Building resilience
achieving effective post-disaster reconstruction

i-Rec 2008

A proactive multi-stakeholder approach to attaining resilience in the UK

Lee Bosher, Andy Dainty, Patricia Carrillo, Jacqueline Glass and Andrew Price
Department of Civil and Building Engineering, Loughborough University, Loughborough, England LE11 3TU, UK
Email: L.Bosher@Lboro.ac.uk

Abstract

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. For this reason, professionals involved with the construction industry, and the expertise they can offer, need to understand the principles of, and become more involved with Disaster Risk Management (DRM) if lessons are to be learnt from the past and a resilient built environment created for future generations. Currently however, there is a lack of guidance and poor levels of involvement in DRM activities on the part of key construction stakeholders. In light of these findings, the ongoing PRE-EMPT Project is developing a toolkit to support the structured integration of DRM (and particularly resilience) strategies into the construction sector's decision-making processes. Early research findings from questionnaires and interviews are presented which demonstrate that the pre-construction/post-disaster reconstruction phase is identified as the critical stage of the Design-Construction-Operation Process when DRM activities (such as hazard mitigation) should be undertaken by people such as architects/designers, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers.

Keywords: disaster risk management, decision-making, resilience, UK.

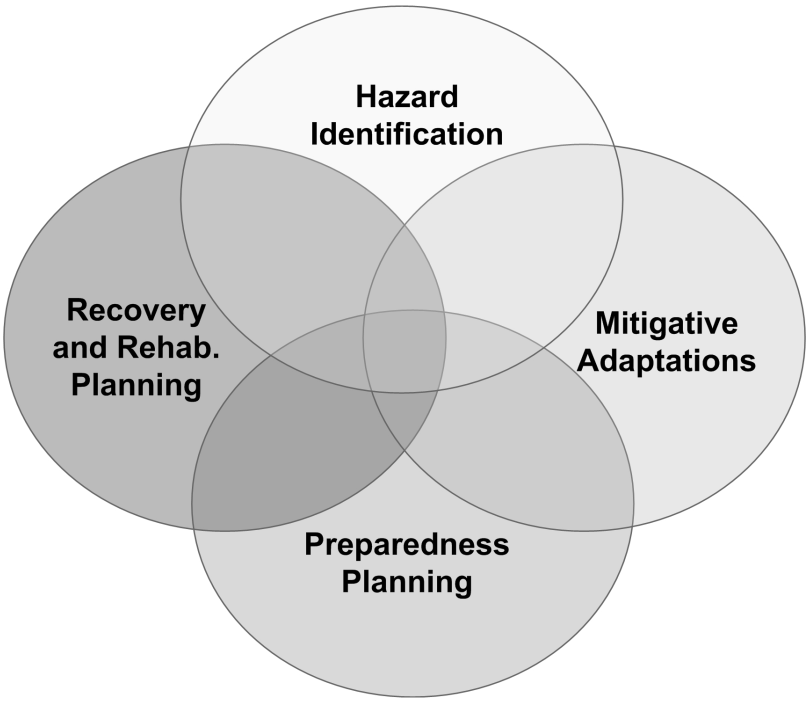
Introduction

Since the built environment and urban infrastructure provide the core framework for most human activity, it is crucial to develop them with an effective measure of resilience so they can withstand, and adapt to, the threats of natural and human-induced hazards (Bosher 2008). Threats to society and the built environment are diverse and include extreme natural and human induced hazards. Such hazards may not only threaten the lives of many people but can result in disasters that threaten economies and long term development. The impacts of disasters also drain millions of dollars every year in relief, rehabilitation, reconstruction and insurance costs for many nations. This paper will highlight why it is important to embed the structural and non-structural aspects of hazard mitigation within pre-construction activities, particularly during post-disaster reconstruction. However, for this to occur, a wide range of stakeholders (such as engineers, designers, urban planners and most importantly the affected communities) need to be consulted and actively involved in informed decision-making.

Towards a more proactive approach

The observed shift in the way disasters are being managed has been illustrated by the move away from the reactive attributes of Disaster Management towards the more proactive Disaster Risk Management (DRM) paradigm that should be 'mainstreamed' into developmental initiatives. The United Nations' International Strategy for Disaster Reduction (UN/ISDR 2004) has adopted a concept of DRM that can be summarised into four mutually interconnected phases (Figure 1), being: 1) Hazard identification; 2) Mitigative adaptations; 3) Preparedness planning; and 4) Recovery (short-term) and reconstruction (longer-term) planning.

Figure 1: The interconnected phases of the DRM Framework



DRM should be concerned with people's capacity to: manage their natural, social and built environments; and take advantage of it in a manner that safeguards their future and that of forthcoming generations. DRM needs to be holistic; it must ensure that associated strategies are viewed as a shared responsibility towards the attainment of resilience that includes issues such as hazard mitigation (Pelling 2003; Trim 2004) and land-use planning (Burby *et al.* 2000; Wamsler 2004). Part of the shared responsibility that is required could be achieved by embedding construction professionals, who possess the knowledge and experience of how to design, build, retrofit and operate what are typically bespoke built assets, into the DRM framework (Bosher *et al.* 2007b). The construction sector should play an important role in the structural elements of hazard mitigation (and adaptation), while developers and planners should be able to positively influence the non-structural elements (Bosher *et al.* 2007a; Wamsler 2006). The concept of hazard mitigation begins with the realisation that many disasters are not unexpected (Mileti 1999), and the impacts of many natural and human-induced hazards can therefore be reduced. It is common to discuss two types of hazard mitigation, as summarised below.

1. Structural mitigation – such as the strengthening of buildings and infrastructure exposed to hazards (via building codes, engineering design and construction practices, etc.).
2. Non-structural mitigation – includes directing new development away from known hazard locations through land use plans and regulations, relocating existing developments to safer areas and maintaining protective features of the natural environment (such as sand dunes, forests and vegetated areas that can absorb and reduce hazard impacts).

However, there is little evidence of DRM being a priority for construction professionals, which may explain the inability of the industry to mitigate the effects of natural and human-induced threats. Thus, integrating the multitude of disciplines responsible for how the built environment is delivered is critical to the mainstreaming of DRM into long-term development (Dainty and Bosher 2008); arguably post-disaster reconstruction should therefore be seen as an opportunity to attain physical and social resilience.

It has been acknowledged that the way the built environment is delivered can itself lead to disasters, particularly in less developed nations where building codes and planning regulations may not be as well policed as they are in other nations (Ofori 2002). It would also appear that with socio-economic progress, the built environment becomes increasingly vulnerable as settlements become more reliant on their increasingly extended supply lines (Menoni 2001), and ever-expanding and vital distribution networks of water, power, gas and telecommunication systems. Moreover, with globalisation, major urban settlements are also inter-connected and a disaster in one of them can precipitate widespread disruption in many others. There are also socio-economic and political pressures for swift reconstruction after a disaster has occurred which tends to impinge on the ability to learn lessons from previous events (see Menoni 2001).

It is clear that existing and future threats to the built environment in the UK are acutely important issues that all stakeholders need to urgently act upon. Resilience of the built environment should be high on the agenda and therefore should be systematically built-in to the planning, design, construction and operation processes not simply added on as an after thought. A resilient built environment '*should be designed, located, built, operated and maintained in a way that maximises the ability of built assets, associated support systems (physical and institutional) and the people that reside or work with in the built assets, to withstand, recover from, and mitigate for the impacts of extreme natural and human-induced hazards*' (Bosher 2008: 13).

Bosher *et al.* (2007a) argue that there are a number of key actions required to address systems in the built environment that are at risk from natural hazards (such as floods) and human induced hazards (such as terrorist attacks). These actions are categorised as broadly relating to:

- Innovation and knowledge - transdisciplinary training and hazard awareness ;

- Operations - information exchanges between a wide range of stakeholders such as planners, designers, engineers and the emergency services;
- Planning (well designed and suitable locations); and
- Legislation and regulatory incentives (building codes and good practice guidance) (*Ibid.*).

However, previous research has identified that there is a lack of guidance for the construction sector in the UK on how to deal with extreme emergencies and disasters and how to improve the way buildings and infrastructure are designed and built to cope with a range of hazards (Bosher *et al.* 2007b). Consequently, Bosher *et al.* (*Ibid.*) establish the need for a framework to help construction and non-construction stakeholders to address hazards during the earliest planning and design stages and that this can be achieved through the creation of decision support tools that could also be applied in post-disaster situations.

The Research

The three-year long PRE-EMPT project (due for completion in September 2009) will pro-actively address strategic weaknesses in protecting the built environment and attaining built-in resilience. This will be achieved via the development of hazard mitigation guidelines for the construction sector and the PRE-EMPT assessment toolkit. The initial work packages of the PRE-EMPT project have identified and prioritised the key threats to the built environment whilst also reviewing key legislation, standards and guidance that is currently available to key stakeholders and decision makers (while at the same time identifying any key gaps).

Specific objectives of the project

- Evaluate, identify and prioritise key threats to the UK's built environment.
- Identify building systems (such as architecture, design and structural engineering) to provide robust and economic building solutions that are resistant to disturbances, minimise damage, and are conducive to repair.
- Configure and develop PRE-EMPT with various process frameworks via iterative consultation with stakeholders.
- Evaluate PRE-EMPT under a range of scenarios and in partnership with key collaborators (in the first instance flood related scenarios will be considered).

Ultimately, it is intended that PRE-EMPT will be developed iteratively to improve the way buildings and infrastructure are planned, designed, built and retrofitted to cope with natural and human-induced threats; this will be implemented in the form of a hazard mitigation toolkit that will be used by a wide range of stakeholders.

Data collected

A state of the art literature review; including academic papers, governmental and non-governmental reports, UK legislation and regulations, governmental, institutional and industrial guidelines and policy documentation was undertaken. The EM-DAT database (EM-DAT 2007) of global emergency events was searched and the data was analysed to assess the most prevalent and high impact (regarding financial costs and the loss of human life) disasters in the UK. Between July and November 2007, 50 questionnaire surveys were also completed by a selective range of experts involved with construction, risk and emergency management, local and national government and urban planning. These questionnaires were designed to elicit perspectives and opinions about hazard and threat awareness and knowledge of available governmental and non-governmental guidance for hazard mitigation and emergency preparedness. This data was augmented by five semi-structured in-depth interviews with experts from the construction sector, engineering, emergency planning, and urban planning.

Preliminary research results

The PRE-EMPT Project is in the first half of its 3 years duration, therefore the results presented here are only very provisional findings. The data will need to be extended and further analysed but these provisional findings nonetheless provide essential foundations for the latter stages of the project and raise some important issues.

Evaluation and prioritisation of identified threats

A provisional analysis of this data indicates that from a historical perspective the greatest threats to the built environment in the UK are from flooding (riverine, pluvial and coastal) and severe windstorms. The perspectives and opinions of the stakeholders were very much in-line with the historical evidence of emergency events. Where historical evidence and professional perspectives did differ was related to the threat from terrorist attacks. Terrorist bomb explosions are still relatively isolated events (and arguably less frequent occurrences than bomb attacks undertaken by the Provisional IRA in the 1970-90s) but the impact psychologically, and the high profile in the media, of the July 2005 attacks in London has possibly heightened concerns about the threat posed by such events.

The most surprising observation from the data obtained from the questionnaires was that, according to the respondents, none of the threats associated with the key identified hazards have been significantly reduced in the last decade (Table 1). This observation is somewhat unexpected because it is in spite of numerous efforts (by government and business) to address such hazards; through for instance, flood defences, Sustainable Urban Drainage Systems, increased spending and resources on intelligence to counter terrorism and rafts of legislation and guidance to improve the safety of industrial sites.

Table 1: Perception of whether threats from hazards have increased or decreased in the last decade

Threats	Responses (%) Increased	Neither increased or decreased	Decreased	Don't know
Coastal flooding	80	18	0	2
Earthquakes/tremors	6	84	2	8
Flooding (pluvial)	92	4	0	4
Heat waves	68	28	0	4
Industrial explosions	14	56	28	2
Landslides subsidence	36	52	6	6
Transport accidents	44	42	12	2
Riverine flooding	90	10	0	0
Terrorist bombs	90	10	0	0
Tornadoes	32	50	0	18
Windstorms	46	50	2	2

Synthesis of current guidelines and procedures

The occurrence of events during summer 2007 (such as the floods across many regions of the UK and the unsuccessful terrorist attacks in London and Glasgow) plus the relatively reactive nature of governmental decision-making means that literature related to the mitigation of hazards is ever changing. Therefore, the review and assessment of this burgeoning (but still poorly integrated) literature needs to be regularly reviewed.

Provisional analysis of the data supports the findings of our earlier research (see Bosher *et al.* 2006, 2007b) in that while there is an ever growing range of information, there is a lack of suitable guidance that is specifically focused on proactive mitigation measures for the construction sector. This is a particular concern because an earlier scoping project found that there was a general lack of awareness from construction stakeholders regarding who is responsible for, and involved with, disaster risk management planning and hazard mitigation in the UK (Bosher *et al.* 2006). It is likely that the lack of coherent guidance on how hazard mitigation considerations should be integrated into the Design-Construction-Operation Process will therefore inhibit the ability of the construction industry to attain a more resilient built environment and also constrain appropriate re-construction after disasters. Where suitable guidance was available (refer to Table 2 for examples of guidance related to riverine flooding in the UK), awareness and use of such guidance by construction stakeholders was poor.

Table 2: Selection of guidance available to construction professionals for addressing riverine flooding in the UK

Details of available guidance for riverine flooding in the UK (from Governmental and private sector sources)
Pre-design and design stages
• BS EN 752-4:1998 Drain and sewer systems outside buildings. Hydraulic design and environmental considerations • BS EN 13564: Anti-flooding devices for buildings • PAS 1188-2:2003 Flood protection products. Specification. Temporary and demountable products • PAS 1188-1:2003 Flood protection products. Specification. Building apertures • PAS 64:2005 Professional water mitigation and initial restoration of domestic dwellings. • Approved Document C of the Building regulations • CLG, (2006), Planning Policy Statement 25: Development and Flood Risk (PPS25), Department of Communities and Local Government, London • Environment Agency Flood risk mapping website • Scottish Environmental Protection Agency Flood risk mapping website • DEFRA, (2005), Making space for water, March 2005, DEFRA, London • EA, (2004), Catchment Flood Management Plans: Policy Guidance • National Flood Forum website and documentation • CIRIA Designing for exceedance in urban drainage - good practice (C635) • CIRIA Low-cost options for prevention of flooding from sewers (C506) • CIRIA Development & flood risk - guidance for the construction industry (C624) • CIRIA Infiltration drainage - manual of good practice (R156) • CIRIA Scope for control of urban runoff, Volume 1 - overview (R123) • BRE Climate change - impact on building design and construction.
Post-construction
• CIRIA Standards for the repair of buildings following flooding (C623) • BRE Repairing flood damage

These aforementioned issues and a number of concerns that have been raised in the aftermath of the flooding events in the UK in 2007 and 2005 have underscored the importance of achieving a more informed and joined up multi-stakeholder approach to attaining a resilient built environment.

Identification of key stakeholders

A review by Sir Michael Pitt into the 2007 summer floods in the UK concluded, amongst numerous other issues, that a lack of clarity in the responsibilities of government agencies and non-governmental stakeholders was one of the key factors that contributed towards the extent of the flooding (Cabinet Office 2007). Appropriately informed stakeholder decision-making is therefore an important aspect of how disastrous events can be reduced or managed. Previous research has demonstrated which stakeholders should be involved in DRM activities and also at what stages of the Design-Construction-Operation Process (DCOP) these stakeholders should be involved (for details see Bosher *et al.* 2007b). The levels of stakeholder input required to attain 'built-in resilience' were categorised into the following types:

- Formal specified input – Essential structured input that may need to be driven by legislation.

- Formal unspecified input – Essential input that may be driven by 'best practise' guidance rather than legislation
- Informal input – Non-essential but nonetheless important information exchange that would be considered as 'best practice'.
- No input required – Stakeholder's input is not required at this particular stage.

The pre-construction phase was identified as the critical phase in the Design-Construction-Operation Process when DRM activities can be (and need to be) integrated. It is during this phase in particular that critical inputs should be made by architects/designers, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers (Table 3).

Table 3: The key stakeholders that need to make DRM related inputs into the pre-construction phase (after Bosher *et al.* 2007b)

Phase of DCOP	Formal specified input required by stakeholder	Formal unspecified input required by stakeholder
Pre-Construction *(stages of this phase listed below)* • Outline proposals/Outline conceptual design • Scheme design/Full conceptual design • Detail design/Coordinated design • Production information • Tender documentation • Tender action	Architects/designers Engineering consultants Structural engineers Specialist contractors Urban planners/designers Civil Engineers Emergency/risk managers Local authorities Developers Contractors Materials suppliers Clients Utilities companies Quantity surveyors	Emergency services End users Government agencies Professional orgs/inst. Insurers

Discussion and conclusions

This research has revealed that the greatest threats to the built environment in the UK are from flooding (riverine, pluvial and coastal) and severe windstorms; the perspectives and opinions of key construction related stakeholders were very much in-line with the historical data. However, while there is an ever increasing range of guidance, information and legislation for stakeholders in the construction sector, there is a lack of suitable guidance that is specifically focused on proactive mitigation measures (as espoused by the principles of DRM) that are targeted for use by key stakeholders in the construction sector. When suitable guidance is available, awareness of when to best use such guidance by key construction related decision makers is poor.

Key lessons learned so far

- The greatest threats to the built environment in the UK are from flooding (riverine, pluvial and coastal) and severe windstorms.
- While there is an ever growing range of information there is a lack of suitable guidance that is specifically focused on proactive mitigation measures for the construction sector.
- The pre-construction/post disaster reconstruction phase of a building's life cycle is the most critical phase when DRM activities (such as hazard mitigation) should be undertaken by architects/designers, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers.

The pre-construction phase has been identified as the critical stage of the Design-Construction-Operation Process when DRM activities (such as hazard mitigation) should be undertaken by architects/designers, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers. It is argued here, that the components of the pre-construction phase are substantially aligned to the reconstruction activities required after a disaster. It is therefore pertinent to suggest that post-disaster reconstruction needs to formally involve architects/designers, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers (while not forgetting the important roles of relevant stakeholders from within the local community). These stakeholders should also be suitably informed/trained as to the most appropriate ways to embed hazard mitigation approaches into post-disaster reconstruction. If these important stakeholders are not consulted prior to post-disaster reconstruction then the ability to learn lessons from previous events and mainstream DRM into long term development will be severely inhibited.

Engaging with key stakeholders

One of the key challenges for the PRE-EMPT project will be in sufficiently engaging with key stakeholders from the construction sector and increasing their awareness of not only appropriate hazard mitigation approaches, but also the important roles they can play in mainstreaming DRM into long-term development. Charrette workshops are a technique used by practitioners to involve various individuals and organisations directly in the planning, programming, or design of a project (Glass 2008). PRE-EMPT will use design charrettes, as an alternative research method to examine the principles of resilient design. The charrette is often used in community planning to encourage involvement from local stakeholders. PRE-EMPT will therefore use multi-disciplinary charrettes to explore the issues of creating resilient buildings. A design scenario will be tabled, with supporting documentation; the design actions of the invited group of key stakeholders will be the focus for a set of predominantly qualitative research instruments to analyse differences in process, actions, conflicts and resolutions.

The charrettes workshops will enable the project team to review current decision making processes during project briefings and to identify how decisions are informed. This process will enable the project team to develop the PRE-EMPT framework and also identify possible formats that the 'toolkit' might take. Synthesising this wide range of data will enable the development of user defined tools that will assist key stakeholders to integrate key 'resilience' options into how they plan, design, build, operate, maintain and reconstruct the built environment. It is anticipated that the toolkit may consist of a range of tools such as a CD-ROM based software package, guidance manuals and a matrix to signpost decision makers to key regulations, guidance and best practice literature.

It is important to emphasise that it isn't feasible to be too prescriptive about what solutions will be required as these will inevitably be contingent upon the types of built asset and the nature of the hazards that have been identified. Nonetheless, there is an urgent requirement for a methodology that can enable construction stakeholders, such as civil and structural engineers and architects, to make informed decisions regarding the proactive integration of DRM activities during the design, planning, (re)construction, operation and maintenance of existing and future construction projects.

References

Bosher L.S., (ed.), (2008), *Hazards and the Built Environment: Attaining Built-in Resilience*, Taylor and Francis, London

Bosher L.S., Carrillo P.M., Dainty A.R.J., Glass J., and Price A.D.F., (2007a), 'Realising a resilient and sustainable built environment: Towards a strategic agenda for the United Kingdom', *Disasters: The Journal of Disaster Studies, Policy & Management*, **31** (3): 236–255

Bosher L.S., Dainty A.R.J., Carrillo P.M., and Glass J., (2007b) 'Built-in Resilience to Disasters: A Pre-Emptive approach', *Engineering Construction and Architectural Management*, **14** (5): 434-446

Bosher L.S., Dainty A.R.J., Carrillo P.M., Glass J., and Price A.D.F., (2006), 'The Construction Industry and Emergency Management: Towards an integrated strategic framework', *Proceedings of the Information and Research for Reconstruction (i-Rec) Third International Conference on 'Post-disaster reconstruction: Meeting stakeholder interests*', 17th -19th May, University of Florence, Italy

Burby, R., Deyle, R.E., Godschalk, D.R. & Olshansky, R.B. (2000), 'Creating hazards resilient communities through land-use planning', *Natural Hazards Review*, **1** (2): 99-106

Cabinet Office, (2007), *The interim conclusions of The Pitt Review - Learning Lessons from the 2007 Floods*, Cabinet Office, London

Dainty A.R.J. and Bosher L.S., (2008), 'Afterword: Integrating resilience into construction practice' in: Bosher L.S., (ed.), (2008), *Hazards and the Built Environment: Attaining Built-in Resilience*, Taylor and Francis, London

EM-DAT, (2007), *The OFDA/CRED International Disaster Database*, Université catholique de Louvain – Brussels – Belgium

Glass, J. (2008) 'Facing the future by designing in resilience – an architectural perspective', in: Bosher L.S., (ed.), (2008), *Hazards and the Built Environment: Attaining Built-in Resilience*, Taylor and Francis, London

Menoni S., (2001) 'Chains of damages and failures in a metropolitan environment: some observations on the Kobe earthquake in 1995', *Journal of Hazardous Materials*, **86** (1-3):101-19

Mileti D.M. (1999), *Disasters by Design: A Reassessment of Natural Hazards in the United States*, Joseph Henry Press, Washington DC

Ofori G., (2002), 'Construction Industry Development for Disaster Prevention and Response', *Proceedings of the i-Rec International Conference on Post-Disaster reconstruction: Planning for reconstruction*, May 23rd – 25th, Montreal, Canada

Pelling M. (2003) *The vulnerability of cities: natural disaster and social resilience*, Earthscan, London

Trim, P., (2004), 'An Integrated Approach to Disaster Management and Planning', *Disaster Prevention and Management*, **13** (3): 218-225

UN/ISDR (2004), *Living with Risk: A global review of disaster reduction initiatives*, United Nations International Strategy for Disaster Reduction, Geneva

Wamsler C. (2006) 'Mainstreaming risk reduction in urban planning and housing: a challenge for international aid organisations', *Disasters*, **30** (2): 151-177

Wamsler C. (2004) 'Managing Urban Risk: Perceptions of Housing and Planning as a Tool for Reducing Disaster Risk', *Global Built Environmental Review* (GBER). **4** (2): 11–28

Author's Biography

Photo here

Dr Lee Bosher is a Research Fellow that is currently specialising on research into disaster risk management (DRM) processes and the trans-disciplinary integration of DRM principles within the construction sector's decision-making processes. His other research interests encompass the mainstreaming of disaster risk reduction and sustainable vulnerability reduction strategies into long-term development, and the social institutional roles in improving the resilience of society and critical infrastructure to extreme events. His books include '*Social and Institutional Elements of Disaster Vulnerability*' (2007) and '*Hazards and the Built Environment: Attaining Built-in Resilience*' (2008). Lee has worked in the Department of Civil & Building Engineering at Loughborough University since 2005. The co-authors on this paper are the other members of the PRE-EMPT project team, being: Prof. Andy Dainty, Professor of Construction Sociology; Prof. Patricia Carrillo, Professor of Strategic Management in Construction; Dr Jacqueline Glass, Lecturer in Architectural Engineering; and Prof. Andrew Price, Professor of Project Management.