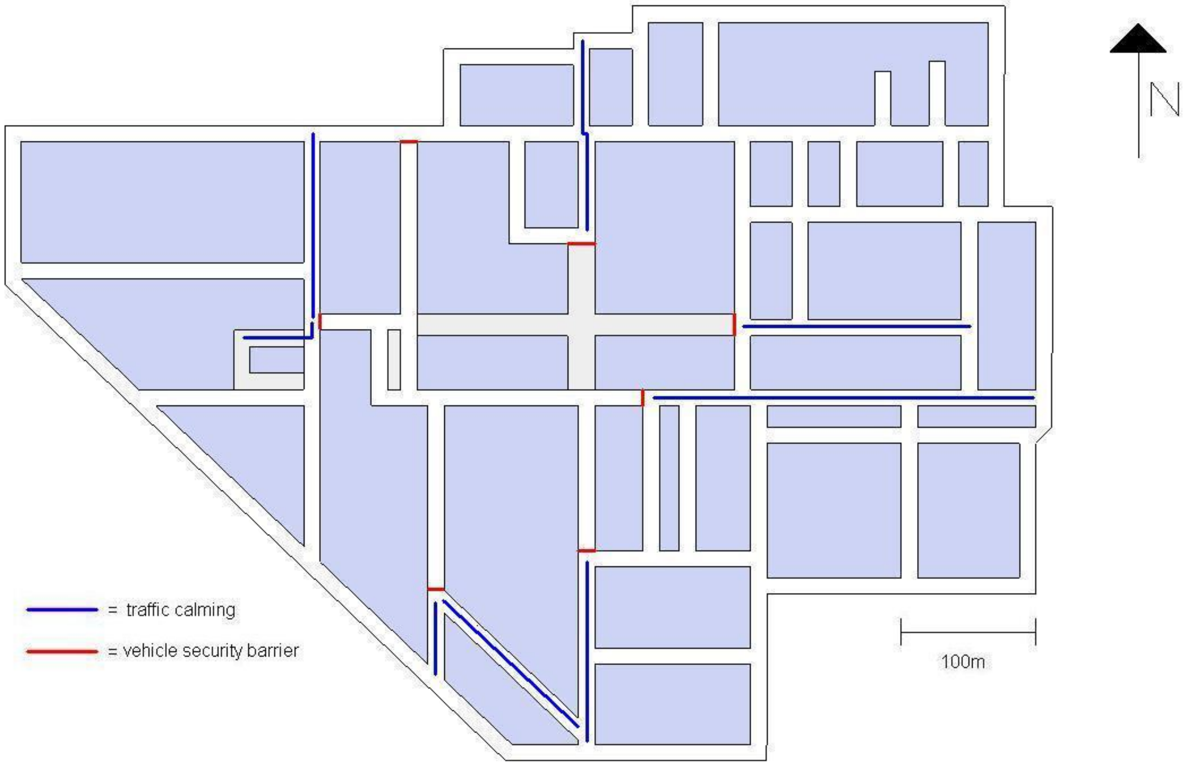


Figure 7.8. Required VSBs and traffic calming in order to enforce sufficient stand-off

The benefits of incorporating such an approach would also encompass the benefits that have been cited for traffic exclusion and pedestrianisation, most notably the increase in footfall and revenues of businesses, as well as the reductions in pollution. The consequences, however, would be disruption to traffic on the surrounding roads, due to the traffic calming measures that would be required, as well as the increased congestion as a result of the exclusion zone. If traffic calming measures weren't used, the requirements of the VSBs to withstand greater impact would potentially result in their increased cost and obtrusiveness. The cost of incorporating such an approach may be minimal compared to potentially 15% of a building's cost that would have to be spent in order to incorporate protective construction measures, but the spatial implications of such an approach would require reconciliation with the affected stakeholders and the inherent consequences of such an approach. As noted by one participant however, in relation to the means by which sufficient stand-off could be incorporated:

> "…the only way you're going to do it is to pedestrianise places" (I21. Technical Director, Construction Company)

7.3.2.2 Insufficient stand-off

If insufficient stand-off was available (or the means through which sufficient stand-off could be incorporated were denied), the impetus is then placed on protective construction as opposed to HVM. Whilst VSBs could be used to enforce some form of stand-off, as 'every metre counts' (CPNI, 2011, p.9), protective construction would be required to enhance the robustness of the building and protect the glazing. Such enhancements were stated as costing between 4-15%, dependent on the extent of glazing used (I17. Technical Director, Construction Company). Intrinsically linked to this scenario is the influence of the design stage in which such protection is being considered, as there are cost implications as well as restrictions in terms of what is feasible and what is not. If it was a designing-in scenario, laminated glazing could be incorporated, significantly reducing the impact of a blast and providing some environmental benefits in terms of UV ray reduction. If it was a retro-fit scenario, ASF could be applied to the existing glazing (and anchored within the frames if required, also dependent on the robustness of the frames and fixings due to the increased weight of the glazing). Internal partitions could also be incorporated or enhanced in order to protect users of the building, as could the relocation or reorganisation of offices, moving relatively redundant or less used offices towards the more vulnerable areas (i.e. those facing the roads). A secondary layer of glazing could also be incorporated, providing a 'sacrificial layer' of protection for users. Some of the aforementioned CTMs could be incorporated at no additional cost, but the impacts of blasts are entirely contingent on context, therefore subjective assessments of the damages (and their costs) are required on a case-by-case basis to identify cost-effective solutions.

The relationship between HVM and protective construction is clear; stand-off. Incorporating sufficient stand-off has inherent benefits for the occupiers of protected buildings, with cost savings being accrued through not having to incorporate protective construction measures. Benefits resulting from traffic exclusion, pedestrianisation and regeneration would also be accrued, however the consequences are profound, as was demonstrated in Figure 7.8. Where such stand-off is not feasible, or allowed, CTMs can be incorporated at no additional cost that provide cost-effective solutions to reducing the impacts of an attack. A negative consequence, however, could be the impact of sacrificial design and office relocation on productivity and user experience, which require further research. Only the subjective assessment of the impacts of an attack will determine the cost implications inherent in incorporating HVM measures to enforce external stand-off, and/or protective construction measures to incorporate internal stand-off. With the prominence of dense, urban settings evident today, the use of both will arguably provide the most cost-effective solution, especially considering the relatively low likelihood of an attack occurring.

7.4 Four Prominent Agendas

Throughout the literature review and the results of the research, four agendas have been consistently prominent, due to perceptions of them being at odds with counter-terrorism, or simply as a result of their importance in the design of crowded places. Those agendas are cost and return on investment, un-impinged design and permeability, user experience, and environmental and energy concerns. Each of these will now be explored, analysing their prominence and ascertaining the extent to which the protection of crowded places can contribute to or reconcile each one.

7.4.1 Cost and return on investment

The cost of incorporating CTMs has been seen as a key issue in relation to their incorporation (Andrew, 2009, p.695; Coaffee, 2008a, p.300; Little, 2004a, p.55). Yet, as highlighted by Little (2004, p.55), there is a paucity of data to support a convincing calculation of the costs and benefits of such measures and the issue remains evident to this day. There have been sporadic statements of potential costs of specific CTMs (see Crawford's (1995a) account of ASF, BBNC and protected spaces costing between 0-5% of building costs) and of cost-benefit analyses in relation to crime (Armitage, 2000) and natural hazards (Multihazard Mitigation Council, 2005), whereas others have offered insights into how costs can potentially vary. Forman *et al*. (2009, p.254) and Marshall (2002, p.9) have both raised how costs can vary depending on the design stage in which the CTMs are being incorporated (see section 7.3.1). Whilst the research has been unable to provide specific data in relation to the costs of CTMs (most notably due to participants stating that they felt this was not realistically achievable and would not be accurate), the research has presented a typology of CTMs that can be used to protect crowded places, as well as their relative performance and consequences. CTMs that can significantly reduce the risk to the health and safety of users of crowded places can be incorporated at no additional cost, through the organisation of the space plan of a building and by utilising existing assets and arrangements to fulfil counter-terrorism purposes, such as evacuation planning. Cherry *et al*. (2008, p.88) stated that:

> "Because terrorist attacks are relatively rare and design elements to deter terrorism are very expensive, these design elements must serve multiple purposes in order to be justified"

This research has highlighted that CTMs can be incorporated at no additional cost, but it has also shown that no single CTM explicitly benefits counter-terrorism and so such justification, as alluded to above, seems relevant. The incorporation of HVM measures can generate revenue and the exclusion of traffic can increase footfall and revenues for businesses, as well as catalyse the regeneration of areas. Protective construction mitigates the impact of a range of hazards, threats and major accidents and the protection of glazing can reduce energy costs. Planning, detection and procedures can facilitate the identification of hostile reconnaissance and interrupting of plots before attacks are carried out, the training for which is provided for free by CTSAs. Some cost data has been forthcoming, most notably the 4-15%

of building costs required to incorporate protective construction measures (dependent on the level of glazing and stand-off distances incorporated), and returns on investment are achievable. What has been presented are the inherent requirements, performance and consequences of CTMs that can be used to protect crowded places, as well as influences that can contribute to or nullify the value of CTMs themselves, all of which influence required costs and their resulting returns on investment. What has been presented therefore aids those tasked with the protection of such places to understand the influences on the protection of crowded places and on the value of CTMs, as well as the performance and consequences of the measures themselves, so that they can make informed decisions in relation to the subjective and individual context that each will face.

7.4.2 Un-impinged design and permeability

Evident in the literature was a plethora of work focussing on the symbolism and physical appearance of CTMs, with connotations of target hardening, architecture of fear, and the militarisation of public places and spaces. Such connotations of counter-terrorism therefore seem in direct contrast to un-impinged design and permeability. However, whilst the literature purported to the militarisation of such places and spaces, the demise of iconography, the decentralisation of places, increased fear, reductions in civil liberties and the increase in security zones, the research provides evidence to the contrary. During an interview with an architect, they stated that their ultimate goal when incorporating CTMs is to make the place or space look like it would have otherwise looked, yet still meet the security requirements (I8. Architect). This is the essence of un-impinged design and permeability and its achievement whilst incorporating CTMs is possible. Street furniture can be structurally enhanced to provide HVM functions and yet appear unprotected. Landscaping and nature can be used too, again providing HVM functions, replacing the bollards and planters to provide more aesthetically pleasing and ‘environmentally friendly’ CTMs. Protective construction can result in buildings being structurally enhanced and robust, mitigating the impacts of hazards, threats and major accidents whilst appearing indifferent; protection in stark contrast to perspectives of ‘architecture of fear’ and ‘target hardening’. Where connotations of such hardening are apparent, most notably through the protection of glazing, again, glazing can appear unprotected, yet be able to mitigate the impact of a blast. A negative consequence of incorporating such ‘invisible’ CTMs, however, is evident in both the literature and the results of the research. Literature purports to the use of such measures resulting in users of protected places feeling vulnerable to attack (Coaffee *et al*., 2009, p.499; Zilbershtein, 2005, p.812), yet Guidry (2007, p.69) highlights that it would alleviate such fears and enhance the quality of the area. As raised by one participant:

> "Half the value of a camera is knowing the camera's there…if you don't make it foreboding enough, then maybe you're actually encouraging threats" (I7. Associate Director, Design Consultancy)

The design of crowded places can appear to be un-impinged and facilitate permeability, yet concerns regarding perceptions of security and insecurity remain and directly relate to user experience.

7.4.3 User experience

> "When we consider the architectural environment as a caterer for the physical and physiological comfort of its users, issues as image and functioning of a facility become very relevant" (Zilbershtein, 2005, p.809)

As highlighted by Coaffee *et al.* (2008, p.104), however, academic work fails to address these issues. The literature review highlighted that further research was needed into the use of visible and invisible CTMs and how they influenced perceptions of the places where they were incorporated, as well as comparisons against unprotected sites. This was an issue informed by the results of the research, in which participants believed that visible CTMs lead to a perception of protection, yet the use of invisible measures would result in a perception of vulnerability and the attraction of an attack. Whereas such data provides an insight into the perspectives and inclinations of those who design and construct crowded places, specific data from end-users is lacking in the literature and this research. As suggested by Richards (2011, p.192), it is difficult to know which CTMs reassure the public and users of such places, and what CTMs cause greater anxiety. As discussed in the previous section, CTMs can be incorporated that do not appear to impinge on the design and permeability of crowded places, and should not increase the vulnerability to attack due to hostile reconnaissance and 'trained eyes' being able to identify that it is physically not possible to attack such places, yet how such measures influence the perceptions of those who use the places is unknown. It is not known whether visitors to crowded places are aware of CTMs and are therefore consciously aware of feelings in relation to protection or vulnerability, and neither is it known how staff in such places, especially previously targeted crowded places, perceive protection and the use of such measures. A pertinent recommendation, therefore, is for future research to address these issues, as such findings will influence the value of CTMs themselves and therefore influence whether crowded places are protected, and/or by what means.

7.4.4 Environmental and energy concerns

> "In future decades it is most likely that the sustainability agenda will provide the most appropriate policy vehicle for the achievement of resilience, with security seen as an

> essential element of corporate and organisational responsibility alongside economic, environmental and social concerns" (Coaffee, 2008b, p.4636)

Such environmental concerns were evident in the literature review (see section 3.3.2). A move towards a 'turquoise agenda' was explored, in which the merging of security and sustainability inherently results in the achievement of resilience. How the protection of crowded places and CTMs themselves can contribute to such agendas has also been made evident through this research. In terms of environmental benefits resulting from CTMs themselves, reductions in noise and air pollution are evident where traffic is excluded and restricted from areas, the protection of glazing can reduce energy consumption, and the incorporation of landscaping and nature can encourage biodiversity and 'green spaces', with the latter also being achievable through traffic exclusion also. The protection of crowded places can therefore positively contribute to environmental and energy concerns, proving that there are inherent synergies between the agendas. In relation to the broader resilience of such places and of organisations, the research contributes to the three-generation definition of resilience that was presented in the literature review (section 2.2.3). The definition of resilience purported that:

- First Generation resilience is concerned with the ability of systems to absorb shocks and to return quickly into operation
- Second Generation resilience relates primarily to community resilience and the recognition of social and psychological dimensions
- Third Generation resilience involves anticipation, as well as recognising that the system is often better off not 'bouncing back' to its original state (IPPR, 2009, p.73)

The research has highlighted that in terms of first-generation resilience, the incorporation of CTMs can aid organisations, built assets and urban areas to absorb shock and return to operation quickly, through the mitigation of the impacts of an attack and resulting reductions in damage, and more expedient responses and recovery (through such means as business continuity planning). In relation to second-generation resilience, findings have highlighted that greater research into the psychological dimensions of resilience are required, although significant benefits can be gained from protecting wider areas. Also evident through the research is the benefits of anticipation and pro-activity, most notably through the incorporation of CTMs prior to an attack and as a means of accruing the benefits of doing so in relation to the incentives of protecting crowded places. The research highlights that the relative performance and consequences of CTMs provide indications as to what can be expected when incorporating elements of resilience into crowded places and organisations, as terrorist attacks are one type of 'shock', many more pose risks to the built environment and require consideration and mitigation.

7.4.5 A reconciled design?

Having identified the aforementioned agendas, and analysing the extent to which this research contributes to their understanding in relation to CTMs, it could be questioned whether a design is achievable that reconciles those four agendas. When considering cost and return on investment there are two inherent issues; incorporating CTMs at no cost, and incorporating CTMs that provide a return on investment (albeit at a cost to implement them). Section 7.1.2.4 highlighted that the space plan of a building can be organised so as to reduce the impacts of a blast, and that a range of planning arrangements that are typically already used in businesses can be modified to incorporate counter-terrorism arrangements. Modifying the space plan of a building impinges on the design and permeability and on user experience of a building, and therefore conflicts with two of the identified agendas. Obtaining a return on investment, which is achievable through the use of advertising boards as VSBs and excluding traffic from a wider area (resulting in pedestrianisation, regeneration and increased property and area values in the long-term) also conflicts with design and permeability, and therefore the user experience as well.

Ensuring design and permeability appear/are un-impinged can be achieved through the use of laminated glazing in terms of protective construction, and the use of VSBs in the form of landscaping and nature, as well as street furniture. Depending on the VSBs used, the user experience would at least be un-impinged (although arguably it could be enhanced if landscaping and nature are used to improve the quality and amenity of the area), and environmental issues could be contributed to. Those CTMs, however, have cost implications and could only potentially provide a return on investment if the increased quality of the area (as opposed to the quality that would be gauged if SEBs had been incorporated) was seen as worthy of such increased property and area values. Linked to the design and permeability of buildings and areas is user experience, which as highlighted in section 7.4.3, is uncertain in relation to the impact of CTMs on users of visibly or invisibly protected, as well as un-protected, crowded places; further research is required on this issue in order to ascertain the extent to which user experience is affected by CTMs, which will in turn create the ability to discuss the implications of the range of CTMs available in relation to this. Environmental and energy issues can be positively contributed to through the use of glazing that reduces energy costs and the incorporation of traffic exclusion or restriction, which will reduce noise and air pollution, soiling of buildings and accidents involving pedestrians. The CTMs required to fulfil these concerns, however, have cost implications and therefore conflict with the cost agenda, but do provide a return on investment in the form of reduced energy consumption and the increases in property and area values as evident through the exclusion of traffic.

Whilst a design is achievable in which CTMs can be incorporated at no cost (the space plan of a building) and provide a return on investment (the use of advertising boards, and the exclusion of traffic resulting in increased property and area values), these impact the design and permeability, as well as the user experience, of a building and area. However, the incorporation of pedestrianisation was proven to increase footfall for businesses within the protected areas, due to the increased comfort and safety of pedestrians (which provides an insight into the findings of investigations into the experience of those using crowded places). Environmental and energy concerns could be contributed to by reductions in pollution and building soiling, as well as increased safety of users, whilst glazing could reduce energy consumption. Figure 7.8 shows how such a design would be achieved. Evident in the Figure is the disruption to the permeability of the area outside of the protected ‘zone’; whilst reconciling the agendas as much as possible, significant implications are inherent for those outside the exclusion. Therefore, a reconciled design based on the four prominent agendas is not achievable; the extent to which any reconciliation could be achieved is dependent on the values of those involved in the design or retro-fitting of crowded places, which will inform the trade-offs made to incorporate CTMs that vary in terms of cost and return on investment, un-impinged design and permeability, user experience, and environmental and energy concerns.

7.5 Conclusion

The relative performance and consequences of CTMs used to protect crowded places show that no single CTM explicitly mitigates the impact of a terrorist attack; additional benefits are inherent in every measure that has been identified and analysed during this research. The notions of single-purpose products and the protection of vulnerable places only being achieved through ‘target hardening’ have been proven to be misleading. The benefits of HVM includes the increased safety and comfort of pedestrian users of spaces, the removal of the need to modify the design and structure of a building, the increased footfall and revenue for protected businesses, the ability of CTMs to generate revenue, as well as the environmental benefits in terms of reduced pollution. Anecdotal evidence even asserts the ratio that for every £1 spent on HVM and street enhancement, increases in value of £5 can be gained. However, the implications of such CTMs includes the displacement of traffic and increased congestion in areas surrounding traffic exclusion and restriction. The benefits of protective construction includes the robustness of buildings to the impacts of a range of hazards, threats and major accidents, as well as reductions in energy costs. Protective construction measures can also be incorporated at no additional cost, although others can result in 4-15% of building costs being spent, and impacts of sacrificial design and the specific organisation of space plans require further attention. The benefits of planning, detection and procedures includes the resilience of businesses to a plethora of potential disruptions and challenges, as well as the free training of staff to enhance their skills and awareness of a range of security threats, which can even interrupt plots prior to their manifestation into attacks. Encompassed CTMs typically already exist in organisations and therefore provide additional incentives for their use.

The benefits and implications of the CTMs that have been identified are somewhat objective; determined positive and negative consequences of a specific set of decisions. Their perceived value will depend on the values of those involved in the decision-making processes and the context in which the crowded place is being designed or retro-fitted. It is the subjective assessment of the relative performance and consequences of the CTMs that will aid in the reconciliation of differing perspectives and agendas. The incorporation of CTMs can lead to revenue generation and returns on investments, can incorporate un-impinged design and permeability, enhance the aesthetics and functions of an area, and positively contribute to environmental and energy concerns. However, this research has also shown that a number of influences determine whether crowded places are even protected, before consideration of CTMs has begun. Influences on the value of the CTMs themselves are also apparent, with TARAs, stakeholder understanding and engagement, and auditing having the potential to nullify any benefits that have been accrued through the incorporation of CTMs.

8.0 Conclusions of the Research

In fulfilment of the aim and objectives of the research, this chapter presents the conclusions of the research, highlighting its key findings and contribution to knowledge, with the validity and reliability of the research itself also being examined. Recommendations for further research and practical recommendations will then be presented, followed by a final thought that emanates from the research.

8.1 Fulfilment of the Aim and Objectives of the Research

The aim of the research was to examine the relative performance and consequences of protecting crowded places from VBIEDs (as presented in section 1.2.1), which was to be achieved through the fulfilment of five objectives, each of which will now be explored.

8.1.1 Objective one

Objective one of the research was to "examine current research on protecting key components of the built environment from terrorism and on the emergence of the terrorist threat". Chapters Two, Three and Four examined such literature, most notably identifying the emergence and evolution of the threat that is faced from terrorism, and the means through which the built environment is protected from it. Analysis of the literature highlighted that the crowded places are at particular threat from the use of VBIEDs, and three categories of CTMs are used to protect them, those being HVM, protective construction, and planning, detection and procedures. The research also found that several factors influence the protection of crowded places and the value of CTMs themselves (section 8.2.1).

8.1.2 Objective two

The second objective of the research was to "develop a typology of CTMs that are used to protect crowded places from terrorist attacks, specifically in relation to the mitigation of VBIEDs". The typology, which presents the relative requirements, performance and consequences (including additional information such as cost data and reconciliatory comments) is presented in Appendix C7.1. The typology was formed from Chapter Four, with its completion and validation being achieved through research in both the UK and USA, as discussed in Chapter Five.

8.1.3 Objective three

Objective three of the research was to "evaluate the relative performance of CTMs in relation to their cost, effectiveness and impact for a range of scenarios". The typology (Appendix C7.1) presents the relative performance of each CTM that can be used to protect crowded places, yet exploration of their performance was also made in Chapter Seven. The research found that every CTM has additional benefits (section 8.2.2), with CTMs being able to be incorporated at no cost, and generate revenue (section 8.2.3).

8.1.4 Objective four

The fourth objective of the research was to "identify the impacts, positive and negative consequences, and trade-offs that derive through designing in and retro-fitting CTMs". The typology (Appendix C7.1) also presents the consequences and trade-offs that are inherent in the incorporation of CTMs, as does Chapter Seven. The research found that the negative consequences of incorporating CTMs can be profound (section 8.2.4), and that retro-fit scenarios reduce the feasibility of their incorporation, increase their cost, and can reduce their effectiveness (section 8.2.5).

8.1.5 Objective five

Objective five of the research was to "produce guidance for key decision makers who are responsible for the protection of crowded places, to inform future legislation, guidelines and codes of practice". The research itself can be seen as guidance as it has presented its findings in fulfilment of its aim and objectives, yet it also makes a number of practical recommendations that directly relate to those who are responsible for the design, construction and operation of the built environment. Publications that are already in the public domain are presented in Appendix C8.1, and it is anticipated that forthcoming publications based on the findings of the research will form a significant part of the impact of the research itself.

8.2 Key Findings of the Research

In line with the above, there are five key findings of the research, those being:

- several factors influence the protection of crowded places and the value of CTMs themselves;
- every CTM has additional benefits;
- CTMs can be incorporated at no cost and can generate revenue;
- the unintended consequences of incorporating CTMs can be profound; and

- retro-fit scenarios reduce the feasibility of incorporating CTMs, increase their cost, and can reduce their effectiveness.

8.2.1 Several factors influence the protection of crowded places and the value of CTMs themselves

The research developed a theoretical framework, identifying that eight factors influence whether the protection of crowded places occurs, and three factors that influence the value of CTMs themselves (section 7.2). A summary of the influences that result in the protection of crowded places not occurring is presented in Figure 8.1. Whilst the literature interprets existing legislation encompassing duties of care in relation to the mitigation of terrorist attacks, the empirical findings of the research do not concur. As a result, CTSAs and ALOs have been intentionally left out of the planning and design of some crowded places, and organisations have fired employees in order to ensure protective measures are not incorporated into developments. The incentives of protecting such places are widely unknown and under acknowledged, with empirical findings highlighting evident reductions in risk and impacts of hazards, threats and major accidents, competitive advantages, revenue generation, conducive agendas and possible insurance benefits. TARAs can result in excessive outcomes that are disproportionate to the threat; perceptions of terrorism can be at odds with the reality of the situation and leave places vulnerable to attack. Stakeholder understanding and engagement can also leave such places vulnerable, through the intentional avoidance of security professionals (as already stated) and a lack of understanding regarding risk, with neighbouring businesses to high-profile crowded places not incorporating protective measures due to perceptions of ‘not a target, not at risk’. Economic influences, varying local policy, and building stock rotation can also influence whether such places incorporate protective measures.

8.2.2 Every CTM has additional benefits

The empirical findings of the research have highlighted that every CTM that can be used to protect crowded places has inherent additional benefits. While some HVM measures perform security-specific functions (and are therefore termed ‘security-explicit barriers’, their incorporation results in protection from a range of threats. Street furniture that can be enhanced to perform HVM functions evidently perform additional functions in providing forms of public amenity and in some instances, revenue generation. Landscaping and nature, whilst also having the capability to perform HVM functions, also evidently perform additional functions. Protective construction results in the mitigation of hazards, threats and major accidents, enhancing the robustness of a building, so incurring less damage as a result of the manifestation of any of the aforementioned risks.

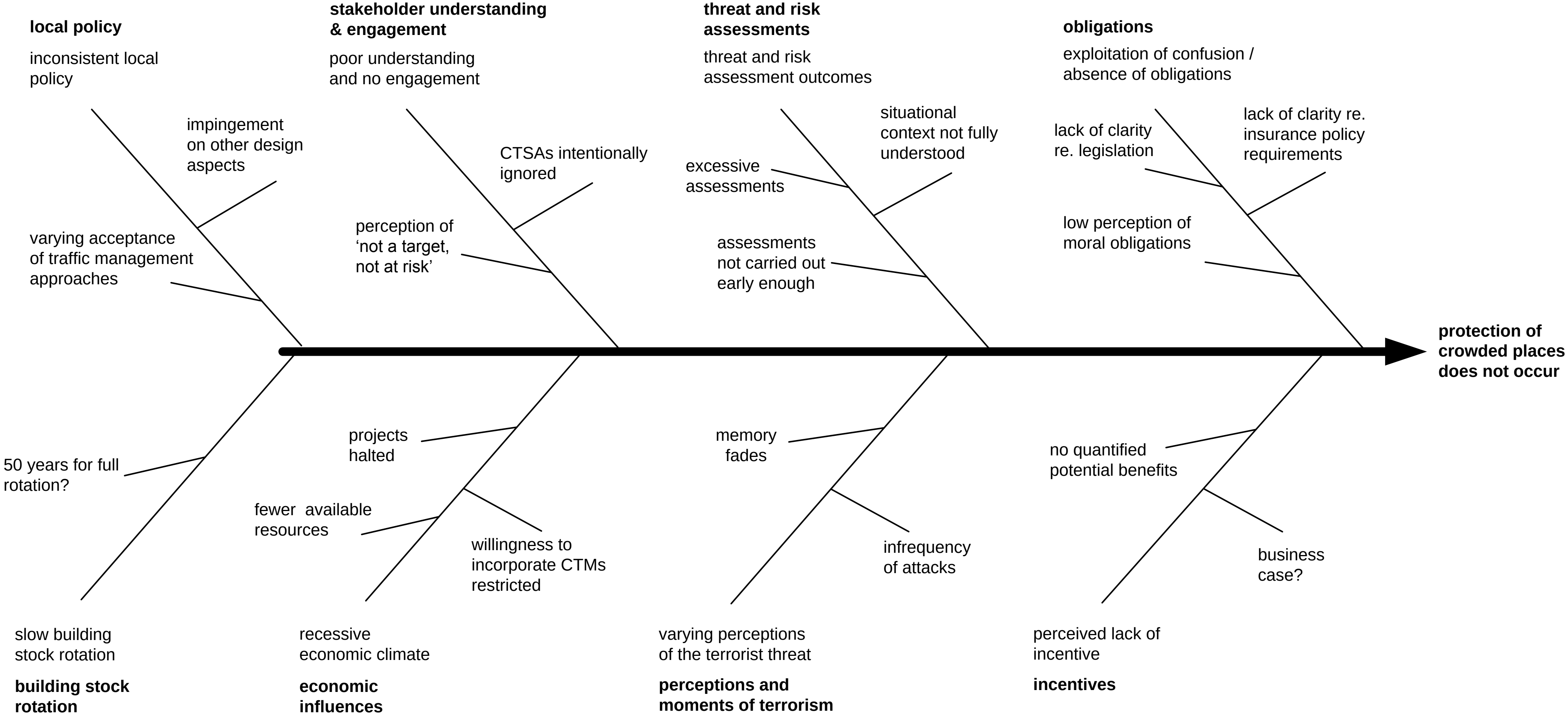


Figure 8.1. A fish-bone diagram summarising the influences that prevent the protection of crowded places

The vast majority, if not all, of the CTMs within planning, detection and procedures typically exist in crowded places due to the functions they provide and/or fulfil; an example being the use of security guards to deter, identify and respond to crime, as well as business continuity planning which aids businesses in preparing for, mitigating, responding to and recovering from a plethora of potentially disruptive events. None of the CTMs examined here are counter-terrorism-explicit.

8.2.3 CTMs can be incorporated at no additional cost and can generate revenue

Evident in the literature was the association of CTMs with expenditure, however, the empirical findings of the research have highlighted that a number of CTMs can be incorporated at no additional cost, most notably when being considered during the planning and design stages of a project. The organisation of structural columns, location of services, and the organisation and positioning of space plans can all be incorporated without cost, enhancing the robustness of structures to mitigate a plethora of hazards, threats and major accidents, as well as reducing the impacts of such events. There may be disruption costs and implications if the space plan of a building is changed in a retro-fit scenario, nonetheless it provides a cost-effective means of reducing potential impacts, especially when considering the implications of enforcing sufficient stand-off to reduce blast impact.

CTMs can also generate revenue, through their inherent functions or through the increase of property and rental values (most notably advertising boards, although such means of advertising could be incorporated onto/in any large CTM and provide income streams for building owners/occupiers). Through the incorporation of CTMs, empirical findings suggest building owners could charge increased rent, due to the increased security of the building and the resulting reduction in damages that would be incurred in the event of an attack or other such event. Also, the incorporation of traffic exclusion and the resulting increases in footfall and revenues of businesses, as well as the facilitation of pedestrianisation, regeneration, environmental enhance and holistic design, can lead to increased property values, providing returns on investment for those who own, rent and lease developments.

8.2.4 The unintended consequences of incorporating CTMs can be profound

Unintended consequences are inherent in relation to HVM. The findings of the research highlight that traffic exclusion can result in increased congestion within the surrounding areas, and that where traffic restriction is incorporated, users of the protected site and users of the road networks that are external to the site can be impacted. Authenticating and searching vehicles has inherent time implications that, dependent on the vehicle throughput and the juxtaposition of the site to its surrounding area, can cause queues that can encroach onto external road networks and disrupt traffic. Where traffic calming measures are incorporated into road networks, disruption to traffic is also evident. The consequences of visible CTMs and the organisation of space plans to shelter critical areas from vulnerable locations require further research: the findings of the research highlighted concerns in relation to increases in fear and the reduction of productivity, but evidenced accounts (either way) have not been forthcoming.

8.2.5 Retro-fit scenarios reduce the feasibility of incorporating CTMs, increases their cost, and can reduce their effectiveness

Retro-fit scenarios can restrict the feasibility of incorporating CTMs, most notably through a number of protective construction measures not being physically achievable in such circumstances, and can result in less effective CTMs being incorporated. The design stage in which CTMs are incorporated also has implications in terms of time, costs, and disruption. Designing-in CTMs can therefore have a number of time, cost and disruption advantages. Designing-in CTMs can therefore have a number of advantages over retro-fitting such measures, through reductions in the time, cost and disruption implications of stakeholder engagement and the deciding on appropriate courses of action; the removal, making safe, and replacement of existing street elements or inappropriate CTMs with the required, fit-for-purpose CTMs; the diversion of existing utilities; the robustness (and potential obtrusiveness) of CTMs; as well as nullifying restrictions in relation to the feasibility of incorporating CTMs that could be used.

8.3 Contribution to Knowledge

Knowledge can be seen as a justified true belief (Knight and Turnbull, 2008, p.65); a belief in itself is not enough, it has to be justified. Through the interpretation and analysis of existing literature and collected and analysed data, the findings of the research assert such beliefs through methodological, empirical, theoretical and industrial contributions to knowledge.

8.3.1 Methodological contribution

Methodologically, the research contributes to the knowledge on the conduciveness of qualitative research methods to inductive research. The research adopts an interpretivist epistemological position, and a critical realism position in relation to ontology. The constructed research design facilitated the development of a provisional typology that was validated through a preliminary study, from which a theoretical framework that underpinned the collection and analysis of data also emerged. A scenario-based research instrument was also developed, from which the main study was conducted both in the UK and in the USA.

The research highlights the capacity of inductive research to represent the reality of a situation that is being investigated, through the exploration of the subjective interpretations of participants who work in the area being investigated. The use of observations during site visits, as well as document analysis, result in the research adopting a qualitative research design of international scale that is not evident in any prior counter-terrorism research.

8.3.2 Empirical contribution

Empirically, the research provides original, previously uncollected data on the protection of crowded places from terrorist attack, most notably in relation to what measures can be used (Objective Two), the relative performance of those measures (Objective Three), and their implications (Objective Four). As a result of the inductive nature of the research and its informed direction, the research also provides empirical data on the influences that determine whether such places are protected and which can impact the value of their protection. The research therefore provides a significant body of empirical knowledge that, whilst being pertinent to those who influence the protection of crowded places from terrorist attack, is also of relevance to those who are responsible for the design, construction and operation of the built environment more broadly.

8.3.3 Theoretical contribution

Theoretically, the research provides an original and up-to-date account of the protection of the built environment (Objective One), whilst advancing debates surrounding the perceived implications and (lack of) benefits from protecting vulnerable places. It provides a theoretical framework that identifies influences on the protection of crowded places, as well as on the value of CTMs that can be used to protect them. Literature on those influences is explored, with the empirical findings of the research also being used to conduct a thorough analysis of their implications. By developing a typology of such measures (Objective Two; Appendix C7.1), which also captures their relative requirements, performance and consequences (Objectives Three and Four), the research contributes to theory in relation to the protection of vulnerable places, not just from terrorist threats, but from a range of threats, hazards, major accidents and other disruptive events. The creation of the theoretical framework is also pertinent here, as the research is the first to produce such a framework and investigate the protection of crowded places in such a way. It therefore provides a significant amount of theory that is pertinent to those who study counter-terrorism specifically, as well as those who research the design and resilience of the built environment and the socio-institutional systems that exist within them.

8.3.4 Industrial contribution

Practically, the research has importance for those who have a role in the protection of crowded places from terrorist attack, as well as those who are responsible for the design and resilience of the built environment more broadly. The research has highlighted the scale of factors that are evident in the design, construction and operation of such places, most notably in relation to the obligations, incentives, risk assessments, perceptions of risks, understanding of (and engagement between) stakeholders, economic situation, local policies, and building stock issues that influence the incorporation of protective measures. As well as this, influences on the value of incorporating such measures have been made evident, so that stakeholders are aware of the factors that can potentially nullify any value that has been accrued through the protection of such places. Most notably and specifically in relation to the protection of crowded places from terrorist attack, the research indicates that there are both legislative and non-legislative obligations to incorporate CTMs into such places, but also significant incentives for a range of stakeholders who adhere to them. The research also provides those stakeholders with a typology of CTMs that can be used to protect crowded places, as well as providing information on their relative performance and consequences, guiding those who are responsible for the protection of such places (Objective Five).

8.3.5 Policy contribution

Considering the contributions of the research (section 8.2) and the aforementioned contributions to knowledge (section 8.3) that have been made, the research concludes that the encouragement of incorporating CTMs into crowded places should receive greater emphasis considering the evident benefits. The implications, therefore, of incorporating CTMs (and of the 'Protect' strand of CONTEST), result in a number of other agendas being positively impacted, such as increased quality and amenity of public space, regeneration, and holistic approaches to security and resilience. As a result of CTMs being able to mitigate a range of other threats, hazards and major accidents, greater consideration of the range of risks that a crowded place can face is required; a more inter-connected and over-arching strategy is therefore required for the resilience (as opposed to 'protection' in relation to counter-terrorism) of crowded places. NaCTSO and the CPNI should therefore continue to increase cohesion between other institutions, and governing and regulatory bodies.

8.4 Research Validity and Reliability

> "…unless you can show your audience the procedures you used to ensure that your methods were reliable and your conclusions valid, there is little point in aiming to conclude a research dissertation" (Silverman, 2010, p.274)

Silverman (2010) asserts that there are four 'quality criteria' that can be used to ensure such rigour, those being the use of theory and analytic depth, the use of a self-critical approach, the use of appropriate research methods, and the making of a practical contribution. The rigour of proposed or carried out research can be checked by reflecting on those criteria in the form of questions. Each question will now be presented and reflected on, in order to ascertain the validity and reliability of the research itself whilst also identifying and reflecting on the limitations of the research and acknowledging the need for and use of reflexivity by the researcher.

8.4.1 Analytic depth

> "How far can we demonstrate that our research has mobilized the conceptual apparatus of our social science disciplines and, thereby, helped to build useful social theories?" (Silverman, 2010, p.303)

Prior to any data collection and analysis, an extensive literature review was undertaken for a period of over 12 months, which constructed an informed account of the plethora of design considerations that are evident in the agendas of those who design, construct and operate the built environment. How they are designed in order to incorporate resilience was also examined, which lead to the specific investigation of terrorism and counter-terrorism in the UK. A provisional typology of measures that can be used to mitigate the impacts of terrorist attacks was then formed, from which the consideration of research methodology and the subsequent construction of a research design were formed. The adopted research design and subsequent analysis of data resulted in the identification of a number of influences on the protection of crowded places, as well as on the value of measures used to protect them. This lead to the re-visiting of the literature in order to construct a theoretical framework that was based on the aforementioned influences and under-pinned the remaining collection and analysis of data, as well as its presentation, discussion, and verification. The empirical results of the research were compared and contrasted against the literature, in order to provide informed and evidenced findings. It is therefore argued that the analytical depth of the research is its inherent strength, through the iterative nature of the collection and analysis of data with the identification and analysis of literature, resulting in the internal validation of the findings themselves, as was evident in Chapter Seven.

8.4.2 Self-criticality

> "How far can our data, methods and findings satisfy the criteria of reliability and validity or, put more crudely, counter the cynic who comments 'Sez you'?" (Silverman, 2010, p.304)

What Silverman (*ibid*.) questions is whether the research has based its validity solely on its theoretical roots and has ignored conventional methodological approaches, or has applied such methodological rigour in order to ensure greater validity and reliability. The theoretical grounding of the research and its findings are evident, with the development of a theoretical framework, typology, and scenario-based research instrument being informed by the literature. The development of a typology was an objective of the research, but the formulation of a theoretical framework was not; the framework was created as a result of data that had been collected and the realisation that such a framework was needed to capture data that the participants felt were important. It is therefore apparent that the research does indeed reflect the 'social reality', and a number of conventional methodological approaches, as referred to above, were incorporated into the research design. Firstly, the research instruments were formed through the iterative processes of literature review, and data collection analysis, upon which the data itself was coded. Procedures were incorporated to ensure that interviews were analysed cyclically, by repeating their analysis during a 'second round' once all of them had been originally analysed, in order to ensure that any new themes or categories that emanated towards the end of the research were then analysed against earlier interviews. Additional, internal validation of the data and findings was also undertaken, through the use of discursive analytical chapters, evidencing the typology itself, as well as the theoretical framework and emanating key issues (Chapter Seven). However, the adopted sampling methods are at odds with objectives of representativeness and unbiased collection of data because of the theoretical and snowball sampling methods that were chosen for the research. While those sampling methods do not support claims of representativeness, it is argued that they do adhere to being reflective of the 'social reality' and that the analytical methods used are of such rigour to warrant the research being determined as both valid and reliable.

8.4.3 Appropriate research methods

> "To what extent do our preferred research methods reflect careful weighing of the alternatives or simple responses to time and resource constraint – or even an unthinking adoption of the current fashions?" (Silverman, 2010, p.304)

Considering the inductive nature of the research, a qualitative research strategy and design were adopted, in order to understand and probe the subjective interpretations of participants. An objective of the research was to develop a typology of CTMs that can be used to protect crowded places (Objective Two), which could not be achieved without the creation of theory, through findings (inductive process requiring qualitative research methods). The same can be said for the examination of the relative performance and consequences of the CTMs themselves, as only sporadic data on such attributes was evident in the literature, and the use of qualitative research methods was required in order to ascertain participants' knowledge regarding these issues. The research was predominantly based on interviews, but observations during site visits and document analysis were also used, as was a scenario-based research instrument that graphically aided participants in exploring the performance and consequences of CTMs (the need for such an instrument was evident from the initial responses of participants). However, the lack of specific data in relation to the monetary costs of the majority of the identified CTMs is clear, despite the collection of such data being part of one of the objectives of the research (Objective Three). Participants felt that the accurate collection of such data was unachievable, as reflected on in section 5.4.2.2, but the construction of a quantitative research instrument that created price brackets, whilst also utilising qualitative research methods to explore the subjective reasoning of such assertions, could have provided, at the very least, indications as to the potential expenditure required. Yet, as mentioned previously, the decision was taken to adhere to the importance of the influences that determine whether crowded places are protected, and the performance of the CTMs themselves, that was made evident by the participants. The research was therefore unsuccessful in fulfilling that particular component of Objective Three, and is therefore a recommendation for further research.

8.4.4 Practicality of the research

> "How can valid, reliable and conceptually defined qualitative studies…contribute to practice and policy by revealing something new to practitioners, clients and/or policy makers?" (Silverman, 2010, p.306)

Discussions on the industrial/practical contribution to knowledge (section 8.2.4) highlighted that the research contributes to such practice in a number of ways. Firstly, it has developed a typology of CTMs that can be used to protect crowded places. This aids those who are responsible for the protection of such places to make informed decisions, through having all the possibilities that can be used presented to them. Secondly, and in line with the development of the typology, the performance and consequences of the CTMs themselves has been presented, again to inform those responsible as to the potential benefits and consequences of their actions. In addition, influences on the protection of crowded places have been identified, one aspect of which is the identification of six over-arching incentives to protect such places, as were influences on the value of CTMs themselves, which can nullify any value that has been accrued. Therefore, the research presents a significant body of knowledge that is relevant not only to stakeholders who are responsible for the protection of crowded places from terrorist attack, but also to those whose roles influence the design and resilience of the built environment, as well as its socio-institutional systems.

8.5 Recommendations

The research has produced guidance for key decision makers who are responsible for the protection of crowded places (Objective Five), guidance that has examined how the built environment is protected, most notably in relation to the mitigation of terrorist attack (Objective One), and has developed a typology of CTMs that can be used to protect such places (Objective Two), which highlights the relative performance and implications of doing so (Objectives Three and Four). However, in doing so it has also uncovered a number of areas that require further attention, and therefore makes practical recommendations, as well as recommendations for further research.

8.5.1 Practical recommendations

Practical recommendations made by the research are: the clarification of the legislative situation in regard to duties of care as a result of the terrorist threat; the need for governing bodies and institutions to disseminate and promote the incentives for, and benefits of, protecting crowded places; the need for further debate on what constitutes proportionality and proportionate protection of a crowded place; and encourage greater engagement between stakeholders and the means through which this can occur.

8.5.1.1 Clarification of the legislative situation in regard to duties of care

Whilst literature states that there are obligations to protect crowded places under existing legislation, notably the Management of Health and Safety at Work Act (1992), and the Corporate Manslaughter and Corporate Homicide Act (2007), empirical findings of the research do not reflect such assertions; there is confusion and uncertainty regarding the legislative requirements to protect such places, which is resulting in CTSAs being intentionally avoided and CTMs not being incorporated into vulnerable places. There is therefore a need for greater clarity regarding the legislative situation in relation to the protection of such places, with a clear statement from a governing, regulatory or authoritative body (such as NaCTSO, CPNI, the Home Office, or the Health and Safety Executive), articulating the extent to which existing legislation is applicable to terrorism-related scenarios, and therefore, the extent to which duties of care apply to crowded places.

8.5.1.2 The dissemination of the incentive for and benefits of protecting crowded places

Evident in literature and the empirical findings of the research is the notion that the incentives for, and benefits of, protecting crowded places from terrorist attack are not widely known.

The incentives, as presented in section 7.2.1.2 and Figure 7.5, highlight that incorporating CTMs can result in reductions in risk and impacts of an attack, create competitive advantages, generate revenue, be conducive with other agendas, and can result in insurance benefits. If those responsible for the design, construction and operation of crowded places are to continually be encouraged to incorporate CTMs, then the incentives for them to do so (regardless of any legislative requirements) must be made publically available and appropriately disseminated. It is therefore recommended that information on this is made publicly available, which could be achieved through the publishing of such guidance by NaCTSO, based on this research.

8.5.1.3 Further debate and transparency on what constitutes proportionality and proportionate protection

Coupled with the recommendation for further research in relation to this (section 8.5.2.3) is the need for public debate on how proportionality is assessed, by CTSAs and others who undertake TARAs, and how crowded places are thus 'proportionately protected'. Empirical findings of the research highlight that a lack of transparency by CTSAs in relation to this is acting as a barrier between them and the stakeholders they are trying to work with, which transcends to the incorporation of CTMs (or not) being affected. Guidance is therefore required to aid those responsible for undertaking TARAs and creating designs in gauging proportionate responses and being able to have transparent discussions on how such responses are formed, whilst also acknowledging and understanding that there will always need to be a secrecy surrounding intelligence regarding terrorist threats.

8.5.1.4 Encourage greater engagement between stakeholders and the means through which this can occur

Empirical findings of the research have highlighted that numerous benefits exist in relation to the incorporation of CTMs into crowded places, and in designing-in such measures as opposed to retro-fitting them; designing-in CTMs has a number of advantages over retro-fitting, through reductions in the time, cost and disruption implications of:

- stakeholder engagement and deciding on appropriate courses of action;
- removal, making safe, and replacement of existing street elements or inappropriate CTMs with the required, fit-for-purpose CTMs;
- diversion of existing utilities;
- robustness (and potential obtrusiveness) of CTMs; and
- nullifying restrictions in relation to the feasibility of incorporating CTMs that could be used.

Findings also highlighted that engagement between stakeholders responsible for the design, construction and operation of crowded places is not occurring to the extent it could, which impacts the stage in which CTMs are considered and incorporated, and as demonstrated above, can influence their cost and effectiveness. Greater encouragement by governing and authoritative bodies and institutions, such as NaCTSO and RIBA, therefore needs to be forthcoming, with one solution being the use of charette-type meetings (Glass, 2008), which would provide a platform for stakeholders to quickly assess potential solutions and their benefits and consequences.

8.5.2 Recommendations for further research

Further research should be undertaken in relation to the monetary costs of incorporating CTMs, user experience of protected crowded places and the implications of 'invisible' CTMs, and the assessment and incorporation of proportionality.

8.5.2.1 The cost of incorporating CTMs into crowded places and organisations

The literature review highlighted that there was a paucity of data in relation to the costs of CTMs, a paucity that has not been contributed to as was previously intended and documented in the objectives of this research. The research has presented findings in relation to the relative performance and consequences of CTMs, but only sporadic data on the monetary costs of such measures has been forthcoming. Considering a crucial component of risk assessments and the carrying out of TARAs is the assessment of the cost-effectiveness of such solutions, such assessments cannot be carried out without specific cost data. Such costs are specific to the subjective and unique nature of each area, site and building, but there is potential for the quantitative investigation of such costs, or their investigation through case study research, which ideally suits the context-dependent nature of such research, especially considering the establishment of a typology of CTMs that can be used and the identification of factors that influence their incorporation. The need for detailed research into the cost-effectiveness of such measures, as previously highlighted by Harre-Young *et al*. (2009, p.1290) remains. A recommendation is, therefore, that such research is carried out in order to contribute to the growing body of research on the value, not just cost-effectiveness that is inherent in the mitigation of hazards, threats and major accidents.

8.5.2.2 User experience of protected crowded places and the implications of 'invisible' CTMs

Whilst the development of the typology of CTMs identified that connotations of such measures solely encompassing 'architecture of fear' and 'target hardening' were misleading, and that CTMs can be incorporated that do not appear to be performing counter-terrorism functions, the implications of those measures on the users of such places is unknown. Whilst a range of benefits of CTMs is evident, their value could be somewhat nullified or irrelevant if users of crowded places are detrimentally affected by their use. Whether obtrusive, proportionate yet visible, or invisible, the visibility of CTMs requires further attention in order to identify the subjective interpretations of such protection by those who come into contact with them. For example, while the exclusion of traffic results in numerous benefits, including increased revenue for businesses and reductions in pollution, if the productivity and psychological comfort of staff within protected buildings is negatively impacted, such benefits will be irrelevant if the measures incorporated to increase the security and safety of those people actually makes them feel less secure and/or safe.

8.5.2.3 The assessment and incorporation of proportionality

The research has highlighted what CTMs can be used, as well as their performance and consequences, yet there is a lack of clarity regarding how proportionality is assessed and incorporated into urban and building designs (again, whilst acknowledging the need for secrecy surrounding intelligence on terrorist threats). TARAs influence both the protection of crowded places, and the value of the CTMs that are used to protect them. Proportionality is the essence of such assessments, yet little is known regarding how such a phenomenon is assessed or translated into the design of crowded places. The clandestine nature of the assessment of risks to crowded places by CTSAs was made apparent by participants, who felt that being told what level of risk they faced but not being told why was not helpful in holding open discussions about the ways to reduce the vulnerabilities of such places. This leads to the question of 'what is proportionate?'. How can the proportionate protection of crowded places occur if the risk assessments that highlight their vulnerabilities (and the proportionate means through which they can be mitigated) are not made available to those who are designing the places themselves?

> "Anecdotal evidence suggests that architects and other consultants engaged on sensitive projects are not able to divulge information to anyone outside the immediate project team, so published case studies of benefit to other designers are hardly likely to become readily available" (Glass, 2008, p.179)

Whilst this may be so, sensitive information in relation to the vulnerabilities of sites only needs to be known by those involved on that particular project, in order to formulate proportionate solutions. The research therefore recommends that further debate is embarked on in relation to this matter, as well as research being carried out to identify the components of urban and building design that influence proportionality. This should be done in order to aid those who are responsible for the protection of crowded places to fully understand why and how such places are vulnerable, to identify the most proportionate means through which such vulnerability can be mitigated, and to fully understand why certain information (such as in relation to specific threats) cannot be made public. This, in turn, will result in the chances of such places and the CTMs used to protect them being over-engineered and obtrusiveness, or under-engineered and vulnerable, being significantly diminished.

8.6 A Final Thought

> *Why should organisations spend money incorporating counter-terrorism measures when they don't have to?*

This was the question repeatedly asked by participants whilst the research was being undertaken in meeting rooms throughout the UK and USA. However, the findings of the research conclude that, as well as moral obligations to protect users of vulnerable buildings being evident, there *are* legislative requirements for organisations to incorporate CTMs, with interpretations of existing legislation encompassing the applicability of duties of care to the mitigation of terrorist attacks. However, the research also found that CTMs can be incorporated at no additional cost, as not all of the measures that can be used to protect such places involve capital outlay. In providing an answer to the question above, therefore, this research suggests that:

> *Organisations should incorporate counter-terrorism measures, but that does not necessarily have to involve spending money*

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Appendix C5.1. Participant Information and Ethical Consent Form

PARTICIPANT INFORMATION AND INFORMED CONSENT FORM

PARTICIPANT INFORMATION SECTION

Research Title

The Relative Performance and Consequences of Protecting Crowded Places from Vehicle-Borne Improvised Explosive Devices.

Research Aim

The aim of the research will be to evaluate the relative value and systemic implications of counter-terrorism measures (CTM's) that are used to protect built assets in crowded places, within the context of varying design parameters and criteria.

Main Objectives

The main objectives of the research will be to:

- Examine current research on protecting key components of the built environment and the emergence of the terrorist threat
- Develop a typology of CTM's used to protect built assets within crowded places
- Evaluate the relative value of CTM's in relation to their cost, effectiveness and impact for a range of scenarios
- Identify the impacts, intended and unintended consequences and trade-offs involved in designing in and retro-fitting CTM's into built assets
- Produce guidance for key decision makers who are responsible for the protection of crowded places, to inform future legislation, guidelines and codes of practice

Investigator(s)

The research is being undertaken by a team in the Department of Civil and Building Engineering at Loughborough University. The team consists of Professor Andrew Dainty (Principal Investigator), Dr Lee Bosher, Dr Jacqueline Glass and Steven Harre-Young.

Purpose of the Study

The purpose of the study is to identify the implications and value of measures that are used to protect crowded places from terrorist attack, in order to contribute to the knowledge of this subject and inform future guidelines, codes of practice and legislation.

Organisation of the Study

In relation to data collection, the study has been organised into two main stages. Those are:

Stage 1: Discussions on the protection of the built environment, the emergence of the terrorist threat and the possibility and feasibility of a typology of CTM's

Stage 2: Population and validation of the CTM typology, alongside the examination of their relative value and systemic implications

Contributors to the Research

This study is part of a student research project, which is funded by an Engineering and Physical Sciences Research Council grant, awarded through the Innovative Manufacturing and Construction Research Centre at Loughborough University. The research project is supported by the National Counter Terrorism Security Office.

Withdrawal from the Study

All participants are able to withdraw their involvement at any time. No explanation is required and all data collected will be destroyed.

Involvement in the Study

Each interview is expected to last between 1 to 2 hours. Participants will be asked whether they would be willing to attend any future interviews. Future participant is entirely at the participant's discretion.

Expectations

During an interview, participants will be asked to answer questions relating to the stage of the research that the interview is being conducted in.

Personal Information Requirements

None.

Confidentiality

All information given from participants will be treated as confidential and not identifiable unless agreed otherwise. All storage of data will comply with the Data Protection Act 1998. All data will be kept secure, not released to any other party and will be destroyed within six years of the completion of the investigation.

Results

Results of this study will form an integral part of a thesis that will be submitted to Loughborough University, in partial fulfilment of a Philosophical Doctorate. Findings will also be given to the National Counter Terrorism Security Office, in order to inform their knowledge and working practices. Findings will also form integral parts of future academic and industrial publications relating to this research.

As a Result of Participating

As a result of participating, participants will be asked whether they would like to be sent any publications that contain the findings of this study.

Points of Contact

If you have any general enquiries regarding this study, then please contact:

Name: Steven Harre-Young

Email: S.N.Harre-Young@lboro.ac.uk

Telephone: [Withdrawn from Appendix]

Address: Department of Civil and Building Engineering, Loughborough University, Loughborough, LE11 3TU.

If you are not happy with how the research is being conducted or wish to talk to the Principal Investigator regarding any other serious matter, then please contact Professor Andrew Dainty at the Department of Civil and Building Engineering. Loughborough University Switchboard's telephone number is 01509 263171.

INFORMED CONSENT SECTION

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethical Advisory Committee.

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with) it is judged that confidentiality will have to be breached for the safety of the participant or others.

I understand that on this occasion, I am being interviewed during Stage 2 of the study, which encompasses the "population and validation of the CTM typology, alongside the examination of their relative value and systemic implications".

I agree to participate in this study.

Participant's Name: ____

Participant's Signature: ____________________ **Date:** _____ / _____ / _______

Investigator(s) Present: ____

Investigator(s) Signatures: ____________________ **Date:** _____ / _____ / _______

Appendix C5.2. Pre-Interview Letter

The Relative Performance and Consequences of Protecting Crowded Places from Vehicle-Borne Improvised Explosive Devices

Introduction to the Research

The aim of this research is to examine the value and wider implications of counter-terrorism measures used to protect crowded places and when design parameters vary. The research responds to the increase in the use of suicide attacks, improvised explosive devices and vehicle-borne devices, which has resulted in a need to reassess how crowded places and open areas are protected, whilst ensuring that proportionate responses are provided.

However, in order to design and retro-fit crowded public places, the relative value and implications of counter-terrorism measures and approaches need to be understood.

This research aims to examine the relative value and systemic implications of counter-terrorism measures and approaches through the use of scenario-based interviews, which will collate individual perspectives and knowledge regarding the protection of different places. This research will culminate in informed guidance for key decision makers, so that such places are neither under-engineered and vulnerable, nor over-engineered and obtrusive.

Interview Information

The interviews, which will take no more than 60 minutes, will explore your perspectives on the issues surrounding the incorporation of counter-terrorism measures into urban and building design, to protect crowded public places.

Although the interviews can involve scenarios, you are encouraged to provide information and reflect on any real examples of which you have prior knowledge and experience.

The interview will be split into four parts:

Part 1: Working Practices and Perspectives

Your current / future working practices, structure and roles

Your thoughts on the design, construction and operation process, plan of works and counter-terrorism in relation to these

Your perspectives on the incorporation of counter-terrorism measures into urban and building design

Part 2: The Protection of Open Spaces & Individual Buildings

Your perspectives on the protection of open space, considering:

- different counter-terrorism approaches, i.e. total traffic exclusion, traffic exclusion with screening, traffic inclusion and temporary barriers
- different counter-terrorism measures used in conjunction with the approaches named above
- whether the approaches and measures are being designed-in or retro-fitted

Part 3: The Value and Implications of Counter-Terrorism Measures

Your perspectives on the protection of individual buildings, considering:

- the relative value of each counter-terrorism approach and counter-terrorism measure
- the implications of the different counter-terrorism approaches and measures
- how these attributes vary between being incorporated during the early design stages and retro-fitted into an existing site

Part 4: Final Thoughts

Any final thoughts on the matters discussed during the interview or on any matters that you feel would be appropriate and valuable

Contact Details

For further information on either the interviews or the research project itself, do not hesitate to contact **Steven Harre-Young…**

…directly on: [Withdrawn from Appendix]

…by email at:: S.N.Harre-Young@lboro.ac.uk

…via the Web: http://saferspaces.lboro.ac.uk

Appendix C5.3. Post-Interview Letter Template

Name
Organisation
Address Line 1
Address Line 2
Address Line 3
Postcode

Steven Harre-Young
Direct Line: [Withdrawn from Appendix]
E-mail: S.N.Harre-Young@lboro.ac.uk

Date

Dear

Subject – Thank You

Please accept my sincerest thanks for becoming involved with and participating in the counter-terrorism research that is being carried out here at Loughborough. I found our discussions incredibly interesting and it was immediately clear that the wealth of experience and knowledge that you have has informed and will continue to inform the research and its findings tremendously.

As you requested, I will send anything interesting that we do your way and I look forward to hearing your thoughts on the outputs of this research when these are nearing completion, which is expected to occur in early 2011.

Please do not hesitate to get in touch if there is ever anything that I can do for you or if you have any questions regarding the research or any other issue that I can help with.

It was a real privilege to talk to you and I thank you once again for your time and hospitality.

Yours sincerely

Steven Harre-Young

Appendix C7.1. A Typology of Counter-Terrorism Measures

The typology itself is split into three sections, according to the classification of CTMs that has been adopted throughout the thesis.

Hostile Vehicle Mitigation

HVM encompasses the control of vehicles within a given area, in order to deter an attack from occurring, deny methods of attack from being achievable and to minimise the impacts of an attack should one be carried out. This is achieved through the consideration and choice of specific traffic management, access and calming approaches, which would be enforced through the use of VSBs. The requirements, performance and consequences of each CTM will vary depending on the measure themselves. HVM comprises:

- Traffic management
- Vehicle access control points
- Traffic calming
- Vehicle security barriers

Traffic management

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Traffic Exclusion	The exclusion of traffic would need to be enforced through the use of VSBs, which have their own requirements	Public amenity and safety of pedestrians. Increase in footfall, resulting in higher turnovers for businesses. Reduction in pollution also evident	Blast impact and level of protective construction required reduced (if needed). Stand-off distances and surrounding area would determine extent of protection	Disruption due to vehicles unable to get close to destinations and increased walking time. Traffic congestion would increase in the surrounding area	Increased revenues and property values could reconcile any unintended consequences and provide additional incentives on top of the security benefits
Traffic Restriction	The enforcement of a perimeter and access point(s) would be achieved through the use of VSBs, each of which have their own requirements	Environmental and safety benefits, yet relatively less than those experienced through traffic exclusion. Access control can be escalated and de-escalated, aiding permeability	Risk of an attack would decrease, subject to access control approach. Day-to-day impact reduced, due to throughput of traffic (also dependent on access control approach)	Traffic disruption, dependent on access control approach used. Less than 100% screening increases risk of attack. Traffic displacement and disruption due to queuing	Traffic restriction can be incorporated with no protective construction, but human reaction is then relied on to stop an attack. Off-site screening would reduce risk
Traffic Inclusion	Including traffic would require VSBs around individual buildings, which have their own requirements	Allows permeability and un-impingement of traffic	Results in less business disruption and maximum throughput of vehicles	Increased risk of attack and impacts of a blast. Greater need for protective construction	Un-impingement of traffic needs to be reconciled against the cost of protective construction
Temporary Barriers	Possible specialist transportation and deployment. No permanent foundations	Escalation/de-escalation ability. Moves on impact, low aesthetic performance and permeability	Reduces blast impact (dependent on stand-off) and traffic throughput (if any)	Incorporation based on intelligence increases risk of attack	Reduced (relative) cost needs to be reconciled against less performance and increased risk

Vehicle access control points

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Single-Line	A single line of VSBs, each of which have their own requirements. Rejection facilities for unauthorised vehicles	More aesthetically pleasing than other approaches. Depending on VSBs used, can be escalated and de-escalated	Reduction in risk of an attack occurring, although searching less than 100% of vehicles diminishes such gains	Traffic disruption, dependent on time taken to search vehicles. Vulnerable to tailgating	Least secure form of access control, yet relatively high aesthetic performance and least disruptive, compared with others
Inter-Lock	Two lines of VSBs, which will have their own requirements, with no ability for vehicles to encroach whilst in-between. Rejection facilities for unauthorised vehicles	Less aesthetically permeable than a single line of barriers. Could be escalated and de-escalated through use of one access point	Removes risk of tailgating, increasing the effectiveness of the VACP. Greater deterrent than a single line of barriers	Greater disruption than a single line of barriers, due to increased time taken for each vehicle to gain access	Larger amount of space required than a single line of barriers and more disruptive. Reconciled against greater effectiveness
Final Denial	Access point and route to final denial line enforced through VSBs, which have their own requirements. Rejection facilities for unauthorised vehicles	Ability to escalate and de-escalate, most conducive to high vehicle throughput	Ability to stop an attack from occurring whilst minimising traffic disruption	Increased risk of an attack due to the stopping of an attack being dependent on guard force reactions	Increased risk of an attack being attempted and being successful. Reconciled against it being less disruptive than an inter-lock system

Traffic calming

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Horizontal Deflections	The creation of chicanes or bends that cannot be traversed, enforced through VSBs, which have their own requirements	Aesthetic performance dependent on VSBs used to enforce deflections. Ability to escalate and de-escalate, depending on VSBs used	Reduced speed of vehicles, resulting in less impact energy and therefore, less robust/obtrusive VSBs required	Increased time to travel through deflections and site	Consideration must be given to size of vehicles travelling through deflections. Space required reconciled by reduced impacts of an attack
Vertical Deflections	Requirements will vary depending on scale of vertical deflections, i.e. road humps, inclines etc	Aesthetic performance dependent on VSBs used to enforce deflections. Ability to escalate and de-escalate, depending on VSBs used	Reduced speed of vehicles, resulting in less impact energy and therefore, less robust/obtrusive VSBs required	Increased time to travel through deflections and site	Consideration must be given to size of vehicles, ability of road humps to stop a hostile vehicle and the impact of ground conditions. Space required reconciled by reduced impacts of an attack

Vehicle security barriers

VSBs are themselves categorised into three groups, those being security-explicit barriers, street furniture, and landscaping and nature.

Security-explicit barriers

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Barriers	Foundation and infrastructure requirements will vary depending on type of barrier used	Less aesthetic performance and permeability than bollards and planters. Ability to raise and lower	As with any VACP or active measure, ability to stop hostile and unauthorised vehicles	As with any VACP or active measure, disruption to traffic and throughput	As a trade-off, barriers could be kept raised during lower threat levels, although this increases risk of an attack
Blockers	Foundation and infrastructure requirements will vary depending on the individual blocker used	Less aesthetically pleasing than more permeable measures. Ability to raise and lower	As with any VACP or active measure, ability to stop hostile and unauthorised vehicles	As with any VACP or active measure, disruption to traffic and throughput	As a trade-off, blockers could be kept lowered during lower threat levels, although this increases risk of an attack
Bollards	Foundation and infrastructure requirements will vary depending on bollards used. Minimum air gap of 1200mm and height of 500mm	Most visually and functionally permeable SEB. Ability to raise and lower	As with any VACP or active measure, ability to stop hostile and unauthorised vehicles	As with any VACP or active measure, disruption to traffic and throughput	Robustness of bollards will vary depending on the possible impact of a vehicle. Obtrusiveness reduced through traffic calming
Fencing	Foundation requirements will vary depending on the fencing used	Aesthetic performance dependent on the nature of the fence, its robustness and size of area being protected	Deterrence of crime and increased risk of intruders being caught	Low aesthetic performance and visual permeability	More conducive to the enforcement of large perimeters and sites, not individual buildings

Gates	Installation and infrastructure requirements will vary depending on the gate(s) used	Aesthetic performance dependent on the nature of the gate and its robustness	As with any VACP or active measure, ability to stop hostile and unauthorised vehicles	As with any VACP or active measure, disruption to traffic and throughput	Robustness is dependent on potential impact of a vehicle. More conducive to the large perimeters and sites, not individual buildings
Planters	Requirements will vary depending on the planter. Maintenance will be needed to ensure aesthetic performance and un-impingement of other CTMs	Relatively high aesthetic performance compared to other SEBs, although less permeable than bollards. Minor environmental benefit	Ability to stop hostile vehicles, through a more aesthetically pleasing means	Can create a new risk in impinging surveillance and obstructing other CTMs, if not maintained appropriately	Less permeable but provides better aesthetic performance. Can be surface-mounted, reducing installation costs
Walls	Requirements will vary depending on the nature of the wall. May require enhanced/additional structural reinforcement	Least permeable SEB. Could incorporate advertising boards etc as means of generating revenue	Deterrence of crime and increased risk of intruders being caught	Arguably creates new risks through the impingement of surveillance	More conducive to the enforcement of large perimeters and sites, not individual buildings

Street furniture

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Advertising Boards	Dependent on nature of the boards. Lethal fragmentation would need to be within lethal radius of a blast itself	Relatively high aesthetic performance compared to SEBs. Provides public amenity and revenue generation	Ability to stop hostile vehicles, through a more aesthetically pleasing and functional means	Construction of board must take fragmentation into account, so as to not create new risks and worse impacts	Relatively low permeability is reconciled against aesthetic performance and generation of revenue

Art	Dependent on nature of artwork and whether it was surface-mounted or required foundations. Lethal fragmentation would need to be within lethal radius of a blast itself	Relatively high aesthetic performance, compared to SEBs (and perception of art). Public amenity. Permeability dependent on nature of the artwork	Ability to stop hostile vehicles, through a more aesthetically pleasing means	Could hinder surveillance opportunities and impinge on other CTMs	Potentially high cost implications for testing of robustness of artwork to ensure appropriate for use
Bicycle Racks	Requirements will vary dependent on the nature of the bicycle rack	Permeability will depend on size and number of racks. Relatively high aesthetic performance, providing public amenity	Ability to stop hostile vehicles, through a more aesthetically pleasing and functional means	Could create a new risk through the concealment of IEDs	Relatively high aesthetic performance and function reconciled against potential for additional risks
Furniture	Requirements will be dependent on the nature of the furniture itself	Relatively high aesthetic performance and provides public amenity	Ability to stop hostile vehicles, through a more aesthetically pleasing and functional means	Could create a new risk through the concealment of IEDs	Relatively high aesthetic performance and function reconciled against potential for additional risks
Lamppost	Requirements will vary depending on the nature of the lamppost, earthworks underneath and potential impact of vehicles	Relatively high aesthetic performance, providing public amenity	Ability to stop hostile vehicles, through a more aesthetically pleasing means, also aiding in surveillance and deterrence/detection of crime	Consideration must be given to interaction with other CTMs, as lighting could impinge on CCTV for example	Relatively high aesthetic performance and permeability, with additional deterrence/detection benefits

Landscaping and nature

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Bunds	Sufficient height and incline to stop vehicle encroachment. Maintenance and monitoring requirements to ensure not being tampered with	Environmental benefits and relatively high aesthetic performance, dependent on nature of the bund	Ability to stop hostile vehicles, through a more aesthetically pleasing means	Could create new risks in hindering surveillance and concealing persons	Conducive to large sites and perimeters. Cost savings could be accrued through recycling of spoil
Ditches	Depth and width to be sufficiently maintained to ensure they cannot be overcome	Relatively low aesthetic performance and permeability. Provides no amenity	Ability to stop hostile vehicles	Potential health and safety issues and accidental incursion by vehicles	Unfeasible in dense, urban settings. Conducive to large sites and perimeters
Topography	Stability, compaction and erosion must be considered, ensuring it is not traversable by vehicles	Relatively high aesthetic performance, environmental benefits and public amenity	Ability to stop hostile vehicles, through a more aesthetically pleasing and functional means	Could create new risks in hindering surveillance and concealing persons	Relatively high aesthetic performance and function reconciled against potential for additional risks
Trees	Sufficient girth, rooting and spacing so encroachment cannot occur. Maintenance to ensure they are not climbed to overcome CTMs	Relatively high aesthetic performance and environmental benefits	Ability to stop hostile vehicles, through a more aesthetic and environmental means	Could create new risks in hindering surveillance and concealing persons/IEDs	Realistically unlikely to be used solely, due to spacing and size of trees required
Water	Sufficient depth and width when considering large-scale features, topography when considering smaller scales	Relatively high aesthetic performance and environmental benefits, also providing public amenity	Ability to stop hostile vehicles, through a more aesthetic and environmental means	Could create new risks in relation to health and safety, hindering surveillance and concealing persons/IEDs	Relatively high aesthetic performance and function reconciled against potential for additional risks

Protective Construction

Protective construction encompasses the robustness and design of a building, in order to mitigate the impacts of a blast. The requirements, performance and consequences of each CTM will vary depending on the measure themselves. Protective construction comprises:

- Skin
- Structure
- Services
- Space plan

Costs of protective construction varied, with a range of 2-5% of budgets being sufficient when designing in CTMs, and 10-15% when retro-fitting them.

Skin

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Cladding	Attached directly to floor slabs using robust connections and access for inspection and replacement	Aesthetic performance will be dependent on the cladding itself, can appear no different than if not protected	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	Blast wave reflection will result in increased damage to surrounding buildings	Increased cost of robust connections reconciled against potential re-use of connections and performance
Façades	Convex in form and avoidance of re-entrant corners, recesses and set-backs	Dependent on materials used. Aesthetic performance can be relatively high and can appear no different than if not protected	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	Blast wave reflection will result in increased damage to surrounding buildings	Convex façades will cost more than a straight ones. 2% of façade budget can be sufficient, yet depending on extent of glazing used, can be as much as 15%
Glazing (Anti-Shatter Film)	Adhesive film applied to the inside of glazing. Can be anchored into frames for additional protection and retro-fitted with minimal disruption	Aesthetic performance can be high if transparency is not reduced significantly. Reductions in energy bills. 50% less risk of injury compared to annealed glass	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	Blast wave reflection will result in increased damage to surrounding buildings. If not properly anchored, whole pane can be forced inwards	Cheapest option in terms of protecting glazing. Potential negative impact on transparency reconciled against performance.
Glazing (Bomb-Blast Net Curtains)	Length and width typically double that of glazing, with the excess stored at cill level. As with ASF, suits retro-fitting	Relatively low aesthetic performance, with little or no visibility and light permeability and restricted ventilation	Reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents. Removal of air-borne fragments	Can be penetrated if annealed glass is used	Less effective than other forms of glazing protection, but relatively cheap solution, suiting temporary protection

Glazing (Toughened Glass)	Reheating of annealed glass to a plastic state, followed by controlled cooling	Four- to six-fold increase in strength compared to annealed glass. Relatively high aesthetic performance and transparency	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	Will shatter if it breaks, but will produce smaller fragments than annealed glass	Whilst more effective than ASF and BBNCBs, no environmental benefits and less effective than laminated glazing
Glazing (Laminated Glass)	Two or more plates of glass, held together by a flexible plastic layer (PVB layer). PVB should be a minimum of 0.76mm and be secured into frames	Relatively high aesthetic performance, as well as environmental benefits from removal of UV rays and noise pollution	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents. Little or no fragmentation	Could shatter, but the glass is held to the PVB layer	Most expensive form of glazing protection, but is the most effective in terms of protection and performance

Structure

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Columns & Frames	As a minimum, measures for robustness against disproportionate collapse for Class 2B building as in Part A3 of Building Regulations. Tensile capacity and ductility in elements and connections	Mitigates impacts of hazards, threats and major accidents	The enhancement of robustness, most notably through alternate load paths	None	Evident preference for steel or reinforced concrete frames, with enhanced robustness mitigating multiple risks

Floors	Tied into structural frames and have the ability to withstand load reversal. Continuity of flood spans and their reinforcement in both of the slab faces (lower floors)	Mitigates impacts of hazards, threats and major accidents	The enhancement of robustness and the prevention of uplift of floors	None	Enhanced protection on lower floors is due to increased pressure from blasts
Roofs	Roofs and components of them should be 150mm thick reinforced concrete	Mitigates impacts of hazards, threats and major accidents	The enhancement of robustness due to blast loads	Implications of the increased weight on the structural requirements of the building	Enhanced protection, most notably from blast and mortar attack
Stairwells	At least two stairwells, no more than 50m apart, orientated towards different escape routes or exits	Mitigates impacts of hazards, threats and major accidents, also providing protected spaces in buildings (dependent on construction)	The enhancement of access and egress routes, facilitating evacuation or the protection of residing persons	The greater the number of stairwells, the less usable floor space	Aids in evacuations and invacuations, benefitting responses to multiple risks

Services

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Services	Located away from vulnerable façades. HVAC systems should be located on third floor or above	If enhanced to scrub for additional contaminants, enhanced air quality and reductions in sickness	Mitigation of damage resulting from blasts, as well as reduced risk of persons throwing substances in to the system	None	When used in conjunction with mitigation air-borne threats, performance benefits obtained

Space plan

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Evacuation Routes	Routes to be duplicated and be sufficiently protected from impacts of a blast	Aids in the mitigation of and response to hazards, threats and major accidents, as well as other emergencies	The enhancement of access and egress routes, facilitating evacuation or the protection of residing persons	None	Evacuation routes can be used as protected spaces, if robust enough. See 'Protected Spaces' for requirements
Internal Partitions	Robust partitions capable of stopping fragmentation from a blast, without adding to it	Dependent on nature of partition, reduces visual permeability	Mitigation of damage resulting from a blast, through the removal of an amount of air-borne fragments	Questionable impact on workplace productivity. Unprotected partitions can result in additional fragmentation	Possible workplace productivity decreases, reconciled against increased protection of life and property
Protected Spaces	Ability to contain occupants of buildings, minimum 0.66m^2 space per person. Ideally deep within buildings with no glazing	Aids in the mitigation of and response to hazards, threats and major accidents, as well as other emergencies	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	None	Can be incorporated at no additional cost during the planning and design stages
Sacrificial Design	Use of secondary layers of glazing or the positioning of less critical offices closest to vulnerable areas	Dependent on glazing used, environmental benefits. Mitigates hazards, threats and major accidents	The reduction in impact of a blast or similar damage, mitigating impacts of hazards, threats and major accidents	Potentially moves most used areas away from externally-facing glazing, as opposed to internal courtyards, impacting productivity and usable space ratios	Can be incorporated at no additional cost during the planning and design stages

Planning, Detection and Procedures

Planning, detection and procedures (PDP) encompasses the detection of hostile vehicles and/or suspicious behaviour, through the human, technological and procedurally-based CTMs that aid in preventing and responding to terrorist attacks. PDP comprises:

- Security culture
- People and technology
- Planning and procedures

Security culture

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Security Culture	Staff adopting a 'security first' habit, overseen by supportive management and effective support and communications	Aids in the mitigation of and response to hazards, threats and major accidents, as well as other emergencies	Increased mitigation of, preparedness for and response to threats, as well as other risks	Questionable disproportionate focus on such threats, inciting disproportionate levels of fear	Management and support infrastructure could already be in place, reducing costs and increasing capacity to incorporate such a culture

People and technology

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Capable Guardians	Persons who are able to identify suspicious behaviour and act on it	Aids in the deterrence and identification of numerous threats	Deterrence of attacks and the identification of suspicious behaviour, which is acted on	'False alarms' or inconvenience to staff	Encompasses any user of a place or space, resulting in no cost implications
CCTV	Appropriate training of staff using such technology to ensure no blind spots are left etc	Can aid in the deterrence and mitigation of, as well as the response to, a range of threats	To deter an attack from happening, aid in a response to an attack and in any investigations afterwards	Could be left in inappropriate positions, leaving places vulnerable to attack and no ability to identify perpetrators afterwards	Typically already incorporated for other crime prevention purposes
Communication Systems	Protection from impacts of a blast. Ability to send and receive communications from protected spaces	Aids in the co-ordination of responses to a range of threats and emergencies	Increased capacity to respond to a range of emergencies, enhancing communication	None	Typically already incorporated for other purposes

Intruder Detection Alarms	Integrated into a wider security system, including lighting and response provisions	Can aid in the deterrence and mitigation of, as well as the response to, a range of threats	Deterrence of attacks and the identification of suspicious behaviour, which is acted on	None	Typically already incorporated for other crime prevention purposes
Lighting	Placement of lighting so that surveillance is not impinged	Can aid in the deterrence and mitigation of, as well as the response to, a range of threats	Deterrence of attacks and the identification of suspicious behaviour, which is acted on	Can detrimentally impact surveillance	Typically already incorporated for other purposes
Security Guards	Trained personnel who are able to identify and respond to suspicious behaviour and attacks	Can aid in the deterrence of and response to a range of threats and other risks/emergencies. Can be escalated and de-escalated	Deterrence of attacks and the identification of suspicious behaviour, which is acted on	Can leave CTMs in vulnerable positions if not properly trained and motivated	Typically already incorporated for other crime prevention purposes

Planning and procedures

The CTM	Requirements	Performance	Positive Consequences	Negative Consequences	Additional Information
Awareness	Training of staff to be able to identify and respond to hostile reconnaissance, suspicious behaviour and attacks	Applicable to all threats, with ability for heightened senses during times of increased threat	Deterrence and identification of , and response to, hostile reconnaissance, suspicious behaviour and attacks	'False alarms' or inconvenience to staff	Typically already incorporated for purposes

Business Continuity Planning	BCP incorporated into the organisation, with senior management responsible for it	Increases the resilience of businesses to a range of disruptive events	Increased mitigation of, and preparedness and response to, a range of emergencies and disruptive events	None	Typically already incorporated for business purposes. There are British Standards for BCP
Contingency Planning	Adequate and tested plans that aid in the response to a range of scenarios	Applicable to planning for all hazards, threats, and major accidents, as well as other emergencies/disruptions	Increased mitigation of, and preparedness and response to, a range of emergencies and disruptive events	None	Typically already incorporated for business purposes
Evacuation & Invacuation Planning	Multiple protected routes that are known by staff and regularly exercised	Applicable to planning for all hazards, threats, and major accidents, as well as other emergencies/disruptions	Increased mitigation of, and preparedness and response to, a range of emergencies and disruptive events	None	Typically already incorporated for business purposes
Housekeeping	Regular cleaning and inspection of areas within crowded places	Increases the aesthetics and safety of places and spaces	Increased mitigation of, and preparedness and response to threats	Possible increase in number of ‘false alarms’, suspicious packages identified	Typically already incorporated for business purposes
Search Planning	The searching of evacuation and invacuation routes, prior to and after such movements occur	Applicable to planning for all hazards, threats, and major accidents, as well as other emergencies/disruptions	Increased mitigation of, and preparedness and response to, a range of emergencies and disruptive events	Possible increase in number of ‘false alarms’, suspicious packages identified	Risk of secondary devices, especially at rendezvous points or on the way to them, must be considered

Appendix C8.1. List of Papers

Peer-Reviewed Papers

HARRE-YOUNG, S., BOSHER, L., DAINTY, A., and GLASS, J., 2010. Counter-terrorism complexity: identifying opportunities for innovation. In: ANUMBA, C., BOUCHLAGHEM, N.M., MESSNER, J.I., and PARFITT, M.K., (eds) *Proceedings of the 6th International Conference on Innovation in Architecture, Engineering and Construction*. 9-11 June, Pennsylvania State University, USA. 1121-1130

HARRE-YOUNG, S., 2009. From global systems to a single device… *Blueprint* **58**(3), 8-9

HARRE-YOUNG, S., BOSHER, L., DAINTY, A., and GLASS, J., 2009. The Implications of the UK's Counter-Terrorism Strategy for the Construction Sector. In: DAINTY, A., (ed) *Proceedings of the 25th Association of Researchers in Construction Management Conference.* 7-9 September 2009, Nottingham, United Kingdom. 1285-1294

Contributions

Clarke, L., and Gilbertson, A., eds. 2011. *Addressing Crime and Disorder in Public Places through Planning and Design*. London: Construction Industry Research and Information Association