**Entrepreneurship and innovation sustainable built environment: a research agenda**George Ofori

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**Abstract**

What is new in “green built environment”? In considering this question, it is necessary to explore two others: why is it necessary to seek to attain a green built environment? What has been achieved in the efforts towards attaining it? What are the persisting challenges and problems? Thus, what else needs to be done? Again, in considering the question of what else needs to be done, it is necessary to investigate the full range of sustainability in the built environment – i.e., to go beyond ‘green’. Such an investigation shows that whereas some headway has been made in formulating policies, strategies, regulations and actions in industry to enhance environmental performance in the built environment, much more needs to be done under that pillar of sustainable development. Moreover, the other elements of sustainability: economic, social and governance, have not been given much attention. Focus has also been put on ‘building’ at the expense of other elements of the built environment. A more appropriate conceptualisation of the subject is explored.

After discussing key features of a sustainable built environment, entrepreneurship is considered. “Eco innovation” in building is next discussed. The definition of innovation is analysed, again, focusing on the current understanding. Innovation and entrepreneurship as they relate to a sustainable built environment is considered. The link between innovation and entrepreneurship is subsequently analysed. The relevance of these two processes to the process of planning, design, construction and management of the built environment today is discussed.

The main theme and each of the 23 sub-themes of the conference are then briefly considered individually. In each case, the current state of knowledge on, and special relevance of, the subject is discussed, followed by consideration of implications for further research. Some other points which are relevant to a sustainable built environment are also highlighted. It is found that there is scope for more work under each of the sub-themes, and that, together, the points highlighted constitute a research agenda for innovation and entrepreneurship in the built environment.

Keywords: innovation, entrepreneurship, sustainable development, built environment, research

1. INTRODUCTION

**1.1 What is new in green building?**

The theme of this conference is: “Greening Environment, Eco Innovations and Entrepreneurship”. Some 23 sub-themes are outlined. It is pertinent to consider the need for a green built environment, and what has been achieved in this endeavour. If there is more to be done, and obstacles to overcome, then the role of innovation and entrepreneurship in the effort to make progress can be explored.

The creation of sustainable constructed items (which make up the built environment) is one of the key issues in all countries today. It is because it is recognised that construction plays a critical role in putting in place the foundation for sustainable socio-economic development by building place the needed physical assets (HM Treasury, 2011; National Infrastructure Unit, 2015). Considering sustainable development, it is pertinent to highlight the unique features of construction which make it possible that construction activity and constructed items can have a potentially negative impact on sustainable development (Ofori, 2015), and which also enable them to offer the possibility of making a significant positive contribution to efforts to address the effects of inappropriate economic development – for example, the Intergovernmental Panel on Climate Change (IPCC) (2007) suggested that the building stock offers the most cost-effective means of addressing climate change.

Much has been achieved in many countries in the effort to attain a sustainable built environment (see, for example, a global survey of trends in green building McGraw-Hill Construction, 2013). Four examples from the arena of statutes and policies may be outlined. First, in some countries, laws and codes have been introduced which require appropriate action in attaining green construction. Second, a few countries, such as Singapore (BCA, 2014) have launched green building master plans. Third, in many other countries, such as Malaysia (CIDB, 2015) and the UK (HM Government, 2013), green building is a major element of national construction industry improvement strategies and subsequent policies. Finally, green building is a major component of the programmes in national sustainable development strategies – an example is Singapore where the target is to attain 80 percent green buildings in the building stock by 2030 (Inter-Ministerial Committee on Sustainable Development, 2009).

Developments in terms of the response of the industry (at the macro level) can also be outlined. The first is the formation of green building councils which bring parts of the industry together to pursue progress in green building. For example, the Singapore Green Building Council (SGBC), with membership from all sections of the construction industry, was formed in 2009. Its mission is “to propel the Singapore building and construction industry towards environmental sustainability by promoting green building design, practices and technologies, the integration of green building initiatives into mainstream design, construction and operation of buildings as well as building capability and professionalism to support wider adoption of green building development and practices in Singapore” ([www.sgbc.sg/index.php/green/about/mission/](http://www.sgbc.sg/index.php/green/about/mission/)). The vision of the Green Building Council of Sri Lanka (GBCSL) is: “to transform the construction industry in Sri Lanka with green building practices and to fully adopt sustainability as the means by which our environment flourishes, economy prospers and society grows to ensure the future wellbeing of our Motherland” (<http://srilankagbc.org/Vision.html>).

Second, professional institutions and trade associations have formulated green building manifestos (such as Royal Institution of British Architects, 2000; Chartered Institute of Building (CIOB), 2013) and guides (such as Singapore Institute of Architects, 2013) for their members. Green building assessment and benchmarking tools have been developed in some countries by government agencies such as in Singapore (where the Building and Construction Authority (BCA) launched Green Mark (BCA, 2012)), by groupings in the industry such as in Malaysia (where the Green Building Index (GBI, 2009) was formulated by architects and consulting engineers and in Sri Lanka where the GreenSL® Rating System for Existing and New Buildings was set up by the GBCSL (<http://srilankagbc.org/Rating%20System%20for%20Built%20Environment.html>). At the company level, design and construction firms in many countries now use their capability and track records in green building as a strategic tool. An example of the periodic development of a UK company in the consideration of sustainability in corporate practices is provided by Whitehead (2015).

**1.2 Aim and objectives**

The aim of the study is to investigate the potential role of innovation and entrepreneurship in the effort to realise a green built environment. The discussion is focused on consideration of the main theme and sub-themes of this conference.

The objectives are to:

* consider the need for a green built environment, the progress which has been made in the effort to attain it, and the remaining issues, challenges and problems
* consider the meaning of innovation and entrepreneurship today, and analyse their potential to facilitate the efforts towards creating and managing a sustainable built environment
* present a research agenda for a sustainable built environment by considering the 23 sub-themes of this conference.

2. SUSTAINABLE BUILT ENVIRONMENT

**2.1 Why does more need to be done to realise sustainable built environment? What really needs to be done?**

More needs to be done in the effort to attain a sustainable built environment, not only to ensure net-neutral impact of the process of creating and managing the built environment on sustainable development, but to maximise the potential positive impact. As a manifestation of the need for more work, some of the Sustainable Development Goals (SDGs), which outline what is to be achieved to bring about improvements in the quality of life of people around the world, relate directly to the expansion, improvement and better management of the built environment. These include (United Nations, 2015):

* Goal 6. Ensure availability and sustainable management of water and sanitation for all
* Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all
* Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

(Goal 11, on cities, is considered below.)

Some examples of how the built environment can address all the pillars of sustainable development are now considered.

1. environmental ... minimisation of land use change; conservation of resources – using fewest (in number) and least (in volume or weight), maximising recycling/reuse; minimising all forms of pollution

2. economic ... creation of jobs, enhancing of incomes; integration of (and deriving synergies among inter-linkages among) elements of the built environment; enhancing productivity of production processes in organisations using the built items; saving of costs in built environment firms’ own production; incentives

3. social ... cultural suitability; lifestyle changes possibilities – examples include design for crime reduction and personal safety, and provision of leisure and sports facilities

4. institutional … policies and programmes, regulation, enforcement, incentives and awards.

Another issue worth considering here is that of governance. In construction, corruption and mismanagement is responsible for the leakage of very high proportions of the funds which are meant to be invested in public construction projects (Transparency International, 2005; Hawkins and McKittrick, 2012). The factor of “project governance”, as well as governance at the national level concerning the administration of projects are key in sustainable development (Ofori, 2016). Thus, it is possible to reconsider the concept of “project governance” in construction as the effort to attain sustainable development in the construction process, through the construction process, from the constructed item.

**2.2 Why are current definitions inadequate? What would an appropriate conceptualisation of the subject be?**

Viewed through the prism of sustainable development, the current focus on "green building" which has seen translation into policy and practice, and the formation of "Green Building Councils" and assessment systems in many countries, is inadequate. There is often some confusion on the subject. For example, the mission of the GBCSL is: “to develop the sustainability of the built environment by transforming the way it is planned, designed, constructed, maintained and operated and drive the adoption of green building practices through market-based solutions, while helping to forge a new partnership between government, industry and other stakeholders” (<http://srilankagbc.org/Vision.html>). Thus, the mission (which refers to “the built environment” is wider than the vision (which mentions “green building” and “the construction industry”). The attempt by some authors to equate green building with sustainable building, or to use expressions such as "green and sustainable construction" (Office of the Federal Environmental Executive, 2003) are not satisfactory. The existing definitions of “sustainable construction” do not go far enough; an example is that offered by the International Organisation for Standardisation (ISO) (2008). An attempt by the SIA (2013) to offer elements of a sustainable built environment goes much further than most of the existing ones.

Appropriate definitions of sustainable construction are needed. These should go beyond green building and consider the inter-linkages among the components of the built environment, well as the economic, social-cultural-historical and institutional-governance pillars of sustainable development. Ofori (2013) considers a sustainable building as:

“one which has been designed and constructed with due consideration of aspects relating to sustainable development including: preservation of land and effective decision making in answer to the fulfilment of the client’s need for space (for example, is a new building needed?); resource conservation, and maximisation of utilisation of renewable resources; utilisation of existing natural factors such as daylight, wind direction and sunlight; prevention of pollution all types; protection and preservation of natural ecosystems; effective management of waste; enhancement of the durability of the built facilities including safeguarding the fabric of the built facilities in changing atmospheric conditions; promotion of the health and well-being of the workers building the items as well as occupants of nearby buildings (during construction), and of users of the built facilities (upon completion); and development of environmentally conscious lifestyles of the users”.

It would be appropriate to consider, analyse and improve upon this definition. The appropriate definition would: consider all appropriate elements of sustainable development; seek to cover, and be relevant to, all types of constructed items; consider the lifecycle of the constructed item; seek to explore and exploit possible contributions of construction; and inspire and challenge the industry to perform to a higher level.

**2.3 What are some recent developments?**

Some recent developments can be outlined. The Open Building Institute in the US has launched a crowdfunding campaign to allow anyone the chance to create his or her own affordable eco-house. The open source platform has a free library designs for structures, furniture and utilities contributed by designers whose buildings met the (Quirke, 2016). However, many of the items have not been prototyped. The Low Emissions Intensity Lime and Cement consortium (LEILAC), which includes HeidelbergCement of Germany, Mexico’s Cemex, Tarmac of UK (a materials firm) and Calix of Australia (a mineral-processing and carbon capture technology company) was set up to exploit carbon capture technology developed by Calix, which may enable Europe’s cement and lime industries to slash their carbon emissions without significantly increasing their costs (Rogers, 2016). The consortium is building a plant in Belgium which could capture more than 95 percent of CO2 emissions from lime and cement manufacturing.

**3. ENTREPRENEURSHIP AND ECO INNOVATION**

**3.1 What is the possible relationship between entrepreneurship and sustainable built environment?**

There is a huge volume of literature on entrepreneurship (Shane and Venkataraman, 2000), and there are many myths, misunderstandings and arguments with entrenched positions on many aspects of entrepreneurship, and issues relating to it (Carlsson et al., 2013). There is general agreement that, as Schumpeter (1934) suggested many years go, entrepreneurship is important in all economies. For sustainable development, entrepreneurship could be considered to be crucial.

Today, the appropriate definition of "entrepreneurship" would have the following elements: (i) the ability to identify opportunities, often in a field or operating environment involving risks; (ii) the capability to assess the potential of these opportunities and determine that they are viable; (iii) the decision to enter into business or other activities to take advantage of these opportunities, a decision others might not have made; and (iv) the ability to build upon these opportunities to create other opportunities to apply, and hence, create additional wealth. Also, it is pertinent to state that there is a consensus today that entrepreneurship is not limited to business; it can be involved in any activity, and can also an involve individual, a group or an organisation.

The importance of entrepreneurship is even more evident today, with Schumpeterian disruption in many areas of endeavour which have taken many firms, including those which thought they were agile and competitive, by surprise and threatens to make whole segments of industries redundant. In the built environment field, it is necessary to pay attention to these possible developments in entrepreneurial disruption: (a) possible empowerment of small companies by easily available data and computer power (via the cloud); (b) rise of companies able to utilise new technologies such as BIM more effectively during development and in management of built items; (c) companies which will come up with the next technological innovation after BIM; (d) new production approaches and working methods such as greater automation; (e) new organisational working arrangements, lifestyles and shopping habits and their impact on the volumes of built items in different segments which will be needed; and (f) nature and volume of infrastructure which will be required to enable and support renewable energy, its basic unit of production and necessary aggregation, and the new methods of transportation.

Two other areas where disruptions will occur in the way the built environment is planned, designed, constructed and managed could be considered. First, there will be greater stakeholder involvement, as users and beneficiaries, empowered with computers and smart telephony, and emboldened by the social media, will show greater interest in the process of creating the components of the built environment. Thus, there will be the need for more effective stakeholder management in the planning and design process, in monitoring of projects, and in feedback during the operation of the facilities. The second disruption will be in the forms of ownership including community ownership of large-scale infrastructure. Thus, the local community could replace national government in public-private partnerships. These developments make a new understanding of entrepreneurship in the built environment necessary.

**3.2 How can innovation contribute to attaining sustainable built environment?**

It is suggested that innovation and value creation are among the key sources of economic growth today. A committee set up by Singapore’s government to formulate new strategies for the future highlighted this factor (Committee on the Future Economy Secretariat, 2015).

Innovation has many definitions. It can be considered as a new idea, method or item of equipment; a new way of using an existing idea, method or equipment; or the opening up of new ways of providing goods or services, and so on. An innovation should be of direct use, and should have an impact on society. It is helpful to consider Schumpeter’s (1934) idea of creative destruction, and suggest that businesses, governments and individuals should continually find better ways of doing things, whether in the form of more effective processes, better inputs, better products (improved quality, durability, service, price), or better ways to reach the clientele (choice, waiting time, convenience). The link between entrepreneurship and innovation is often highlighted. For example, to Drucker (1985), “Entrepreneurship is the act of innovation involving endowing existing resources with new wealth-producing capacity”. The strong link between entrepreneurship and innovation is evident in the many major global companies which were start-ups a few years ago.

It is pertinent to note that innovation does not only involve the application of new or more sophisticated technology. It includes new or smart ways of using existing or simple methods. Thus, it is often pertinent to explore traditional (old) approaches.

There are many possible areas where innovation is relevant to sustainable built environment. It should be noted that, in the context of sustainable development, the full range of innovation should be explored for possible application, rather than focusing on the ‘eco’ dimension, as in the theme of this conference. Some examples are: (a) planning and design approach – innovative planning to maximise use of space and preserve land; (b) passive design to create appropriate indoor environment with human comfort and productivity; (c) novel materials and their production methods; (d) high performing plant and equipment, installations and fittings; and (e) attention to social-community and personal-psychological aspects.

4. THE FUTURE

**4.1 The conference themes as further research agenda**

The 23 sub-themes of this conference are presented below. Under each sub-theme, some comments are first made on its relevance and current state of knowledge on it. The implications for further research are then presented, with a focus on new considerations which will push the frontiers of knowledge and also lead to progress in the practice of sustainability in construction.

1 *Green Buildings*

As discussed above, the concept of “green building” should be extended beyond ‘building’ to cover ‘construction’ and ultimately, the entire built environment; and beyond ‘green’ to cover other elements of sustainable development other than the environmental module. It would be pertinent to study the concept of “sustainable construction” which includes “green building”. Other relevant elements of this broad subject should also be institutionalised in order to set up appropriate headings for research. Arguably key among these is ‘governance’ (as discussed in section 2.1).

2 *Sustainable Urbanisation*

Urbanisation is a critical issue in many countries, especially in the developing nations. The merits and disadvantages of urban areas and their growth have been debated for several decades (Hall, 1996). It is now realised that cities offer possible arenas for developing and instituting solutions in sustainable development (**Bouteligier, 2013;** United Nations Human Settlements Programme, 2014). However, it is also evident that there are major problems in the cities in developing countries where millions of people live economically precarious lives in unsafe and unhealthy built environments (United Nations, 2015). A particular SDG, Goal 11, concerns cities, as it states: “Make cities and human settlements inclusive, safe, resilient and sustainable”. Making cities work, through effective planning and management, is a current major task in practice, administration and research. Sustainability across the urban area involves dealing with the inter-connection among built items. Much more work is needed in this important area.

3 *Sustainable Construction Practices*

The construction industry in each country has a range of practices, based on history, tradition and law. Reviews of the construction industries in many countries have found that the industries’ prevailing practices have a major impact on performance (Construction 21 Steering Committee, 1999; HM Government, 2013). For example, the allocation of the roles of the participants tend to constitute an obstacle to effective integration, co-ordination and value chain management. It is suggested that whole-industry approaches to establishing progressive and performance enhancing practices, procedures, contracts and relationships should be developed and instituted (Bernstein, 2003). It is also pertinent to consider the international variations in practices, sieve out good practices, and seek their effective dissemination for application, while recognising context specificity in each case.

4 *Procuring Sustainable Built Infrastructure*

Sustainable procurement has the potential to provide direction, guidance and incentives to practitioners and companies. Ofori (2000) suggests that procurement can be used to influence appropriate decision making in enterprises, and by individuals, throughout the value chain of construction firms. Some pertinent research questions include: (a) How different should the procurement arrangements for items of sustainable infrastructure be from those for 'regular' items? (b) What would be the appropriate assessment and bidder selection criteria for awarding these projects? (c) As environmental assessment is currently usually done at the design stage, what would be the relevant project success criteria? and (d) How can government set the example in procurement of sustainable built infrastructure, considering the differences in main considerations of public and private-sector clients during procurement.

5 *Cost Management*

‘Cost’ comes first when considering the performance parameters of construction projects, even in the so-called “iron triangle” (Association for Project Management, undated). The importance of the management of the cost of the constructed item is perhaps signified by the fact that a particular profession (Quantity Surveying or Cost Engineering) has been developed to practice it. Cost is also important in the context of sustainable development. It relates to the ‘economy’ pillar of the concept. It is necessary to progress from the persisting focus on cost in decision making on built environment projects. It is also necessary to enhance knowledge and application of life-cycle consideration of cost and related aspects of projects. This has relevance to sustainability with its stress on inter-generational equity and relevant considerations (Drexhage and Murphy, 2010). Studies are also needed on how best to balance cost with value, and then to relate cost to the other project performance parameters.

6 *Process Improvement*

Process improvement is important in the field of sustainable built environment as the industry uses massive volumes of materials. Thus, such concepts as Sustainable Consumption and Production (UNEP, 2015) are especially relevant to that field. Process improvement should be extended upward and downward beyond the construction process to include the extraction and production, transportation, storage and handling of materials; management or disposal of wastes during construction; continuous management of materials, components and installations in the facility during its operation, and appropriate reuse or recycling of its materials and components upon demolition.

7 *Building Information Modelling and Information Management*

From the perspective of a sustainable built environment, BIM offers the possibility of: effective collaboration in planning, design and construction; experimenting with various patterns and components; simulating the long-term performance of various materials and components; avoiding errors, rework and waste. Information management would help in the capturing, processing, dissemination and application of key information and data relating to aspects of the construction project and constructed items. Further research in BIM and information management should also consider the legal and other obstacles. Work is also required in integrating BIM with other technologies such as virtual reality and augmented reality, and the application of drones in various aspects of construction; and “the post-BIM era” in construction (Thasarathar, 2016).

8 *Innovative Green Technologies*

Innovation, in green technologies, in relation to the built environment, should not mean advanced, most mechanical technologies. Technologies should be explored and applied in construction in the most fundamental and widest sense, including equipment, methods, materials, processes, procedures, and so on. The technologies explored should be on the entire continuum, from the most advanced such as nanotechnology in the study of materials, and non-mechanical technologies as in passive methods. Contextual local relevance is key. Also worth exploring are the life-cycle cost implications of the new materials, components, techniques and tools.

9 *Sustainable Procurement Strategies*

The comments on this sub-theme are the same as on sub-theme 3.

The adoption of a strategic approach to procurement would be most useful. Sustainability here also refers to long-term, continuous development of strategies, policies and approaches, with stakeholder feedback.

10 *Public Private Partnerships (PPPs) and Green Innovation*

PPP is being increasingly used for various projects. It has merits and demerits, and while it has led to the realisation of some critical projects around the world, it has also resulted in projects which have involved problems and failures (European PPP Expertise Centre, 2015). It is appropriate to continuously innovate in the effort to apply PPP to constructed items and the urban infrastructure and rural built environment.

11 *PPPs for a Sustainable Built Environment*

Considering the increasing importance of PPP in the realisation of the elements of the built environment, further study of the effective application of PPP in this segment is necessary. Community level (instead of national level) PPP application is worth exploring.

12 *Environmental Economics and Management*

The subject of Environmental Economics and Management has not yet become established as a research area in construction. This requires key attention. Some possible topics in Environmental Economics with respect to the built environment include: (a) modelling life cycle assessment incorporating all dimensions of sustainability; (b) valuation of the priceless in built items; (c) what price premium to charge reasonably; and (d) what should the value of relevant incentives be, and for what duration. The possible research topics in Management are: (a) sustainability management as a project management knowledge area; and (b) managing the delivery of the sustainable built item.

13 *Affordable Sustainability*

Affordability is not given sufficient attention in construction. It is applied in practice without much analysis. This is a fertile area for further research.

14 *Socio-Economic Sustainability*

The focus on the ‘environmental’ pillar of sustainable development in built environment practice has been discussed above. This fixation even exists in research. Work on the other pillars is required. The expression “socio-economic” should be rendered more appropriately in its two component parts ‘social’ and ‘economic’, in addition to their combination to determine possible synergies.

15 *Entrepreneurship*

Entrepreneurship is relevant to the effort to pursue sustainable development, as discussed above. However, it should be reiterated that entrepreneurship should not only relate to individuals and businesses; it should also be applied to administrators, and organisations outside the business sector.

16 *Sustainable Materials/Green Building Materials*

Research on materials from the perspective of sustainable development should go beyond ‘green’ to cover the other pillars, in order to explore the full range of sustainable development in the development, production, installation or fixing and maintenance of construction materials. Affordability is also a relevant aspect to study in these respects.

17 *Green Rating and Certification*

The development of rating and benchmarking tools, and their application in certification is considered an important step in the pursuit of “green building”. These tools require further development in many regards, including: the contextual appropriateness of the tool; the theoretical basis of the segments of the tool; and the “further development during use” of the tools. Most important is the extension of the tools from ‘green’ to ‘sustainable’ (see, for example, CEEQUAL (ICE, undated)), and from ‘building’ to the entire range of constructed items. Other issues to consider are: (a) the stage at which the assessment should be done – design stage versus post-completion, and one-off assessment versus periodic re-assessment; and possibility of involvement of clients and users in the evaluation of performance. Finally, studies into the theoretical bases of the indicators and scores of assessment tools are required (Jayawickrama, Ofori and Low, 2014).

18 *Energy Management*

It is estimated that energy management in buildings can make a major contribution to the efforts to mitigate against climate change. In many countries, such as Singapore and the UK, reducing energy consumption in buildings is the main plank of national sustainable development. This big area of research should go beyond technology to cover social and community factors.

19 *Legal Aspects Relating to Sustainable Construction*

The legal aspects of sustainable construction include legislation as well as civil and contract law. The statutes provide guidance; codes and standards provide help with good practice; and the norms of professional negligence keep practitioners mindful of their responsibilities. The various aspects of the law should be co-related and continually studied, with focus on ways of realising synergies among various elements in application.

20 *Sustainable Facilities*

The design and construction process might result in the creation of a sustainable constructed item. Systematic management of the item in its operation is of paramount importance. The concept of Strategic Sustainable Facilities Management, which is proactive, long-term and comprehensive, should be formulated and continually developed.

21 *Education on Sustainable Construction*

The inculcation of appropriate practice, attitude and behaviour among practitioners and companies in the construction industry to pursue sustainable development has been highlighted. It is important that this education is continuous, and the principles covered are appropriate. Students should be given a love for life-long learning, and an interest in, and commitment to, the pursuit of sustainability.

22 *Linking Design & Construction to Operation & Maintenance*

The importance of considering the construction and operation and maintenance stages during the design stage has been highlighted for several decades. Technology, such as BIM, will facilitate and enable the optimisation of the pre-consideration of

23 *Disaster Management*

The impact of human activity, including construction, on the environment is deemed to be a major cause of disasters. These range from the events of global warming such as floods and sea level rise; and droughts which affect food security. **Munich Reinsurance (2016) reported that losses caused by natural catastrophes in the first half of 2016 were US$ 70bn, compared to the previous year’s US$ 59bn. The main loss drivers were powerful earthquakes in Japan and Ecuador, storms in Europe and the US, and forest fires in Canada.** Disaster management and resilience in the built environment are major research areas.

Disaster prevention should also be considered in research. The impact of disasters on lives and livelihoods, beyond physical infrastructure and other assets is also worth investigating. Capacity building in resilience and disaster management, including industry preparedness and effective systems for marshalling resources are also relevant.

24 *Other possible topics*

24a Time Management and Productivity

It is necessary to incorporate the sustainability dimension among the generic project performance parameters, so that it is not considered to be an optional extra. For example, it is necessary to balance it with many other aspects, and whereas the trade-off with cost is usually done, the possible impact on time and other parameters is also worth considering. Time should be built in to allow for comprehensive evaluation of the negative and positive environmental impacts of the proposed project.

 Productivity should also relate to the workers in the completed facility. This puts into focus the impact of the indoor environmental conditions on worker performance.

24b Safety and Health

These performance parameters should also be balanced with the sustainability dimension. The health implications of innovative materials is one key issue. The health and productivity of users is another.

24c Logistics

It is often suggested that one of the elements of sustainability is to use local materials as much as possible. However, this is usually unrealistic as not all materials required on any project can be obtained from local sources. There is also the question of what is 'local'. For a large country, obtaining the material locally (from within the country) might involve a lot of travelling. Thus, in the era of globalisation, sustainable logistics should be a research area, especially in a field which uses such large volumes of heavy and bulky items.

24d Technology and Sustainable Built Environment

It is suggested that the future of construction is technology. Thasarathar (2016) outlines technological trends in construction including: 3D printing, the Internet of Things (IoT), robotics, drones, cloud computing, infinite computing, reality capture, augmented reality, gaming engines, crowd-funding, crowdsourcing, generative design, big data and artificial intelligence. Beyond the building scale, there is the concept of smart cities and districts. It is necessary to explore the possible exploitation of the whole range of technologies, including the new and emerging ones, in the effort to attain a sustainable built environment. The possibilities of synergistic integration of technologies could also be studied.

5. CONCLUDING REMARKS

Entrepreneurship can enable built environment organisations and practitioners to produce more with less, with higher quality and “sustainability awareness”, and to constantly seek to innovate. Thus, entrepreneurship can act as a spur to the contributions of each participant in each project. Entrepreneurship could also replace legislation and clients’ cost-revenue considerations in the decision making on the planning, design, construction and management of the built environment. Entrepreneurship, risk taking and innovation are relevant to the need for balance among aspects of the development project in the built environment, and the need to explore new materials, methods, practices and procedures in order to attain sustainable built and managed items.

A personal characteristic of long-term entrepreneurship and constant innovation. Another notion is “sustainable entrepreneurship”, one which is long-term and enduring, and which grows and improves over time. That of “sustainable innovation” can also be perceived. It is pertinent to seek to develop such characteristics and aptitudes among built environment organisations, agencies and practitioners.

There have been debates on whether both entrepreneurship, and the capacity to be creative and innovative can be developed. Whereas the discussion continues, it is pertinent to consider the role of education and training at least in creating awareness of knowledge on, and possibly, capability in, these two processes, in order to enable each nation to realise the potential of its citizens in these regards. It would be appropriate for tertiary educational institutions to build these into their curricula. The various professional institutions in the industry should also explore the possibility of setting up networking, coaching and mentoring schemes for the continuous development of entrepreneurship.

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