Synergising Disaster Risk Management and Construction Research: A Multi-Disciplinary Initiative from the UK

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ABSTRACT

Many scientists believe that the magnitude and frequency of extreme events is escalating and in so doing will increase the vulnerability of the built environment. This paper discusses the synergies between three ongoing research projects being conducted at Loughborough University, the University of Salford and the University of Reading. The ‘Big Ideas’ project aims to identify and understand the challenges, issues, drivers and barriers for the UK construction sector over the next 10 to 20 years. This work is being complemented by Loughborough’s ‘PRE-EMPT’ project and research being undertaken on behalf of the RICS Presidential Commission for Major Disaster Management. Mutually, these three projects form a basis for a deeper understanding of the future of both construction and the environment in which we live and work. The synergies between these projects will ultimately provide trans-disciplinary suggestions for how the industry and society can better prepare itself for any unforeseen eventualities.

KEYWORDS: Disasters, Construction, Futures, Protocol, Integration

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1. INTRODUCTION

Threats to the built environment in the United Kingdom (UK) are diverse and include extreme natural and human-induced hazards. Typically, these hazards cause relatively minor disruptions to the economy, infrastructure and residents of the UK, but some observers believe that the magnitude and frequency of these extreme events is increasing due to hazards associated with events such as climate change and terrorist threats. It has also been suggested that with socio-economic progress the built environment becomes more vulnerable as settlements become more reliant on their increasingly extended supply lines (Menoni 2001), and ever-expanding critical infrastructures of transport, water, power generation and distribution, and information and telecommunication systems. Moreover, with globalisation, the major settlements are also inter-connected and a disaster in one of them can precipitate widespread disruption in many others (Ofori 2002).

Human induced hazards are a significant threat to the built environment because construction represents a significant amount of every nation’s savings, e.g. the Gross Domestic Fixed Capital Formation in construction has been shown to be between 45-60 percent of the total value (Ofori, 1999; Hillebrandt, 2000). Indeed, in light of the findings from the Stern Review (Cabinet Office/H.M. Treasury, 2006) on the economics of climate change, it is imperative that all stakeholders and decision makers in the construction sector proactively deal with the hazards that are likely to threaten society. As well as general higher temperatures, changing patterns of precipitation and changing sea levels, the UK CIP (Climate Impact Programme) warns that in the future we must expect, “an increase in frequency and intensity of extreme weather conditions, such as very high temperatures, or heavy downpours of rain” (West and Gawith 2005). Some of these changes are already being felt; the 1990s was recorded as the warmest decade in central England since records began in the 1660s and 2006 was also the warmest year in the UK since records began. There is however, “little evidence that UK construction companies are implementing or considering adaptation strategies or mitigation measures...” to reduce the impacts of climate change on the built environment (Vivian et al 2005). Although the effects of climate change is being taken into account in the development of new building standards, recommendations are lacking in other forms of current guidance, as well as implementation.

Despite the potential links between threats such as climate change and terrorism, and the built environment, the integration of construction industry professions with disaster management issues has largely been overlooked (Spence and Kelman 2004). To date, inputs into disaster management by construction industry professions have principally been focused on topics such as fire safety, tall building design and egress considerations, despite the obvious skills, knowledge and positive input that they could provide.
2. BACKGROUND TO THE PROJECTS

Three research projects have recently been running concurrently at Loughborough, Reading and Salford universities, all of which were developed independently of one another. Only when the three projects were underway were their synergies and commonalities realised and consequently discussed.

2.1 The ‘Big Ideas’ Project

‘Sustained competitiveness in the UK construction sector: a fresh perspective’, or the ‘Big Ideas’ for short, is a government-sponsored collaborative research project between the Innovative Manufacturing Research Centres (IMRCs) at Loughborough, Reading and Salford Universities. This 3-year project began in April 2005 and aims to engage with industry to identify and understand the challenges and opportunities facing the UK construction sector over the next 10 to 20 years. The project is founded on the contention that research in support of the competitiveness of the UK construction sector needs a fresh impetus, and that there is little evidence to suggest that previous research has improved the competitiveness of the construction sector as whole. That is, previous efforts have been sporadic, piecemeal and failed to appreciate the structural and cultural fabric in which the construction sector operates. The research embraces five inter-connected objectives as follows:

- Grounding the project in a thorough investigation of the current structural and cultural configurations and dynamic capabilities of the UK construction industry as a whole;
- Identifying key issues which could shape the construction industry over the next 10 to 20 years;
- Establishing a range of possible future scenarios based upon groupings of their interdependencies;
- Creating an interactive IT tool to explore and simulate these future issues and scenarios;
- Developing appropriate strategies and policies at both industry and firm levels to help organisations prepare for the future.

Work Package 1 (WP1) has been focussing on developing possible future scenarios for the UK construction industry over the next 10 to 20 years. The initial stages of this work involved reviewing the many construction futures reports which had been published in the last 9 years (Harty et al., 2007). More than 300 separate issues were identified from this literature and content analysis was used to group these in high-level clusters of related issues (Soetanto et al., 2006). These issues were used as a basis for identifying emerging themes in the data collection exercise, which was

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aimed to capture people’s perceptions and interpretations of future events in industry workshops, in the form of causal ‘cognitive’ maps. From this, emerging future scenarios for a particular theme could be identified. The data has then been converted into pictorial maps and an associated textural explanation of the scenarios, thus permitting further analysis and validation of the data.

WP2 is analysing the structural forces which have influenced the development of the construction industry to date, including the overall economic conditions, the state of the industry itself, and the nature of construction demands. The business path development and dynamic capabilities of construction firms has been studied using case studies to understand how a construction firms’ business path is related to the initiatives and industry environment of the time. A review of construction ‘futures’ reports using discourse analysis is also being conducted and an assessment of the three sources of data at a chosen point/s for interconnections and causal relationships is also being undertaken.

Findings from WP1 and 2 will then be used by WP3 to enable a series of multiple cause-and-effect analyses to be performed using a modelling technique called System Dynamics (SD). In consultation with practitioners, aspects of the industry are then modelled in terms of feedback loops that provide an understanding of current trends and possible futures. The adopted approach enables the complex interrelationships between issues to be investigated in a methodical rather than an intuitive way. The modelling of “What If?” scenarios should provide insights into the issues facing the construction industry over the next 10-20 years. The dynamic model simulations will consequently enable construction organisations to improve their strategic approaches to envisaged change and sustained competitiveness. The three partners will then work together towards the end of the project to deliver WP4, which will deliver a 10-year research agenda for the academic community, research councils and IMRCs, strategic guidance for industry and individual companies for the implementation of innovation-based competitiveness and an improved capacity for strategic planning in the sector aimed at individual companies within the sector.

2.2 PRE-EMPT

The vision of the PRE-EMPT (Proactive Resilient Engineering and Emergency Mitigation Toolkit) Project is to ensure that a more resilient built environment is attained via the structured integration of hazard mitigation strategies into the whole life cycle decision-making process of buildings. PRE-EMPT will pro-actively address strategic weaknesses in protecting critical infrastructure and attaining built-in resilience via the development of hazard mitigation guidelines for the construction sector and the PRE-EMPT assessment toolkit. The toolkit will be developed in consultation with, and

\footnote{For more details refer to the Bosher et al (2007a) paper presented at this conference.}
targeted at, construction professionals and other agencies and stakeholders with responsibility for the planning, design, operation and maintenance of the built environment. This research is particularly timely given the renewed focus on safety and security brought about by recent terrorist threats and the onset of disasters caused by natural and human-induced hazards. The UK Government have continued to prioritise homeland safety and security, channelling additional monies towards improving the resilience of the country’s built assets and infrastructure. This work will also complement guidance on developing professional skills for sustainable communities and help operationalise the Sustainable and Secure Buildings Act (Stunnell 2004) and the Civil Contingencies Act 2004. This project will also anticipate possible government directives regarding Critical Infrastructure Protection in the UK.

PRE-EMPT will be designed to assess the ‘resilient performance’ of structures in the following areas: management, land use, design, integrated infrastructure, construction methods and materials, and security. PRE-EMPT will be applied to a range of critical infrastructure and built assets, such as offices, residential property, industrial and retail units, schools, hospitals, water supply and sewerage networks, power generation and distribution networks, transport infrastructure, communications infrastructure, and leisure facilities. Developers and designers in the UK will be encouraged to consider these issues at the earliest opportunity to maximise their chances of achieving a high PRE-EMPT rating.

The project is important because: firstly resilience needs to be systematically built-in to the planning and design processes not simply added on as an afterthought, but this is not being achieved in the UK (Bosher et al 2007b). Therefore, this project aims to develop a solution for something that is currently being overlooked as a problem. Secondly PRE-EMPT will contribute towards the integration of processes that are typically fragmented; This will be achieved through the exchange of ideas and solutions for a more resilient built environment from the perspective of many key stakeholders (such as architects, planners, engineers, materials suppliers and emergency managers) via involvement with local and regional resilience forums as recommended by the Civil Contingencies Act 2004 and the United Nations (UN/ISDR 2005). Thirdly, the government in the UK has the power to legislate for a sustainable and secure built environment via the Stunnell Bill (2004) but the industry currently does not have the mechanism to deliver it. PRE-EMPT will help to embed security and resilience (and arguably sustainability) considerations into the construction industry’s delivery of the built environment. The project will also build upon complementary research at Loughborough University and Salford University as well as industrial and academic networks that have been established through the previous projects. The project is also likely to inform the activities of CIB Task Group 63 ‘Disasters and the Built Environment’.
2.3 RICS Project

The President of The Royal Institution of Chartered Surveyors (RICS) has established a Presidential Commission for Major Disaster Management. During 2006 it commissioned the University of Westminster’s Max Lock Centre to evaluate the status of the reconstruction process following a major disaster (Lloyd-Jones, 2006). This highlighted an interim period before long-term reconstruction commenced. Issues such as funding, coordination, communications and stakeholder integration etc were highlighted. Following the publication of this report, The University of Salford was commissioned to explore ways in which this ‘gap’ in reconstruction of the built environment following a major disaster could be bridged. As the research commenced it became apparent that to ‘design a bridge’ research needed to focus on three areas:

1. a disaster management and reconstruction framework;
2. the identification of, and engagement with, stakeholders to the framework; and
3. the identification of sources of funding for the development and implementation of the framework.

A series of literature reviews were undertaken, and in addition, a number of interviews with key experts were conducted in the areas of construction, disaster management and process management fields. The interviews served to identify the key issues to be considered in relation to disaster management and subsequent reconstruction. 26 issues were identified in total, including project, knowledge, risk and resource management, politics, liability, standards and planning, amongst others.

A number of these activities are included in best practice management systems. Activities such as project management and resource management are well established and documented. Typically, a framework is developed for these activities that outline the process for their execution. Activities were also identified that were specific to disaster management and reconstruction: preparedness is a specific activity that attempts to consider and reduce the affects of potential disasters. Assessment is another specific activity that attempts to collect information in a disaster’s aftermath to enable correct short- and long-term decision making. After the assessment phases a prioritisation exercise occurs that feeds into a strategic overview that helps to support the development of a model for reconstruction. From the interviews it became apparent that the whole disaster lifecycle needs to be considered.

Many of the issues that arose, such as co-ordination, transparency, consistency, continuous improvement and knowledge management are also issues that the construction industry faces and were previously considered during the development of the Generic Design and Construction Process Protocol (Kagioglou et al 1998). Therefore, it was felt that the Process Protocol would provide a suitable framework for a disaster management process.
The high level activities were initially grouped according to issue or theme. Each theme was then populated with further levels of detail which were arranged in a hierarchy of three levels. The issues were then initially represented on the Process Protocol sub process templates and the next step was to contextualise the issues in terms of the sequence (or phases) they would be undertaken in real life. The phases are as follow:

0. Start Up
1. Pre Event Planning
3. Event Aftermath: Detail Assess.
4. Prioritisation
5. Prepare Strategic Overview
6. Strategic Overview
7. Re / Construction Info.
8. Re / Construction
9. Operation & Maintenance

Once the phases had been developed, the activity streams / zones that the processes would reside in were developed. Once the phasing and activity clustering had been agreed upon the content was translated onto a high level Process Map. The provisional high-level generic process map will have to be validated, through defining the sub processes and testing on a live case study. Further work aims to explore activity boundaries, content, terminology, barriers to acceptance and contextualisation. The high level process will serve to inform the proposed phase 3 of the RICS project. The process will serve to provoke discussion and thought. It is envisaged that the high level process will form one element of a future suite of disaster management tools.

3. COMPLEMENTARY ELEMENTS OF THE PROJECTS

The Big Ideas, PRE-EMPT, and RICS projects can each be broken down into individual inter-linked work packages, as shown in Figure 1. How the work packages from each individual project complement the work packages from the other 2 associated projects is also shown, which highlights the complementary aspects of the 3 projects. The key elements from the 3 projects have been drawn out and summarised in Table 1 and an outline of these with regards to the 3 projects and their similarities is given below.

<table>
<thead>
<tr>
<th>Key elements of project</th>
<th>Big Ideas</th>
<th>PRE-EMPT</th>
<th>RICS</th>
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<tbody>
<tr>
<td>a) Built Environment</td>
<td>✓</td>
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<td>b) Extreme Events</td>
<td>✓</td>
<td>✓</td>
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<td>c) Development of Scenarios</td>
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<td>d) Decision-making support</td>
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<td>e) Future challenges to the construction sector</td>
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<td>f) Improving capacity for strategic planning</td>
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<td>g) Develop a research road map</td>
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<td>h) UK-focused but international aspects</td>
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i) IT modelling of inter-connected issues √ √

j) Lifecycle integration and reconstruction # √

√ - Integral element of the project
# - Not a core element of the project but a potentially important consideration

a) Built environment
All 3 projects aim to harness the experience and expertise of companies and experts within the built environment in order to deliver the work.

Fig 1. Project Work Packages and associated interconnectivities
b) Extreme events
Extreme events are fundamental aspects of the PRE-EMPT and RICS work, with PRE-EMPT focusing on the resilience and hazard (natural and human induced) mitigation elements of individual structures and developments and the RICS on measures within the process framework to cope with and design for extreme events. The Big Ideas is focused mainly upon higher probability events and developments, but will take into account more unpredictable and high impact events such as extreme weather and terrorism and their potential impact upon the built environment and the construction sector over the next 10 to 20 years.

c) Development of scenarios
A key element of the Big Ideas is on developing possible future development scenarios for the UK construction industry over the next 10 to 20 years. Workshops have been used to capture peoples perceptions and interpretations of future events, in the form of causal maps. From these, emerging future scenarios for a particular theme can be identified. These maps and emerging future scenarios can then be used as a tool to explore plausible states and pathways to an envisioned future. Case studies of possible future scenarios will also be conducted in 2007 in order to validate the RICS Process Protocol and it is likely that the potential utility of the PRE-EMPT toolkit and guidelines will be evaluated via the utilisation of various scenarios, such as short-term high impact events (i.e. floods or terrorist bomb attacks) and long-term but discrete events (i.e. increased summer temperatures and water scarcity).

d) Decision making support
PRE-EMPT aims to deliver a decision-making support protocol that will guarantee that hazard mitigation strategies are embedded into the planning, design and construction decision-making processes. The RICS Process Protocol will also provide a process that will support decision making, but during the reconstruction phase of a project. Though it will not develop a decision making support tool, the outputs from the Big Ideas will enable construction companies to make better informed decisions regarding their future strategies and development paths on a longer term basis than they now traditionally employ.

e) Future challenges of the construction sector
The key element of the Big Ideas work is to identify the future challenges facing the UK construction sector over the next 10 to 20 years, together with the associated drivers and barriers. The interconnectivity of these future issues will be investigated via the production of causal maps, textural scenarios and system dynamic models which will identify the different overlapping possible future paths and challenges of the sector.

f) Improving capacity for strategic planning
One of the main objectives of the Big Ideas project is to try and improve the UK construction sector’s capacity for strategic planning. Anecdotal
Evidence has shown that firms in this sector traditionally usually only plan several years ahead, or until the next project, and very few take a long term strategic view. This will be done by the production of future scenarios on different aspects and sectors of the industry as well as working with actual construction companies to map out their individual futures more strategically. The RICS Process Protocol will enhance strategic planning capability in the realm of disaster risk management by considering the whole lifecycle of a disaster by developing a consistent approach that enables continuous improvement. PRE-EMPT will also be configured and aligned with various process frameworks (such as the 'Process Protocol') via iterative consultation with key stakeholders and will therefore help to embed security and resilience considerations into the construction industry’s delivery of the built environment.

**g) Develop a research road map**
A key deliverable for the Big Ideas will be a research road map to enable industry and government funding bodies to identify the key issues and challenges in the future which need to be researched now in order to provide the UK with the skills, knowledge and techniques required to address them in the future. Although PRE-EMPT will not be developing a research road map specifically, dialogue with academic institutions in the USA, Asia, Africa and Australasia will be undertaken to explore the transferability and potential exploitation of the toolkit in wider non-UK contexts.

**h) UK focused but international aspects**
The Big Ideas and PRE-EMPT projects will focus upon the UK construction sector, but many of the issues that will impact upon it in the future such as climate change, terrorism, globalisation and demographics are international issues, and so no study of these issues can fail not to include these wider international aspects.

**i) IT modelling of interconnected issues**
The Big Ideas will a modelling technique called System Dynamics (SD) in order to model a series of ‘What If?’ scenarios which enables the complex interrelationships between future issues to be investigated. These dynamic model simulations will consequently enable construction organisations to improve their strategic approaches to their future paths. The RICS project may further explore the interconnecting issues within the Process Protocol using available IT tools to gain further insights and to simulate behaviours.

**j) Focus on lifecycle integration and reconstruction**
One of the key aims of the RICS work is to consider the whole lifecycle of a disaster and to consider how long- and short-term issues can be aligned to ensure that the activities undertaken during the lifecycle are complementary and do not detract from one another. The PRE-EMPT project also aims to encourage the structured integration of hazard
mitigation strategies into the whole life cycle decision-making process of buildings.

4. SUMMARY

This paper has considered the synergies between three ongoing research projects in the areas of disaster management and the built environment. By working closely together, it is hoped that the 3 projects will complement one another and hence provide trans-disciplinary ideas for how the industry and society can better prepare itself for any unforeseen eventualities. As mentioned earlier, construction professionals are rarely involved in disaster risk management, despite the obvious benefits of them being so. If industry does not take a lead and make the appropriate steps required itself, then it may require government incentives for them to be encouraged to do so. However, it should also be remembered that threats such as climate change, and terrorism are only one of many factors that influence strategic decision-making within companies and governments. Other factors such as technological developments and changing business markets are often stronger drivers of change. One factor that is certain, is that the built environment will have to become more adaptable to an increasingly changing and more volatile ‘environment’ in which it lives, works and operates.

5. ACKNOWLEDGEMENTS

The authors would like to acknowledge the valuable contribution of the Big Ideas and PRE-EMPT research teams at the universities of Loughborough, Salford and Reading, the RICS Presidential Commission for Major Disaster Management, the EPSRC and the IMRC.

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