Incorporate disaster management perspective into built environment undergraduate curriculum

Niraj Thurairajah
School of Property, Construction and Planning, Birmingham City University
niraj.thurairajah@bcu.ac.uk
Roshani Palliyaguru
School of the Built Environment, University of Salford
R.S.Palliyaguru@salford.ac.uk
Aled Williams
School of the Built Environment, University of Salford
A.W.Williams@salford.ac.uk

Abstract

The built environment profession is primarily concerned with design, construction, planning, procurement, management and technological aspects related to construction and maintenance of built environment structures. Nowadays, nevertheless, there is an emerging need of improving built environmental professionals' role within the disaster management discipline because the built environment has now been realised as a sector that can enormously add value to the entire disaster management process.

Provision of higher education in the related areas can be practical means to build disaster management capacities. There are few postgraduate and undergraduate degree courses currently available in the UK to provide disaster management education in relation to the built environment discipline. However, the critical role played by the built environment undergraduate degrees in offering the knowledge and skills relevant to disaster management process is seriously overlooked. The special professional knowledge, skills and competencies that need to be shared across all the built environment professions in relation to the entire disaster management process are established in the current literature. However, less is known about how changes could take place to reflect a disaster management perspective in the built environment undergraduate curriculum. Hence, this paper aims to explore the means of systemising the built environment undergraduate curriculum by integrating the concepts and practices of disaster management. A literature synthesis and a comprehensive desk review were carried out to review the existing UK undergraduate built environment curricular to understand the disaster management aspects placed within them. Finally, the paper maps built environment undergraduate curricular with knowledge and skills needed within the disaster management process in order to identify the gaps for curricular integration.

Keywords: Built environment curriculum, Disaster management, Knowledge and skills, Built environment professionals

1. Background

Japan tsunami (2011), Haiti earthquake (2010), Cyclone Nargis (2008) and Asian tsunami (2004) are some recent natural disasters that bring to mind the scenes of despair, destruction and terrible human loss. Increasing frequency and intensity of natural disasters has resulted in severe disruptions of communities and built environment facilities. Built environment facilities have become more vulnerable to disasters due to their inherent features such as location specificity/immobile nature, substantial cost involvement, long development process, durability and specific use (Ofori, 2002). Impact of disasters on communities is further exaggerated when hazards hit built environment facilities such as buildings and infrastructures. It is a kind of transfer of impact on the built environment facilities to the community. Improving disaster resilience and resistance features of built environment facilities are not only a solution to protect such facilities but also to protect communities from devastating disasters, improve their coping capacities and speedy recovery from disasters. Key to integrating sustainable built environment development with disaster management principles is the widespread education about it (Lorch, 2005).

Built environment profession is primarily concerned with design, construction, planning, procurement, management and technological aspects related to construction and maintenance of built environment facilities. However, increased vulnerability of built environment facilities to hazards, call upon built environment professionals to broaden their role to areas such as disaster management. On top of that, international agencies such as United Nations have invoked disaster prone countries to adopt disaster resilient city concepts and mainstream disaster risk reduction initiatives into planning and construction of built environment facilities (Bosher and Dainty, 2011). Moreover, the recent research suggest and promote the significant contribution of built environment discipline towards preventing and minimising disaster losses through the discipline's routine activities - planning, designing, construction/reconstruction, maintenance and operation of built environment facilities. These emerging needs and the vocational-oriented nature of the built environment education emphasise the need to incorporate disaster management perspectives into built environment education. Thus, this paper describes how built environment undergraduate curriculum can consider the incorporation of disaster management issues by addressing the growing trends in disaster management.

2. Research method

A literature review was carried out to investigate the need of incorporating the disaster management perspectives into built environment discipline. Thereafter, a comprehensive desk review was carried out to review the existing built environment undergraduate curricular in the United Kingdom, in terms of the modules covered within built environment sub-disciplinary programmes. Finally, the findings from the literature review and the desk review was mapped against each other to propose curriculum changes.

3. Disaster management process and built environment professionals' role

3.1 Multi-disciplinary nature of disaster management process

"*Disaster management*" can be defined as the systematic process of using administrative decisions, organisation, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impact of natural hazards and related environmental and technological disasters (UN/ISDR, 2009). Multi faceted nature of activities pertaining to the disaster management process is evident of the multi-disciplinary nature of the whole disaster management process. As Jayaraj (2002) describes, disaster management cannot be seen in isolation but it is a collection of various phases of management in addressing this particular issue. OECS (2007) explains a comprehensive disaster management framework composed of six phases called risk identification, risk mitigation, risk transfer, disaster preparedness, emergency response and rehabilitation and reconstruction. A simpler version of the above is proposed by ADRC (2005), which looks at the disaster management cycle as a four stage cycle consisting of phases called prevention/mitigation, preparedness, response and rehabilitation/ reconstruction. Figure 1 depicts a summarised version of the disaster management process.

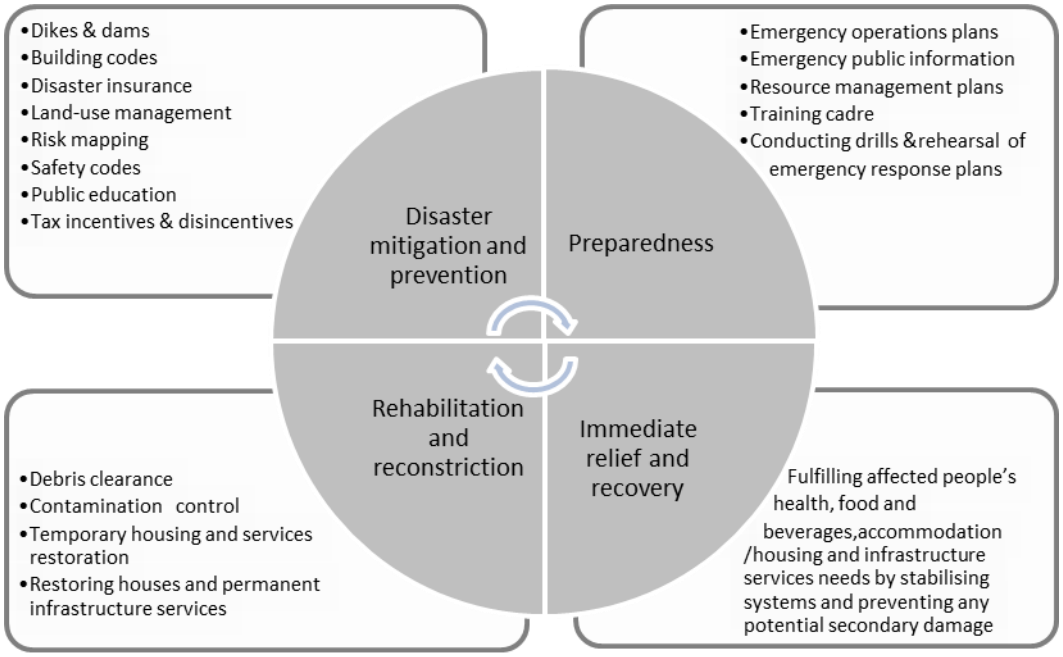

Figure 1: Disaster management process

The process of making the impact less severe is called disaster prevention/mitigation. During this phase, people and organisations recognise the need for certain measures that may be needed to reduce the extent or impact of damage during another similar disaster. The efforts are made to prevent or mitigate damage by implementing various strategies such as the construction of dikes and dams against floods, building codes, disaster insurance, land-use management, risk

mapping, safety codes, public education and tax incentives and disincentives also form part of this phase (ADRC, 2005; Kim and Lee, 1998).

Activities and measures for ensuring an effective response to the impact of hazards are classified as preparedness and are not aimed at averting the occurrence of a disaster (ADRC, 2005). Kim and Lee (1998) describe this phase as one where plans, warning systems and other means adopted in advance of a disaster to aid in its management and activities that develop operational capabilities for responding to an emergency; for example, emergency operations plans, emergency public information, resource management plans, training cadre, conducting drills, rehearsal of emergency response plans, education on warning signs of disasters, methods of safe and successful evacuation and first aid measures.

In consequence of a disaster, the most important phase following the rescue operation is immediate relief and early recovery phase. The immediate needs of the affected communities are looked after during this phase.

Rehabilitation phase involves short-term oriented activities that restore vital life-support systems to minimum operating standards, and long-term activities that return life to normal conditions existing prior to the disaster; for example, debris clearance, contamination control, temporary housing and services restoration, reconstruction of permanent houses and infrastructure (Jayaraj, 2002; Kim and Lee, 1998; Shaw, 2006).

3.2 Skills and values that built environment professionals could bring in to improve the disaster management process

The concept of disaster resilience in built environment has been a topic of interest to many researchers/authors such as Bosher and Dainty (2011); Lloyd-Jones (2006) and Ofori (2002) in the recent past. Bosher *et al.* (2007) describe design, engineering and construction as the most influential disciplines that shape the resilience of the built environment. Therefore, the professionals involved in designing and construction of built environment facilities require an in-depth expertise and knowledge on how to avoid and mitigate the effects of hazards to built environment facilities (Hamelin and Hauke, 2005 cited Bosher and Dainty 2011). Without being limited to the proactive pre-disaster actions, the built environment professionals should be able to provide their expertise during post-disaster context (immediate relief, rehabilitation and reconstruction). The emerging trends in concepts such as disaster risk reduction, vulnerability reduction and hazard mapping emphasise the multi-disciplinary nature of the professional knowledge that need to be integrated within a single setting. Built environment professionals have to share their skills and knowledge among various other disciplinary professionals involved in the disaster management process through which the built environment professionals can add value to the disaster management process. Accordingly, Table 1 tabulates skill sets and activities proposed by various authors, in which built environment professional are of great importance before, during and after major disasters.

Table 1: Main responsibilities/skills/activities of built environment professionals in disaster management

Main responsibilities/skills/activities of built environment professionals in disaster management	*Lloyd-Jones et al (2009); Lloyd-Jones (2006); Owen and Dumashie, (2007)*	*Benson and Twigg (2007)*	*Ofori (2002)*	*Pardasani (2006); Ngowi's, (1997)*	*Wamsler (2006)*	*Pheng et al. (2006)*
Identify, survey and procure safe land for new housing	*X*	*X*			*X*	*X*
Review, implement and advice on appropriate and accurate new and revised building statues (e.g:- land-use planning and building design regulations)	*X*	*X*	*X*		*X*	*X*
Advice on land boundary issues/survey for cadastral proposes	*X*					
Hazard, vulnerability and disaster risk assessments	*X*	*X*	*X*		*X*	*X*
Valuation, cost planning and spending priorities, development finance advice, financial planning and management	*X*	*X*			*X*	
Monitoring funding	*X*	*X*			*X*	
Design and carry out appropriate forms of disaster-resistant construction and engineering	*X*	*X*	*X*		*X*	*X*
Procurement management including source and procure essential construction materials/equipment/skilled labour	*X*	*X*	*X*			
Project and contract management	*X*	*X*				
Assist in establishing property/land rights and claims and moderate conflicts	*X*					
Assistance and assessment of compensation claims	*X*					
Review and implement local regulatory frameworks and improve them	*X*	*X*			*X*	*X*
Conduct training on safe/sustainable construction methods and knowledge transfer	*X*	*X*			*X*	*X*
Contacts with local business and industry (networking)	*X*				*X*	
Housing needs assessments and establish baseline and eligibility	*X*					
Project performance evaluation		*X*				
Help community participation, review local capacity, capturing community knowledge		*X*		*X*	*X*	
Building quality audits pre- and post-disaster, particularly resistance to disaster risks	*X*	*X*				
Detailed assessment of damage to housing	*X*					
Re-establish damaged major infrastructures	*X*	*X*				
Procure & supply emergency shelters; repair lightly damaged property; plan & (re)construct transitional shelter & damaged homes	*X*	*X*				
Land surveying, GIS and rapid mapping of disaster impacts and risks	*X*					
Plan recovery efforts and logistical planning	*X*					
Initial estimation of damage and need assessment of survivors	*X*					
Ensure environmental and social impacts of the proposed solution are acceptable		*X*			*X*	
Provide guidelines for operation and maintenance to maintain the design level of hazard resilience		*X*				*X*

4. Incorporating disaster management into built environment undergraduate education

4.1 Review of existing built environment undergraduate curriculum

Formal built environment education is not a relatively new discipline. For years, built environment higher education has trained and educated students and produced world-renowned experts to the construction and property industry. Boundaries for the built environment discipline are not clearly defined in the current knowledge base (Chynoweth, 2009). However, Griffiths (2004) has described it as "a range of practice-oriented subjects concerned with the design, development and management of buildings, spaces and places" (pp711).

A desk review was conducted by referring to 'educational frameworks', 'subject benchmark statements', 'professional competencies assessment documents' produced by a range of built environment professional bodies such as Quality Assurance Agency for Higher Education (QAA), The Chartered Institute of Building (CIOB), Royal Institution of Chartered Surveyors (RICS), The British Institute of Facilities Management (BIFM), The Royal Town Planning Institute (RTPI), Higher Education Statistics Agency (HESA) and UCAS. Furthermore, some academic articles were also useful in the desk review. Classifications produced by the QAA (2007, 2002, 2000), CIOB (2007), (RICS) (2011 and 2009), BIFM (2011), HESA and UCAS (2007/2008), EC UK (2011), RTPI (2004), Temple (2004), Parsons and Hoxley (2007) and Sullivan *et al.* (2010) depict today's academic trends in the subject disciplines covered within the umbrella term of 'built environment'. Accordingly, built environment education is described as a collective discipline of a range of sub-disciplines such as *Architecture, Construction Management, Planning, Civil Engineering, Real Estate Management, Facilities Management, Quantity Surveying,* and *Building Surveying* which can be further classified into sub-areas of studies. Thus, the desk review has resulted in a complete review of the standard built environment undergraduate curriculum of above the mentioned programmes. Curriculum of these sub-disciplines were analysed in terms of modules covered within them and the learning outcomes of each sub-discipline.

4.2 Discussion: Proposed curriculum changes

Although, the growth and importance of effective disaster management is undeniable, it is relatively new to the built environment discipline except its regular concerns on effective and strong structural designs. Authors such as Ofori (2008) and Lorch (2005) emphasise the need of incorporating disaster management perspectives into built environment curriculum. However, sometimes specialised courses are encouraged to address disaster resilience construction against integrating disaster management perspectives into general built environment undergraduate courses (Glass, 2008). As a result, there are a range of postgraduate and undergraduate degrees that exclusively aiming at disaster resilience reconstruction/construction. However, the general awareness of typical built environment undergraduate degree courses about disaster management is relatively low. This was evident from the curriculum review of eight built environment sub-disciplinary programmes. However, to keep up with

the growing needs of effective management of disaster risks, the built environment education programs need to incorporate aspects of disaster management.

Curriculum changes are proposed based on a mapping exercise. It involved mapping the curriculum of each sub-discipline discussed in section 4.1 and a range of literature on built environment professionals' role in disaster management (section 3.1 and 3.2) to identify undergraduate degree courses that can be incorporated with disaster management perspectives. RIBA outline plan of work (2008) by Royal Institute of British Architects (RIBA) was of immense use in identifying the functions of built environment professionals during construction project life cycle. Accordingly, following sub-sections introduce proposed curriculum changes in each sub-discipline.

4.2.1 Architecture and architectural technology

Architecture involves integration of specific subject based knowledge, with the aim of applying these to a design project; it draws together conceptual, contextual, ethical and material considerations in the realisation of space or form (QAA, 2000). Architectural technological programmes provide knowledge to analyse, synthesize and evaluate, design factors in order to produce design solutions which will satisfy performance, production and procurement criteria (QAA, 2000).

While architecture and architectural technology programmes involves study about adaptation/conversion of buildings, the learning outcomes of such programmes are not keen on creating students' ability to apply principles of capturing client requirements to design solutions for reconstruction/repair of existing buildings. However, possible remedial and design solutions for built environment structures before and after disasters require user needs assessments. This necessitates architectural design and technology degrees to incorporate principles of capturing client requirements in emergency situations into the curriculum. Furthermore, curriculum may concentrate on building statues (e.g:- land-use planning and building design regulations), mainly the possible changes that might take place in statues due to contextual differences in their application such as a normal vs. disaster situations. It is because the routine statutory processes can be circumvented when an official state of emergency is declared following a major disaster (Masurier *et al*., 2006). While much of the responsibility of hazard proof and disaster resistant construction lies with the civil engineering professionals, architectural design and technology programmes shall concentrate on building students' skills on integrating disaster-resistant construction and engineering into architectural detailing. Moreover, the curriculum can be re-designed to incorporate principles of emergency shelter and immediate/temporary accommodation designing.

4.2.2 Construction management

Construction management education is concerned with principles of management, mainly planning, organising, leading and controlling construction operations for a wide range of clients. In achieving this, the curriculum focuses on financial and project management, procurement, economics in construction, law, construction technology, construction measurements and costs, building service, land surveying, property development, sustainable construction, health and safety and construction process management (CIOB, 2007).

The current trend demands incorporation of cultural, environmental, and political factors that could affect international projects and other differing operating contexts such as those arise due to disasters. Therefore, construction management curriculum can be further improved by incorporating principles of application of land-use planning for reconstruction of existing built environment structures, principles of post-disaster reconstruction process management because the construction processes of such projects are varied from that of routine construction. Moreover, the procurement systems suitable for post-disaster reconstruction also need attention within the current curriculum. Today's curriculum focuses on critically evaluate and analyse resource implications for a variety of organisational scenarios. It can be further enhanced by incorporating principles of sourcing and procuring essential construction materials/equipment/skilled labour in difficult situation such as reconstruction. Moreover, the principles of capturing disaster affected clients' housing needs can be incorporated into modules such as sustainable design and construction.

4.2.3 Planning

Planning is usually referred to as 'town and country planning', or 'land use planning', as well as 'spatial planning' (Temple, 2004). 'Planning' degrees deal with the study of planning space and place (Temple, 2004). RTPI encourage integrated understanding of broad matters of principle that reveal and connect social science as an analytical framework, the interplay between land use and transportation, design and the realisation of place, economic issues relating to development, environmental challenges and legal and institutional frameworks (RTPI, 2004).

While planners' role in identify, survey and procure safe land for construction following disasters is important, planning curriculum does not provide an understanding about effects of potential hazards on planning. Therefore, it is important to incorporate issues such as hazard, vulnerability and risk assessment studies into the curriculum. Moreover, the curriculum needs to pay attention on contexualisation of certain knowledge areas such as land boundary issues, logistical planning, compensation claims, needs and damage assessments and local regulatory frameworks to provide graduates with some understanding about contextual difference in routine and disaster related construction.

4.2.4 Civil Engineering

Current civil engineering programmes provide knowledge and understanding of essential principles and theories relevant to civil engineering, science, mathematics, technological base, business and management techniques, professional and ethical responsibilities (ICE, 2010; CVCD and UGC, 2006). The curriculum consists of structural engineering, environmental engineering, transportation engineering, surveying, geotechnical engineering, civil engineering materials, construction management, fluids mechanics, water resources technology and soil mechanics (HESA and UCAS, 2007/2008; EC UK, 2011).

While civil engineering curriculum covers most of the requisites of disaster management, the curriculum does not cover skill development for immediate responses for emergency responses and soft issues of vulnerability assessments, although, high technical risk assessments are covered to some

extent. Further, skills development for contextualisation of property and building regulations and land-use planning theories is lacking in the current curriculum. Therefore, it should take into account the development of technical as well as soft skills required for construction process and administration in emergency situations to re-establish damaged major infrastructures, plan and construct transitional shelter, repair lightly damaged property and plan and rebuild damaged and destroyed homes.

4.2.5 Real estate management

Real estate management is focused on management aspects of property (Temple, 2004). Its curriculum consists of areas such as valuation, management, development, contract, landlord and tenant law, sale and letting of commercial property together with provision of corporate consultancy and other professional services (Temple, 2004).

The contemporary real estate management curriculum provides the knowledge on devising strategies for the effective management and development of a range of property types for both occupation and investment reflecting the physical, legal and economic environment. Real estate management curriculum shall incorporate principles of assessing disaster vulnerabilities/risks of property to facilitate effective valuation and investment decision making. Curriculum can be further enhanced by contextualisation of certain knowledge areas such as occupant compensation claims; local regulatory frameworks, and property/land rights for their effective delivery following disasters.

4.2.6 Facilities management

Facilities management is focused on organisation's management of its property, defined as its premises and facilities (Temple, 2004). Its curriculum consists of modules ranging from purchase, utilization and disposal of property facilities; performance management; risk management to construction technology and environmental services; GIS; landlord and tenant including rent reviews and lease renewals; conflict avoidance; and contract practice (BIFM, 2011; RICS, 2009; Sullivan *et al., 2*010).

Facilities managers have a major role in preventing constructed facilities and their associated services from disasters. They are responsible for establishing business continuity plans, as well as disaster recovery plans to enable business recovery to proceed swiftly and smoothly and to limit the damage by disasters (Davies and Walters, 1997). The contemporary facilities management curriculum includes a module on risk management. It can be further improved by incorporating natural hazards, vulnerabilities and risk assessment theories to make students aware about the effects and necessary contingency plans to potential disasters. It is worth providing appropriate knowledge on the entire disaster management cycle to educate students about effective recovery plans and business continuity plans. In addition, contextualisation of curriculum on issues such as corporations with local business and industry networks would be useful to facilities managers to understand the social, economic, legal, environmental and political changes take place following disasters.

4.2.7 Quantity surveying

RICS (2008) claims that "*quantity surveyors are the cost managers of construction. They are initially involved with the capital expenditure phase of a building or facility, which is the feasibility, design and construction phases, but they can also be involved with the extension, refurbishment, maintenance and demolition of a facility*".

Being procurement and cost management the Quantity Surveying profession's unique skill-base, the curriculum can be improved by incorporating the principles of procurement, contract management and cost management for emergency situations and post-disaster reconstruction. The cost management processes and procurement procedures in post-disaster construction significantly vary from that of routine construction because of the differences in spending priorities, clients' needs, sources of finances and finance monitoring procedures. Moreover, the areas such as initial and detailed damage and need assessments of disaster survivors can be incorporated into the estimating practices. Furthermore, the risk management module should incorporate the principles of natural and human-induced disaster risk management to provide a general understanding about their theories and concepts. Moreover, the modules such as environmental economics may facilitate application of cost-benefit analysis to evaluate the disaster risk management strategies incorporated into construction projects.

4.2.8 Building surveying

Building surveying education provides knowledge and skills on construction and maintenance; detailed design; building pathology; procurement; asset care; design economics and cost planning, risk management; health and safety; land ownership matters, boundary disputes, other neighbourly issues; purchase and tenancy agreements, works progress and quality management; sustainability; construction technology and environmental services; quantification and costing of construction works; project financial control and reporting; fire safety; insurance and contract practice (Parsons and Hoxley, 2007; QAA, 2002, RICS, 2009; Temple, 2004).

Building surveyors have a major responsibility towards effective post-disaster reconstruction. As they are of great use in identifying, surveying and procuring safe land for new housing, its education should provide skills for applying land-use planning in hazardous areas. Apart from provision for knowledge on diagnosis of general building defects, the building surveying curriculum should contain principles of linking building defects generated by different disasters with appropriate forms of disaster-resistant construction and engineering. Moreover, the contemporary building surveying curriculum can be re-designed to incorporate theories to operate and maintain hazard resilience, legal dispute resolution procedures to facilitate establishing property/land rights, assistance and assessment of compensation claims and moderate conflicts generated due to major emergency situations.

Based on the above discussion, a matrix was produced to demonstrate the activities that each built environment sub-disciplinary professionals are able to carry out during the disaster management process (Table 2).

Table 2: Matrix on built environment professionals' role in disaster management

		Main responsibilities/skills/activities of built environment professionals in disaster management	Architects and Architectural technologists	Construction managers	Planners	Civil engineers	Real estate managers	Facilities managers	Quantity surveyors	Building surveyors
Rehabilitation/reconstruction phase	Disaster mitigation/prevention phase	Identify, survey and procure safe land for new housing	X	X	X	X				X
		Review, implement and advice on appropriate and accurate new and revised building statues (e.g:- land-use planning and building design regulations)	X	X	X	X	X		X	X
		Advice on land boundary issues/survey for cadastral proposes		X	X	X	X			X
		Hazard, vulnerability and disaster risk assessments	X		X	X	X	X		
		Valuation, cost planning and spending priorities, development finance advice, financial planning and management					X		X	
		Monitoring funding		X	X				X	
		Design and carry out appropriate forms of disaster-resistant construction and engineering	X			X				X
		Procurement management including source and procure essential construction materials/equipment/skilled labour		X					X	
		Project and contract management	X	X		X			X	
		Assist in establishing property/land rights and claims and moderate conflicts		X	X		X	X	X	X
		Assistance and assessment of compensation claims		X	X		X		X	X
		Review and implement local regulatory frameworks and improve them	X	X	X	X	X	X	X	X
		Conduct training on safe/sustainable construction methods and knowledge transfer	X	X	X	X	X	X	X	X
		Contacts with local business and industry (networking)	X	X	X	X	X	X	X	X
		Housing needs assessments and establish baseline and eligibility	X	X	X	X	X	X	X	X
		Project performance evaluation	X			X		X	X	X
		Help community participation, review local capacity, capturing community knowledge	X	X	X	X	X	X	X	X
		Building quality audits pre- and post-disaster, particularly resistance to disaster risks	X			X		X	X	X
		Detailed assessment of damage to housing	X	X	X	X	X	X	X	X
		Re-establish damaged major infrastructures	X	X	X	X	X	X	X	X
		Repair lightly damaged property; plan & (re)construct transitional shelter & damaged homes	X	X	X	X	X	X	X	X
		Land surveying, GIS and rapid mapping of disaster impacts and risks	X	X	X	X				X
		Ensure environmental and social impacts of the proposed solution are acceptable	X	X	X	X	X	X	X	X
		Provide guidelines for operation and maintenance to maintain hazard resilience	X			X		X		X
Immediate relief phase	Prepar-edness phase	Procure and supply emergency shelters	X		X	X	X	X	X	
		Plan recovery efforts and logistical planning			X	X		X	X	
		Rapid mapping of affected areas using remote sensing and GIS	X	X	X	X				X
		Initial estimation of damage and need assessment of survivors	X	X	X	X	X	X	X	X

5. Conclusions and summary

Recent major disasters have highlighted the importance of resilient built environment in reducing the impact of such disasters. This necessitates improving the built environment professionals' role in the disaster management, particularly in managing built environment facilities for improved resilience. Key to integrating sustainable built environment development with disaster management principles is widespread education about it. However, the contemporary built environment higher education, particularly the undergraduate education seems to have significantly overlooked the key principles of disaster management.

This paper has presented knowledge areas and skill sets that built environment professionals could bring into improve the disaster management process as emerging from the current literature base. Furthermore, the paper has reviewed the contemporary built environment curriculum by referring to eight built environment sub-discipline programmes. Curriculum review realised the potential of systematising varied sub-disciplinary education by integrating the disaster management perspectives. Thereafter, a mapping exercise was undertaken to map the built environment professionals' role in the disaster management process with the modules and knowledge areas embedded in sub-disciplinary programme curricular. It emphasised that the theories/principles of disaster management can be incorporated in the whole life cycle of built environment facilities including their planning, designing, construction/reconstruction, operation and maintenance. Appropriate forms of disaster-resistant construction and engineering including design of structures, installations, layout and dimensions, materials and disaster-resistant construction methods are adequately included within the current curriculum. However, the soft issues such as procurement procedures and cost management systems; damage assessment procedures; land use planning; and building regulations and statues need to be contextualised in the current curriculum to provide necessary knowledge base and the skill sets relevant to disaster contexts. In addition, new skills and competencies are to be developed in the areas such as shelter and immediate/temporary accommodation designing; legal dispute resolution procedures/theories to facilitate establishing property/land rights of disaster affected communities; and corporations with local business and industry networks.

References

Asian Disaster Reduction Centre (ADRC) (2005) *Total Disaster Risk Management - Good Practices 2005*, Kobe: ADRC, (available online http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/GP2005_e.html [Accessed on 20/06/200]).

Benson C and Twigg J (2007) *Tools for Mainstreaming Disaster Risk Reduction: Guidance Notes for Development Organisations*, International Federation of the Red Cross and Red Crescent Societies/The ProVention Consortium, Geneva.

Bosher L and Dainty A (2011) "Disaster risk reduction and 'built-in' resilience: towards overarching principles for construction practice". *Disasters* **35**:1-18.

Bosher L S, Dainty A R J, Carrillo P M, Glass J and Price A D F (2007) "Integrating disaster risk management into construction: a UK perspective". *Building Research and Information* **35**: 163–177.

Chynoweth P (2009) "The built environment interdiscipline: a theoretical model for decision makers in research and teaching". *Structural Survey* **27**: 301-310.

Committee of Vice-Chancellors & Directors (CVCD) and University Grants Commission Sri Lanka (UGC) (2006) *Subject benchmark statement in civil engineering*, UGC, Sri Lanka.

Davies H and Walters M (1997) "The role of building and facilities management in disaster recovery planning", *The Annual Research Conference of the Royal Institution of Chartered Surveyors–COBRA 1997*, 10th-12th September 1997, (available online http://www.rics.org/site/scripts/download_info.aspx?fileID=2768 [accessed on 27/04/2011]).

Engineering Council UK (EC UK) (2011) *Engineering Council Examination*, (available online http://www.engc.org.uk/education--skills/engineering-council-exam [accessed on 25/04/2011]).

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

Griffiths R (2004) "Knowledge production and the research-teaching nexus: the case of the built environment disciplines". *Studies in Higher Education* **29**: 709-26.

Higher Education Statistics Agency and UCAS, (2007/2008) *JACS-version 2*, (available online: http://www.hesa.ac.uk/index.php?option=com_studrec&task=show_file&Itemid=233&mnl=07051&href=jacs2.html [accessed on 17/02/2011]).

Institution of Civil Engineers (ICE) (2010) *Development objectives for Eng Tech TMICE/ AMICE/MICE and IEng MICE/CEng MICE*, (available online http://www.ice.org.uk/ice3005a [accessed on 29/04/2011]).

Jayaraj A (2002) "Post-disaster reconstruction experiences in Andhra Pradesh, in India", *Proceedings of Conference of Improving Post-Disaster Reconstruction in Developing Countries*, 23rd-25th May 2002, Université de Montréal, Quebec, Canada. (available from: http://www.grif.umontreal.ca/pages/i-rec%20papers/annie.pdf [accessed on 17/02/2009]).

Kim P S and Lee J E (1998) "Emergency management in Korea and its future directions". *Journal of Contingencies and Crisis Management* **6**: 162-170.

Lloyd-Jones T (2006) *Mind the Gap! Post-Disaster Reconstruction and the Transition from Humanitarian Relief*, London, RICS.

Lloyd-Jones T, Kalra R, Mulyawan B, Theis M, Wakely P, Payne G and Hall N (2009) *The Built Environment Professions in Disaster Risk Reduction and Response: A guide for humanitarian agencies*, MLC Press, University of Westminster.

Lorch R (2005) "What lessons must be learned from the tsunami?". *Building Research and Information* **33**: 209–211.

Masurier J L, Rotimi J O B and Wilkinson S (2006) "A comparison between routine construction and post-disaster reconstruction with case studies from New Zealand", *Proceedings of 22nd ARCOM Conference on Current Advances in Construction Management Research*, Association of Researchers in Construction Management (ARCOM), 4th -6th September 2006, Birmingham.

Ngowi A B (1997) "Community-managed infrastructure facilities". *Facilities* **1**: 323-330.

Ofori G (2002) "Construction industry development for disaster prevention and response", *i-Rec Conference on Improving Post-Disaster Reconstruction in Developing Countries*, 23-25 May 2002, University de Montreal, Canada, (available online: www.GRIF.UMontreal.ca/pages/papersmenu.html [Accessed on 10/11/200]).

Ofori G (2008) "Construction in developing nations: towards increased resilience to disasters", In L.S. Bosher (ed.) *Hazards and the Built Environment: Attaining Built-in Resilience*. Taylor and Francis, London.

Oh E H, Deshmukh A and Hastak M (2010) "Disaster impact analysis based on inter-relationship of critical infrastructure and associated industries: A winter flood disaster event". *International Journal of Disaster Resilience in the Built Environment* **1**: 25-49.

Organisation of Eastern Caribbean States (OECS) (2007) *Vulnerability Benchmarking Tool*, Saint Lucia: OECS.

Owen D and Dumashie D (2007) "Built Environment Professional's Contribution to Major Disaster Management". *Strategic Integration of Surveying Services*, FIG Working Week, 13th-17th May 2007, Hong Kong.

Pardasani M (2006) "Tsunami reconstruction and redevelopment in the Maldives: A case study of community participation and social action". *Disaster Prevention and Management* **15**: 79-91.

Parsons E and Hoxley M (2007) "The trends in building surveying education: a longitudinal study", *Construction and Building Research Conference of the Royal Institution of Chartered Surveyors*, Georgia Tech, Atlanta USA, 6th-7th September 2007.

Pheng L S, Raphael B and Kit W K (2006) "Tsunamis: Some pre-emptive disaster planning and management issues for consideration by the construction industry". *Structural Survey* **24**: 378-396.

Quality Assurance Agency for Higher Education (QAA) (2000) *Architecture, Architectural Technology and Landscape Architecture Subject Benchmark Statement*, QAA, UK.

Quality Assurance Agency for Higher Education (QAA) (2002) *Building and Surveying Subject Benchmark Statement*, QAA, Gloucester.

Quality Assurance Agency for Higher Education (QAA) (2007) *Architectural Technology Subject Benchmark Statement*, QAA, Gloucester.

Royal Institute of British Architects (RIBA) (2008) *RIBA outline plan of work 2007*, RIBA.

Royal Institution of Chartered Surveyors (RICS) (2008) *Your pathway to qualifying in Quantity Surveying and Construction, RICS*, (available online: http://www.rics.org/site/scripts/download_info.aspx?downloadID=161&fileID=165 [accessed on 17/02/2009]).

Royal Institution of Chartered Surveyors (RICS) (2009) *Assessment of Professional Competence/Assessment of Technical Competence*: *Requirements and competencies*, RICS.

Royal Institution of Chartered Surveyors (RICS) (2011) *Practice Areas*, (available online http://www.rics.org/practiceareas [accessed on 17/04/2011]).

Shaw R (2006) "Indian Ocean tsunami and aftermath: need for environment-disaster synergy in the reconstruction process". *Disaster Prevention and Management* **15**: 5-20.

Sullivan K, Georgoulis S W and Lines B (2010) "Empirical study of the current United States facilities management profession" *Journal of Facilities Management* **8**: 91-103.

Temple M (2004) *Studying the Built Environment*, Palgrave Macmillan, Basingstoke.

The British Institute of Facilities Management (BIFM) (2011) *FM Categories*, (available online http://www.bifm.org.uk/bifm/knowledge/resources/Categories [accessed on 16/04/2011]).

The Chartered Institute of Building (CIOB) (2007) *The CIOB Education Framework 2007*, CIOB, Ascot, UK.

The Royal Town Planning Institute (RTPI), (2004) *Policy Statement on Initial Planning Education*, RTIP.

United Nations International Strategy for Disaster Reduction (UN/ISDR) (2009) *UN/ISDR Terminology on Disaster Risk Reduction* (2009), (available online: http://www.unisdr.org/eng/library/lib-terminology-eng.htm [accessed on 20/02/2009]).

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

Warfield, C. (2008) *The Disaster Management Cycle*, (available online: www.gdrc.org/uem/disasters/1-dm_cycle.html [Accessed on 16/08/2007]).