

THE 5TH WORLD CONSTRUCTION SYMPOSIUM - 2016

Greening Environment,
Eco-Innovations & Entrepreneurship



Programme & Abstracts



29th – 31st | JULY 2016

Organized by

Ceylon Institute of Builders, Sri Lanka &
Department of Building Economics,
University of Moratuwa

Sponsored by

International Council for
Research and Innovation in
Building and Construction

THE 5TH WORLD CONSTRUCTION SYMPOSIUM 2016

GREENING ENVIRONMENT, ECO-INNOVATIONS & ENTREPRENEURSHIP

29 - 31 July 2016

at
Galadari Hotel
Colombo, Sri Lanka

Organised by

Ceylon Institute of Builders (CIOB)

&

Building Economics and Management Research Unit (BEMRU),
Department of Building Economics, University of Moratuwa, Sri Lanka

With Associate Partners

Liverpool John Moores University (LJMU),
Centre for Infrastructure & Construction Industry Development (CICID),
The University of Hong Kong,
Indian Institute of Technology Madras (IIT Madras),
Auckland University of Technology, New Zealand,
Northumbria University, United Kingdom,
Robert Gordon University, United Kingdom
Colombo School of Construction Technology (CSCT)

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MESSAGES

Prof. Chitra Weddikara

Chairperson

The 5th World Construction Symposium 2016



It is a pleasure to welcome you to the 5th World Construction Symposium 2016 in Colombo Sri-Lanka on “Greening Environment, Eco Innovations and Entrepreneurship. With climate changes in various parts of the globe having its effects on us, it is very important for Constructors and Researchers to reach out and explore innovations to make our environment green as well as promote the Entrepreneurship among our stakeholders in the construction industry.

In reminiscing the past, our first World Construction Symposium was on “Global Challenges in Construction Industry” in year 2012, organised by the CIOB emphasised the importance of resolving construction management problems through highlighting the definition of sustainability and describing sustainable development as the fulfilment of human needs from simultaneous socio-economic and technological progress and conservation of natural resources. The Second World Construction Symposium emphasised the “Socio Economic Sustainability in Construction: Practice, Policy & Research” serving as an interdisciplinary venue for inspiring new ideas, presenting cutting-edge studies and encouraging collaborations between scholars in the area of sustainable construction. The Third World Construction Symposium was on “Sustainability and Development in Built Environment: The Way Forward” deliberating on the future trends and directions of the Sustainable Construction from the developing country perspective. The topic of the 4th World Construction Symposium was very timely and pertinent as the builders and construction industry practitioners needed to look beyond their perceived limits and raise their awareness on sustainable development in built environment.

Today our builders and our construction industry have matured and the selection of the topic for the 5th symposium is “Greening the Environment, Eco Innovations and Entrepreneurship. This will enable all our participants around the world and we here in Sri-Lanka to discuss their different viewpoints on new innovations and entrepreneurship in the built environment at the Symposium.

The symposium main organiser, CIOB is the professional body for builders in Sri Lanka, who works tirelessly to inspire, educate and train builders to be professionals in Sri Lanka. The symposium is also strengthened by the research excellence of its organising partners, the Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics, University of Moratuwa Sri Lanka, Co-sponsor, International Council for Research and Innovation in Building and Construction (CIB) and all Associate Partners.

I hope that you will find the symposium both informative, and valuable, and also enjoy the architectural, cultural and natural beauty of Sri Lanka, and the new skyline of our Colombo city.

Dr. Rohan Karunaratne
President
The Ceylon Institute of Builders (CIOB)



Dear Participants to the 5th World Construction Symposium,

On behalf of the Organising Committee of the Symposium, it gives me great pleasure in welcoming each one of you for this 5th World Construction Symposium. This annual symposium is a much looked forward to event by the Construction fraternity in Sri Lanka and other participating countries. The participants include the highest echelons of the state and private sector, international organisations, academia, researchers, designers, project managers and construction professionals from participating countries. The symposium provides an opportunity for the participants to share their knowledge, new research findings and other developments in relation to Sustainable Built Environment.

The importance of preserving our environment for the future generations has become critical and the Governments world over emphasise sustainable development in all walks of life including construction. At a time when our country is moving ahead with major construction projects at various stages of implementation, the Sri Lankan government too attaches greater importance and priority to sustainable construction and development.

In line with the above thinking, the organising committee in consultation with the scientific committee for this year's symposium has selected the theme "Greening Environment, Eco Innovations and Entrepreneurship". The extensive technical programme developed by the symposium committee, includes three concurrent papers/ presentation tracks allowing opportunities for participants to earn professional development hours (PDHs) for professionals and researchers. The paper presenters will be sharing their knowledge, experience and findings on the above theme which I am sure will benefit all the participants.

There is a belief among the Sri Lankan construction professionals that employing eco-friendly methods in construction is costly and hence erodes profitability. I am sure that the papers presented and the innovative ideas discussed in the symposium will dispel this belief and encourage our construction professionals to include sustainable development as a genuine integral part of their practices, thereby contributing greatly to preservation of the environment of our country.

Once again, I welcome all of you to the Symposium and wish you a productive and pleasant time in our beautiful country.

Eng. Saliya Kaluarachchi
Hon. Secretary
The Ceylon Institute of Builders (CIOB)



It is my great pleasure to welcome you to the World Construction Symposium 2016. All of us at the Ceylon Institute of Builders are very proud to be hosting this 5th World Construction Symposium. The Symposium which is being hosted annually for the past five years by our Institute, is considered to be the most prominent International Construction Symposium held in Sri Lanka. Construction professionals look forward to participate in this Symposium. I am sure that this Symposium will live up to their expectations and enable the participants gain knowledge from the presentations and the discussion at the Symposium.

I should first convey my sincere appreciation to the International Council for Research and Innovation in Building and Construction (CIB), Netherlands for co-sponsoring the event. Their guidance and support has encouraged us to organise an international event of this magnitude.

Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics, University of Moratuwa, Sri Lanka are the joint organisers of this Symposium and their untiring effort in inviting submissions from all over the world, reviewing and short listing the papers to be presented and publishing the Symposium manual are the chief contributory factors to the success of this symposium. I would like to express gratitude to them for their unwavering dedication and support.

We are also thankful to Liverpool John Moores University, United Kingdom, Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Indian Institute of Technology Madras (IIT Madras), Auckland, University of Technology, New Zealand, Northumbria University, United Kingdom, Robert Gordon University, United Kingdom and Colombo School of Construction Technology for being the Associate Partners of the Symposium.

We have been hugely impressed by the diversity and high standard of submissions we received for this year's conference and we hope that the programme will be both stimulating and informative. We are all grateful for the contributions of our keynote speakers, workshop facilitators, session chairs, and all our oral and poster presenters.

I am thankful to the ministries and professional institutions that have helped us in organising this Symposium. We will fail in our duty, if we don't thank all of our Sponsors and well-wishers for your generous contribution. You had enabled us to successfully plan and organise this Symposium.

Mr. Sagara Gunawardena

Mr. Kalana Alwis

Co-Chairmen

The 5th World Construction Symposium



We warmly welcome all delegates to the 5th World Construction Symposium to be held from 29 to 31 July 2016 at Hotel Galadari. This is an exciting venture organised jointly by the Ceylon Institute of Builders, International Council for Research and Innovation in Building and Construction (CIB) and Department of Building Economics, University of Moratuwa. We are pleased that you have chosen to attend the 5th World Construction Symposium. The conference committee has worked extremely hard to put together what promises to be an exciting weekend.

The Symposium includes papers from the multidisciplinary and international body of researchers who share an interest in the field of Sustainable Construction. This will provide a unique opportunity to learn, not just about current research, but also how eco-friendly construction is studied and practiced throughout the world.

Besides, the international delegates will have the opportunity to learn about the massive development projects that is being planned and undertaken in our country. In order to make Sri Lanka a regional hub, the government has launched an ambitious programme of physical infrastructure development to completely upgrade the sea, air, road, power and telecom backbone of the country. This will result in a construction boom in the country and a need for flow of investment and introduction of innovative construction techniques. All these will present you with many opportunities.

On behalf of the organising committee, we hope you enjoy your visit to Colombo and return home with fond memories.

Dr. Yasangika Sandanayake
Head of the Department
Department of Building Economics
University of Moratuwa



I am very pleased to send this message as the Head, Department of Building Economics to extend my warm wishes for the 5th World Construction Symposium and International Construction Expo 2016 from 29th to 31st July 2016. This is a perfect venture jointly organised by Ceylon Institute of Builders (CIOB), the International Council for Research and Innovation in Building and Construction (CIB) and the Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka for the fifth consecutive year. Liverpool John Moores University, Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Indian Institute of Technology Madras (IIT Madras), Auckland University of Technology, Northumbria University, Robert Gordon University and Colombo School of Construction Technology are the associate partners of the Symposium. The two awards arranged by Built Environment Project and Asset Management (BEPAM), an Emerald Group Publishing has further enriched the symposium.

Sri Lankan construction industry has witnessed a boom in the recent years and last year continued to grow at 20.2% on the back of declining interest rates and low inflation, according to the industry reports. Hence, Sri Lankan construction industry plays an indispensable role in supporting the economy while focusing on sustainability and eco-innovations, which are fundamental to the country's development.

The 5th World Construction Symposium 2016 provides a platform for both local and international delegates to share their knowledge and ideas with regard to the greening environment, eco-innovations and entrepreneurship around the globe. I hope all delegates would take this opportunity to share their knowledge, ideas and views on the theme of the year.

I wish all the success for 5th World Construction Symposium 2016 and Construction EXPO 2016.

KEYNOTE SPEAKER

Prof. George Ofori

BSc (Building Technology) (University of Science & Technology, Kumasi, Ghana), MSc (Architecture) Building Economics and Management (University of London), PhD (University of London), DSc (University of London)



Professor

Department of Building

School of Design and Environment

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George Ofori received both his doctoral degree and a higher doctorate degree from the University of London. He is a Fellow of the Ghana Academy of Arts and Sciences. He is currently a Professor at the National University of Singapore, and Director of the multi-disciplinary MSc (Environmental Management) programme. He is also a Chair Professor at Tsinghua University, China. He is a Fellow of the Chartered Institute of Building, UK; Fellow of the Royal Institution of Chartered Surveyors, UK; and Fellow of the Society of Project Managers, Singapore. He is the Deputy Chairman of the International Board of the Construction Sector Transparency Initiative (CoST).

His main research area is strategic construction industry development, focusing on the improvement of the construction industries of developing countries. He has also undertaken research on sustainable construction, international construction, productivity and leadership development in construction. He has authored several papers which have been published in international refereed journal, conference papers, books, chapters in books, and published reports. He has been invited to deliver some keynote papers at many international conferences. He is a member of the editorial boards of many leading international peer-reviewed journals. He was the Founding Co-ordinator of the CIB Working Commission 107 (W107) on Construction in Developing Countries of the International Council for Research and Innovation in Building and Construction (CIB).

The subjects he has taught at the under-graduate and graduate levels include Construction and Development Economics, Development Management, Environmental Management, International Project Management, and Research Methods. His experience in the construction industry has been as a senior quantity surveyor, mainly in Ghana. He has also been a consultant on construction industry development to many governments and international agencies since 1978. The countries where he has undertaken assignments include: Bahrain, Ghana, Indonesia, Malawi, Malaysia, Myanmar, Singapore, South Africa, Swaziland and Tanzania.

KEYNOTE SPEECH

ENTREPRENEURSHIP AND INNOVATION SUSTAINABLE BUILT ENVIRONMENT: A RESEARCH AGENDA

George Ofori*

Department of Building, National University of Singapore, Singapore

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.*

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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” (Singapore Green Building Council [SGBC], 2016). 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” (Green Building Council of Sri Lanka [GBCSL], 2016a).

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 Green^{SL}® Rating System for Existing and New Buildings was set up by the GBCSL (GBCSL, 2016b). 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, and
- 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” (GBCSL, 2016a). 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 crowd funding 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 Heidelberg Cement 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 95percent 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 involve an 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 tends 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 AND CONSTRUCTION TO OPERATION AND 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*

24.a. *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.

24.b. Safety and Health

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

24.c. 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.

24.d. 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, crowd sourcing, 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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Established in 1961, the Ceylon Institute of Builders (CIOB) is the premier institute for Building Professionals in Sri Lanka with a strong network of Engineers, Architects, Surveyors and similar allied professions who work to inspire, encourage, educate and train students, builders, and professionals in the country. The institute welcomes young entrants and mature professionals with or without a background in construction to achieve professional level careers in the country. They are provided with a well-structured development programme that eventually leading to gaining corporate membership of the institute.

www.ciob.lk

Department of Building Economics, University of Moratuwa



The Department of Building Economics, University of Moratuwa, Sri Lanka was founded in 1983. It is currently the pioneer Sri Lankan institution to offer programmes in Quantity Surveying, Facilities Management, Project Management, Construction Law and Dispute Resolution and Occupational Safety and Health Management. Building Economics and Management Research Unit (BEMRU) is the research arm of the Department of Building Economics, which specialises in research in Building Economics and Management in the country as well as internationally.

www.becon.mrt.ac.lk

International Council for Research and Innovation in Building and Construction (CIB)



The CIB acts as a global network for international cooperation and information exchange in building and construction research and innovation. CIB collaborates with the organisations around the world supporting the development of the industry, while facilitating international knowledge transfer on topics of interest. It covers the technical, economic, environmental, organizational and other aspects of the built environment during all stages of its life cycle.

www.cibworld.nl

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Northumbria University was first established in 1969 and is based in the heart of Newcastle upon Tyne, regularly voted the best place in the UK for students. The Department of Architecture and Built Environment has recently had Architecture placed 10th in the UK in the Guardian 2017 and Property Management 7th in the Complete University Guide 2017. Quantity Surveying is one of our longest established degrees having commenced in the 1970's.

www.northumbria.ac.uk

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The Robert Gordon University, commonly referred to as RGU, is a public university in the city of Aberdeen, Scotland. As one of the top modern universities in the UK, RGU offers a diverse suite of courses through three faculties; the Faculty of Design and Technology, the Faculty of Health and Social Care, and Aberdeen Business School. Consistently ranked among the UK's top universities for graduate employment for many years, RGU is rated as the Top University for graduate prospects and Top University in Scotland for Architecture, Health Professions, Journalism, and Pharmacy in the Guardian University Guide 2017.

www.rgu.ac.uk

Colombo School of Construction Technology (CSCT)



The CSCT was established in 2008, with the motto 'Sapientia et Doctrina', which is Latin for Wisdom & Learning. It strives to create a learning environment to nurture the development of critical thinking skills; support innovation; and develop knowledge and expertise of our students. CSCT faculty have expertise in a broad range of specialties and have developed curriculums in each of the programs that meet the needs of the construction industry.

www.csct.edu.lk

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SYMPOSIUM INFORMATION

International Construction EXPO

The International Construction EXPO inauguration is on 29 July 2016 from 09.30 am to 12.00 noon at the Bandaranaike Memorial International Conference Hall (BMICH), Baudhaloka Mw, Colombo 07. Foreign participants those who have already requested transportation from Galadari to BMICH and the return, please assemble at the hotel lobby at 8.30 am. Inauguration will be end at 11.00 am and guest will be provided with one hour to visit the exhibition. The guest will be transported back to the hotel at 12.00 noon from BMICH.

The 5th World Construction Symposium and Investor Forum

The Symposium and Investor Forum is on 29 July 2016 from 01.30 pm to 06.30 pm and on 30 July 2016 from 09.00 am to 06.30 pm at the Galadari Hotel, Lotus Road, Colombo 01. The inauguration is held at Bougainvillea Ballroom, Galadari Hotel.

Cultural Dinner and Green Building Award Ceremony

The Symposium Cultural Dinner and Green Building Award Ceremony are held on 30 July 2016 at Ramada Hotel, No. 30, Sir Mohamed Macan, Colombo 03 from 07.30 pm onwards. Foreign participants those who have requested transportation from Galadari to Ramada Hotel and the return, please assemble at the hotel lobby at 07.00 pm. The foreign guest will be transported back to the hotel at 10.30 pm from Ramada Hotel.

Symposium Secretariat

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Language

The official language of the symposium is English. There will be no simultaneous translation.

Dress Code

Construction EXPO and Symposium - Business, Lounge or National
Symposium Dinner and Green Building Awards Ceremony - Smart Casual

Registration

Symposium delegates can collect their materials at the registration desk, located at the Galadari Hotel. Opening times of the registration desk will be from 12.00 noon to 06.30 pm on 29 July 2016 and from 08.30 am to 06.30 pm on 30 July 2016.

Secretariat Room

During the symposium, the secretariat room is located at the Salon Rose of Galadari Hotel, where the main symposium is being held. The opening hours of the secretariat will be from 08.30 am to 06.30 pm on 29– 30 July 2016.

Awards

Following awards will be presented to the winners during the symposium cultural dinner on 30 July 2016. Award winners will be announced during the symposium sum-up.

- Emerald BEPAM Best Paper Award
- Emerald BEPAM Highly Commended Paper Awards (Two Awards)
- CIOB Best Paper Award
- CIOB Best Presenter Award

Certificate of Attendance

A certificate of attendance will be issued to all participants, after the symposium sum-up.

Excursion to Kandy

The excursion to Kandy on 31 July 2016 starts from Galadari Hotel at 08.00 am and expected to be returned to the hotel at 09.00 pm. The excursion includes bus tour, morning tea, lunch, evening tea, guiding and visiting attractions such as the Temple of Sacred Tooth Relic (Sri Dalada Maligawa) and Pinnawala Elephant Orphanage. This offers only to foreign delegates with prior reservation. Please assemble at the hotel lobby at 07.45 am.

Liability

The organising committee is not liable for personal accidents, loss or damage to private properties of registered participants during the Symposium. Participants should make their own arrangements with respect to personal insurance.

Disclaimer

Whilst every attempt be made to ensure that all aspects of the Symposium mentioned in this announcement will take place as scheduled, the Organising Committee reserves the prerogative to make last minute changes should the need arise without prior notice.

SYMPOSIUM PROGRAMME

Friday, 29 July 2016

International Construction EXPO 2016 at BMICH

09.30 am **Opening Ceremony** BMICH

The 5th World Construction Symposium 2016 at Galadari Hotel – First Day

12.00 noon **Symposium Registration**

12.30 pm **Lunch** Anthurium
Ballroom

01.30 pm **Symposium Inauguration** Bougainvillea
Ballroom

01.35 pm Welcome Address by Symposium Chairperson
Prof. Chitra Weddikkara

01.40 pm Address by President, CIOB
Dr. Rohan Karunarathne

01.50 pm Address by Deputy Vice Chancellor, University of Moratuwa
Prof. R.A. Attalage

02.00 pm Address by the Chief Guest

02.10 pm Keynote Address
Prof. George Ofori

03.00 pm Investor Forum - Address by Head of Investments,
Western Region Megapolis Planning Project
Mr. Nayana Mawilmada

03.45 pm Vote of Thanks by Hon. Secretary, CIOB
Eng. Saliya Kaluarachchi

03.55 pm End of Symposium Inauguration

04.00 pm Symposium Photograph

04.15 pm Tea/Coffee Break

04.30 pm **Parallel Sessions 1** Salon Orchid,
(There will be THREE parallel sessions) Salon Jasmine,
VIP Lounge

Saturday, 30 July 2016

The 5th World Construction Symposium 2016 – Second Day

- 09.00 am **Parallel Sessions 2**
(There will be THREE parallel sessions)
- 10.45 am Tea / Coffee Break
- 11.00 am **Parallel Sessions 3**
(There will be THREE parallel sessions)
- 12.30 pm Lunch
- 01.30 pm **Parallel Sessions 4**
(There will be THREE parallel sessions)
- 03.00 pm Tea / Coffee Break
- 03.30 pm **Panel Discussion on “Need for Innovation and Entrepreneurship to accelerate our pursuit of Sustainable Development”** Bougainvillea Ballroom
- Sri Lankan Perspective
Prof. Chitra Weddikkara
Prof. Mohan Kumaraswamy
Prof. Priyan Dias
Dr. Asanga Gunawansa
- International Perspective
Prof. George Ofori
Prof. Makarand Hastak
Prof John Tookey
Dr. Kevin Thomas
- Moderator**
Ch. QS. Suranga Jayasena
- 05.00 pm Rapporteur’s Report by
Dr. Sachie Gunatilake
Dr. Thilini Jayawickrama
Dr. Nirodha Fernando
- 05.10pm Address by BEPAM Editor-in-Chief
Prof. Mohan Kumaraswamy

SYMPOSIUM SESSION PLAN AT-A-GLANCE

Friday, 29 July 2016							Saturday, 30 July 2016					
08.00 - 09.00	Construction EXPO - BMICH						Registration					
09.00 - 09.15							Session 2A	S9043	Session 2B	S9049	Session 2C	S9010
09.15 - 09.30								S9054		S9012		S9022
09.30 - 09.45								S9046		S9019		S9023
09.45 - 10.00								S9075		S9030		S9029
10.00 - 10.15								S9074		S9085		S9078
10.15 - 10.45							Q&A		Q&A		Q&A	
10.45 - 11.00							Tea / Coffee Break					
11.00 - 11.15							Session 3A	S9036	Session 3B	S9065	Session 3C	S9076
11.15 - 11.30								S9050		S9079		S9008
11.30 - 11.45								S9039		S9005		S9004
11.45 - 12.00								S9006		S9033		S9061
12.00 - 12.15												S9084
12.15 - 12.30							Q&A		Q&A		Q&A	
12.30 - 13.30							Lunch					
13.30 - 13.45							Symposium Inauguration – Galadari Hotel					
13.45 - 14.00	S9082	S9062	S9038									
14.00 - 14.15	S9064	S9066	S9040									
14.15 - 14.30	S9067	S9055	S9086									
14.30 - 15.00	Q&A		Q&A		Q&A							
15.00 - 15.30	Tea / Coffee Break											
15.30 - 16.00	Symposium Photograph and Tea / Coffee Break											
16.00 - 16.30	Panel Discussion						S9071	Session 1B	S9069	Session 1C	S9080	
16.30 - 16.45							Session 1A		S9077		S9013	S9053
16.45 - 17.00									S9068		S9056	S9083
17.00 - 17.15									S9020		S9003	S9073
17.15 - 17.30									S9032		S9025	S9060
17.30 - 17.45							Q&A		Q&A		Q&A	
17.45 - 18.15	Symposium Sum-Up											
19.30 - 22.30	Cultural Dinner and Green Building Awards Ceremony – Ramada Hotel											

DETAILED SESSION PLAN

Friday, 29 July 2016

Session 1A

Theme Risk Management
Session Chair Prof. Mohammed Arif
Venue/Time Salon Orchid – 04.30 pm – 06.15 pm

Time	Paper ID, Title and Author(s)
04.30 – 04.45 pm	S9071 - Risk Allocation between Main Contractors and Subcontractors in Building Projects in Sri Lanka <i>K.R.S. Perera, S. Gunatilake, D.T. Vijerathne and N.N. Wimalasena</i>
04.45 – 05.00 pm	S9077 - A Review of Safety Climate and Risk-taking Propensity in Occupational Health, Safety and Well-being in the Construction Industry <i>Steve Rowlinson, Yuzhong Shen and Tas Yong Koh</i>
05.00 – 05.15 pm	S9068 - Risk Management Strategies for Facilities Manager's in Sri Lanka <i>N.S.D. Abeysinghe and A.K. Andaraweera</i>
05.15 – 05.30 pm	S9020 - Risk Associated with Facilities Management Outsourcing and its Impact on Service Performance <i>K.K.G.P. Somarathna and Nayanthara De Silva</i>
05.30 – 05.45 pm	S9032 - Interactional Analysis for Two-Party Risk Assessment in Public Private Partnerships (PPP) <i>Rana Khallaf, Nader Naderpajouh and Makarand Hastak</i>
05.45 – 06.15 pm	Q&A

Session Coordinator : Ms. Anushika Ekanayake

Friday, 29 July 2016

Session 1B

Theme Performance Management
Session Chair Prof. John Tookey
Venue/Time Salon Jasmine – 04.00 pm – 06.15 pm

Time	Paper ID, Title and Author(s)
04.30 – 04.45 pm	S9069 - Industry Attractiveness of Outsourced Facilities Management Services in Sri Lanka <i>R.P.N.P. Weerasinghe, D.M.P.P. Disanayake and A.K. Andarawera</i>
04.45 – 05.00 pm	S9013 - Using Safety Climate as A Tool for Improvement of Safety Performance in Construction Organizations <i>Tariq Umar and Sam Chris Wamuziri</i>
05.00 – 05.15 pm	S9056 - Construction Management Practices Influencing Productivity in Building Projects <i>Argaw Tarekegn Gurmu, Ajibade Ayodeji Aibinu and Toong-Khuan Chan</i>
05.15 – 05.30 pm	S9003 - Critical Success Factors for Construction of Governmental Projects in Egypt <i>Nael Y. Zabel, Ghadeer R. Alfandi, Yasser W. Eraky and Moheeb E. Ibrahim</i>
05.30 – 05.45 pm	S9025 - Strategic Approach to Ensure Process Safety in Apparel Manufacturing Industry Using Total Productive Maintenance (TPM) <i>H.W.S.N. Denipitiya, Nayanthara De Silva, S.D.A. Soorige and H.W.N. Madhusanka</i>
05.45 – 06.15 pm	Q&A

Session Coordinator : Mr. Udara Abeydeera

Friday, 29 July 2016

Session 1C

Theme Disaster Management
Session Chair Prof. Lalith De Silva
Venue/Time VIP Lounge – 04.30 pm – 06.15 pm

Time	Paper ID, Title and Author(s)
04.30 – 04.45 pm	S9080 - Optimisation of Project Performance in Post-Disaster Building Reconstruction Projects in Sri Lanka <i>Maheshi Hulugalla and Nirodha Fernando</i>
04.45 – 05.00 pm	S9053 - Coastal Zone Adaptation in Trinidad and Tobago: A Review of Literature <i>Carianne Johnson and Udayangani Kulatunga</i>
05.00 – 05.15 pm	S9083 - Involvement of Construction Management Professionals in Property Level Flood Adaptation <i>Azom Uddin and Gayan Wedawatta</i>
05.15 – 05.30 pm	S9073 - Emerging Competencies within National and Local Government for Societal Resilience to Disasters in Sri Lanka <i>S.S.L. Hettiarachchi, H. Goonasekera, S. Gunatilake and S. Weerasinghe</i>
05.30 – 05.45 pm	S9060 - Black Swan Effects on the Real Estate Environment: A Conceptual Framework <i>Treshani Perera and David Higgins</i>
05.45 – 06.15 pm	Q&A

Session Coordinator : Ms. Navodana Rodrigo

Saturday, 30 July 2016

Session 2A

Theme **Building Information Modelling**
Session Chair Ch.QS. Indunil Seneviratne
Venue/Time Salon Orchid – 09.00 am – 10.45 am

Time	Paper ID, Title and Author(s)
09.00 – 09.15 am	S9043 - Potential to Implement BIM Project with Sri Lankan Professionals <i>A.P.N.Y.K. Pathirana and Himal Suranga Jayasena</i>
09.15 – 09.30 am	S9054 - Towards Facilities Information Management Through BIM <i>K.A.D.N.C. Wijekoon, Anupa Manewa, Andrew Ross and Dianne Marsh</i>
09.30 – 09.45 am	S9046 - Capacity of Information Technology Infrastructure in Sri Lanka to Support Building Information Modelling Systems <i>G.W. Nadith Kalhara and Himal Suranga Jayasena</i>
09.45 – 10.00 am	S9075 - Review on Lean Construction and TPS Approximation with BIM <i>M.Z.M. Zuhair, Himal Suranga Jayasena and M.R.M.F. Ariyachandra</i>
10.00 – 10.15 am	S9074 - Implementation of Building Information Modelling within Construction SMEs <i>Anupa Manewa, Tanisha Blake, Andrew Ross, Dianne Marsh and Mohan Siriwardena</i>
10.15 – 10.45 am	Q&A

Session Coordinator : Ms. Nethmin Pilanawithana

Saturday, 30 July 2016

Session 2B

Theme Occupational Safety and Health Management in Built Environment

Session Chair Prof. Steve Rowlinson

Venue/Time Salon Jasmine – 09.00 am – 10.45 am

Time Paper ID, Title and Author(s)

09.00 – 09.15 am **S9049 – Review of Strategies to Improve Workplace Safety through Ethical Climates**
Uthpala Rathnayake and Gayani Karunasena

09.15 – 09.30 am **S9012 - Developing A Framework to Ensure Safety of Maintenance Workers in Sri Lankan Commercial Buildings**
S.H.M.I. Udani, P.A.P.V.D.S. Disaratna, R.P.N.P. Weerasinghe and H.W.N. Madhusanka

09.30 – 09.45 am **S9019 - A Review of Construction Safety, Challenges and Opportunities - Oman Perspective**
Tariq Umar and Sam Chris Wamuziri

09.45 – 10.00 am **S9030 - Managing Occupational Stress of Professionals in Large Construction Projects in Sri Lanka**
Rasika Samanmali and Nayanthara De Silva

10.00 – 10.30 am **S9085 - The Loopholes of Evacuation Process in the Sri Lankan Healthcare Sector**
Thanuja Ramachandra and Achini Weerasinghe

10.15 – 10.45 am **Q&A**

Session Coordinator : Ms. Nipuni Wimalasena

Saturday, 30 July 2016

Session 2C

Theme Construction Law and Dispute Resolution
Session Chair Ch.QS. (Mrs.) Kanchana Perera
Venue/Time VIP Lounge – 09.00 am – 10.45 am

Time	Paper ID, Title and Author(s)
09.00 – 09.15 am	S9010 - Win-Win Settlement: Applicability of Negotiation Principles for Dispute Negotiations in Construction Projects <i>Samurdi Baduge and Himal Suranga Jayasena</i>
09.15 – 09.30 am	S9022 - Legal Framework For Effective Implementation of ADR Methods Under The Construction Industry Development Act <i>Jayarajan Jeyavernee and Mahesh Abeynayake</i>
09.30 – 09.45 am	S9023 - Dispute Avoidance Model for Sri Lankan Construction Industry <i>Isuru De Alwis, Mahesh Abeynayake and Mathusha Francis</i>
09.45 – 10.00 am	S9029 - Effectiveness of Alternative Dispute Resolution Methods Used in the Highway Construction Projects in Sri Lanka <i>C.M. Gammanpila and Mahesh Abeynayake</i>
10.00 – 10.30 am	S9078 - Establishment of the Most Common Ground on Which Local Arbitral Awards Become Unenforceable in Sri Lanka <i>Manathunga D. Hemantha and L.D. Indunil P. Seneviratne</i>
10.15 – 10.45 am	Q&A

Session Coordinator : Ms. Udara Ranasinghe

Saturday, 30 July 2016

Session 3B

Theme Energy Management in Built Environment
Session Chair Dr. (Mrs.) Nayanthara De Silva
Venue/Time Salon Jasmine – 11.00 am – 12.30 pm

Time	Paper ID, Title and Author(s)
11.00 – 11.15 am	S9065 - Factors Affecting the Indoor Environmental Quality in Sri Lanka: Green vs. Conventional Hotel Buildings <i>L. Gayathri, B.A.K.S. Perera and D.M.G.A.N.M. Sumanarathna</i>
11.15 – 11.30 am	S9079 - Carbon and Cost Critical Elements of Office Building: A Case Study <i>Michele Victoria , Srinath Perera, Alan Davies and Nirodha Fernando</i>
11.30 – 11.45 am	S9005 - Adopting Net Zero Energy Building Concept to Reduce Energy Cost of Commercial Buildings in Sri Lanka <i>Iresh Weerasinghe, Harshini Mallawaarachchi and Lalith De Silva</i>
11.45 – 12.00 noon	S9033 - Saving Energy in Office Buildings without Compromising their Indoor Environmental Quality <i>R.A.D.K. Akalanka, B.A.K.S. Perera and N.H.C. Manjula</i>
12.00 – 12.30 pm	Q&A

Session Coordinator : Mr. Sadith Chinthaka

Saturday, 30 July 2016

Session 3C

Theme Construction Project Management
Session Chair Dr. (Mrs.) Anupa Manewa
Venue/Time VIP Lounge – 11.00 am – 12.30 pm

Time	Paper ID, Title and Author(s)
11.00 – 11.15 am	S9076 - Synergy Between Lean and Value Engineering Concepts: Sri Lankan Construction Industry Perspective <i>E.M.A.C. Ekanayake and Y.G. Sandanayake</i>
11.15 – 11.30 am	S9008- Strategies for Tactful Time Management for Quantity Surveyors <i>Sivakumar Abiramy, Vijitha Disaratna and Nishadi Anuruddika</i>
11.30 – 11.45 am	S9004 - Use of Provisional Sums in the UAE Construction Industry: An Empirical Study <i>Krisanthi Seneviratne, Ahmad Feras Arar and Hagir Hakim</i>
11.45 – 12.00 noon	S9061 - Is Construction Getting Quicker? <i>Andrew Ross, Rebecca Norman, Anupa Manewa and Dianne Marsh</i>
12.00 – 12.15 pm	S9084 - Stakeholder Management in Road Construction Projects in Sri Lanka: A Contractor Perspective <i>K.H.N.P. Jayathissa, Aparna Samaraweera and K.A.T.O. Ranadewa</i>
12.15 – 12.30 pm	Q&A

Session Coordinator : Ms. Mahendrini Ariyachandra

Saturday, 30 July 2016

Session 4A

Theme Knowledge Management
Session Chair Dr. Mohan Siriwardena
Venue/Time Salon Orchid – 01.30 pm – 03.00 pm

Time	Paper ID, Title and Author(s)
01.30 – 01.45 pm	S9070 - Incorporating Tacit Knowledge in Performance Measurement System in a Sri Lankan Hotel <i>Haja Alawdeen Mohamed Aashik and Sepani Senaratne</i>
01.45 – 02.00 pm	S9082 – Improving Collaboration Between Academia and Industry through Use of the Knowledge Transfer Partnerships <i>Finlay Mac Beath and Michael Dignan</i>
02.00 – 02.15 pm	S9064 - Development of a Professional Doctoral Programme in Built Environment to Enhance Societal Resilience to Disasters <i>Solomon Babatunde, Kanchana Ginige, Onaopepo Adeniyi, Srinath Perera and Dilanthi Amaratunga,</i>
02.15 – 02.30 pm	S9067 - Integrating Disaster Management Perspective into Architectural Design Education at Undergraduate Level – A Case Example from Turkey <i>Emrah Acar and Fadime Yalçinkaya</i>
02.30 – 03.00 pm	Q&A

Session Coordinator : Ms. Nethmin Pilanawithana

Saturday, 30 July 2016

Session 4B

Theme Procurement and Integrated Project Delivery
Session Chair Prof. Sam Wamuziri
Venue/Time Salon Jasmine – 01.30 pm – 03.00 pm

Time	Paper ID, Title and Author(s)
01.30 – 01.45 pm	S9048 - Gaps in Public Procurement Process in Sri Lankan Construction Industry <i>K.A.P. Gunawardhane and Gayani Karunasena</i>
01.45 – 02.00 pm	S9062 - The Adoption of Integrated Project Delivery in Public Sector Projects in New Zealand: The Way Forward <i>Nicola Naismith, John Tookey, Ali Ghaffarian Hoseini and Rahul Kekreja</i>
02.00 – 02.15 pm	S9066 - Suitability of Package Deal Contracts for Residential Building Construction <i>U.S.C. Bandara, H. Chandanie and Lalith de Silva</i>
02.15 – 02.30 pm	S9055 - A Study of Delays in Procurement of Engineered Equipment for EPC Projects in India: A Mixed Method Research Approach <i>Srikar Kalidoss Sandilya and Koshy Varghese</i>
02.30 – 03.00 pm	Q&A

Session Coordinator : Ms. Udara Ranasinghe

Abstracts of the Proceedings

The 5th World Construction Symposium 2016

Theme:

**Greening Environment, Eco-Innovations &
Entrepreneurship**

Edited by:

Dr. Y. G. Sandanayake

Dr. G. I. Karunasena

Dr. T. Ramachandra

Building Economics and Management Research Unit (BEMRU)

Department of Building Economics

University of Moratuwa

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PAPER ABSTRACTS

3R.6R EXTENDED WATER HIERARCHY MODEL FOR SUSTAINABLE USE OF WATER DURING CONSTRUCTION

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ABSTRACT

There is a broad consensus in literature that effective utilisation of natural resources in any industry greatly influences sustainability of built environment. Hence, better management strategies of water began to emerge in all sectors; thus, different dimensions are in need to assess different industries. With this scenario, water sustainability on construction sites is one significant area, which demand the attention of construction stakeholders. Today many construction projects survive on potable water, and many strategies are available that can reduce the amount of water consumed by the construction industry. Water hierarchy is one strategy proposed for construction sites to reduce potable water consumption and encourage alternative water sources within the site. Literature and preliminary interviews further support identification of new 3R principles: Regulations, Responsibility, and Rewards that can influence on better water management on construction sites.

Therefore, purpose of this paper is to examine the applicability and implementation of 3R principles in conjunction with six stages (6R) of water hierarchy to improve efficient water use on construction projects in Sri Lanka. The study adopted triangulation convergence mixed method approach, and data collection involved case studies and a structured survey. Qualitative data is presented as narratives and quotations while quantitative data is presented as descriptive statistics. The results revealed that all factors were considered as 'applicable' and the possibility of implementing them on construction sites. Reuse and recycle were identified as the least applicable, and are rarely practised on sites, if it is not initially identified as a mandatory process. Experience and commitment of individual staff and costs are identified as important drivers on implication of each 9R principle. New 3R principles were recognised as supportive policies to implement all six existing stages of water hierarchy. Finally, the paper discusses the extended water hierarchy model developed for construction industry.

Keywords: *Construction; Extended Water Hierarchy; Sustainability; Water Efficiency.*

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A REVIEW OF CONSTRUCTION SAFETY, CHALLENGES AND OPPORTUNITIES - OMAN PERSPECTIVE

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ABSTRACT

Data from a number of industrialized countries show that construction workers are 3 to 4 times more likely than other workers to die from accidents at work. In the developing world, the risks associated with construction work may be 3 to 6 times greater. Construction is one of the world's biggest industrial sectors, including the building, civil engineering, demolition and maintenance industries and in Oman it account 10% of the total GDP. Statistic indicates that a total of 723,000 residents were working in construction industry in 2014. Construction workers build, repair, maintain, renovate and demolish houses, office buildings, factories, hospitals, roads, bridges, tunnels, stadiums, docks, airports and more. During the course of their work they are exposed to a wide variety of hazards on the job, including dusts and vapours, asbestos, awkward working positions, heavy loads, adverse weather conditions, work at heights, noise, vibration from tools, among many others. In most developed countries, organizations have significantly reduced the risk of injuries and fatalities by understanding the impact of construction safety on their performance. This involves the development and implementation of construction safety rules and laws by the organizations itself and by authorities responsible for this purpose. Such safety rules and laws are based on the studies of organization safety cultural and post-accident investigations. Statistics indicates that worker deaths in America are down on average, from about 38 worker deaths a day in 1970 to 12 a day in 2014 and worker injuries and illnesses are down from 10.9 incidents per 100 workers in 1972 to 3.3 per 100 in 2013. This paper presents the challenges and opportunities available for Oman to improve the construction safety performance of the organization by developing and implementing standard safety rules and laws. The research methodology includes the comparison of existing construction safety in Oman with some of the developed countries. The paper further describe how Oman can improve construction safety by developing specific safety rules and regulation and their enforcement through inspection of construction site under an independent authority of health and safety.

Keywords: *Construction Industry; Risk; Worker; Safety Performance; Safety Rules and Laws.*

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A REVIEW OF SAFETY CLIMATE AND RISK-TAKING PROPENSITY IN OCCUPATIONAL HEALTH, SAFETY AND WELL-BEING IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

Studies which take safety climate as a safety monitoring tool are rarely reported. This study reports a benchmarking program to identify prominent safety management issues in three ongoing railway projects using a combination of quantitative and qualitative methods. In the quantitative aspect, the research team conducted a safety climate survey with three random samples, one sample from each ongoing project. A robust 11-factor structure of the safety climate questionnaire emerged after factor analysis. Most of the mean scores of safety climate indicators for subcontractors were below 3 (out of 4) and specific indicators were identified as in need of urgent attention. The main contractor's direct labour scored similarly with subcontractors. Two main contractor management teams had to do more to take on the leadership role. The major weaknesses were the following indicators: work procedure for safety, safety compliance, safety priority over work pressure, safety cooperation and involvement, and appreciation of risk. In the qualitative aspect, the research team sought respondents' comments on current safety management practice and suggestions as to further improvement in safety performance. Content analysis showed that conflicting safety rules and inadequate training were common in the three projects, and increased supervision was proposed as the way to improve safety performance.

Keywords: *Safety Climate; Risk-taking Propensity; Occupational Health, Safety and Well-being.*

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A STUDY OF DELAYS IN PROCUREMENT OF ENGINEERED EQUIPMENT FOR ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) PROJECTS IN INDIA: A MIXED METHOD RESEARCH APPROACH

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ABSTRACT

The supply chain of the EPC industry operates predominantly in an engineered to order manner. Most of the equipment procured are specially made for the project as per the technical specifications laid in the contract. Due to this the lead time of these equipment are generally higher than products that are 'out of the shelf'. Any delay in procurement of these equipment can have a cascading effect on the overall construction schedule. There is limited literature available on the procurement in the EPC industry. This paper thus presents a comprehensive review of the existing systems and practices for procurement of engineered equipment in EPC projects in India. The practices are analysed separating them into two segments, i.e. pre-order and post order procurement cycles. An exploratory sequential mixed method of research has been adopted for the purpose by taking inputs from Subject Matter Experts from different industries in the EPC sector. These inputs were in the form of semi structured interviews, which were analysed using the qualitative data analysis package NVIVO 10. A triangulation methodology has been attempted to validate the qualitative data collected. Finally a framework for improving the most significant of the delays in these projects has been presented.

Keywords: *Procurement; EPC; Engineered Equipment; Mixed Method; Delays.*

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ADOPTABILITY OF GREEN LEASE IN DEVELOPING COUNTRIES: THE CASE OF SRI LANKA

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ABSTRACT

The concept of Green Buildings is now being promoted as there is an increasing requirement for energy efficient buildings. With the boom of Green Buildings, Green Lease concept has become significant. However in Sri Lanka, presently Green Lease is not practiced very much. Nevertheless, attempts at adopting Green Lease cannot be ignored as there are clauses relevant to green buildings even in the existing lease agreements. Therefore, this research was carried out to investigate the adoptability of the Green Lease concept in Sri Lanka. Firstly, a literature synthesis was carried out to understand the Green Lease concept and its significance. Semi structured interviews and a documentary review were done thereafter to further identify the importance, and enablers and barriers of Green Lease. Subsequently, the findings were validated through expert interviews. The analysis revealed the significance of the Green Lease concept which provides a healthier work environment, lower utility charges and a good reputation for both the tenant and the landlord. However, there can be enablers and barriers of Green Lease. The contribution from the Green Building Council of Sri Lanka (GBCSL), the Government's attempts to promote sustainable activities and conducting of business in Green Buildings are few of the enablers. Factors such as lack of policies and government rules, and poor awareness of the community about Green Lease are the significant barriers. The Government's positive influence and the promotion of the Green Lease within the community will be beneficial towards adopting Green Lease. Several suggestions to minimize the identified barriers also have been made through the development of a framework.

Keywords: *Green Building; Green Lease; Sri Lanka; Adoptability.*

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ADOPTING NET-ZERO ENERGY BUILDING CONCEPT TO REDUCE ENERGY COST OF COMMERCIAL BUILDINGS IN SRI LANKA

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ABSTRACT

Fulfilling energy demand has become a major challenge faced by most of high rise buildings today as it creates high utility cost to the organization. Hence, most of the organisations, especially in commercial building sector seek better options to fulfil their energy demand as a major energy consumer among the other building facilities. Hence, several energy management practices have been introduced to enhance energy efficiency. In the governing concern on less energy and less environmental impact, Net Zero Energy Building concept has received attention. Net Zero Energy Buildings have a greatly reduced energy demand by an equivalent generation of energy from low-cost, locally available, non-polluting, renewable sources. However, the adaptation of this concept has become a major challenge due to various barriers. Therefore, the purpose of this research is to identify the barriers to adopt Net Zero Energy Building concept to commercial buildings in Sri Lanka for proposing probable solutions. As this research required a detailed investigation, case study approach was selected under qualitative phenomenon. Three cases were conducted in three selected commercial buildings to collect the data. Cross-case analysis technique was applied as the appropriate data analysis technique. Nvivo and Decision-Explore software's are used to analyse and present the data. As the focal point of the research, barriers to adopt Net Zero Energy Building concept was determined relating to five major categories, such as, financial, legal, policy, social, and technical barriers. According to case study findings, this concept is more suitable for new building constructions than the existing buildings, as it is more effective to adopt it at the early stage of the building. Further, major barriers include limitations of organisational internal policies, preference of organisations for short term profits, unawareness and government rules and regulations. Accordingly, a framework is developed to propose probable solutions. The developed framework gives a value to the research, as it could use as a firm base in both organisational and national levels to adopt Net Zero Energy Building concept to reduce energy cost of commercial buildings in Sri Lanka.

Keywords: *Net Zero Energy Building; Commercial Buildings; Energy Conservation; Barriers; Solutions.*

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APPLICABILITY OF GREEN HUMAN RESOURCE MANAGEMENT CONCEPT TO ACHIEVE SUSTAINABLE GOALS OF GREEN BUILDINGS IN SRI LANKA

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ABSTRACT

Nowadays in world, construction of green building becomes a new trend. Many studies noticed that there are considerable amount of investments to the green buildings than conventional buildings. Since in last decade, the world has concerned about green building concept as one of the solutions to reduce environmental impacts. In achieving such foremost benefits of green buildings, human resource plays a vital role, especially to achieve sustainable goals of green buildings. Green Human Resource Management came into practice as a newest concept to create green responsive employees who make a significant contribution to environmental sustainability. However, Human Resource is not utilized in effective and efficient manner in most of the organizations. Therefore, the intention of this research is to investigate the applicability of Green Human Resource Management concept to achieve sustainable goals of green buildings in Sri Lanka.

As this research required an in-depth investigation, the research problem was approached through three case studies which are conducted in three selected green buildings in Sri Lanka. Content and cross case analysis techniques are used to analyse the data. QSR NVivo software is used to simplify the data analysis. As key research findings derived through case analysis, in Sri Lanka, existing green buildings have not been implemented the proper Green Human Resource Management process. Hence, the gaps in existing Human Resource Management process in green buildings are identified in relation to the job analysis, recruitment, selection, induction, training and development, performance evaluation and discipline management. Improper job designing, not including green competencies, use of traditional Human Resource Management process, unawareness, no proper performance evaluation criteria are identified as major gaps in Human Resource Management process in green buildings. Accordingly, a framework is developed to propose various strategies to fill the gaps in existing process to effectively utilize the Human Resource for achieving sustainable goals of green buildings in Sri Lanka as the main implication of this research.

Keywords: *Green Human Resource Management; Green Buildings; Human Resource Management Process; Gaps; Sri Lanka.*

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APPROACHES TO FOSTER GREEN BUILDING CONSTRUCTIONS IN SRI LANKA

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ABSTRACT

With world's trend, though the Sri Lankan government has taken a substantial effort for local green building movement, still it has not become as a major and pressing concept in Sri Lanka due to several barriers. Those barriers could be identified under five key areas as financial barriers, regulatory barriers, social barriers, knowledge/skills barriers and industrial barriers. Thus, the purpose of this study is to recommend the probable approaches to foster green building constructions in Sri Lanka by overcoming the existing barriers.

A qualitative research approach was adopted for attaining the research aim while conducting semi structured interviews with 15 local professionals who are in local regulatory bodies for green buildings and sustainable constructions, who are involving with green building constructions as well as who have not still involved with green constructions but expect it in future. The findings were analyzed with content analysis technique. It was recommended to follow simple and primary green strategies, take the correct consultation, implement mandatory regulations, make collaboration between existing authorities, increase public awareness, correct common misconceptions, provide knowledge and education, promote research and development, government takes the leadership and take the support from organizational managements as few major approaches to overcome the identified barriers for Sri Lankan green building constructions. The recommended approaches can be followed by industry players in order to foster green building constructions in national level, local level or organizational level and it will provide a basis to achieve the sustainability goal of Sri Lanka.

Keywords: *Barriers; Foster Green Building Constructions; Green Building Concept; Probable Approaches.*

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BEHAVIOUR CHANGE IN THE SUSTAINABLE BUILT ENVIRONMENT

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ABSTRACT

Humans are always driven by their sensation for adequate comfort. Occupants' behaviour is important in the built environment as it affects the building performance and the indoor comfort requirements. The built environment industry is moving towards high-performance buildings. However, high-performance buildings often fail to achieve 'as designed performance'. It is due to occupant behaviour. The purpose of the paper was to investigate the theoretical background of behavioural economics and its relevance in developing sustainable human behaviour in a building's lifecycle. Behaviour Economics uses the combined knowledge of psychology and economics to analyse and understand human behaviour. It has been successfully used to influence human behaviour in consumer markets, healthcare and insurance policies. This study explains six behavioural anomalies along with their applications in different industries. Behavioural anomalies such as Status Quo Bias, Incentives and Social Norms have been applied in consumer industry to create a positive impact on human behaviour. It concludes by highlighting the potential of applying behaviour economics in built environment and influencing occupant behaviour towards eco-friendly behaviour. This research study is a part of a research endeavour to develop strategies for office buildings' operation to change human behaviour towards more eco-friendly behaviour. It will be useful for built environment professionals to use these literature findings in design and operation strategies of an office building. It also provides a good initial research note for researchers working in the field of sustainable human behaviour.

Keywords: *Behavioural Economics; Energy Consumption; Occupant Behaviour; User Energy Behaviour.*

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BLACK SWAN EFFECTS ON THE REAL ESTATE ENVIRONMENT: A CONCEPTUAL FRAMEWORK

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ABSTRACT

Unpredictable events can have a major impact on real estate, yet they are often overlooked in many property decisions. This research looks at linking property market analysis to Black Swan (BS) Event theory, a term made famous by Taleb (2008) as those unpredictable disastrous events which have three key characteristics: rarity, extreme impact and retrospective predictability. The research takes the form of a narrative synthesis applying a literature review approach to define an extensive range of BS events into a conceptual framework so as to measure the impact on property markets with reference to risk and uncertainties.

For property asset managers, this is important as BS events can be related to the impact on Place/location and Space/operation. To improve the resilience and reduce vulnerability towards these events, property strategies can embrace new disaster management research and so lower the impact of Place risk, although improved connectivity makes global organisations more vulnerable to space risk failure after a major BS Event. In this paper, BS management models are funnelled to the antifragility concept, as a positive sensitivity to increases in volatility. Finally, the study offers a conceptual framework of illustrating the relationship between BS effects and its respective fragile and antifragile strategies.

Keywords: *Antifragility; Black Swan Effects; Black Swan Management; Randomness; Real Estate Environment.*

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CAPACITY OF INFORMATION TECHNOLOGY INFRASTRUCTURE IN SRI LANKA TO SUPPORT BUILDING INFORMATION MODELLING SYSTEMS

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ABSTRACT

Building Information Modelling (BIM) is a concept, improved with Information Technology (IT) to upgrade construction, maintenance and operation of a building or an infrastructure project. Information Technology Infrastructure (ITI) is a crucial aspect in implementing BIM. Rapid improvement of ITI has benefited mostly to AEC and FM industry while enhancing the accessibility to more numerical dimensional BIM modelling such as scheduling (4D), costing (5D), operation (6D), sustainable design (7D) and safety (8D). Therefore, it is necessary to investigate on ITI in Sri Lanka for successful implementation of BIM in Sri Lankan construction industry. Thus, this research is aimed at identifying the capacity of information technology infrastructure in Sri Lanka to support BIM systems. A qualitative approach to the research methodology was proposed in order to carry out an in-depth investigation on subject matter.

Major five BIM systems and minimum ITI requirements for each BIM systems were identified through a comprehensive literature review. Existing ITI in Sri Lanka was identified from various organizations which represent IT, construction, banking and apparel sectors. Further, risks and challenges in each infrastructure were identified. By combining the literature findings and existing knowledge which was obtained through a deep analysis. Then a framework was developed to indicate the capacity of ITI in Sri Lanka to support BIM systems. From the findings of the study, the conclusion was made that the BIM implementation in Sri Lanka is possible even there are several risks and challenges bound with ITI. Ultimately, it was recommended that Sri Lanka has enough capacity to implement BIM with minimum ITI requirements.

Keywords: *Building Information Modelling (BIM); Construction; Information Technology Infrastructure (ITI); Sri Lanka.*

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CARBON AND COST CRITICAL ELEMENTS OF OFFICE BUILDINGS: A CASE STUDY

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ABSTRACT

Buildings emit two types of carbon (and greenhouse gases) namely Operational Carbon (OC) and Embodied Carbon (EC). Operational carbon is regulated in the UK as it contributed up to 70-80% of total emissions. On the other hand, EC started gaining attention with the rise of zero carbon buildings and due to the fact that the EC is unregulated at present. However, estimating EC is not completely standardised and there is room for improvement. EC can be controlled only by vigilant building designs. Studying building closely will provide better understanding of the carbon significant elements and enable designers to make informed decisions. Accordingly, a case study of an office building located in London in the UK is selected for the study. Capital cost (CC) and EC estimates were prepared using detailed cost plan of the building. Then, the building elements were classified as per NRM1 (New Rules of Measurement 1) element classification and the most carbon and cost significant elements were identified in the case study building. Not all of the identified carbon significant elements are identified as cost significant but Substructure, Frame and Services are identified as both carbon and cost critical elements while Stairs and Ramps, Internal Doors and Fittings, Furnishings and Equipment were identified to be the least carbon and cost significant elements. Findings of the case study building inform designers about the elements that has a vast reduction potential and worth investing their time on experimenting. However, the findings are based on single case study and, hence, cannot be generalised but to be seen as an exemplar for further research.

Keywords: *Carbon Hotspots; Capital Cost; Cost Hotspots; Embodied Carbon; Office Building.*

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COASTAL ZONE ADAPTATION IN TRINIDAD AND TOBAGO: A REVIEW OF LITERATURE

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ABSTRACT

Empirical evidence supports that anthropogenic activities have brought about significant changes in our climate. In the instance of Small Island Developing States (SIDS) there is a potentially significant impact from the effects of climate change as the majority of the population resides within the coastal zone, thereby increasing potential loss of life and damage to property during climate related events. Determining vulnerability can provide an assessment of the factors that place communities at risk to the potential loss of life and property and assist in the creation of solutions towards increased resilience and adaptation.

This paper explores the literature on the coastal zone vulnerabilities of Trinidad and Tobago with particular focus on the Caroni River Basin, the most populated basin on the island. In addition to the population growth in the coastal zone, key sectors of subsistent agriculture, fisheries, cottage industries, oil refineries and manufacturing are located within the coastal zone. Therefore, this paper also highlights the myriad of vulnerabilities of Caribbean SIDS and outlines environmentally sensitive design solutions for coastal zone adaptation.

Keywords: *Caribbean SIDS; Vulnerabilities; Climate Change Adaptation; Trinidad and Tobago.*

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CONSTRUCTION MANAGEMENT PRACTICES INFLUENCING PRODUCTIVITY IN BUILDING PROJECTS

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ABSTRACT

The adverse effects of management related problems affecting productivity in construction projects can be reduced by implementing best management practices that are suitable for a specific project type. Previous studies identified the best practices for infrastructure and industrial projects. However, these practices could not directly be used for building projects as the management practices might vary from project to project and from country to country. Moreover, a little research has been conducted on what the best practices might be in the context of building projects in Victoria, Australia. Face-to-face in-depth interviews were conducted with nineteen experienced professionals in the construction industry and forty-seven context specific best practices for building projects such as long lead materials identification, machinery productivity analysis, short interval planning, incentive programs, dynamic site layout plan and safety policy are identified. The study revealed that some best practices that are applicable to infrastructure and industrial projects are not suitable for building projects. Therefore, implementation of the best practices identified in other contexts could not improve productivity in building projects and principal contractors involved in building construction should adopt context-specific practices to enhance the productivity of their projects.

Keywords: *Australia; Best Practices; Building Projects; Management Practices; Productivity.*

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CRITICAL SUCCESS FACTORS FOR CONSTRUCTION OF GOVERNMENTAL PROJECTS IN EGYPT

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ABSTRACT

The identification of Critical Success Factors (CSFs) for construction projects enables appropriate decision making to achieve the project objectives. Limited studies focused on the CSFs in previous researches particularly in Egypt. Therefore, this paper aims to explore the CSFs necessary to achieve Governmental Projects objectives in Egypt. A number of CSFs have been determined through a comprehensive literature review. These factors were grouped under five main groups: project aspects, owner, contractor, consultant, and environment. A questionnaire was developed to facilitate systematic data collection in this study. Experts with an overall average of 20 years of experience in the construction industry were invited to participate in the survey. The results of this survey were ranked based on their degrees of importance in relation to success using the relative importance index. The results can be used as a guideline to successfully handle construction projects in Egypt as well as in other developing countries.

Keywords: *Construction Management; Critical Success Factor; Egypt; Governmental Projects.*

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DEVELOPING A FRAMEWORK TO ENSURE SAFETY OF MAINTENANCE WORKERS IN SRI LANKAN COMMERCIAL BUILDINGS

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ABSTRACT

Maintenance is one of the most important and critical activities in every high rise commercial building. Maintenance activities often comprised of risk increasing factors and different kinds of potential hazards. Significant numbers of maintenance workers may be exposed to a variety of risks when doing their job. The safety of the maintenance workers should be prioritized in every maintenance work. It is mandatory to provide a safe working environment for their workers. Organisations and maintenance workers are not adhering appropriate safety practices to safeguard their lives and properties. Initiated regulations and standards are not specifically designed for the building maintenance activities. Therefore, this research intended to address this issue by developing a framework to ensure safety of maintenance workers in commercial buildings. Initially, a comprehensive literature review was carried out on the subject matter. Based on the nature of the study, data collection was carried out in two phases. A case study approach was used to gather existing information on maintenance works carried out under different categories, their related hazards. Semi structured interviews were conducted with a professional who is in the management level of the maintenance department in each selected case study. Expert survey was then carried out with three industry professionals to gather information about appropriate suggestions to ensure the safety of maintenance workers. The study highlighted key categories of maintenance works as confined space works, hot works, works at height, works involve with electrical equipment and works involve in using dangerous substance. These activities involve with different kinds of potential hazards such as physical, chemical, biological and psychological. The exposure level of the maintenance workers to the hazards is significantly high in this work environment. The study identified safe procedures to follow during different maintenance tasks.

Keywords: *Maintenance Works; Occupational Safety and Health; Safety and Health Measures.*

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DEVELOPMENT OF A PROFESSIONAL DOCTORAL PROGRAMME IN BUILT ENVIRONMENT TO ENHANCE SOCIETAL RESILIENCE TO DISASTERS

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ABSTRACT

Integrating disaster resilience into education is a key factor for reducing the adverse impact of future disasters. This paper in this context presents the methodology of developing an innovative professional doctoral programme (DProf) that integrates professional and academic knowledge in the built environment to enhance societal resilience to disasters. The DProf programme addresses the career needs of practicing professionals, particularly those in, or who aspire to, senior positions within the construction industry and caters for the researching professional. In developing the DProf programme, a detailed market needs analysis for built environment stakeholders to increase societal resilience to disasters was conducted capturing inter-disciplinary needs across a range of stakeholders and countries. A series of semi-structured interviews on current and emerging market needs with members of six built environment related stakeholders, namely, local and national governments; community; NGOs, INGOs and other international agencies; academia and research organisations; and private sector facilitated the aforementioned analysis. Qualitative data analysis techniques were employed in analysing the interview data. The findings of the interviews revealed the current and emerging needs and skills of the six stakeholders related to built environment professionals towards enhancing social, economic, technological, environmental and institutional dimensions of disaster resilience of societies. These findings were used to develop the appropriate learning outcomes and the content of taught and research components of the DProf programme.

Keywords: *Professional Doctorate; Disaster Resilience; Built Environment.*

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DISPUTE AVOIDANCE MODEL FOR SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Construction disputes have become a major hindrance for the performance of construction projects. Most of the practices in construction projects have contributed to avoid disputes while serving its own purposes. It is still hard to find a construction project with no disputes due the existence of root causes for disputes. Many steps have been taken to introduce effective dispute resolution mechanisms giving more concern on cost, time and enforceability of the solution, which still contain many drawbacks in practical applications. Therefore, 'prevention is better than cure' and thus the concept of dispute avoidance has been emerged. The research therefore aims to develop a dispute avoidance model for Sri Lankan construction industry.

Primarily, literature review was done in order to find the issues related to dispute and factors contributing to dispute avoidance. The review revealed that risk allocation, selection of contractors, quality of documentation, time management, and procurement method could contribute to dispute avoidance. A survey research approach was adopted and questionnaires were issued to the professionals who have experience in dispute management in Sri Lanka. The collected data was analysed statistically using t-test. The research proposed 'Dispute Forecasting Session (DFS)' as dispute avoidance model for Sri Lanka. The research revealed that DFS need to be carried out middle of the briefing stage, in between pre and post contract stage and beginning of post contract stage of the project. Further the research identified the participants to DFS in terms of each stage of construction project; in briefing stage client and consultant; in pre contract stage client, consultant and neutral third party; in post contract stage contractor, consultant, nominated subcontractor and neutral third party. In addition, the research participants identified the activities to be performed in each stage of projects in order to avoid disputes. Finally the research suggests to utilise the DFS dispute avoidance model which will forecast construction disputes, thereby avoiding the foreseen construction disputes in Sri Lankan construction industry.

Keywords: *Disputes; Dispute Avoidance; Dispute Forecasting; Dispute Resolution.*

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EFFECTIVENESS OF ALTERNATIVE DISPUTE RESOLUTION METHODS USED IN THE HIGHWAY CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

Effectiveness of dispute resolution affects immensely for success or failure of construction projects. This document consists of a literature review about alternative dispute resolution (ADR) methods including negotiation, mediation, Dispute Adjudication Board (DAB), ad-hoc adjudication, arbitration and ten critical factors affecting to effectiveness of ADR methods such as cost, speed, relationships, fairness etc. After decades of use there is no clear detailed analysis about used alternative dispute resolution in highway projects for their effectiveness and efficiency. In order to fulfil this gap, this research is conducted to evaluate effectiveness of used ADR methods regarding ten critical factors.

The research methodology adapted was qualitative within multiple case studies from disputes arisen in Expressway Construction projects. The primary data collection techniques used in this study was ADR documents and semi structured interviews. Content analysis was used to analyse these documents and cross case analysis to compare cases findings to each other. The research findings revealed that ratings for critical factors fluctuate from case to case significantly. In the discussion of research findings, key attributes identify which was the cause for fluctuations. So one cannot simply say this or that factor affects most to the success and this ADR method is best way to deal with disputes. According to study it's not fair to deal with every dispute in the same manner, so categorization of disputes concerning key attributes needed for improved efficiency of ADR methods.

Guidelines developed include steps, tables and flowcharts for using ADR methods effectively. These findings and guidelines are presented in a logical, systematic and a sensible way to identify the ideal ADR method for a given dispute rather than relying on subjective decisions. It is hoped that these findings and guidelines will be useful to the stakeholders in future highway projects and can be adapted to the whole industry.

Keywords: *Alternative Dispute Resolution; Critical Factors in Dispute Resolution; Expressway Construction Projects; DAB; Cross Case Analysis.*

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EMERGING COMPETENCIES WITHIN NATIONAL AND LOCAL GOVERNMENT FOR SOCIETAL RESILIENCE TO DISASTERS IN SRI LANKA

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ABSTRACT

Emerging competencies for societal resilience to disaster within the built environment domain of Sri Lanka were analysed in the aim of developing a professional doctoral (DProf) course through the CADRE (EU-FP7) project. Competencies were compiled following the amalgamation of both emerging market needs and skills within the built environment domain of Sri Lanka. In its investigation, qualitative and quantitative data collection was facilitated through a literature review. Data collection was conducted in respect to all stages of the construction cycle (i.e. Preparation, Design, Pre-construction, Construction, Use). The analysis was conducted using resilience themes for five thematic areas (i.e. social, technological, environmental, economic and institutional) in relation to each stage of the construction cycle.

Despite local and national government bodies affecting a central role in policy, planning and implementation of land use changes and construction, built environment professionals with specialised expertise was minimal. Parallels were drawn regarding the gaps within the private sector and local and national government, such as a critical need for skills development programmes to ensure a viable skilled labour force and job security. Finally, it is critical for national and local government to enforce existing certification systems and standards for skilled workers to ensure a safe, viable and competitive construction industry.

Keywords: *Professional Doctorate; Disaster Resilience; Built Environment.*

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ENERGY FROM WASTE: A SOLUTION FOR THE GARBAGE CRISIS AT MEETHOTAMULLA, KOLONNAWA, SRI LANKA

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ABSTRACT

Municipal Solid Waste (MSW) generation and management is a continually growing problem at global level, and is becoming more complicated day by day. Sri Lanka as a developing country also confronts the issue of increasing solid waste. Its major conventional solid waste management practice of open dumping is being challenged at present due to its negative impacts on environment and public health. Therefore, there is a necessity to look at this problem from a new perspective. Being identified the Energy from Waste (EfW) technologies as one of the best solutions to solve MSW problem, this paper aims at assessing the viability of setting up an EfW facility to get rid of Meethotamulla, Kolonnawa Garbage Mountain which has become a pressing issue today. The data gathered from secondary sources such as government publications, journal articles, newspaper articles, and other published reports intensifies this analysis. Based on the analysis, it is identified that mass combustion is the best possible technology to treat about 1300 tons of waste per day in order to make the Meethotamulla garbage site hazard free zone by 2040 and to generate 14MW of electricity per day as a by-product of waste combustion. And eventually, the PESTE analysis identifies the opportunities and threats that can be affected when implementing such a capital intensive facility.

Keywords: *Energy from Waste; Municipal Solid Waste; Meethotamulla Garbage Dump; Sri Lanka.*

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ESTABLISHMENT OF THE MOST COMMON GROUND ON WHICH LOCAL ARBITRAL AWARDS BECOME UNENFORCEABLE IN SRI LANKA

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ABSTRACT

The parties select more adversarial arbitration process over other alternative dispute resolution methods mainly due to the enforceability of the arbitral award. If the arbitral award becomes unenforceable due to any reason, the selection of arbitral process is useless. In this scenario, a research was conducted specially to find out the most common ground on which local arbitral awards become unenforceable in Sri Lanka and to explore the reasons to occur the unenforceability under that most common ground with the expectation that this improved knowledge would assist to minimize the unenforceability of local arbitral awards.

The research was conducted under the quantitative research approach. A cross-sectional, retrospective and non-experimental study design was adopted. The local arbitration cases registered at the High Court-Colombo during 2009-2012 for the setting aside or for the enforcement of the awards and the courts had completed the proceedings were selected as the convenient sample. The sample contained 910 cases.

The data collection process was a two tiered process. In the first tier, a cross sectional survey was carried out at the High Court-Colombo to find out arbitral awards become unenforceable due to setting aside or refusal of the enforcement by the High Court. If the judgment of the High Court was appealed to the Supreme Court the judgment of the Supreme Court was also considered. Through the first tier of data collection, it was found that non adherence to the enforcement procedure is the most common ground on which local arbitral awards become unenforceable in Sri Lanka.

During the second tier of data collection, semi structured interviews were conducted with the parties who failed to enforce the arbitral award due to non-adherence to enforcement procedure, those parties were mainly financial institutions and contained 16 organizations. Through the interviews it was found that performance defects of the legal counsel and the performance defects of the officer in charge of the case are the main reasons for the unenforceability of arbitral awards under the most common ground. Therefore it is recommended to establish proper reporting and monitoring systems within the organizations dealing with arbitration.

Keywords: *Arbitration; Setting aside; Enforcement; Unenforceability.*

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FACTORS AFFECTING THE INDOOR ENVIRONMENTAL QUALITY IN SRI LANKA: GREEN VS. CONVENTIONAL HOTEL BUILDINGS

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ABSTRACT

The hotel building sector is now using sustainable design and construction practices thereby helping to prevent environmental pollution. Green building practices are capable of promoting a healthy and comfortable indoor environment for hotel occupants (including guests and staff). Some criticism has been made by occupants of green buildings on the accuracy of the certification process and the performance of LEED certified buildings. Therefore, this study is aimed at identifying the key factors affecting the Indoor Environmental Quality (IEQ) of green buildings compared to that of conventional hotel buildings by evaluating building performance. Firstly, a literature survey was conducted to identify the importance of IEQ in green buildings and the methods of evaluating IEQ performance. Subsequently, key and sub factors relating to IEQ performance identified from the literature review were validated through expert interviews. A questionnaire survey and semi structured interviews were used as data collection techniques by making use of two green buildings and two conventional buildings. The data was analysed using Mann-Whitney U-test and "Nvivo 10" software. The analysis revealed that green hotels provide an overall IEQ performance that is higher than that of conventional hotels. However, factors such as lighting, acoustics and the degree of personal control that occupants have on the indoor environment were comparatively less satisfactory in green hotels. The paper also discussed the reasons for the low satisfaction of IEQ in respect of these factors. Finally this study confirms that the hotel industry needs to consider a climate responsive design to ensure a better IEQ and pay attention to post occupancy evaluation throughout the life cycle of a building.

Keywords: *Green buildings; Indoor Environmental Quality (IEQ); Occupants' Satisfaction; Sustainability.*

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FRAMEWORK FOR MITIGATING CONTRACTUAL DISPUTES IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Dispute is defined as “any contract question or controversy that must be settled beyond the jobsite management”. Most of the construction disputes related to the contractual matters. The aim of the research was to develop a framework as a strategy that could mitigate to the occurrences of contractual disputes in Sri Lankan construction industry. Literature synthesis aimed at adapt the nature of contractual disputes by establishing critical attributes of contractual disputes, causes of contractual disputes, strategies used to avoid contractual disputes, Alternative Dispute Resolution methods and attributes in ADR methods. The five Semi-structured interviews and thirty five detailed questionnaire surveys were aimed at detailed studying of practical situation in Sri Lankan contractual disputes, identifying the areas, causes, effects, avoidance strategies of contractual disputes and attribute in Alternative Dispute Resolution methods and behaviour of the attributes in ADR methods. The research findings revealed major areas of contractual disputes named as general causes, contractor and owner related causes. Major causes of contractual disputes are ambiguities in contract documents, delays in work progress, design errors and major effects identified as cost overruns, project delays and damage business relationships. Contract documentation, proper coordination between contract documents and proper contract administration are the major contractual dispute avoidance strategies. Furthermore, major attributes in ADR methods are identified as duration of the proceeding, obtaining fairness decision and binding of the decision. Further research findings are revealed that arbitration require highest duration of the proceeding, mediation provide the more fair decision and arbitration decision is more binding and enforceable.

Keywords: *Sri Lankan Construction Industry; Contractual Dispute Avoidance; Contractual Dispute Resolution.*

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GAPS IN PUBLIC PROCUREMENT PROCESS IN SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Procurement Process is back bone of the country to achieve the economic development. Accordingly, since 2006, government of Sri Lanka has made significant efforts toward to reform and develop the Public Procurement Process (Public PP) in construction industry with the assistance of the Ministry of Finance and Planning (MOFP), the Construction Industry Development Authority (CIDA), foreign funding agencies, and relevant institutions and practitioners. Current regime is in process of formulating a sustainable framework to the Public PP not only to the construction industry but also to the entire industries.

Thus aim of this paper is to carryout comprehensive diagnosis to identify the gaps in Public PP in Sri Lankan construction industry and propose remedial measures to bridge the gaps in order to facilitate the government endeavour. Paper is based on secondary data and opinions of experts. The gaps are identified as absence of procurement strategy and legislative framework, lack of integration with governance, unavailability of procurement regulatory body, and Incapable Capacity Development.

Further paper presents the remedial measures and provides recommendations to bridge the gaps that will enable to the GOSL to initiate the Sustainable Public Procurement Process (SPPP) to the construction industry. Findings revealed that establishment of procurement strategy and legislative framework, integration with governance, establishment of procurement regulatory body, and capacity development as the remedies in line with the short term, medium term, and long term measures to initiate and implement contemporary version of Public PP to the Sri Lankan Construction industry.

Keywords: *Public Procurement Process; Construction Industry; Sustainable Public Procurement Process; Gaps; Remedies.*

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IMPLEMENTATION OF BUILDING INFORMATION MODELLING WITHIN CONSTRUCTION SMES

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ABSTRACT

Building Information Modelling (BIM) is promoted as a requisite to improve construction project performance. In the UK, the Government has set the construction industry targets to attain with timescales, such as achieving the BIM Level 2 for all government projects by the year 2016. In terms of the UK construction sector, over 86% of employees work within small and medium sized enterprises (SME), and are responsible for 75% of the turnover. However, BIM implementation within the SME sector is considerably low. As such, SMEs may be left behind in the BIM journey, thereby hindering the policy level targets.

This research was aimed at identifying the key barriers to the implementation of BIM within the construction SMEs in the UK. The data were collected through a literature review, questionnaire survey and four semi-structured interviews.

The findings reveal lack of investment and commitment to resource to skill development in relation to BIM, and the absence of incentives within the government procurement processes as significant among the several barriers to the implementation of BIM within the UK construction SMEs. Despite the UK government's intention that at least 25% of all central government contracts should be awarded to SME businesses by 2015, many construction SME firms are finding it difficult to win public sector work. Therefore, the research findings highlight implications for both policy and practice. For the macro level policy makers, the non-consideration of the diversity and the market dynamics the construction industry may lead to unrealistic policy level targets being developed. For the construction industry and its firms, it is high time to reflect on their current practices and the level of commitment to resource skill development and continuous improvement.

Keywords: BIM; SMEs; Barriers; Construction Industry; United Kingdom.

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IMPROVING COLLABORATION BETWEEN ACADEMIA AND INDUSTRY THROUGH USE OF THE KNOWLEDGE TRANSFER PARTNERSHIP

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ABSTRACT

Collaboration between the construction industry and academia has always been difficult. Both sides of the equation have different wants, needs and requirements and these are seemingly at odds with each other. However, it is well documented that, despite the challenges involved, the outputs of such collaboration are seemingly very successful. It is against this backdrop that the United Kingdom Government has recognised the importance of facilitating opportunities and helping in the development of models to assist in overcoming the gap between industry and academia. One of these models is the Knowledge Transfer Partnership (KTP). The KTP model specifically allows businesses to solve issues they have by accessing knowledge and expertise held by academic institutions that otherwise may be out with their reach. In this paper we demonstrate how the Scott Sutherland School (SSS) and Abertay Housing Association (AHA) fostered a partnership with the aid of KTP funding to test/ monitor a solution to upgrade some of their non-traditional housing stock. We found that a deep relationship developed during the initial stages of drafting the funding proposal set the foundation for the rest of the project to date. The partnership has allowed both parties to benefit - AHA has new found knowledge of the performance of their existing housing stock, whilst SSS has added knowledge of steel house behaviour to its expertise of other house types.

Keywords: *Collaboration; Funding; Knowledge Transfer Partnership.*

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INCORPORATING TACIT KNOWLEDGE IN PERFORMANCE MEASUREMENT SYSTEM IN A SRI LANKAN HOTEL

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ABSTRACT

Performance Measurement (PM) has been received an increasing attention over the past 20 years in the hotel industry. It is critical for the development of strategic plans and for evaluating the achievement of organisational objectives. A growing understanding of the limitations of financial measures has led the development of integrated systems and frameworks. Among the conventional models, Balanced Scorecard (BSC) is widely accepted and implemented in organisations. However, identification of Critical Success Factors (CSFs) and formation of BSC model into a practical context is based on several assumptions that could lead to failures. Tacit knowledge addresses the value of the expert's knowledge and specifies techniques to capture current context and changing needs of the organisation. However, the extent of literature on PM has failed to incorporate tacit knowledge into the PM models using any of the externalisation techniques due to several reasons.

Therefore, this study explored the method to incorporate expert's tacit knowledge for PM in the Sri Lankan hotel industry. The research problem was approached through a single case study with an action research phase in a five star hotel that successfully practice Performance Measurement System (PMS) in Sri Lanka. Semi-structured interviews were conducted among the experts in the hotel and combined three methods namely; archival analysis, ethnographic analysis and experts' participation to extract expert's knowledge in to CSFs identification process.

The case study findings revealed that hotel staff subconsciously carries out activities for externalising, preserving and developing their tacit knowledge. However, there is no evidence of considering tacit knowledge in the process of CSFs identification for PM in Sri Lankan hotel industry. Action research phase affirmed, at minimum, either the ethnographic or the interactive method could be used along with archival analysis method to represent both the explicit and tacit knowledge of the organisation to produce an effective PMS. The approach used in this study for incorporating tacit knowledge into performance measurement is adaptable to Sri Lankan hotel industry.

Keywords: *Hotel Industry; Sri Lanka; Critical Success Factors; Performance Measurement; Tacit Knowledge Externalisation.*

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INDUSTRY ATTRACTIVENESS OF OUTSOURCED FACILITIES MANAGEMENT SERVICES IN SRI LANKA

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ABSTRACT

Buildings should be habitable, safe, durable, energy efficient and adaptive to use though it is expensive to manage. The specialized team of Facilities Management (FM) is thus invited to create a comfort built environment that strongly supports the core business of the organization. The emergent trend of outsourcing FM services has become widespread topic in the field of built environment though it is relatively new to the Sri Lankan context. Hence, this study aims to examine the attractiveness of the market for 'FM services' in Sri Lanka as a primary step. Porter's five forces analysis was developed at the line-of-business industry level to analyse the existing market. A comprehensive literature review was carried out on a broader perspective with the purpose of getting familiarise with the research phenomena. In order to examine the attractiveness of the outsourced FM market two FM professionals; one from an International FM company and the other from a Local FM company, employed at the strategic level were interviewed. The research findings revealed that the market for FM services in Sri Lanka is long been considered as a niche market with a slower growth and is still in its infancy. Two companies, a local and a global company are dominating in the industry. The Porter's five forces indicated that average bargaining power of client; less bargain power of suppliers; less substitutes; lower level competition thus there are few barriers to enter the market. However, it is clear that the boundaries of the market have not been defined yet; hence the new entrants have the freedom to define their own market share. This study urges to define the market for outsourced FM services and further, FM companies can get the benefit of this analysis in order to formulate successful business strategies to enter and sustain in the market.

Keywords: *Market Competition; Outsourced Facilities Management; Porter's Five Forces.*

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INTEGRATING DISASTER MANAGEMENT PERSPECTIVE INTO ARCHITECTURAL DESIGN EDUCATION AT UNDERGRADUATE LEVEL - A CASE EXAMPLE FROM TURKEY

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ABSTRACT

The paper highlights key points and problem areas associated with integrating management perspective into the architectural design education. Architects with appropriate training can easily broaden their traditional roles to enhance the capacity of the society to respond to disasters through efficient, sustainable, socially and culturally responsible designs. However, the number of undergraduate and post-graduate programs which integrate disaster management perspective into their curriculum as a long-term proactive strategy to build resilience is very low. Based on experience from a series of Construction Project Studios' with different themes and scenarios at Istanbul Technical University, Department of Architecture, the paper compares the typical design process with a disaster-focused process to highlight the differences. There are a couple of key issues in the educational context to integrate disaster management perspective into the architectural education: a shift towards a more collective problem solving space in the design studio along with an intellectual familiarity with the problems of contemporary society; an understanding of the heterogeneity of the needs and characteristics of different vulnerable groups; an adequate background knowledge to filter and adapt common design principles and norms, so that they are relevant to disaster and project scenarios; and a familiarity with technical solutions patterns such as open prefabrication and adaptive re-use. The findings may show directions for future educational research, where little empirical evidence exists.

Keywords: *Architectural Design Education; Built Environment, Disaster Management; Disaster Preparedness.*

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INTERACTIONAL ANALYSIS FOR TWO-PARTY RISK ASSESSMENT IN PUBLIC PRIVATE PARTNERSHIPS (PPP)

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ABSTRACT

Public Private Partnerships (PPP) have been increasingly used over the past years. However, problems have arisen with the increased use of this procurement strategy. These problems usually occur as a result of various risks that manifest over the long duration of the project. These include risks at the macro, market and project level specific to PPP projects. Examples include concessionaire default in loans for the Sydney Airport Rail Link project, bank refusal to loan the concessionaire for the Channel Tunnel Rail Link project in the United Kingdom and high interest loans on private debt for the Taiwan High Speed Rail project. Identifying risks in previous projects would lead to a risk registry that would help in understanding the sequence of events as well as the parties involved. Case studies have suggested that the outcome of the identified risks can be linked to the interaction of the parties in a PPP project. Parties to the risk in a PPP project include owner or government, developer, financier, sponsor, supplier, architect, subcontractors, contractors, non-governmental organizations (NGOs), media, authorities and regulatory, politicians, workers, end-users and experts. In this paper, game theory is used to analyse the interactions between parties to understand dynamic outcome of the associated risks in PPP project because of the actions taken by the parties to the risk. The scenarios of risks are defined based on actions and their transaction cost as well as outcomes and their payoff. Strategies would be developed and simulated to propose mitigation plans to address risks.

Keywords: *Game Theory; Interactional Analysis; Public Private Partnerships; Risks.*

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INVOLVEMENT OF CONSTRUCTION MANAGEMENT PROFESSIONALS IN PROPERTY LEVEL FLOOD ADAPTATION

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ABSTRACT

Flooding is a significant concern across the UK that has caused property damage, economic impact and health and safety concerns. The national climate change risk assessment for the UK projects the risk of flooding to increase in the future, and thus flood risk management is identified as an area that requires serious action. Whilst community level flood protection measures have been and are being put in places where there is an economic case for such intervention, the need for implementing property level flood adaptation (PLFA) is increasingly highlighted. This industry is worth £2.1 billion globally; with a forecasted UK growth at a rate of 7.1% by 2017-18. The aim of this research is to identify the ability of construction managers to provide PLFA advice to homeowners. Interviews were conducted with 10 professionals currently involved in flood adaptation product/service provision to gather their views on construction manager involvement within this niche area. Majority of participants interviewed accepted that construction managers could enter the PLFA industry. However, there has been a lack of evidence that suggest that construction managers have played a key role in this field. The paper suggests that there are several barriers that have resulted in the lack of involvement of construction managers in the PLFA industry. Previous research recognises lack of relevant skills and knowledge required to provide PLFA advice as a key barrier, this is supported by participants interviewed mentioning that the qualification, knowledge and training required were a barrier for construction managers to enter into the PLFA industry.

Keywords: *Construction Industry; Construction Managers; Flooding; Property Level Flood Adaptation; UK.*

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IS CONSTRUCTION GETTING QUICKER?

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ABSTRACT

Construction time performance has been a frequent topic of discussion in the literature and government reports in which the performance of the UK construction industry has been reviewed. It is evident that construction duration is one of the measures by which the success of a project is measured and there has been a great deal of research to develop reliable methods of predicting construction duration. There has been significant research identifying factors which have an effect on the duration of a construction project but little research has been undertaken which considers the changes in construction duration over time. This paper reports on a desktop study considering project duration by collecting data from the Building Cost Information Service (BCIS) and modelled in a general linear model (GLM) and an analysis of variance (ANOVA) to investigate the relationships between the contributory factors for construction duration for projects constructed in the UK between 1995 and 2014. The paper draws a conclusion which suggests that the meeting of the targets set in Construction 2025 of a reduction of time by 25% is unrealistic is drawn; counter intuitively the duration of construction projects in the UK was seen to have increased between 1995 and 2014.

Keywords: *Construction Duration; Building Cost Information Service (BCIS); General Linear Model (GLM); Analysis of Variance (ANOVA); UK.*

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LEGAL FRAMEWORK FOR EFFECTIVE IMPLEMENTATION OF ADR METHODS UNDER THE CONSTRUCTION INDUSTRY DEVELOPMENT ACT

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ABSTRACT

The recently enacted Construction Industry Development Act No. 33 of 2014 is for the development of the construction industry in Sri Lanka. The Act facilitates the resolution of disputes within the construction industry. There is ineffectiveness on implementation of ADR methods for the settlement of disputes. Thus, this study focuses on developing a legal framework for effective implementation of ADR methods for the settlement of disputes in accordance with the said Act.

The research was initiated with a literature survey. A survey approach was implemented whereby two rounds of questionnaires were distributed and semi-structured interviews were conducted among construction professionals with more than 10 years of experience. A pilot study was conducted as a preliminary measure to design the questionnaire round one. Questionnaire survey was conducted by Delphi technique with two rounds by targeting 36 and 30 professionals in round one and two respectively. Data was analysed by taking as a percentage of the total number of respondents for questionnaire round one. For questionnaire round two, first t-test was used to identify the significant problems and potential solutions and then MWR was used to rank them. The structured interviews were analysed using content analysis. The sampling technique was a judgemental sampling.

The survey results on questionnaires revealed the problematic areas related ADR methods used by the construction industry and at the said Act. The survey findings also presented potential solutions to overcome those problematic areas. In addition to the questionnaire survey, interviews were generated recommendations to the part IX - Settlement of disputes of the said Act. Through these results of the study legal framework for effective implementation of ADR methods under the Construction Industry Development Act No. 33 of 2014 was developed. This framework can be adopted to settle the dispute effectively in the Sri Lankan Construction Industry. By practicing this framework the projects can be continued without deadlock, whenever dispute is arisen.

Keywords: *Alternative Dispute Resolution; Construction Industry Development Act No.33 of 2014; Settlement of Disputes.*

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MANAGING OCCUPATIONAL STRESS OF PROFESSIONALS IN LARGE CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

This research aims to take an insight at construction professional-specific occupational stress causing factors, and their impacts to the productivity. The occupational stress causing factors pertinent to construction professionals, consequences of occupational stress and occupational stress prevention strategies that could be implemented within the construction sites were studied and a questionnaire survey was carried out among construction professionals such as project managers, Engineers and Quantity surveyors to identify the significance of them. Ten stressors were identified as significant in causing occupational stress among construction professionals. Further it was recognized the organization related factors have a significant variance of occupational stress among professionals. Thereafter 11 significant impacts for project managers, 9 significant impacts for Engineers and 11 significant impacts for Quantity surveyors were explored. Impact of occupational stress of construction professionals for low performance and productivity can be reduced and job satisfaction can be enhanced by implementing the occupational stress management strategies in construction sites.

Keywords: *Occupational Stress; Productivity, Large Construction Projects; Construction Professionals; Occupational Safety and Health*

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OCCUPANT PRODUCTIVITY AND INDOOR ENVIRONMENT QUALITY LINKED TO GLOBAL SUSTAINABILITY ASSESSMENT SYSTEM

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ABSTRACT

Occupant productivity is gaining momentum in the field of sustainable built environment. Humans spend most of their time indoors, and the majority of the world's population lives in urban areas and work in an office environment. Different Indoor Environment Quality (IEQ) factors affect productivity in an office environment. This paper investigates Global Sustainability Assessment System (GSAS) rating system to identify criteria and submittals focusing different physical indoor environment quality factors that influence occupant productivity. It draws implicit links between the current state of sustainable research and indoor environment quality factors covered in the GSAS rating system. The study highlights that GSAS has focused one-third of its weightage to indoor environment quality factors. Most IEQ criteria like indoor air quality, thermal comfort, lighting and day lighting, Biophilia and views are well addressed in the GSAS. There is still room to focus on factors like office layout, look and feel, and location and amenities. This paper is a part of ongoing research endeavour to update GSAS to incorporate occupant productivity and well-being in rating system's focus to improve green buildings in the Middle East. The paper would help researchers and professionals who aim to understand the link between the GSAS rating system and indoor environment quality factors that affect productivity.

Keywords: *Green Building Rating System; Indoor Environment; Quality Occupant Productivity; Sustainability.*

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OPTIMISATION OF PROJECT PERFORMANCE IN POST-DISASTER BUILDING RECONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

Natural catastrophes occur frequently around the world and cause severe undesirable impacts on human lives and properties of the communities. The restoration of a human life style after such massive event, consume some significant time and cost, comparatively to the conventional day-to-day constructions. Recovery and rehabilitation of the affected nature have to be completed at extreme cost and within strict time limitations, in order to achieve the project goals up to highest possible level of satisfaction. Whereas, numerous issues and challenges, affecting the reconstruction projects, leading to failures and inefficient outcomes at the project completion stage. Time, cost and quality parameters will always be the highlighted aspects in the process of determination of project performance level in reconstruction projects. Thus, the lack of strategies to enhance the degree of performance status is addressed as the research gap of the study.

Case study was selected as the most appropriate approach for the study. Six interviews were conducted among Project Engineers and Managers and Client's Representatives. Further, document reviews also conducted in the case study. Consequently, code-based content analysis was used to capture the substantial factors as well as the probable elements that can be implemented to optimise project performance in post-disaster reconstruction projects in Sri Lanka. Thus, conclusions are drawn and recommendations are suggested.

The outcomes of the analysis were able to identify critical issues of post-disaster reconstruction projects in Sri Lanka, and probable attributes which can be implemented for a proper trade-off in time, cost and quality perspectives. The findings would be much effective for developing strategies to implement to achieve the best performance level in reconstruction projects.

Keywords: *Cost Performance; Post-disaster Reconstruction; Project Performance Optimisation; Quality Performance; Time Performance.*

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POTENTIAL TO IMPLEMENT BIM PROJECT WITH SRI LANKAN PROFESSIONALS

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ABSTRACT

Building Information Modelling (BIM) was found by construction industry, to increase the productivity of construction, while other industries gain more productivity by automating the processes and using software. BIM opened a new era to the construction industry, in which stakeholders in the industry deals with concepts in three dimensional virtual environments, leaving behind the time which used two dimensional concepts on papers. Even though other countries are gaining the benefit of BIM, Sri Lanka is still in the infant stage when it comes to BIM. If BIM is to be used for a construction project in Sri Lanka, a major barrier would be finding suitable persons as the participants to the project team. Therefore, this research is aimed to identify the best BIM team in Sri Lanka, for successful completion of a project using BIM.

With the aim of identifying the best BIM team in Sri Lanka, first a literature review was conducted to identify the tasks to be carried out in a BIM project. Having identified the tasks to be performed such as advising the client on purpose of using BIM, the required skills to perform each task were also identified. Thereafter, the conventional design team in the current construction industry in Sri Lanka was identified, and tasks to be performed by the BIM team were mapped to the conventional design team, to create hypothetical ideal BIM team.

Thereafter the hypothetical BIM team was analysed through a qualitative research approach to formulate the ideal BIM team.

Keywords: *Building Information Modelling; Construction Industry; Professional Team; Sri Lanka.*

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RE-DIRECTING CONSERVATION RISKS TO DISASTER RISKS IN CONSERVING WORLD HERITAGE SITES IN MALAYSIA

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ABSTRACT

Although a host of researches have fished-out attributes collectively defining Conservation Risks (CR's) at World Heritage Sites (WHS's) in Malaysia, these attributes are reported to threatening WHS's thereby posing as potential Disaster Risks (DR's) to the WHS's. These fished-out CR attributes however somewhat fall within the confines of 'hazards' (as conceived by some researches and policy documents on DR's) leaving out the other two variables (vulnerability and capacity) which alongside hazards, collectively define DR's. *This study as such, intends to explore the studies on CR in Malaysia with a view to aligning these studies to a DR approach in conserving WHS's in Malaysia. Literature is sourced and reviewed by means of document analysis. Interpreted inferences drawn will be used presenting results. Findings reveal that attributes CR while bearing semblance to attributes of DR however predominantly qualify to being hazards both originating from nature and human induced. It is recommended that adopting the full concept of DR to WHS involves exploring the other two variables (vulnerability and capacity) which alongside DR attributes qualified to being hazards will collectively define DR at WHS's both in Malaysia and beyond.*

Keywords: Conservation Risk; Disaster Risk; Malaysia; World Heritage Sites.

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RE-THINKING POST-CONTRACT COST CONTROLLING TECHNIQUES IN THE NIGERIAN CONSTRUCTION INDUSTRY

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ABSTRACT

The challenges of cost and time overruns, construction disputes and client dissatisfaction have plagued the construction industry in Nigeria. This may be as a result of the approaches used in monitoring construction costs. The execution phase of a construction project relies on post-contract cost controlling techniques, such as cash flow monitoring, interim valuations, final account preparation, monitoring activities, site meetings and documentation of activities on site. These techniques are imperative for project success. The purpose of this paper is to assess the various techniques used in post-contract cost control in Nigeria, in terms of their effectiveness. The data was gathered from one hundred and thirty five (135) cost and project managers in Nigeria. The Kendall's coefficient of concordance was used to test the post-contract cost controlling techniques identified, through an extensive literature review along with one sample run test.

The findings reveal that monitoring material cost was the most effective and important technique with a Kendall's W score of 1.33 and 11.44 respectively. Cash flow monitoring had the lowest score of 7.85 for effectiveness, while variation management had the lowest score of 6.88 for importance. The effectiveness of the techniques was further evaluated using one sample run test. The findings show that sixteen out of the eighteen techniques were not effective from an overall point of view. The cost controlling techniques used in the Nigerian construction industry are deficient and generally ineffective. Therefore, there is a need to research alternative post-contract cost controlling techniques for the construction industry in Nigeria.

Keywords: *Construction Industry; Cost; Cost Controlling Techniques; Nigeria; Post-contract.*

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REVIEW OF STRATEGIES TO IMPROVE WORKPLACE SAFETY THROUGH ETHICAL CLIMATES

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ABSTRACT

Occupational Health and Safety (OHS) is an important aspect in every type of organisations. Healthy workers are an important asset to the organisation and safety issues causes various losses to the organisation. Therefore, it is vital to formulate strategies to improve the occupational health and safety in every type of organisations.

It has been found out that 80% of the workplace accidents are due to employee behaviours. Moreover, according to past researches, ethical climate of the organisation affects the individual employee behaviours. Ethical climate refers to the shared perceptions of organisational members regarding what is considered correct behaviour in the organisation and how the organisation deals with ethical issues. Ethical climate guides the employees to determine what is considered right and wrong behaviour at work. Therefore, it is much clear that there is a strong link between ethical climates and the workplace safety.

Thus, this study discusses how the ethical climates affect the employees' work place safety behaviours and ultimately on the occupational health and safety. The literature review shows that among the nine types of ethical climates, principal-local climates and benevolent- local climates have the highest positive effect on workplace safety behaviours. Therefore, the organisations should encourage these types of ethical climates in their organisations and can enhance the safety performance by aligning their safety initiatives with ethical climates.

Keywords: *Occupational Health and Safety; Ethical Climates; Employee Safety Behaviours.*

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REVIEW ON LEAN CONSTRUCTION AND TPS APPROXIMATION WITH BIM

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ABSTRACT

Lean construction is a substantial feature of construction including both pre-construction and post-construction activities which leads a project towards a successive or catastrophe end result. Nowadays, most of projects frequently face uncertainty and it causes to produce continuous waste throughout the construction process making negative outcomes of quality, cost, time and scope. Synergy of TPS (Toyota Production System) philosophy and BIM (Building Information Modelling) methodology is the key to diminish the above-mentioned project hazards which creates an opportunity to stimulate the construction process by avoiding negativity for a better lean future. Hence, aim of the paper focuses on determining most effective potentials that could be derived from the Toyota way philosophy to incorporate to BIM to benefit the lean construction industry.

A qualitative approach has been used considering the nature of the research, comprises of primary and secondary data collection which totally ran across information grabbed from online publications concerning the reliability of sources.

Evidences revealed that TPS-BIM model has agreeably accepted by construction field and the features of this model need to be more precised and refined to achieve more accomplishments in conditions of leanness. It was revealed that even if the method of synchronizing TPS capabilities on BIM tools by balancing nature of human dynamics along with technological endeavours, TPS-BIM integrated elements need more amendments and verifications to perform with its superlatives. Moreover, lean principles derived from TPS contain adequate capabilities to up heave BIM potentials to maximize the benefits in construction with all the positivity throughout the process.

Keywords: *Building Information Modelling (BIM); Lean Construction; Toyota Production System*

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RISK ALLOCATION BETWEEN MAIN CONTRACTORS AND SUBCONTRACTORS IN BUILDING PROJECTS IN SRI LANKA

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ABSTRACT

Risk is identified as a probability of occurrence of an event which may have an adverse impact on the project objectives. Therefore, risk identification and allocation in a well-defined manner is a mandatory prerequisite for a successful project. An optimum risk allocation between main contractor and subcontractor becomes crucial as because in most projects, considerable amount of risk is usually being allocated to subcontractors, and success of a project hugely depends on risk allocation decisions. Hence the aim of this research was to identify and prioritise risks which are common and significant to the relationship between main contractor and subcontractor and to develop a guidance to allocate those risks to the party best placed to manage them. To achieve the aim of this research first, an extensive literature survey was carried out to identify the common risks and to review the concept of risk allocation and its application to the construction industry. A questionnaire survey was carried out to prioritize those short listed risk factors and to find the optimum risk allocation between concerned parties. Through the analysis of collected data using RII, a 'risk register' and a 'risk matrix' were developed. It is recommended that the developed risk register be used as a guidance during the risk identification phase and risk matrix when allocating those risks between concerned parties.

Keywords: *Main Contractor; Risk Allocation; Risk Management; Risk Matrix; Subcontractor.*

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RISK ASSOCIATED WITH FACILITIES MANAGEMENT OUTSOURCING AND ITS IMPACT ON SERVICE PERFORMANCE

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ABSTRACT

In Sri Lanka, Facilities Management (FM) outsourcing has shown steady growth in recent years. Although FM outsourcing has become popular, organizations do not aware about what risks are involved with outsourcing and its impact on service performance. Therefore, the purpose of this study is to develop the strategic framework to analyse risks associated with FM outsourcing and their impact on service performance. Firstly, a literature review was done to identify FM outsourcing risks and its impact on service performance. Further, management strategies were reviewed to overcome FM outsourcing risk with a view to improving performance. A quantitative research approach based on questionnaire was followed to achieve research aim. The initial literature survey findings and preliminary survey finding were included in the questionnaire. Subsequently, questionnaire survey was conducted among the professional experts in both FM service provider companies and client organisations. The results were analysed using descriptive and inferential statistical methods. Accordingly, 31 factors were identified among the analysed 32 FM outsourcing risk factors. The relationship between FM outsourcing risks with service performance attributes were identified by using correlation analysis and FM service provider related risks were rated at the high side of correlation. The factor analysis was also carried out and six management strategies were identified as the most efficient strategies. Finally, a framework to enhance the FM outsourcing practice was developed based on the research findings, in order to suggest appropriate solution to overcome FM outsourcing risk. Hence developed framework can be used to effectively manage FM outsourcing practice for FM practitioners.

Keywords: *Facilities Management; FM Outsourcing; Management Strategies; Risks.*

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RISK MANAGEMENT STRATEGIES FOR FACILITIES MANAGER'S IN SRI LANKA

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ABSTRACT

Value is a function of risk and return. Every decision either increases, preserves, or erodes value (COSO, 2004). Given that risk is integral to the pursuit of value, strategic-minded enterprises do not strive to eliminate risk or even to minimize it, a perspective that represents a critical change from the traditional view of risk as something to avoid. Rather, these enterprises seek to manage risk exposures across all parts of their organizations so that, at any given time, they incur just enough of the right kinds of risk-no more, no less-to effectively pursue strategic goals. The Facilities Management (FM) industry delivers a range of services and products through the spectrum of the facility life cycle, all of which carry varying degrees of risk, identifying risks and being prepared to manage them will minimise any negative impact they may have. Effective Risk Management (RM) planning and practice is an essential component of the practice of FM. Delivering on strategies that enable the organisation to realise the opportunities in their activities while appropriately managing risk is the central to successful management of Facilities. The purpose of this paper is to provide leadership to manage risks within Sri Lankan FM context with an overview of risk assessment approaches and techniques that have emerged as the most useful and sustainable for decision-making.

Keywords: *Facilities Management; Risk Management; Sri Lanka; Office Buildings; Case Studies.*

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SAVING ENERGY IN OFFICE BUILDINGS WITHOUT COMPROMISING THEIR INDOOR ENVIRONMENTAL QUALITY

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ABSTRACT

The concept of Internal Environmental Quality (IEQ) has emerged as a determinant of the performance of built environments due to its direct impact on the health, comfort and satisfaction of the occupants of the buildings and also due its role in ensuring a productive work environment. However, IEQ indicators such as thermal comfort, indoor air quality, and lighting level are associated with the most energy consuming utilities, namely HVAC and lighting. While IEQ and energy efficiency have been researched extensively, there is no published research on energy saving strategies that will optimize the IEQ in office buildings. Therefore, the aim of this study was to identify energy efficient strategies that will optimize the IEQ in office buildings. The research problem was approached through a case study analysis of four office buildings. The study identified energy efficient strategies that can be practiced without compromising the IEQ of a building. However, findings also asserted that there is no common platform to optimize the IEQ performance while achieving the best energy performance of a building. Energy efficient strategies to be adopted can depend on various internal and external factors of a facility. The findings will be useful for building managers who manage office buildings.

Keywords: *Built Environment; Energy Efficient Strategies; Indoor Environmental Quality; Office Buildings.*

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STAKEHOLDER MANAGEMENT IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA: A CONTRACTOR PERSPECTIVE

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ABSTRACT

Possessing rights and abilities to influence the project activities, project stakeholders have become a major source of uncertainty in construction projects. Road construction projects are associated with such a varied range of stakeholders and it is necessary to recognize and manage them properly to complete projects successfully. Being in constant interactions with many of the project stakeholders daily within the project lifecycle, contractor requires a proper management of stakeholders from their standpoint. Thus, this research intends to analyse the power (importance level of impact) and interest (influence probability of those impacts) of stakeholders in road construction projects and recommend suitable strategies to manage them. This aim was approached through a quantitative research methodology using a questionnaire survey including a random sample of 43 contractors' personnel from different construction projects in Sri Lanka. The research findings revealed that client, consultant, government authorities, funding bodies and subcontractors are imposing a high level of impact on project decisions and are with a high probability of having an impact on project decisions. Thereby, contractors suggest adaptation and compromising strategy to manage those stakeholders. Further, suppliers, environmental pressure groups and general public are unable to impose a high level of impact on project decisions but they are with a high probability of bringing in some sort of impact on project decisions. Thus, contractors suggest compromising and influence strategy to manage them. Finally, a matrix developed incorporating the aforementioned findings would serve as a guideline for contractors to manage stakeholders in road construction projects in Sri Lanka.

Keywords: *Interest; Power; Road Construction; Stakeholder Management.*

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STRATEGIC APPROACH TO ENSURE PROCESS SAFETY IN APPAREL MANUFACTURING INDUSTRY USING TOTAL PRODUCTIVE MAINTENANCE (TPM)

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ABSTRACT

Accidents in the apparel manufacturing process lead to huge monetary and productivity losses. Total Productive Maintenance (TPM) can be identified as a rapidly spreading process improvement tool which is targeting zero defects, zero breakdowns and zero accidents. The aim of this research was to explore the suitability of TPM to ensure Process Safety (PS) in the apparel industry. An extensive literature review was carried out to identify process safety, process accidents and relationship between process safety TPM in the apparel industry. Accordingly set of accidents and existing Occupational Safety and Health (OSH) practices were identified in the apparel manufacturing process.

Both qualitative and quantitative approaches were used for the effective fulfilment of research aim. During first phase of data collection questionnaire survey and document survey were carried out with support of OSH experts to gather knowledge regarding process related accidents. Second phase of data collection was conducted using semi structured interviews and observations to identify TPM approaches used to enhance the PS in apparel manufacturing process.

Findings of the study revealed that implementing TPM led to improve the process safety in the apparel manufacturing process up to some extent. But 90% of the identified TPM approaches focused to ensure the production and quality systems. Therefore, process safety was not adequately addressed by identified TPM approaches in both cases. Hence after implementing TPM, still there were accidents in the apparel manufacturing process. Since the research highlighted the importance of paying adequate attention to process safety when implementing TPM otherwise achieving zero accidents remains as a challenge.

Keywords: *Apparel Manufacturing Process; Process Safety (PS); Total Productive Maintenance (TPM); Safety Health and Environment (SHE).*

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STRATEGIES FOR TACTFUL TIME MANAGEMENT FOR QUANTITY SURVEYORS

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ABSTRACT

More than ever before, today's global competition is driven by time. Many issues constituted problems for construction professionals, among them central issue is the time frame. Especially Quantity Surveyor's day to day work involves management of activities and achievement of the short-term goals of the project. Therefore this study focuses on tactful time management for Quantity Surveying professionals practicing worldwide. Literature synthesis and preliminary survey were undertaken to establish the research problem of this study that emphasised lack of awareness and training among Quantity Surveyors on time management. Survey method was adopted whereby initially a preliminary survey was conducted among 10 Quantity Surveyors who are having vast experience in the field of study. Further questionnaires were distributed among 90 Quantity Surveyors and semi-structured interviews were conducted with 7 experts having specialised knowledge and experience in Quantity Surveying, Time management, Human Resource Management and Project Planning.

The research findings acknowledged Quantity Surveyor's roles and duties in a typical organization followed by critical activities that consume more time among the other duties such as preparation of final accounts and agreements and procurement and coordination of stakeholders etc. while dominant causes were lack of experience in Quantity Surveying practices and type and requirements of clients. The survey findings also offered possible techniques to maximise time management such as effective team work and Key Performance Indicators (KPIs) and identified barriers that could arise in implementing them. MANOVA test was carried out with the aid of SPSS tool, which verified the influence of type of sector, type of organisation, country of practise and managerial position employed on each factor. Further NVIVO software package was used to produce cognitive map to visualise the overall picture of study. Ultimately the solutions that emerged from the research findings were used to formulate guidelines to assist Quantity Surveyors achieving tactful time management in professional career - the aim of this research.

Keywords: *Construction Industry; Quantity Surveyors; Tactful; Time Management; Sri Lanka.*

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SUITABILITY OF PACKAGE DEAL CONTRACTS FOR RESIDENTIAL BUILDING CONSTRUCTION

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ABSTRACT

Residential construction is becoming an increasingly important subdivision of construction industry, necessitating advanced procurement methods in order to accommodate changing requirements. Commonly, residential construction demand is met by the informal sector of construction industry. With the changing environments, a novel trend of package deal contracts is spreading in the context bringing in formalities to the residential construction projects. Package deal is a developed procurement method with unique characteristics. However, in selecting an appropriate procurement method for a specific housing construction project, proper understanding of characteristics of available procurement options are utmost of importance. Therefore, this research aimed to elucidate the suitability of package deal contracts for residential building construction, against time, cost and quality benefits.

Study identified 43 time, cost, and quality related expectations through a comprehensive literature survey, which residential construction clients would expect to be born of package deal contracts. The factors were ranked against industry experts' view and further, tested via a survey with a sample of clients with package deal and informal construction experience. Data were analysed for medians and standard deviations in to rank the factors considering the reliability. Consequently, experts appreciated time and cost benefits of package deal contracts over informal construction. Importantly, projects start quickly with known early commitments under package deal contracts. However, informal construction offers better quality with attractive finished products. Therefore, the package deal is suitable for the clients, who are concerned of time and cost benefits, while informal construction is suitable for the client's with prime concern of quality benefits.

Keywords: *Benefits; Informal Construction; Package Deal; Procurement; Residential Construction.*

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SUSTAINABLE CONSTRUCTION PRACTICES OF SRI LANKAN CONTRACTORS

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ABSTRACT

Construction industry is conversely depleting of natural resources. It impacts on the environment, economy and society, not only during a project's life cycle but also for coming generations. Adhering sustainable principles in construction industry brings the sustainable construction which ensures better quality of life for everyone. The contractor as a key player in the construction industry has to play an imperative role to promote sustainable construction by minimising their negative impact on the environment and society while maximising their economic contribution. Thus, this research intended to examine current sustainable construction practices and issues of contracting organisations to suggest a framework which can be used for the ultimate delivery of sustainable construction in Sri Lanka. Case study research approach was used to collect data among contracting organisations and eight semi-structured interviews were conducted. Four industry expert interviews were conducted to verify the gathered opinions and suggestions on enhancements of sustainable construction practices of contracting organisations. Cross-case analysis was used to analyse multiple cases using code based content analysis technique. Findings revealed that the organisations were at primary stage in sustainable construction practices, namely legal framework, standards, guidelines or policies, design, procurement, technologies, processes and innovations, organisational structure and people, education and training, measurements and reporting.

Keywords: *Construction Industry; Contracting Organisations; Sri Lanka; Sustainable Construction; Sustainable Practices.*

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SYNERGY BETWEEN LEAN AND VALUE ENGINEERING CONCEPTS: SRI LANKAN CONSTRUCTION INDUSTRY PERSPECTIVE

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ABSTRACT

The allied competitiveness and unpredictable nature of the construction industry forced to rethink on the performance enhancement tools in order to address the urgent matter of resource scarcity as a global dilemma. Hence, most of the construction firms highly concern about the customer's satisfaction by means of giving value for the client's money. The researchers established that Value Engineering (VE) and Lean concepts supersede all the other value achieving strategies since; both address the concept of Value in a greater extent. VE addresses the areas, which are not aligned with the methodological purview of Lean. In turn, Lean could enhance the effectiveness of VE efforts. Although there were some arguments on the above, there is lack of a research of investigating the synergy between Lean and VE concepts with related to the construction sector. Hence, this study investigates the synergy between Lean and VE concepts in order to explore the best value for client.

Accordingly, a qualitative research approach was followed to attain the research aim. A comprehensive literature review followed by expert opinion surveys were used to investigate the synergy between the concepts. The information gathered was subsequently subjected to a content analysis. This study revealed that, there is a synergy among customer value principle, pre study, information and presentation phases, value stream principle with functional analysis and presentation phases, flow principle with creativity, evaluation, development and presentation phases, pull principle with functional analysis, presentation and post study phases, perfection principle with presentation and post study phases. The findings would be very much effective for advanced value achieving strategy development purpose, which achieve the best value for the client in the extremity.

Keywords: *Value for Client; Synergy; Construction Industry; Lean; Value Engineering.*

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THE ADOPTION OF INTEGRATED PROJECT DELIVERY IN PUBLIC SECTOR PROJECTS IN NEW ZEALAND: THE WAY FORWARD

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ABSTRACT

The construction industry in New Zealand is responsible for around 40% natural resources, 30% energy consumption, and 30% greenhouse gases. The increased costs in natural resources, and energy, together with environmental concerns have pushed the demand for green buildings. Integrated Project Delivery (IPD) process has emerged as an enabler for green buildings. Successful IPD combines the partnering concept and lean thinking, it addresses the participant's expectations, cuts costs, eliminates waste, reduces variability and generates value for all the participants. Yet many public sectors owners do not have the authority to adopt features of IPD. However, owners can benefit from the IPD philosophy and features to take advantage of some key benefits. The purpose of paper is to examine the IPD tools and techniques appropriate for public sector organizations in New Zealand and to examine the barriers that public sectors organizations face in New Zealand while adopting those IPD features. A pilot study was conducted to examine these issues, semi structured interview were carried out with four public sector construction industry specialists. The interviews revealed that there is a gap between current and best practice in the New Zealand construction industry that is impacting on the adoption of IPD or IPD approaches. To improve the delivery of public sector projects a checklist of specific IPD tools and techniques appropriate for NZ public sector projects has been developed.

Keywords: *Integrated Project Delivery; IPD; Public Sector, Construction Industry.*

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THE LOOPHOLES OF EVACUATION PROCESS IN THE SRI LANKAN HEALTHCARE SECTOR

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ABSTRACT

Healthcare facilities are traditionally seen as places of sanctuary and safety by the general public. The fire hazard is one of the challenges faced by any healthcare organization. Therefore, in order to save lives and reduce injuries, well-designed evacuation process is significant. Thus, this research investigates the loopholes of the evacuation process in the Sri Lankan healthcare sector which, would be helped to improve the evacuation process in hospital buildings in Sri Lanka near future. The research study was initiated with a comprehensive literature review and subsequently adopted a qualitative research approach to investigate the research phenomena. Semi-structured interviews were conducted with fire safety professionals to investigate the requirements and parameters of the evacuation process and the loopholes of fire evacuation process in Sri Lankan healthcare sector. The collected data was analysed through content analysis by manual. The research findings revealed that the fire safety door, evacuation assembly point, compartmentation, fire detection and alarm system and closings of high risk rooms' doors are engaged with some loopholes which need to be improved. Loopholes contributing to evacuation process are; inadequate space in assembly points, lack of inspection by fire wardens etc. The research therefore suggests that regular maintenance, involvement of space planner from the initial construction stage, conducting training programs to staffs including managerial level, would help to improve the existing evacuation process in the Sri Lankan healthcare sector.

Keywords: *Healthcare Sector; Evacuation; Loopholes Fire Safety.*

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TOWARDS FACILITIES INFORMATION MANAGEMENT THROUGH BIM

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ABSTRACT

Information plays a significant role in managing built environment facilities. These information are generated at different life cycle stages, by different parties, which also provide different values to a variety of stakeholders. The acquisition of appropriate information efficiently and effectively is two of highly important considerations in facilities management because of the nature of information flows, number of information providers and users. Building Information Modelling (BIM) is one of the popular mechanisms, which has adopted in construction sector to manage its information. This preliminary paper investigates how construction information is valued in facilities management. This is an initial step of understanding the possibilities and hindrance of using BIM as an effective vehicle to manage information during the facilities management stage.

To achieve this aim, data were collected through literature review and 13 semi-structured interviews among construction professionals. Data were analysed thematically. The literature reveals BIM is an efficient mechanism to manage construction information. However, there is a difficulty of transferring appropriate information from construction stage to facility management. The study further identified the types of construction information that are highly usable for completing FM tasks, their uses and value attached to them.

Keywords: *Building Information Modelling; Construction Information; Facilities Management; Information Flows; Information Value.*

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USE OF PROVISIONAL SUMS IN THE UAE CONSTRUCTION INDUSTRY: AN EMPIRICAL STUDY

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ABSTRACT

Provisional sums are widely used in the FIDIC (Red Book) forms of contract in the UAE construction industry. The practices on dealing with provisional sums have exposed the contracting parties to a number of risks. Therefore, this research aimed at identifying such risks and mitigation measures to limit such risks in using provisional sums in the UAE. The research started with a comprehensive literature review followed by a questionnaire survey among the UAE construction industry professionals. Based on the survey findings, six semi-structured interviews were conducted with expertise in the construction industry to verify the survey findings and close any gaps in the data. The study found that provisional sums are mainly used in the FIDIC (Red Book) forms of contract in the UAE for special works, contingencies, the works which can be only defined in the site, facilitating the appointment of nominated subcontractors and overlapping design and construction. The most common risks of using provisional sums are related to claims, variations and conflicts among the contracting parties. Defining the scope of provisional sums before tendering, incorporating the provisional sums into the project programme and limit the value of provisional sums in the contract are suggested as the key measures to minimize the risk of provisional measures.

Keywords: *Provisional Sum Uses; Advantages; Risks; Mitigation Measures; FIDIC; UAE.*

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USING SAFETY CLIMATE AS A TOOL FOR IMPROVEMENT OF SAFETY PERFORMANCE IN CONSTRUCTION ORGANIZATIONS

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ABSTRACT

Data from a number of industrialized countries show that construction workers are 3 to 4 times more likely than other workers to die from accidents at work. In the developing world, the risks associated with construction work may be 3 to 6 times greater. Construction is one of the world's biggest industrial sectors, including the building, civil engineering, demolition and maintenance industries, and in Oman it accounts for approximately 10% of the total GDP. Statistics indicate that a total of 723,243 residents including 91% foreigners were working in 100,000 construction organizations in 2014 and was having second larger rate of occupational injuries after manufacturing industry with an estimated cost of 3,700,000 US\$ per year. Construction workers are exposed to a wide variety of hazards on the job, including dusts and vapours, asbestos, awkward working positions, heavy loads, adverse weather conditions, work at heights, noise, vibration from tools, and therefore more closer to occupational accidents. In recent years the awareness of the importance for safety performance of organizational, managerial and social factors, has increased. Safety climate is an aspect of organizational climate, and offers a route for safety management, complementing the often predominant engineering approach. Safety climate investigations are more sensitive and proactive bases for developing safety, rather than reactive information from accident rates and accident and incident reports. Based on a thorough literature review, relevant safety climate dimensions including (1) management safety priority, commitment and competence; (2) management safety empowerment; (3) management safety justice; (4) workers' safety commitment; (5) workers' safety priority and risk non-acceptance; (6) safety communication, learning, and trust in co-workers' safety competence; and (7) workers' trust in the efficacy of safety systems, are identified and discussed. This paper further describes how construction organizations in Oman can improve their safety performance by using and assessing leading safety climate dimensions/ factors among their workers.

Keywords: *Construction Safety, Safety Climate Dimensions, Safety Performance, Construction Organisations, UAE*

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WIN-WIN SETTLEMENT: APPLICABILITY OF NEGOTIATION PRINCIPLES FOR DISPUTE NEGOTIATIONS IN CONSTRUCTION PROJECTS

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ABSTRACT

Effective resolution of dispute is always helpful for sustainable construction practices. However, it is experienced that parties continuously failing to reach settlements in an effective and efficient manner. Although many researches write on how to carryout negotiations successfully those concepts hardly adopted in construction dispute negotiations. Construction dispute negotiations are different to other business negotiations due to some unique features inherited such as complexity, regulated by contract, and tendency of discouraging claims. Therefore, it is identified new theories need to be developed and applied in construction dispute negotiations. Thus, the study was focused on improvement of fundamental principles of negotiation to address characteristics of construction projects.

The study was approached through a multiple case study and in-depth study was carried out on two selected cases which claims based dispute negotiation successfully concluded. Success factors of claims based dispute negotiation identified through literature review compared with actual setting of selected cases. Further, it was identified how parties have addressed special characteristics of claims based disputes in construction projects when conducting negotiations.

Analysis reveals that, how far theory can be explained through research findings and which theory should be extended based on knowledge explored. Accordingly conceptual framework had been developed and it is concluded that the negotiation process shall be merged with characteristics of construction disputes in order to achieve win-win settlement through negotiation. Major deviation from existing theory when applying to claims based dispute negotiation in a road project is negotiation shall be based on both position and interest of the parties.

Keywords: *Claims; Dispute Resolution; Negotiation; Win-win Settlement; Road Projects.*

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