THE 4TH WORLD CONSTRUCTION SYMPOSIUM - 2015

12th – 14th JUNE 2015

GALADARI HOTEL COLOMBO

SUSTAINABLE DEVELOPMENT IN THE BUILT ENVIRONMENT: GREEN GROWTH & INNOVATIVE DIRECTIONS

Sustainable Development in the Built Environment: Green Growth and Innovative Directions
12-14 June 2015 - Colombo

Programme & Abstracts

Organized by

CEYLON INSTITUTE OF BUILDERS (CIOB) SRI LANKA
DEPARTMENT OF BUILDING ECONOMICS, UNIVERSITY OF MORATUWA

Sponsered by

INTERNATIONAL COUNCIL FOR RESEARCH AND INNOVATION IN BUILDING AND CONSTRUCTION (CIB)

ORGANISERS SPONSOR ASSOCIATE PARTNERS

Silver Sponsors

Partners

Official Banker

Bronze Sponsor

Media Sponsor

Convention Partners

THE 4TH WORLD CONSTRUCTION SYMPOSIUM 2015

SUSTAINABLE DEVELOPMENT IN THE BUILT ENVIRONMENT: GREEN GROWTH & INNOVATIVE DIRECTIONS

12 - 14 June 2015

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 Innovation in Construction and Infrastructure Development (CICID)
The University of Hong Kong,
Indian Institute of Technology Madras (IIT Madras),
CIB -TG 72 (Public Private Partnership),
CIB - W092 (Procurement Systems),
Colombo School of Construction Technology (CSCT)

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

ISSN: 2362-0935

Published by:
Ceylon Institute of Builders (CIOB),
4 - 1/2, Bambalapitiya Drive,
Colombo 04,
Sri Lanka.
Tel : 0094-11-2508139
Fax : 0094-11-2508139
Email : info@ciob.lk; ciob.2015@yahoo.com
Web : http://2015.ciobwcs.com/

CONTENTS

Messages

Keynote Speaker

Organising Committee

Scientific Committee

Symposium Information

Symposium Programme

Symposium Session Plan At-A-Glance

Detailed Session Plan

Paper Abstracts

Acknowledgements

Sponsors, Partners and Advertisers

MESSAGES

Prof. Chitra Weddikkara

Chairperson
The 4th World Construction Symposium 2015

It is a pleasure to welcome you to the 4th World Construction Symposium 2015 on **"Sustainable Development in the Built Environment: Green Growth and Innovative Directions"** in wonder of Asia, our wonderful city of Colombo.

The First World Construction Symposium on "Global Challenges in Construction Industry" in year 2012, organized by the CIOB emphasized the importance of resolving construction management problems through highlighting the definition of sustainability and describing sustainable development as the fulfillment of human needs from simultaneous socio-economic and technological progress and conservation of natural resources. The Second World Construction Symposium on "Socio Economic Sustainability in Construction: Practice, Policy & Research" served 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 on "Sustainability and Development in Built Environment: The Way Forward" deliberated the future trends and directions of the Sustainable Construction from the developing country perspective.

I believe that the theme of the 4th World Construction Symposium is timely and pertinent as the builders and construction industry practitioners now need to look beyond their perceived limits and raise their awareness on sustainable development in built environment. I am sure that all participants around the world will look forward to discuss their different viewpoints on sustainability practices in 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, 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 enjoyable and valuable, and also enjoy the architectural, cultural and natural beauty of Sri Lanka, the Pearl of the Indian Ocean.

Dr. Rohan Karunaratne

President
The Ceylon Institute of Builders (CIOB)

The Ceylon Institute of Builders (CIOB) is pleased to organise the Fourth (4th) World Construction Symposium 2015 on the theme; 'Sustainable Development in the Built Environment: Green Growth & Innovative Directions', together with the CIB Netherlands and the University of Moratuwa, Sri Lanka. The CIOB with its roots in the year 1961 has a solid history of acting as the professional body in the building and construction industry in the island. Hence, we are honoured to be part of this symposium that would help industry stakeholders develop an understanding of challenges faced by the global industry, while having an opportunity to expand their international network.

Invitations for the symposium have been extended to professional and academic participants from over 30 countries, thereby bringing in various inputs from across the globe. Companies developing technologies to circumvent or meet these issues are expected to provide new insights. And leading academics and students have been invited to enlighten the audience on recent scientific findings. Therefore, I strongly believe that our invitees would find the symposium to be of great significance.
I would also like to take this opportunity to mention 'Construction Expo 2015', which will be held in parallel to the Symposium at the BMICH, Colombo also for the 4th consecutive year. It would be the, largest international construction event to be held in Sri Lanka. I invite companies which are interested in adopting new technologies and innovations to visit Construction Expo 2015.

I take this opportunity to thank the ministries and professional institutions who have helped us in organising the Fourth World Construction Symposium 2015. I am much grateful to CIB Netherlands and the BEMRU, Department of Building Economics, University of Moratuwa for being an integral part of the organising team. I am also grateful to all our sponsors, partners and well wishers for making this Symposium a grand success.

Eng. Saliya Kaluarachchi

Hon. Secretary
The Ceylon Institute of Builders (CIOB)

It is indeed a privilege to be part of the organising committee of an international symposium that would stand as a milestone for most of its participant countries, including host country Sri Lanka. The symposium will bring together professionals and academics from around the world to discuss and present papers on issues that we all in the global construction industry have come to find as challenges.

I should first extend my sincerest appreciation to the International Council for Research and Innovation in Building and Construction (CIB), the global body that stands for the development of the industry, for their solid guidance in organising this event. I also thank all other partner organizations which have come forward to make this year's Symposium a success.

I would like to express my gratitude to the Building Economics and Management Research Unit (BEMRU), the research arm of the Department of Building Economics at the University of Moratuwa, Sri Lanka for their unwavering support. Their valued academic input will strengthen the local input of symposium, and I hope that its participants too will gain from the knowledge transfer.

I would also like to thank Ministry of Housing and Samurdhi, Ministry of Urban Development, Water Supply & Drainage and various Government agencies that supported this Conference from the planning stage. My thanks also goes out to other national bodies such as Institute of Engineers of Sri Lanka, Chamber of Construction Industries Sri Lanka, Institute of Quantity Surveyors Sri Lanka and other construction related Professional bodies for helping us in promoting the Conference within their respective memberships, Finally, I am also thankful to the management of BMICH and the management of Galadari Hotel for the logistical assistance provided.

.

Mr. Kalana Alwis
Mr. Sagara Gunawardena

Co-Chairmen
The 4th World Construction Symposium

We warmly welcome all delegates to the 4th (Fourth) World Construction Symposium and International Construction Expo 2015 at the Galadari Hotel and BMICH respectively during the period of 12th to 14th June 2015. This is an exciting venture jointly organized 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.

Sri Lanka, after emerging from a period of brutal terrorism for over three decades was able to achieve many economic milestones surpassing many other countries in the region. Today, our nation is breathing with peace, harmony and marching forward with a fast tracked sustainable development program focusing on infrastructure development. The Sri Lankan National economy has started to boom with this rapid development taking place all over the country. The construction industry has shown considerable growth in all sectors concerned.

The Fourth World Construction Symposium 2015 will be a platform for both Local and International delegates to share and exchange practice, policy and research initiatives on various issues related to sustainable development in the built environment. This would further enable to carry back experiences of sharing new skills, technologies and lessons learnt from the current development projects and opportunities in Sri Lanka.

.

Dr. Yasangika Sandanayake

Head of the Department
Department of Building Economics
University of Moratuwa

It is with great pleasure that I write this message to extend my warm wishes for the 4th World Construction Symposium and International Construction Expo 2015 at Galadari Hotel and BMICH respectively during the period of 12 June to 14 June 2015. 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 fourth consecutive year. Liverpool John Moores University, Centre for Infrastructure and Construction Industry Development (CICID), The University of Hong Kong, Indian Institute of Technology Madras, CIB W092 (Procurement Systems), CIB TG72 (Public Private Partnership) and Colombo School of Construction Technology are the associate partners of the Symposium.

Sri Lanka has shown a rapid economic expansion during the past few years, after the end of 30 years old conflict. The construction industry has also shown a significant growth in all its sectors surpassing many other countries in the region. Today, Sri Lankan construction industry plays an indispensable role in providing the infrastructure facilities while focusing on sustainability, which are fundamental to the country's development.

The 4th World Construction Symposium 2015 provides a platform for both local and international delegates to share their knowledge and ideas with regard to the sustainable initiatives and development around the globe. I hope all delegates would take this opportunity to share their knowledge, ideas and views on sustainable development, initiative directions and green growth.

I wish the 4th World Construction Symposium 2015 and Construction EXPO 2015 every success.

KEYNOTE SPEAKER

Prof. Ananda Kithsiri Wijenayaka Jayawardane

BSc Eng Hons (Moratuwa), MSc (Loughborough, UK),
PhD (Loughborough, UK), MSSE(SL), FNASSL, FIPM(SL),
CEng, FIE(SL), Int.PEng (SL)

Prof. Ananda Jayawardane is currently the Vice-Chancellor of the University of Moratuwa. He obtained BSc Engineering degree in Civil Engineering with first class honours from the University of Moratuwa in December 1983, a Master of Science Degree in Construction from the Loughborough University of Technology in the UK in 1986 and PhD in Construction Management in January 1990 from the same university.

He is a Chartered Engineer, International Professional Engineer, a Fellow of the Institution of Engineers, Sri Lanka, a Fellow of the Institute of Project Managers, Sri Lanka, a Fellow of the National Academy of Sciences of Sri Lanka and a Member of the Society of Structural Engineers Sri Lanka. He is also a Senior Professor in Civil Engineering, immediate past NDB Bank Endowed Professor in Entrepreneurship at the University of Moratuwa and a Past President of the Institution of Engineers, Sri Lanka. He has served as the first Head of Department of Management of Technology, Head, Department of Civil Engineering and the immediate past Dean of the Faculty of Engineering, University of Moratuwa.

He served as a member of the governing Councils/Boards of National Institute of Education, Institute for Construction Training and Development, State Engineering Corporation, Post-graduate Institute of Management National Science Foundation, Academy of Financial Studies (Miloda). Currently, he is a member of the Board of Management of the Sir Arthur C Clarke Institute for Modern Technologies, Open University of Sri Lanka, Construction Industry Development Authority and a non-executive Board Member of Commercial Bank and Sierra Cables PLC.

He has co-authored a textbook on “Construction Productivity Management” published by Addison Welsley Longman, UK, contributed to three other textbooks and has published and presented over 75 research papers both locally and internationally and has received several awards for his research publications including thrice the IESL Award for the best paper published in the Engineer Journal and National Achiever’s Award - 2013 under the category of Engineering awarded by Lions Clubs International –District 306A1 and IESL President’s Award – 2012. He is also a Commonwealth Scholar and a Fellow.

ORGANISING COMMITTEE

Chairperson	Prof. Chitra Weddikkara
Co-Chairs	Mr. Sagara Gunawardena Mr. Kalana Alwis
Advisors	Dr. Rohan Karunaratne Eng. Saliya Kaluarachchi Dr. Yasangika Sandanayake
Organising Committee	Mr. Ruwan de Silva Eng. Jayakish Thudawe Eng. Ashoka Randeni Mr. Mahanama Jayamanne Eng. Walter Perera
Scientific Committee Chairs	Dr. Yasangika Sandanayake Dr. Nirodha Fernando Dr. Gayani Karunasena
Symposium Secretariat	Ms. Piumi Dissanayake Ms. Mathusha Francis Ms. Ruchini Jayasinghe Ms. Nishadi Anuruddika Ms. Dimuthu Vijerathna Ms. Nipuni Sumanarathne Ms. Kaushalya Weththasinghe Mr. Rohana Balasuriya Ms. Malathi Piyasena
Symposium Event Director	Mr. Samantha Abeywickrama

SCIENTIFIC COMMITTEE

Chairs

Dr. Yasangika Sandanayake	*University of Moratuwa, Sri Lanka*
Dr. Nirodha Fernando	*University of Moratuwa, Sri Lanka*
Dr. Gayani Karunasena	*University of Moratuwa, Sri Lanka*

Members

Associate Professor Umberto Berardi	*Ryerson University, Canada*
Prof. Peter Brandon	*University of Salford, United Kingdom*
Dr. Daniel W.M. Chan	*The Hong Kong Polytechnic University, Hong Kong*
Prof. Edwin H. W. Chan	*The Hong Kong Polytechnic University, Hong Kong*
Dr. K.A.K. Devapriya	*University of Moratuwa, Sri Lanka*
Prof. Rohinton Emmanuel	*Glasgow Caledonian University, Scotland*
Dr. Hwang Bon-Gang	*National University of Singapore, Singapore*
Dr. Sachie Gunathilake	*University of Moratuwa, Sri Lanka*
Ch.QS. Suranga Jayasena	*University of Moratuwa, Sri Lanka*
Prof. Mohan Kumaraswamy	*University of Hong Kong, Hong Kong*
Prof. Florence Y.Y. Ling	*National University of Singapore, Singapore*
Dr. Anupa Manewa	*Liverpool John Moores University, United Kingdom*
Dr. Wei PAN	*University of Hong Kong, Hong Kong*
Dr. Primali Paranagama	*University of Lincoin, United Kingdom*
Dr. Thanuja Ramachandra	*University of Moratuwa, Sri Lanka*
Ch. QS. Kanchana Perera	*University of Moratuwa, Sri Lanka*
Prof. Srinath Perera	*University of Northumbria, United Kingdom*
Dr. Raj Prasanna	*Massey University, New Zealand*

Dr. Motiar Rahman	*Institut Teknologi Brunei, Brunei*
Dr. Andrew Ross	*Liverpool John Moores University, United Kingdom*
Dr. James Rotimi	*Auckland University of Technology, New Zealand*
Prof. Steve Rowlinson	*The University of Hong Kong, Hong Kong*
Dr. Sepani Senaratne	*University of Western Sydney, Australia*
Ch.QS. Indunil Seneviratne	*University of Moratuwa, Sri Lanka*
Prof. Alfredo Serpell	*Catholic University of Chile, Chile*
Prof. Lalith de Silva	*University of Moratuwa, Sri Lanka*
Dr. Nayanathara de Silva	*University of Moratuwa, Sri Lanka*
Dr. Mohan Siriwardena	*University of Robert Gordon, United Kingdom*
Prof. Koshy Varghese	*Indian Institute of Technology, Madras, India*
Dr. Gamini Weerasinghe	*University of Moratuwa, Sri Lanka*
Dr. Janaka Wijesundara	*University of Moratuwa, Sri Lanka*
Mr. Mahesh Abeynayake	*University of Moratuwa, Sri Lanka*

SYMPOSIUM INFORMATION

International Construction EXPO

The International Construction EXPO inauguration is on 12 June 2015 from 09.30 am to 12.00 noon at the Bandaranaike Memorial International Conference Hall (BMICH), Bauddhaloka 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 4th World Construction Symposium

The Symposium is on 12 June 2015 from 01.30 pm to 06.30 pm and on 13 June 2015 from 09.00 am to 05.30 pm at the Galadari Hotel, Lotus Road, Colombo 01.

Symposium Secretariat

Ceylon Institute of Builders (CIOB), 4-1/2, Bambalapitiya Drive, Colombo 04, Sri Lanka
Tel : 0094-11-2508139 (Samantha) or +94773865250 (Piumi)
Fax : 0094-11-2508139
Email : ciob.2015@yahoo.com
Website : http://2015.ciobwcs.com

Language

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

Dress Code

Symposium - Business, Lounge or National
Dinner - 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 11.00 am to 06.00 pm on 12 June 2015 and from 8.30 am to 6.30 pm on 13 June 2015.

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 07:00 pm on 12 – 13 June 2015.

Awards

Following awards will be presented to the winners during the symposium cultural dinner on 13 June 2015. Award winners will be announced during the symposium sum-up.

Emerald BEPAM Journal Best Paper Award
Emerald BEPAM Journal Highly Commended Paper Award
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 14 June 2015 starts from Galadari Hotel at 08.00 am and expected to be returned to the hotel at 09.00pm. The excursion includes bus tour, morning tea, lunch, evening tea, guiding and visiting attraction. This offers only to foreign delegates with prior reservation. Please assemble at the hotel lobby at 08.00am.

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, 12 June 2015

International Construction EXPO 2015 at BMICH

09.30 am	**Opening Ceremony**

The 4th World Construction Symposium 2015 at Galadari Hotel – First Day

12.00 noon	**Symposium Registration**
12.30 pm	**Lunch**
01.30 pm	**Symposium Inauguration**
01.35 pm	Welcome Address by Symposium Chairperson **Prof. Chitra Weddikkara**
01.40 pm	Address by President, CIOB **Dr. Rohan Karunarathne**
01.45 pm	Address by representative from University of Moratuwa **Prof. Lalith de Silva**
01.50 pm	Address by representative from Associate Partners **Dr. Andrew Ross**
02.00 pm	Address by the Guest of Honour
02.10 pm	Address by the Chief Guest
02.20 pm	Keynote Address by Vice Chancellor, University of Moratuwa **Prof. Ananda Jayawardena**
03.10 pm	Investor Forum - Address by BOI Chairman **Mr. Upul Jayasuriya**
03.30 pm	Investor Forum - Address by UDA Chairman **Mr. Ranjith Fernando**
03.50 pm	Vote of Thanks by Hon. Secretary, CIOB **Eng. Saliya Kaluarachchi**
03.55 pm	End of Symposium Inauguration
04.00 pm	Tea/Coffee Break
04.30 pm	**Parallel Sessions 1** *(There will be THREE parallel sessions)*

Saturday, 13 June 2015

The 4th World Construction Symposium 2015 – Second Day

09.00 am **Parallel Sessions 2**
(There will be THREE parallel sessions)

10.30 am Tea / Coffee Break

10.45 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 "Innovative Directions in Sustainable Construction"**

Panel Members
- Prof. Mohan Kumaraswamy
- Prof. K. N. Satyanarayana
- Prof. Priyan Dias
- Prof.Steve Rowlinson
- Dr. Andrew Ross

Panel Moderator
- Ch QS Lalith Rathnayake

04.30 pm **Industry Presentations**

04.50 pm Rapporteur's Report
Dr. Thanuja Ramachandra
Dr. Sachi Gunatilake

05.10pm Address by BEPAM Editor-in-Chief
Prof. Mohan Kumaraswamy

05.15 pm Address by Coordinators of CIB W092 & CIB TG72
Prof. Steve Rowlinson & Prof. Mohan Kumaraswamy

05.20 pm Announcing the Award Winners
Prof. Mohan Kumaraswamy & Dr. Yasangika Sandanayake

05.25 pm Vote of Thanks by Scientific Committee Co-Chairperson
Dr. Nirodha Fernando

05.30 pm End of Programme

Symposium Dinner

07.30 pm **Cultural Dinner**

Sunday, 14 June 2015

08.00 am Excursion

09.00 pm Return to Hotel

***Note**: Please refer symposium information for further details.*

SYMPOSIUM SESSION PLAN AT-A-GLANCE

Friday, 12 June 2015						Saturday, 13 June 2015					
08.00 - 09.00	Construction EXPO					Registration					
09.00 - 09.15						**Session 2A**	S8045	**Session 2B**	S8021	**Session 2C**	S8015
09.15 - 09.30							S8037		S8026		S8050
09.30 - 09.45							S8057		T8005		S8062
09.45 - 10.00							S8068		S8046		S8049
10.00 - 10.30						Q&A		Q&A		Q&A	
10.30 - 10.45						Tea / Coffee Break					
10.45- 11.00						**Session 3A**	S8028	**Session 3B**	S8002	**Session 3C**	S8029
11.00- 11.15							S8070		S8008		T8003
11.15 - 11.30							T8002		T8001		T8004
11.30 - 11.45							S8019		S8022		S8066
11.45 - 12.00									S8065		
12.00 - 12.30						Q&A		Q&A		Q&A	
12.30 - 13.30	Lunch										
13.30 - 13.45	Symposium Inauguration					**Session 4A**	S8030	**Session 4B**	S8036	**Session 4C**	S8010
13.45 - 14.00							S8032		S8039		S8043
14.00 - 14.15							S8067		S8061		S8053
14.15 - 14.30							S8020		S8051		S8017
14.30 -15.00						Q&A		Q&A		Q&A	
15.00 - 15.30						Tea / Coffee Break					
15.30 - 16.00						Panel Discussion					
16.00 - 16.30	Tea / Coffee Break										
16.30 - 16.45	**Session 1A**	S8069	**Session 1B**	S8059	**Session 1C**	S8042	Symposium Sum-Up				
16.45 - 17.00		S8024		S8035		S8052					
17.00 - 17.15		S8060		S8054		S8063					
17.15 - 17.30		S8055		S8056		S8064					
17.30 - 17.45		S8058		S8025		S8041					
17.45 - 18.00				S8027							
18.00 - 18.30	Q&A		Q&A		Q&A						
19.30 - 22.00						Cultural Dinner					

DETAILED SESSION PLAN

Friday, 12 June 2015

Session 1A

Theme	**Sustainable Materials and Technology**
Session Chair	Prof. Lalith de Silva
Venue/Time	Salon Orchid – 04.30 pm – 06.15 pm

Time	**Paper ID, Title and Author(s)**
04.30 – 04.45 pm	**S8069 - Supervision of Fabrication of Precast Steel Fibre Reinforced Concrete (SFRC) Segmental Lining** *George Varghees*
04.45 – 05.00 pm	**S8024 - Use of Locally Available Material to Develop a Treatment Technique to Reduce the Water Absorption Capacity of Recycled Aggregates** *W.K.A. Madawa, R.M.S.I.B. Rathnayake, D.B. Wijethunga,T.C. Gamage and S. Karunarathne*
05.00 – 05.15 pm	**S8060 - How to Design Durable Concrete Mix for Sustainability?** *Lu Jin Ping*
05.15 – 05.30 pm	**S8055 - A Study on Applicability of Bamboo Fibre Reinforced Mycelium Bonded Sawdust Material for Partition Wall** *O.D.P.C. Vithanage,S.R. Chandrathilake and R.U. Halwathura*
05.30 – 05.45 pm	**S8058 - Building Demolition Waste Management Practices – An Indian Case Study** *V. G. Ram and Satyanarayana Kalidindi*
05.45 – 06.15 pm	**Q&A**

Session Coordinator : Nilmini Weerasinghe

Friday, 12 June 2015

Session 1B

Theme	**Sustainable Built Environments and Green Buildings**
Session Chair	Prof. P.K.S. Mahanama
Venue/Time	Salon Jasmine – 04.00 pm – 06.30 pm

Time	Paper ID, Title and Author(s)
04.30 – 04.45 pm	**S8059 - Indoor Environmental Quality and Occupants' Productivity: Green Certified Office Buildings in Sri Lanka** *Harshini Mallawaarachchi, Lalith de Silva and R. Rameezedeen*
04.45 – 05.00 pm	**S8035 - A Framework for the Evaluation of Indoor Environmental Quality (IEQ) Performance in Apparel Industry Buildings in Sri Lanka** *M.G.D.T. Vijerathne and L.D. Indunil P. Seneviratne*
05.00 – 05.15 pm	**S8054 - Sustaining the Future with Legacy: A Case Study on the UK Government Carbon Emission Targets 2025 and London Olympics 2012** *G.A.G.R. Godawatte*
05.15 – 05.30 pm	**S8056 - Comparative Study of Water Efficiency in Green and Non – Green Buildings in Apparel Industry in Sri Lanka** *Sudeepa N. Silva, K.G.A.S Waidyasekara and D.M.P.P. Dissanayake*
05.30 – 05.45 pm	**S8025 - Water Efficiency Techniques and Strategies for Sustainable Use of Water during Construction Phase of Building Projects** *K.G.A.S. Waidyasekara, Lalith de Silva and R. Rameezdeen*
05.45 – 06.00 pm	**S8027 - Identifying the Success Factors and Failure Factors of Green Building Projects** *Vignesh Venkataraman and Jack C.P. Cheng*
06.00 – 06.30 pm	**Q&A**

Session Coordinator : Kaushalya Weththasinghe

Friday, 12 June 2015

Session 1C

Theme	**Human Resources in Construction**
Session Chair	Dr. Anupa Manewa
Venue/Time	VIP Lounge – 04.30 pm – 06.15 pm

Time	Paper ID, Title and Author(s)
04.30 – 04.45 pm	**S8042 - Framework to Improve Labour Productivity for Indian Building Projects** *Rahul Sahay, Ritesh Kumar Agarwal and Koshy Varghese*
04.45 – 05.00 pm	**S8052 - Team Working in Road Maintenance Functions for Sustainable Construction in Sri Lanka** *H.G.N. Premakanthi and Sepani Senaratne*
05.00 – 05.15 pm	**S8063 - An Investigation into Skilled Labour Requirement in Sri Lankan Building Construction Industry** *Nishadi Anuruddika and Y.G. Sandanayake*
05.15 – 05.30 pm	**S8064 - Strengthening the Safety Culture in Raw Rubber Processing Stage through Human Capacity Building: A Conceptual Framework** *D.M.P.P. Dissanayake and Nirodha Gayani Fernando*
05.30 – 05.45 pm	**S8041 - Training and Development Framework to Improve Employee Job Performance in Public Sector Banks in Sri Lanka** *M.L. Thilini Saubhagya Chandrasiri and Nirodha Gayani Fernando*
05.45 – 06.15 pm	**Q&A**

Session Coordinator : Mathusha Francis

Saturday, 13 June 2015

Session 2A

Theme	**Construction Cost Management**
Session Chair	Prof. K.N. Satyanarayana
Venue/Time	Salon Orchid – 09.00 am – 10.30 am

Time	**Paper ID, Title and Author(s)**
09.00 – 09.15 am	**S8045 - Comprehensive Study about Sri Lankan Contractors' Estimation Practice** *P.Ganeshu, P.A.P.V.D.S.Disaratna and M. Francis*
09.15 – 09.30 am	**S8037- Labour Productivity Norms for Aluminium System Formwork in Low-Cost Housing Construction Projects in Sri Lanka** *S.J.A.R.S. Jayasinghe and Nirodha Gayani Fernando*
09.30 – 09.45 am	**S8057 - Value Engineering Practices and its Impact to Construction Industry** *R.G. Kosala and Gayani Karunasena*
09.45 – 10.00 am	**S8068 - Payment Evaluation Method for Controlling Environmental Defilement in Road Construction Projects in Sri Lanka** *W.M.P.C. Walimuni, Lalith de Silva and Aparna Samaraweera*
10.00 – 10.30 am	**Q&A**

Session Coordinator : Chandanie Hadiwattege

Saturday, 13 June 2015

Session 2B

Theme	**Urban Planning and Development**
Session Chair	Dr. Gamini Weerasinghe
Venue/Time	Salon Jasmine – 09.00 am – 10.30 am

Time	**Paper ID, Title and Author(s)**
09.00 – 09.15 am	**S8021 - A System for Implementing Resettlement Housing Projects in the Northern Province of Sri Lanka** *Ahalya Luxman and B.A.K.S. Perera*
09.15 – 09.30 am	**S8026 - A Review of the Benefits and the Hindrances to the Sustainable Conservation of Heritage Buildings in Malaysia** *Dodo Mansir and Narimah Kasim*
09.30 – 09.45 am	**T8005 - Is 'Human Rights' the End or the Means of Sustainable Urbanization?** *Buddini Chatumaduri Dharmawardhana, Mahesh Devinda Abeynayake and Nazeer Fathima Sabrina Aashik*
09.45 – 10.00 am	**S8046 - Vacant Buildings in Infrastructure Projects: Strategies for Reuse** *Vaishali Anagal, Dharati Sote and Shamishtha Ruikar*
10.00 – 10.30 am	**Q&A**

Session Coordinator : Harshani Mallawaarachchi

Saturday, 13 June 2015

Session 2C

Theme	**Building Information Modelling**
Session Chair	Ch.QS. Indunil Seneviratna
Venue/Time	VIP Lounge – 09.00 am – 10.30 am

Time	Paper ID, Title and Author(s)
09.00 – 09.15 am	**S8015 - Re-examining Contractor's BIM Strategies: A Case Study** *Hongdi WANG, Leo Ke CHEN and Weisheng LU*
09.15 – 09.30 am	**S8050 - BIM as an Effective Information Management Tool for Achieving Key Performance Indicators in Construction Projects** *K.A.D.N.C. Wijekoon, Anupa Manewa, Andrew Ross and Dianne Marsh*
09.30 – 09.45 am	**S8062 - The Legal Framework for Design Liability in Building Information Modelling** *Thilina Laksiri Dissanayake, Himal Suranga Jayasena and Mahesh Abeynayake*
09.45 – 10.00 am	**S8049 - Partnering to Bridge the Gap Between Conventional and BIM Based Project Procurement** *K.A.R.V.D. Kahandawa and Himal Suranga Jayasena*
10.00 – 10.30 am	**Q&A**

Session Coordinator : Kaushalya Weththasinghe

Saturday, 13 June 2015

Session 3A

Theme	**Project Management**
Session Chair	Dr. Nayanthara De Silva
Venue/Time	Salon Orchid – 10.45 am – 12.15 pm

Time	Paper ID, Title and Author(s)
10.45 – 11.00 am	**S8028 - Assessing the Impact of Experienced Project Team Members in Green Building Projects** *Vignesh Venkataraman and Jack C.P. Cheng*
11.00 – 11.15 am	**S8070 - A Study on the Impacts of Schedule Compression Techniques on Construction Projects in Sri Lanka** *Jallini Theivendran and Sachie Gunatilake*
11.15 – 11.30 am	**T8002 - Dimensions of Sustainable Construction: The Perspectives of Construction Stakeholders** *Cheng Siew Goh and Steve Rowlinson*
11.30 – 11.45 am	**S8019 - A Guide for Performance Evaluation Process for Internationally Funded Community Development Projects in Sri Lanka** *Ruwani Perera and Gayani Karunasena*
11.45 – 12.15 pm	**Q&A**

Session Coordinator : Nishadi Anuruddika

Saturday, 13 June 2015

Session 3B

Theme	**Construction Procurement**
Session Chair	Prof. Mohan Kumaraswamy
Venue/Time	Salon Jasmine – 10.45 am – 12.30 pm

Time	Paper ID, Title and Author(s)
10.45 – 11.00 am	**S8002 - Conceptual Framework for Sustainable Public Procurement Process in Construction Industry** *K.A.P. Gunawardhane and Gayani Karunasena*
11.00 – 11.15 am	**S8008 - Strategies to Enhance Sustainability of Public Private Partnership Procurement Process for Infrastructure Development** *Nilesh Agarchand Patil and Boeing Laishram*
11.15 – 11.30 am	**T8001 - Study on Limitations in Material Procurement Practice for Construction in Public Sector** *Vajira Edirisinghe and Kavitha Kajendran*
11.30 – 11.45 am	**S8022 - Suitability of Government Bid Evaluation Procedure for Building Projects in Sri Lanka** *D.M.G.A.N.M. Sumanarathna and B.A.K.S. Perera*
11.45 – 12.00 am	**S8065 - Effect of Accuracy and Timeliness of Information on Performance of Contractors** *Jeyapalan Suventhiny and Himal Suranga Jayasena*
12.00 – 12.30 pm	**Q&A**

Session Coordinator : Dimuthu Vijerathne

Saturday, 13 June 2015

Session 3C

Theme	**Law in Construction Industry**
Session Chair	Prof. Asanga Gunawansa
Venue/Time	VIP Lounge – 10.45 am – 12.15 pm

Time	**Paper ID, Title and Author(s)**
10.45 – 11.00 am	**S8029 - Mitigating Claims through Conflict Avoidance in Construction Industry** *H.D. Sendanayake, P.A.P.V.D.S. Disaratna and and M. Francis*
11.00 – 11.15 am	**T8003 - Dispute Adjudication Board as an ADR Method in the Construction Industry of Sri Lanka** *Mahesh Abeynayake*
11.15 – 11.30 am	**T8004 - Comparative Analysis of Adjudication and Arbitration Methods in Sri Lankan Construction** *Mahesh Abeynayake and Buddini Chatumaduri Dharmawardhana*
11.30 – 11.45 am	**S8066 - Feasibility of the Delay and Disruption Protocol for Claims Management in Sri Lankan Construction Industry** *R.A.N.M. Pathirana and L.D. Indunil P. Seneviratne*
11.45 – 12.15 pm	**Q&A**

Session Coordinator : Harshani Mallawaarachchi

Saturday, 13 June 2015

Session 4A

Theme	**Cost Controlling and Variation Management**
Session Chair	Dr. Andrew Ross
Venue/Time	Salon Orchid – 01.30 pm – 03.00 pm

Time	**Paper ID, Title and Author(s)**
01.30 – 01.45 pm	**S8030 - Applicability of ICTAD Price Fluctuation Formula for Government Funded Intelligent Building Projects** *S.C. Jayaweera, B.A.K.S. Perera and S.J.A.R.S. Jayasinghe*
01.45 – 02.00 pm	**S8032- Minimising Variations in Lump Sum Contracts** *N.H.A. Sampath, P.A.P.V.D.S. Disaratna and M. Francis*
02.00 – 02.15 pm	**S8067- Issues in Submission and Certification of Variations** *Thuritha M. Karunathilake, L.D. Indunil P. Seneviratne and Kaushalya Weththasinghe*
02.15 – 02.30 pm	**S8020 - Suitability of Criteria for Selecting a Delay Analysis Technique Suitable to Analyse Delays in Road Construction Projects in Sri Lanka** *E.M.K. Ekanayake and B.A.K.S. Perera*
02.30 – 03.00 pm	**Q&A**

Session Coordinator : Piumi Dissanayake

Saturday, 13 June 2015

Session 4B

Theme	**Facilities Management**
Session Chair	Ch. QS. Suranga Jayasena
Venue/Time	Salon Jasmine – 01.30 pm – 03.00 pm

Time	Paper ID, Title and Author(s)
01.30 – 01.45 pm	**S8036 - Framework for Ensuring Effectiveness of Maintenance in Building Services** *D.P.S.D. Jayasinghe, P.A.P.V.D.S. Disaratna and R.P.N.P. Weerasinghe*
01.45 – 02.00 pm	**S8039 - Role of Technology in Providing Better Basic Facilities for Condominium properties** *M.D.O.M. Jayarathne and H. Chandanie*
02.00 – 02.15 pm	**S8061 - Development of a Customer Satisfaction Assessment Model for the Immigration and Emigration Service in Sri Lanka** *H.W.N. Madhusanka and Nayanthara De Silva*
02.15 – 02.30 pm	**S8051 - Knowledge Management Strategies for Sustainable Facilities Management in Sri Lanka** *Sepani Senaratne, N.S.D Abeysinghe and A.K Andaraweera*
02.30 – 03.00 pm	**Q&A**

Session Coordinator : Dimuthu Vijerathne

Saturday, 13 June 2015

Session 4C

Theme	**Sustainable Construction Practices**
Session Chair	Ch. QS. Kanchana Perera
Venue/Time	VIP Lounge – 01.30 pm – 03.00 pm

Time	**Paper ID, Title and Author(s)**
01.30 – 01.45 pm	**S8010 - A Conceptual Lean-Based Framework for Improving the Environmental Performance of Ready-Mixed Concrete** Production Processes *Anna George Nellickal, Andukuri Vijaya Rajendra and Sivakumar Palaniappan*
01.45 – 02.00 pm	**S8043- Barriers to the Implementation of Concurrent Engineering Practices within the UK Construction Industry** *Anupa Manewa, Mohan Siriwardena and Andrew Ross*
02.00 – 02.15 pm	**S8053 - Application of Lean Construction Principles and Practices to Enhance the Construction Performance and Flow** *Upeksha Hansini Madanayake*
02.15 – 02.30 pm	**S8017 - Construction and Demolition Waste Recycling: The Case of Construction Waste Management (COWAM) Project** *I.G.T. Samarasingha and Gayani Karunasena*
02.30 – 03.00 pm	**Q&A**

Session Coordinator : Nipuni Sumanarathne

Abstracts of the Proceedings

The 4th World Construction Symposium 2015

Theme:

Sustainable Development in Built Environment:

Green Growth & Innovative Directions

Edited by:

Dr. Y. G. Sandanayake

Dr. N. G. Fernando

Dr. G. I. Karunasena

Building Economics and Management Research Unit (BEMRU)

Department of Building Economics

University of Moratuwa

CONTENTS OF ABSTRACTS

A Conceptual Lean-Based Framework for Improving the Environmental Performance of Ready-Mixed Concrete Production Processes 1
Anna George Nellickal, Andukuri Vijaya Rajendra and Sivakumar Palaniappan

A Framework for the Evaluation of Indoor Environmental Quality (IEQ) Performance in Apparel Industry Buildings in Sri Lanka 2
M.G.D.T. Vijerathne and L.D. Indunil P. Seneviratne

A Guide for Performance Evaluation Process for Internationally Funded Community Development Projects in Sri Lanka 3
Ruwani Perera and Gayani Karunasena

A Review of the Benefits and the Hindrances to the Sustainable Conservation of Heritage Buildings in Malaysia 4
Dodo Mansir and Narimah Kasim

A Study on Applicability of Bamboo Fibre Reinforced Mycelium Bonded Sawdust Material for Partition Wall 5
O.D.P.C. Vithanage,S.R. Chandrathilake and R.U. Halwathura

A Study on Limitations in Material Procurement Practice for Construction in Public Sector 6
Vajira Edirisinghe and Kavitha Kajendran

A Study on the Impacts of Schedule Compression Techniques on Construction Projects in Sri Lanka 7
Jallini Theivendran and Sachie Gunatilake

A System for Implementing Resettlement Housing Projects in the Northern Province of Sri Lanka 8
Ahalya Luxman and B.A.K.S. Perera

An Investigation into Skilled Labour Requirement in Sri Lankan Building Construction Industry 9
Nishadi Anuruddika and Y.G. Sandanayake

Applicability of ICTAD Price Fluctuation Formula for Government Funded Intelligent Building Projects 10
S.C. Jayaweera, B.A.K.S. Perera and S.J.A.R.S. Jayasinghe

Application of Lean Construction Principles and Practices to Enhance the Construction Performance and Flow 11
Upeksha Hansini Madanayake

Assessing the Impact of Experienced Project Team Members in Green Building Projects 12
Vignesh Venkataraman and Jack C.P. Cheng

Barriers to the Implementation of Concurrent Engineering Practices within the UK Construction Industry 13
Anupa Manewa, Mohan Siriwardena and Andrew Ross

BIM as an Effective Information Management Tool for Achieving Key Performance Indicators in Construction Projects 14
K.A.D.N.C. Wijekoon, Anupa Manewa, Andrew Ross and Dianne Marsh

Building Demolition Waste Management Practices – An Indian Case Study 15
V. G. Ram and Satyanarayana Kalidindi

Comparative Analysis of Adjudication and Arbitration Methods in Sri Lankan Construction 16
Mahesh Abeynayake and Buddini Chatumaduri Dharmawardhana

Comparative Study of Water Efficiency in Green and Non – Green Buildings in Apparel Industry in Sri Lanka 17
Sudeepa N. Silva, K.G.A.S Waidyasekara and D.M.P.P. Dissanayake

Comprehensive Study about Sri Lankan Contractors' Estimation Practice 18
P.Ganeshu, P.A.P.V.D.S.Disaratna and M. Francis

Conceptual Framework for Sustainable Public Procurement Process in Construction Industry 19
K.A.P. Gunawardhane and Gayani Karunasena

Construction and Demolition Waste Recycling: The Case of Construction Waste Management (COWAM) Project 20
I.G.T. Samarasingha and Gayani Karunasena

Development of a Customer Satisfaction Assessment Model for the Immigration and Emigration Service in Sri Lanka 21
H.W.N. Madhusanka and Nayanthara De Silva

Dimensions of Sustainable Construction: The Perspectives of Construction Stakeholders 22
Cheng Siew Goh and Steve Rowlinson

Dispute Adjudication Board as an ADR Method in the Construction Industry of Sri Lanka 23
Mahesh Abeynayake

Effect of Accuracy and Timeliness of Information on Performance of Contractors 24
Jeyapalan Suventhiny and Himal Suranga Jayasena

Effective Leadership Behaviours in Construction Safety Practices 25
Zakari Mustapha, Clinton Aigbavboa and Wellington Didi Thwala

Feasibility of the Delay and Disruption Protocol for Claims Management in Sri Lankan Construction Industry 26
R.A.N.M. Pathirana and L.D. Indunil P. Seneviratne

Framework for Ensuring Effectiveness of Maintenance in Building Services 27
D.P.S.D. Jayasinghe, P.A.P.V.D.S. Disaratna and R.P.N.P. Weerasinghe

Framework to Improve Labour Productivity for Indian Building Projects 28
Rahul Sahay, Ritesh Kumar Agarwal and Koshy Varghese

How to Design Durable Concrete Mix for Sustainability? 29
Lu Jin Ping

Identifying the Success Factors and Failure Factors of Green Building Projects 30
Vignesh Venkataraman and Jack C.P. Cheng

Indoor Environmental Quality and Occupants' Productivity: Green Certified Office Buildings in Sri Lanka 31
Harshini Mallawaarachchi, Lalith de Silva and R. Rameezedeen

Is 'Human Rights' the End or the Means of Sustainable Urbanization? 32
Buddini Chatumaduri Dharmawardhana, Mahesh Devinda Abeynayake and Nazeer Fathima Sabrina Aashik

Issues in Submission and Certification of Variations 33
Thuritha M. Karunathilake, L.D. Indunil P. Seneviratne and Kaushalya Weththasinghe

Knowledge Management Strategies for Sustainable Facilities Management in Sri Lanka 34
Sepani Senaratne, N.S.D Abeysinghe and A.K Andaraweera

Labour Productivity Norms for Aluminium System Formwork in Low-Cost Housing Construction Projects in Sri Lanka 35
S.J.A.R.S. Jayasinghe and Nirodha Gayani Fernando

Minimising Variations in Lump Sum Contracts 36
N.H.A. Sampath, P.A.P.V.D.S. Disaratna and M. Francis

Mitigating Claims through Conflict Avoidance in Construction Industry 37
H.D. Sendanayake, P.A.P.V.D.S. Disaratna and and M. Francis

Partnering to Bridge the Gap Between Conventional and BIM Based Project Procurement 38
K.A.R.V.D. Kahandawa and Himal Suranga Jayasena

Payment Evaluation Method for Controlling Environmental Defilement in Road Construction Projects in Sri Lanka 39
W.M.P.C. Walimuni, Lalith de Silva and Aparna Samaraweera

Project Communication within Small and Medium-sized Construction Firms 40
B.M. Aidoo, C.O. Aigbavboa and W.D. Thwala

Re-examining Contractor's BIM Strategies: A Case Study 41
Hongdi WANG, Leo Ke CHEN and Weisheng LU

Role of Technology in Providing Better Basic Facilities for Condominium properties 42
M.D.O.M. Jayarathne and H. Chandanie

Strategies to Enhance Sustainability of Public Private Partnership Procurement Process for Infrastructure Development 43
Nilesh Agarchand Patil and Boeing Laishram

Strengthening the Safety Culture in Raw Rubber Processing Stage through Human Capacity Building: A Conceptual Framework 44
D.M.P.P. Dissanayake and Nirodha Gayani Fernando

Suitability of Criteria for Selecting a Delay Analysis Technique Suitable to Analyse Delays in Road Construction Projects in Sri Lanka 45
E.M.K. Ekanayake and B.A.K.S. Perera

Suitability of Government Bid Evaluation Procedure for Building Projects in Sri Lanka 46
D.M.G.A.N.M. Sumanarathna and B.A.K.S. Perera

Supervision of Fabrication of Precast Steel Fibre Reinforced Concrete (SFRC) Segmental Lining 47
George Varghees

Sustaining the Future with Legacy: A Case Study on the UK Government Carbon Emission Targets 2025 and London Olympics 2012 48
G.A.G.R. Godawatte

Team Working in Road Maintenance Functions for Sustainable Construction in Sri Lanka 49
H.G.N. Premakanthi and Sepani Senaratne

The Legal Framework for Design Liability in Building Information Modelling 50
Thilina Laksiri Dissanayake, Himal Suranga Jayasena and Mahesh Abeynayake

Training and Development Framework to Improve Employee Job Performance in Public Sector Banks in Sri Lanka 51
M.L. Thilini Saubhagya Chandrasiri and Nirodha Gayani Fernando

Use of Locally Available Material to Develop a Treatment Technique to Reduce the Water Absorption Capacity of Recycled Aggregates 52
W.K.A. Madawa, R.M.S.I.B. Rathnayake, D.B. Wijethunga,T.C. Gamage and S. Karunarathne

Vacant Buildings in Infrastructure Projects: Strategies for Reuse 53
Vaishali Anagal, Dharati Sote and Shamishtha Ruikar

Value Engineering Practices and its Impact to Construction Industry 54
R.G. Kosala and Gayani Karunasena

Water Efficiency Techniques and Strategies for Sustainable Use of Water during Construction Phase of Building Projects 55
K.G.A.S. Waidyasekara, Lalith de Silva and R. Rameezdeen

PAPER ABSTRACTS

A CONCEPTUAL LEAN-BASED FRAMEWORK FOR IMPROVING THE ENVIRONMENTAL PERFORMANCE OF READY-MIXED CONCRETE PRODUCTION PROCESSES

Anna George Nellickal, Andukuri Vijaya Rajendra and Sivakumar Palaniappan*

Building Technology and Construction Management, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, India

ABSTRACT

The Ready-Mixed Concrete (RMC) industry is one of the fastest growing construction sectors and plays an important role towards infrastructure development. The RMC industry is expected to rise from INR 155-160 billion in 2009 - 2010 to INR 395 - 400 billion in 2014 – 2015 in India. The use of RMC for construction has proved to be advantageous due to its assured quality, accuracy in the mix proportion, faster construction, less workforce and improved workspace utilization. The RMC industry life cycle consists of five major phases namely manufacturing of raw materials, transportation of raw materials to batching plant, batching plant operations, delivery of concrete to site and site activities for placing and compaction. Significant amounts of resources such as materials, energy and water are used during these five phases. The transportation of raw materials and concrete is considered as one of the major sources of energy use and emissions. This study investigates the application of lean concepts for improving the environmental performance of RMC industry operations. First, the current status of RMC industry is presented. Second, a detailed study of resources used during various phases of RMC industry is summarized based on case studies carried out in Chennai. Third, lean concepts relevant for construction to minimize or eliminate non-value adding activities and wastes are discussed. Finally, this study presents a conceptual framework based on lean thinking to improve the environmental performance of RMC industry. This framework can be used to evaluate alternate RMC production scenarios and enhance the decision-making process for better production and environmental performance.

Keywords: *Lean Construction; Ready-Mixed Concrete Production; Sustainable Construction.*

* Corresponding Author: E-mail - sp@iitm.ac.in

A FRAMEWORK FOR THE EVALUATION OF INDOOR ENVIRONMENTAL QUALITY (IEQ) PERFORMANCE IN APPAREL INDUSTRY BUILDINGS IN SRI LANKA

M.G.D.T. Vijerathne* and L.D. Indunil P. Seneviratne

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

In the modern world, many people spend large portion of their time in built environments. Accordingly, significance of built environments' performance is increasing over past two decades. It draws the attention towards the concept of Indoor Environmental Quality (IEQ) to determine how well built environments are performing as IEQ performance directly affects occupants' health, comfort, satisfaction and ultimately for a productive work environment. Moreover, IEQ concept can be considered as an integral part of total building performance approach.

Today in Sri Lankan industrial sector, especially apparel manufacturing sector grows upward in speedily. For this rapidly development, performance of the built environment is vital as it is having direct relationship with occupants' productivity. At the present, various approaches to evaluate IEQ performance has being developed. However, it is evident that there is no holistic approach. Similarly in Sri Lanka, there is no comprehensive framework applied in industrial buildings to evaluate IEQ performance. This necessitates the important of developing a holistic IEQ evaluation approach which would greatly benefit to the industrial sector.

Survey methodology is used in the research and RII is employed as a data analysing tool to validate the IEQ indicators which have been identified in literature review and modified in preliminary survey. Further, it is established the most significant indicators based on their importance towards IEQ performance in apparel industry buildings with AHP tool. The developed framework comprised with four main IEQ indicators as thermal comfort, indoor air quality, acoustic quality and lighting quality. This framework focused on holistic approach to measure IEQ performance which will allow acceptable built environment while processing continuous improvements.

***Keywords**: Building Performance; Built Environment; Indoor Environmental Quality (IEQ); IEQ Indicators; Industrial Buildings.*

* Corresponding Author- E mail - dimuthuvijerathne@gmail.com

A GUIDE FOR PERFORMANCE EVALUATION PROCESS FOR INTERNATIONALLY FUNDED COMMUNITY DEVELOPMENT PROJECTS IN SRI LANKA

Ruwani Perera* and Gayani Karunasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

In today's world, many development efforts are implemented as Community Development (CD) projects. Their unique nature and qualitative objectives raise a special challenge in performance evaluation as performance evaluation of CD projects is affected by several factors. Thus, this research was aimed at developing a guide for performance evaluation of CD projects implemented by Non-Government Organizations (NGOs) in Sri Lanka to streamline the process.

As identified in literature review, four major impact areas from in and out of the CD project environment and five major stages of performance evaluation process were identified. Five CD projects were selected as case studies and interviews were conducted to gather data.

The research identified existing and proposed strategies applied by NGOs. According to the findings, majority of CD projects have not practiced all identified stages by giving the same weight for each of them.

The identification of lessons learnt and best fit practices are important factors, while responsible officers should carefully select representative stakeholder groups to share the evaluation findings in different ways.

Keywords: *Community Development Projects; Guide; Impact Areas; Performance Evaluation Process; Strategies.*

*Corresponding Author: E-mail - ruwaninimasha_perera@yahoo.com

A REVIEW OF THE BENEFITS AND THE HINDRANCES TO THE SUSTAINABLE CONSERVATION OF HERITAGE BUILDINGS IN MALAYSIA

Dodo Mansir*

Department of Real Estate and Facilities Management, University Tun Hussein Onn, Malaysia

Narimah Kasim

Department of Construction Management, University Tun Hussein Onn, Malaysia

ABSTRACT

Malaysia has an array of Heritage Building's (HB's) most of which have been standing for centuries that are exceptionally valued from the point of view of Architecture and History. Valuable as they are, these HB's are thus assets legally declared to be strictly protected (otherwise termed conservation) according to statutory guidelines. The National Heritage Act among others is a statutory document guiding conservation of HB's in Malaysia superintended by The Ministry of Culture, Arts and Heritage. This study reviewed the benefits and hindrances to the sustainable conservation of HB's in Malaysia. This study shows that while there are enormous benefits reaped from conservation of HB's, there also exist hindrances to the conservation process that could be attributed to planning and implementation at a policy, program and project level. These hindrances ultimately poses challenges to conservation of HB's thereby making conservation of HB's in Malaysia unsustainable. A way forward lies in the need for immediate action to addressing such challenges through sustainable processes, principles and policies. One that strives to strike a balance between environmental, economic, social cultural benefits for all generations. One that is sustainable. As such, a prompt need for Malaysia to benchmark world's best practices in the conservation of HB's that will address notable challenges was recommended. Furthermore, owners of HB's (public and private) must make continuous implementation of the results on such best practices a core priority thus making the conservation process sustainable.

***Keywords**: Heritage Buildings; Malaysia; Sustainable Conservation.*

* Corresponding Author: E-mail - mansirdo14@yahoo.com,

A STUDY ON APPLICABILITY OF BAMBOO FIBRE REINFORCED MYCELIUM BONDED SAWDUST MATERIAL FOR PARTITION WALL

O.D.P.C. Vithanage* and S.R. Chandrathilake

Department of Building Economics, University of Moratuwa, Sri Lanka

R.U. Halwathura

Department of Civi Engineering, University of Moratuwa, Sri Lanka

ABSTRACT

In building construction there is a need of alternative materials which are low cost, high efficiency and environmentally responsible. This research presents an innovative solution for partition walls. The solution is produced by using sawdust, mycelium and other ingredients which are normally used in mushroom cultivation. In this material the mycelium acts as a natural glue to bind sawdust particles. Also bamboo fibre was introduced to increase the strength of the innovative material. The panel making process was done by four steps as preparing mixture, preparing mould to grow mycelium, getting mushroom cultivation and compressing and drying the panel. To find the standard of the properties of the material, compression strength parallel to surface and water absorption tests were done by using the test specimens of the new material. All the tests were conducted according to the ASTM D 1037 (1978) standard to keep the test results at a standard level. The compression strength test showed that the optimum amount of bamboo fibre proportion in order to get the maximum compressive strength. Other than that ultimate compressive strength, yield strength, density, specific strength and Young's modulus were calculated too. The properties of new material were compared with Gypsum and MDF panels to find the position in the market. In this process mushroom is harvested as a by-product which leads to make a link between food industry and construction industry. This material fulfils the requirements of partition walls and can be applied as a green solution in partition wall construction.

***Keywords**: Bamboo Fibre; Mycelium; Partition Wall.*

* Corresponding Author: E-mail – pasanvithange@yahoo.com

A STUDY ON LIMITATIONS IN MATERIAL PROCUREMENT PRACTICE FOR CONSTRUCTION IN PUBLIC SECTOR

Vajira Edirisinghe* and Kavitha Kajendran

International College of Business & Technology, Sri Lanka

ABSTRACT

Due to the high accountability of public construction projects, several rules and regulations are being adopted in material procurement practice in public sector. These rules and regulations are practiced as per the framework provided by Procurement Guideline 2006 - Goods and Works and the Manual. Procurement Guideline 2006 is published by National Procurement Agency, Democratic Socialist Republic of Sri Lanka. This procurement guideline is applicable for any Procurement Action financed in whole or in part by Government of Sri Lanka or a Foreign Funding Agency. While these guidelines are being implemented, there are several limitations found by the practitioners.

Hence this research was aimed to study the practical issues in implementing procedures stated in the Procurement Guideline 2006 - Goods and Works and the Manual.

This study was done by collecting data from semi structured interviews with the industrial professionals who involve in public sector construction material procurement such as Architects, Contract Administrators, Procurement Officers, Project Managers, Quantity Surveyors, Contractors and Site Engineers.

Findings of this study revealed that there are limitations existing in public sector construction procurement practice and that create cost and time overrun and quality issues.

Keywords: *Material Procurement; Procurement Guideline 2006; Public Sector Construction.*

*Corresponding Author: E-mail - vajira@icbtcampus.edu.lk

A STUDY ON THE IMPACTS OF SCHEDULE COMPRESSION TECHNIQUES ON CONSTRUCTION PROJECTS IN SRI LANKA

Jallini Theivendran* and Sachie Gunatilake

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Construction delay is considered to be one of the recurring problems in the construction industry and it has an adverse effect on project success in terms of time, cost and quality. Previous researchers have stressed the importance of early identification of construction delays and have suggested major delay-reducing remedies. Among this, 'Compressing Schedule' is a commonly used method to expedite the construction process. The consequences of schedule compression can be troublesome if productivity and quality of the project are sacrificed for the sake of remaining ahead of schedule. Therefore, this research was carried out to identify the impacts of schedule compression techniques on projects and suggest the strategies to be followed to overcome those negative impacts. A questionnaire survey and ten semi-structured interviews were conducted with Sri Lankan construction contractors. Altogether, 11 number of schedule compression techniques were found to be commonly used in the Sri Lankan context. Additional cost, quality issues, productivity problems, conflicts, coordination problems and abortive works were highlighted as the recurring negative impacts. In order to mitigate the impacts, the research has stressed and recommended strategies for each technique.

Keywords: *Construction Delay; Impacts; Mitigation Strategies; Schedule compression.*

* Corresponding Author: E-mail - jallini@gmail.com

A SYSTEM FOR IMPLEMENTING RESETTLEMENT HOUSING PROJECTS IN THE NORTHERN PROVINCE OF SRI LANKA

Ahalya Luxman*

Ministry of Housing and Samurdhi, Sethsiripaya, Battaramulla, Sri Lanka

B.A.K.S. Perera

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

With the end of the armed conflict in May 2009, the resettlement activities of the Government of Sri Lanka (GOSL) commenced in November 2009 in the Northern Province (NP). Non-Governmental Organisations (NGOs) and International Non-Governmental Organisations (INGOs) and foreign governments were involved in providing transitional shelters, repairing damaged houses and constructing new houses. The number of houses initially planned to be constructed could not be completed on schedule. According to media reports, there have been issues during Before Construction Period (BCP) and During Construction Period (DCP). Thus it has become necessary to propose a framework to identify a suitable system for implementing housing projects in these areas.

This study develops an approach to solve identified problems using a mixed research approach. The Relative Important Index and Spearman Rank Correlation were used for the data analysis.

A suitable system consisting of two frameworks was then developed to make the beneficiaries aware of the importance of keeping land documents safely to prove their ownership of the land and also on the proper utilization of funds they receive through grants. The Implementing Partners also need to conduct awareness programmes on these aspects. Authorities need to issue land documents and resolve common issues related to land ownership and the Banks need to serve the resettled people well and open new branches and mobile banking services in the areas.

Keywords: *Before Construction Period; During Construction Period; Framework; Housing Projects; Resettlement.*

* Corresponding Author: E-mail - ahalya.lk@gmail.com

AN INVESTIGATION INTO SKILLED LABOUR REQUIREMENT IN SRI LANKAN BUILDING CONSTRUCTION INDUSTRY

Nishadi Anuruddika* and Y.G. Sandanayake

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

The construction industry, being predominantly labour intensive, heavily relies on the adequate supply of workforce and their skills. With the speedy growth of Sri Lankan construction industry after the ethnic war, demand for skilled workforce has been increased. The overall aim of this research is to analyse the present situation of skilled labourers in Sri Lankan building construction industry with respect to skill trades, in order to address the timely need of the present and future context of the industry.

The research was conducted using a questionnaire surveys among project managers in the building construction industry. The questionnaire survey was carried out to identify the significant skill trades and to investigate the current status of the skills and future required skills. Further, the questionnaire used to identify the skill shortage in building construction industry.

Skills related to service installation was identified as significant as the skills related to structural construction. However, the current status of the most of the skill trades is that these are not sufficient to fulfil the demand of the industry, except for bricklaying and plastering. The future supply of the skills also indicated an unbalanced level in likely demand and likely supply of skills. Hence, the government, industry and construction companies are having a responsibility of addressing the shortfall. It is also important to consider more training schemes and attractive remunerations with benefits to create a positive attitude towards the building construction industry among migrants and young generation in Sri Lanka.

Keywords: *Construction Industry; Skilled Labour; Skilled Labour Demand and Supply; Skill Shortage; Strategies.*

* Corresponding Author: E-mail - nishadianuruddika@yahoo.com

APPLICABILITY OF ICTAD PRICE FLUCTUATION FORMULA FOR GOVERNMENT FUNDED INTELLIGENT BUILDING PROJECTS

S.C. Jayaweera, B.A.K.S. Perera and S.J.A.R.S. Jayasinghe*

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

In high inflationary situations, government fiscal policies etc., have an effect on price fluctuations in Intelligent Building (IB) projects which are funded by the Government. It can increase the cost of material, plant and labour, while increasing the risks that both the contractors and the clients have to face. The use of the ICTAD price fluctuation formula in construction projects of more than three months duration, especially those of the Government, will help to recover these unforeseen costs at least to a certain extent. The formula however has its own inherent constraints. The objective of this research is to identify these constraints and suggest solutions to overcome them.

An expert survey and a case study were done towards achieving the main objective. The case studies comprised a document review and semi structured interviews. Code-based content analysis was used to identify the significant conclusions that could be made from the semi-structured interviews. The QSR. NVivo computer software was used to simplify the content analysis.

The results emphasised that in the case of IB projects of the Government, there is a difference between the actual price fluctuations and the corresponding figures obtained using Institute of Training and Development (ICTAD) price fluctuation formula as the formula had its own limitations. Therefore there is a need to modify the way the 'cost adjustment' factor is determined in IB projects of the Government. By using reliable price indices while taking steps to improve the currently available norms, it will be possible to make available to future IB projects a better operating framework.

Keywords: *ICTAD Price Fluctuation Formula; Intelligent Building (IB); Price Fluctuation.*

* Corresponding Author: E-mail - jruchini@yahoo.com

APPLICATION OF LEAN CONSTRUCTION PRINCIPLES AND PRACTICES TO ENHANCE THE CONSTRUCTION PERFORMANCE AND FLOW

Upeksha Hansini Madanayake*

School of Built Environment, Liverpool John Moores University, United Kingdom

ABSTRACT

Lean thinking has now become a radical philosophy that has permeated and expanded in to several sectors other than just manufacturing. The concept of Lean thinking evolves the optimization of work flow related functions and the possible outcomes with its contribution to sustainable construction. Correspondingly, application of lean theories and principles in to construction sector has the potential to improve the quality of work, aggravate the function related effectiveness, minimize the cost components/ waste and increase the overall profit in both strategic and operational levels. Apparently, it appears that the lean techniques have immensely contributed for many possible cost reductions compared with the traditional project management techniques. However, few barriers for the implementation of lean principles are also on the contrary. The research aims to investigate the effects of Lean Construction applications while identifying the prevailing barriers related to the same. The research has exploited qualitative methods to explore the aforementioned research question. This paper presents an exploratory study from extent literature, predominantly based on a case study of a project management organisation whereas the arguments were strengthened and underpinned by the formation of a conceptual framework to explore the contribution of implementing lean construction techniques in sustainable construction. The research findings would ultimately help different stakeholders on applying lean theories in to practice.

Keywords: *Integrated Project Delivery System; Last Planner; Lean Construction; Lean Manufacturing.*

* Corresponding Author: E-mail - u.madanayake@gmail.com

ASSESSING THE IMPACT OF EXPERIENCED PROJECT TEAM MEMBERS IN GREEN BUILDING PROJECTS

Vignesh Venkataraman and Jack C.P. Cheng*

Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Hong Kong

ABSTRACT

Project experience is generally regarded as highly valuable in the architecture, engineering and construction industry. This is also true for green building projects, which often need to deal with new building technologies and processes. This paper attempts to study the importance of experienced project team members for successful planning and executing of green building projects. Certified LEED green building projects in Canada were studied in this research. Project information, project team information, green building certification grade, and certification year were collected and analyzed using a link analysis technique. Organisations that have been involved in multiple green building projects and their inter-organisational interactions were identified. The results show that projects certified with higher green building certification grades often involve more experienced project team members, and that working with experienced team members can reinforce mutual experience as compared with working with less experienced member.

Keywords: *Green Building; Organisational Ranking; Page Rank; Project Team.*

* Corresponding Author: E-mail - cejcheng@ust.hk

BARRIERS TO THE IMPLEMENTATION OF CONCURRENT ENGINEERING PRACTICES WITHIN THE UK CONSTRUCTION INDUSTRY

Anupa Manewa*

School of Built Environment, Liverpool John Moores University, United Kingdom

Mohan Siriwardena

Scott Sutherland School of Architecture and Built Environment, Robert Gorden University, United Kingdom

Andrew Ross

School of Built Environment, Liverpool John Moores University, United Kingdom

ABSTRACT

Concurrent Engineering (CE) is considered as one of the emerging methods in the UK construction industry. The product and process optimisation through 'integration' is a key concern of CE. The integrative aspect is tri-fold, which comprises an integration of product(s), integration of process and most importantly the integration of supply chain. A correct adoption of the concepts and principles of CE into construction practice provides significant benefits to project stakeholders, such as reduced time and costs while improving the quality of products and process efficiency. However, its implementation is not optimised to its full potential within the construction industry. Therefore, this paper aims to identify the key factors that hinder the implementation of CE practices within the UK construction industry. Data were collected from an extensive literature review, observations and semi-structured interviews and thematic analysis was adopted to analyse the collected data. The findings indicate that the inability of parties within the construction project settings to communicate effectively is the most significant high level barrier for achieving a wider application of CE practices within the UK construction industry. In total 4 high level barriers, 13 medium level barriers and 38 low level barriers to the implementation of CE with the UK construction practices were identified. The findings of this study will benefit construction organisations, who wish to implement CE practices within their practice.

Keywords: *Barriers; Concurrent Engineering; Construction Industry; Integration; UK.*

* Corresponding Author: E-mail - R.M.Manewa@ljmu.ac.uk

BIM AS AN EFFECTIVE INFORMATION MANAGEMENT TOOL FOR ACHIEVING KEY PERFORMANCE INDICATORS IN CONSTRUCTION PROJECTS

K.A.D.N.C. Wijekoon*, Anupa Manewa, Andrew Ross and Dianne Marsh

School of Built Environment, Liverpool John Moores University, United Kingdom

ABSTRACT

The UK Government mandates the implementation of Building Information Modelling (BIM) for all centrally procured Government contracts from 2016. This of course challenged the industry to shift away from the traditional 'silo' practices to 'collaborative' working environments. BIM provides a collaborative platform to share information between project stakeholders and also guides to deliver products/processes effectively and efficiently. However, what strikes for the practitioners to move for a BIM platform is how it will support the achievement of project specific Key Performance Indicators (KPI). There are massive information generation and heterogeneous flows can be identified throughout a project lifecycle and the value of that information is enormous. From the definition itself, BIM has the capability of absorbing every benefit which can be obtained through information management.

This paper explains the use of BIM as an effective information management tool for achieving the KPIs in construction projects. Initially, an extensive literature review was conducted to identify the application of BIM in construction project lifecycle and its role as an effective information management tool. In addition to six (6) numbers of interviews were conducted among the construction industry professionals to identify the practical use of BIM in construction projects and its effectiveness in achieving project KPIs. The findings of the study illustrate the BIM driven construction project KPIs and their importance in achieving project goals.

Keywords: *Building Information Modelling (BIM); Construction Projects; Information Management; Key Performance Indicators (KPI).*

* Corresponding Author: E-mail - K.A.Wijekoon@2015.ljmu.ac.uk

BUILDING DEMOLITION WASTE MANAGEMENT PRACTICES – AN INDIAN CASE STUDY

V. G. Ram and Satyanarayana Kalidindi*

Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, India

ABSTRACT

Sustainable development has become an increasing concern throughout the world in the last two decades. Construction industry generates a huge quantity of waste, which is termed as construction and demolition (C&D) waste. C&D waste constitutes a major portion of the total solid waste generated in a society. Therefore, adoption of sustainable practices in C&D activities is vital for a society to move towards sustainable development. Moreover, demolition is a phase of construction that produces a large quantity of waste and hence requires explicit attention. During the past few decades, considerable amount of C&D waste is recycled in the developed countries. However, there are very few actively functioning C&D waste recycling facilities available in India. This signals the magnitude of the problem that needs to be addressed with respect to C&D waste management in India. In this paper, a case study research methodology is adopted to study the demolition waste management practices being adopted in Chennai city and the barriers that prevent the recycling of C&D debris have been discussed. The practices were found to be driven purely by economic incentives and unauthorized disposal of C&D waste is prevalent. There is a lack of awareness regarding the recycling possibilities among the stakeholders. Moreover, there are no records containing details on the quantity of C&D waste getting generated. Lack of appropriate policies, rules and strategies to address the C&D waste management have also been found to be some of the major barriers for the lack of C&D waste recycling initiatives in India.

Keywords: *Barriers; C&D Waste; Demolition; Recycling; Waste Management Practices.*

* Corresponding Author: E-mail- satyakan@iitm.ac.in

COMPARATIVE ANALYSIS OF ADJUDICATION AND ARBITRATION METHODS IN SRI LANKAN CONSTRUCTION INDUSTRY

Mahesh Abeynayake*

Department of Building Economics, University of Moratuwa, Sri Lanka

Buddini Chatumaduri Dharmawardhana

Attorney-at-Law

ABSTRACT

Construction claims are more technical intensive and multifaceted than other commercial disputes. The construction industry needs a fast and cost effective method for dispute resolution. Although the area of dispute resolution has been widely discussed and heavily researched, few studies have been conducted with respect to this research area in the Sri Lankan context. The aim of this study is to compare and contrast adjudication and arbitration methods use in Sri Lankan construction industry. To accomplish this aim, a literature survey would be conducted to find out available dispute resolution methods and the extent to which research has been carried out on arbitration and adjudication method. The developed questionnaire would be used to gather primary data from the professionals and the collected data would be analyzed using of statistical tools. Further, factors that can be used to compare arbitration and adjudication methods are presented in the latter part of the literature review. Semi structured interviews were carried out using the factors identified from literature review. The results of this research enable researchers to gain a better understanding on the current adjudication and arbitration methods, recognize significance of critical factors and suggestions for the development of adjudication and arbitration methods in the construction industry of Sri Lanka. The findings of this research indicate that the professionals who involve in the construction industry have overall average level of satisfaction on the current practice of adjudication and arbitration, however they believe that adjudication is an effective mechanism for dispute resolution rather than arbitration. It further revealed that the modernised stair-step model of dispute resolution strategy is the best. The research further makes recommendations in order to make ADR methods more effective and efficient.

Keywords: *Adjudication; Arbitration; Dispute Resolution; Success Factors.*

* Corresponding Author: E-mail - abey92@hotmail.com

COMPARATIVE STUDY OF WATER EFFICIENCY IN GREEN AND NON – GREEN BUILDINGS IN APPAREL INDUSTRY IN SRI LANKA

Sudeepa N. Silva*, K.G.A.S. Waidyasekara and D.M.P.P. Dissanayake

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

At present, the amount of water demanded exceeds the water quantity that remains as a resource and it becomes scarcer each year. When it comes to water consumption in buildings, apparel buildings consume a considerable amount of water for both production processes and to fulfil the requirements of a large number of occupants. However, there are different perceptions towards water efficiency. As an example, one party is aimed at adhering the green building concept in order to retrieve water efficiency while another perception focus towards achieving water efficiency through various methods without giving consideration for adaptation of green status. Therefore, this study looks at how water efficiency is addressed and what benefits have being received for green buildings compared to non- green buildings.

Initially, a comprehensive literature review was carried out with the purpose of getting familiarized with research areas. Case study method was used to compare water efficiency status in green and non-green buildings in apparel industry. Two cases are selected from each building type for the data collection purpose. Semi structured interviews were carried out with respective industrial personnel and findings of case study was analyzed using the Nvivo.

Research findings revealed that both green and non-green building are having similar purviews on the consideration towards the water efficiency and integrated with high quality water efficient practices to enhance the water efficient performances of the buildings. However, certain good practices could be observed in green buildings compared to non- green buildings. That is, individual commitment of the organisation together with third party commitment is making the building more towards water efficient. Finally, the study provides recommendations for good practices towards water efficient practices in the apparel industry.

Keywords: *Apparel Industry; Green Buildings; Non-Green Buildings; Water Efficiency*

* Corresponding Author: E-mail - sdpsilva0@gmail.com

COMPREHENSIVE STUDY ABOUT SRI LANKAN CONTRACTORS' ESTIMATION PRACTICE

P. Ganeshu*, P.A.P.V.D.S. Disaratna and M. Francis

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

The "estimating process" is a significant element within the circle of construction due to the lack of financial resources available. Tender cost estimating in Sri Lankan construction industry requires extensive knowledge and expertise. This research proposed a best estimation practice to the Sri Lankan construction industry. This study expects it will fulfil the research gap and uplift the Sri Lankan contractors' current estimation practice. The aim of this research is to suggest solutions to address the limitations of current estimating practice prevailing in the Sri Lankan construction industry comparing to the proposed best estimation practice. This research has been conducted through literature reviews, questionnaire survey and interviews. The questionnaire included sixteen steps identified as the best estimation practice through literature review and interviews, with a view to find out the current estimation practice of Sri Lankan contractors. The analysis of data revealed although they are following all sixteen steps, they couldn't able to gain the maximum benefit of those steps owing to some limitations. Therefore in order to find out the solutions for those limitations Seventeen interviews were carried out. Among those, nine interviews were from contractors and eight interviews were from consultants.

These conclude that limitations and solutions identified by the contractors were similar with those identified by the consultants. In the comparison of their opinions the degree of agreement on most of the factors between them is high. It shows consultants' understanding about contractors' works are quite high.

The study recommended that both contractors and consultants give more attention to the cost estimating process to manage the projects in a better way and to hire qualified technical staff in order to obtain an accurate estimate. Contractors were requested to keep databases and to make relevant changes and modifications in their existing estimating practices in their future projects.

Keywords: *accuracy; consultants; contractor; tender cost estimation.*

* Corresponding Author: E-mail – sunganesh21@gmail.com

CONCEPTUAL FRAMEWORK FOR SUSTAINABLE PUBLIC PROCUREMENT PROCESS IN CONSTRUCTION INDUSTRY

K.A.P. Gunawardhane* and Gayani Karunasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Public Procurement Process (Public PP) mainly focuses on the satisfaction of stakeholders in line with development objectives of the country. The importance of public expenditures within the world economy has stimulated and established interest in how public money is spent, with an emphasis on transparency and openness through the Public PP. This was identified as critical challenges with prevailing gaps of the Public PP when focuses on Sri Lankan construction industry. In this context Sustainable Public Procurement Process (SPPP) in construction industry emerge to Sri Lanka with numbers of benefits. Though it is a new concept to the developing countries, SPPP is not another type of procurement; it rather seeks to address the environmental, social and economic consequences of procurement actions. Moreover, the developed countries have implemented the SPPP successfully as a solution to challenges and gaps of existing Public PP. Hence, the SPPP has identified as one of most accepted alternative method to address the challenges and gaps of the Public PP in Sri Lankan construction industry.

Thus, this paper has proposed a conceptual framework for the SPPP based on secondary data. Further paper explored the framework in line with significant stages of Conceptual, Planning, Tendering/ Purchasing, Implementation, and Closeout with due consideration to the relationship of these all five stages of the Public PP. Relevant areas scrutinised through the comprehensive literature review to develop the proposed conceptual framework. Further, experts in the field of construction procurement also consulted to gather the opinions in order to evaluate the feasibility of conceptual framework.

Keywords: *Conceptual Framework; Construction Industry; Public Procurement Process; Sustainable Public Procurement Process.*

* Corresponding Author: E-mail - prasannakap@yahoo.com

CONSTRUCTION AND DEMOLITION WASTE RECYCLING: THE CASE OF CONSTRUCTION WASTE MANAGEMENT (COWAM) PROJECT

I.G.T. Samarasingha* and Gayani Karunasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Construction waste in general consists of both waste generated by construction as well as demolition. Disposal of demolition waste is becoming a growing problem which became evident after the Indian Ocean Tsunami in 2004, particularly in Sri Lanka. Management of these wastes came into picture with the establishment of a C&D waste recycling plant by the Construction Waste Management (COWAM) Project. With the development of construction industry, the question arises whether COWAM plant alone is capable of managing such waste. Thus, this paper presents recommendations to further improve the COWAM plant by expanding the same into other local areas. COWAM plant was selected as a single case study and data were gathered through semi-structured interviews. It revealed lack of funds to establish recycling plants and infrastructure and unavailability of a proper C&D waste management policy in Sri Lanka as major problems. Taking contracts to demolish buildings and increasing the number of productions are the most important recommendations to improve the COWAM plant. Further, allocation of requisite budget for infrastructure and public awareness is recommended to enhance the COWAM concept in Sri Lanka.

Keywords: *Construction & Demolition Waste; COWAM Plant; Waste Management; Waste Recycling.*

* Corresponding Author: E-mail - thisaraqsqs@gmail.com

DEVELOPMENT OF A CUSTOMER SATISFACTION ASSESSMENT MODEL FOR THE IMMIGRATION AND EMIGRATION SERVICE IN SRI LANKA

H.W.N. Madhusanka* and Nayanthara De Silva

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Immigration and Emigration Service (IES) is among the most vital set of state services of a country. In Sri Lanka it has played a great role with the augmented rates of immigrants and emigrants during past few years. The efficiency of this service relies on its customers' satisfaction. Thus the focus of the research was to identify the level of satisfaction of customers regarding the quality of services, and to suggest appropriate further improvement strategies to maximize its efficiency.

Quantitative approach was used for the effective fulfillment of desired objectives. During the first phase of data collection, two preliminary surveys were carried out to filter and specifically identify the factors to be included in the satisfaction assessment. Subsequently, the customer satisfaction assessment was completed focusing on 125 customers. In the second phase, semi-structured interviews were carried out with 4 experts, aiming to identify possible improvement strategies for further enhancements in the service quality.

Twenty eight factors were established to appraise the immigration and emigration service quality. The service quality assessment using IPA matrix revealed that the customers were satisfied with 15 factors and dissatisfied with 13 factors. Thus, several improvement strategies were proposed to improve the current service quality.

Keywords: *Customer Satisfaction; Customer Service; Satisfaction Assessment; Service Quality*

* Corresponding Author: Email - nandun.madhusanka@hotmail.com

DIMENSIONS OF SUSTAINABLE CONSTRUCTION: THE PERSPECTIVES OF CONSTRUCTION STAKEHOLDERS

Cheng Siew Goh* and Steve Rowlinson

Department of Real Estate and Construction, The University of Hong Kong, Hong Kong

ABSTRACT

The recent trend of sustainable development in the Hong Kong construction industry has drawn construction organisations' attention to sustainability issues. However, the fragmented nature of construction industry has led to divergence in stakeholders' understanding of sustainable construction, in addition to the traditionally debatable concepts of sustainable development. This paper explores and examines how different stakeholders perceive and treat sustainable construction. Twenty two interviews were carried out with stakeholders from various backgrounds including architects, engineers, surveyors, contractors, developers, facilities managers, environmentalists, suppliers, and sustainability consultants. The results show that there is still a disagreement on embracing the economic and social pillars in sustainable construction, whilst the environmental pillar is acknowledged by the majority. In addition to the triple bottom line, sustainable construction is also linked to culture and health and safety. Interestingly, this study found that construction stakeholders perceive sustainable construction as an ideal situation in which it is very hard to attain zero carbon and complete sustainability in real life development. In view of the absence of a clear definition and direction in applying sustainable construction, a gap can form in sustainable practices when incompatible goals are set by various parties due to their different interests. As a result, more effort should be made by providing a platform for the diverse interest groups of construction stakeholders to share ideas, communicate and distribute sustainability information.

Keywords: *Dimensions; Stakeholder; Sustainable Construction.*

* Corresponding Author: E-mail - goh11@connect.hku.hk

DISPUTE ADJUDICATION BOARD AS AN ADR METHOD IN THE CONSTRUCTION INDUSTRY OF SRI LANKA

Mahesh Abeynayake*

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Unresolved disputes can lead to project delay, increased tension and can damage long term business relationship. As a result, Alternative Dispute Resolution (ADR) methods were evolved during the passage of time to resolve construction disputes. Dispute Avoidance Procedures, which include Dispute Review Boards (DRB) and Dispute Adjudication Boards (DAB) are used in the construction industry since those methods are encourage parties to resolve their disputes at site level. The DAB first started to use in Sri Lanka after the FIDIC (1999) red book was introduced to use and due to the insistence of the World Bank and Asian Development Bank as funding agencies for the mega development projects. Although many research papers of foreign countries stated that their success with the DAB, Sri Lankan construction industry mostly practiced adjudication in ad-hoc manner. This research was carried out to provide suggestions to overcome the barriers to implement the full term DAB method in Sri Lanka. Therefore, it is indeed necessary to find out the genuine reasons behind the reluctance of stakeholders in Sri Lankan construction industry towards ADR methods and why stakeholders even do not use adjudication which has been recognized as an effective and efficient ADR method, elsewhere in the world. Questionnaire survey was carried out among contractor and consultant organisations and semi structured interviews were carried to gather descriptive answers from them. The research revealed the barriers to implement the full term DAB in Sri Lanka and provides suggestions to overcome those barriers. The research would also be conducted based on the provisions in Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer (FIDIC 1999) first edition and Standard Bidding Document Procurement of Works Major Contracts (ICTAD/SBD/02) second edition. A pivotal conclusion of this research is that the stakeholders in the construction industry prefer "adjudication" as an effective ADR method.

Keywords: *ADR Methods; Disputes; Dispute Adjudication Board; FIDIC.*

* Corresponding Author: E-mail - abey92@hotmail.com

EFFECT OF ACCURACY AND TIMELINESS OF INFORMATION ON PERFORMANCE OF CONTRACTORS

Jeyapalan Suventhiny* and Himal Suranga Jayasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Improper information flow within the construction parties are most frequently experienced in Sri Lankan construction industry. Due to this situation, contractors faced several difficulties on their performance in terms of cost, time, and quality. Therefore, this paper intends to identify the accuracy and timeliness of information on performance of contractors. The aim is to identify how deficiencies in accuracy and timeliness of information affect performance of contractors in terms of cost, time, and quality. The outcome of this study will be beneficial for practitioners in Sri Lankan construction industry to reduce practical issues related accuracy and timeliness of information. Detailed questionnaire survey was used to identify the significant factors relating to accuracy and timeliness of information. Findings revealed that 'mistakes in design' and 'incomplete drawings' as the most significant factors on cost performance of contractors; 'delay in design', and 'slow drawing revision and distribution' as the most significant factors on time performance of contractors and 'mistakes in design' and 'incomplete drawings' as the most significant factors on quality performance of contractors. Further, factors were categorized as agreed factors and disagreed factors based on contractors' and clients' and consultants' perspectives. Important finding of the study is that there are number of factors considered highly significant by contractors but clients and consultants do not assume them to be so. Furthermore, the study recommended clients, contractors and consultants to hold their responsibilities with regard to information related issues on performance of contractors. Findings will be further useful to build a good relationship between stakeholders and improve the performance of contractors.

Keywords: *Cost; Information; Performance of Contractors; Quality; Time.*

* Corresponding Author: E-mail - jjsuba1990@gmail.com

EFFECTIVE LEADERSHIP BEHAVIOURS IN CONSTRUCTION SAFETY PRACTICES

Zakari Mustapha*, Clinton Aigbavboa and Wellington Didi Thwala

Department of Construction Management and Quantity Surveying,
Faculty of Engineering and Built Environment, University of Johannesburg,
Johannesburg, South Africa

ABSTRACT

Effective leadership behaviours have been shown in literature to be a contributing factor to construction safety practices. However, researchers have neglected the leadership behaviours and have their focus on the construction projects features of management. The inclusion of leadership as a part of an organisation has been the subject of interest all over the world. This development has driven researchers' interest to come out in a holistic manner to give the clear understanding of leadership. The review of literature in the existing body of knowledge becomes paramount in order to continue with the research on the subject matter. The review will also enable the road map for the future to be drafted. This development has led to the review of empirical studies conducted by researchers on leadership in the construction industry. The research adopted literature study from various sources such as reviews of leadership behaviour in the construction safety practices. This review of literature led to the selection of appropriate literature for the study. A rigorous process was carried out in the selection of appropriate literature for the study, from a total number of fifty-two studies reviewed, out of which thirty-five empirical studies were selected. The findings from literature were summarised through coding, according to the publication outlet, authors, nature of the study, country of publication, target population, methodology and key findings. It was found out that most of the empirical studies have focussed on construction projects features management, while less attention has been given to several other equal dimensions, particularly leadership behaviours in the construction industry. This study focussed mainly on the effective leadership strategies in achieving organisational goals. Discussions also included the health and safety improvement in the construction industry and types of motivational measures for safety

Keywords: *Behaviours; Effective Leadership; Safety Practices.*

* Corresponding Author: E-mail - zakarimustapha1967@gmail.com

FEASIBILITY OF THE DELAY AND DISRUPTION PROTOCOL FOR CLAIMS MANAGEMENT IN SRI LANKAN CONSTRUCTION INDUSTRY

R.A.N.M. Pathirana* and L.D. Indunil P. Seneviratne

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Delay and disruption claims are difficult to resolve due to issues in claims management in construction industry. Those issues are occurred due to wrong practices in the industry and having vague areas in delay and disruption. Although, there are some methods to diminish delay and disruption events, still there is no proper way to deal with those issues. Having a guideline for claims management is an effective mechanism. In that scenario, Society of construction law's (SCL) delay and disruption protocol is the commonly used guideline in other countries and which have comprehensive scope. Hence, it is required to discover how far SCL protocol is appropriate to Sri Lankan construction industry. Therefore, the aim of this research is to investigate the feasibility of adopting SCL protocol for dealing with issues in delay and disruption in claims management in Sri Lankan construction industry. A comprehensive literature review, a questionnaire survey and semi structured interviews were done as the research method for this paper. Interviewees were selected from questionnaire survey. The findings of this study prove that having a guideline for claims management is important and awareness of SCL protocol in Sri Lanka is comparatively less. Further, it demonstrates that adopting SCL protocol to Sri Lankan construction industry is feasible. Management can achieve sustainable construction practices such as using human resource efficiently, willingness to work and effective time management. Finally, it confirmed that implementing SCL protocol will improve knowledge related claims management and it will enable to improve the claim practitioners' practices.

Keywords: *Claims Management; Delay and Disruption; SCL.*

* Corresponding Author: E-mail - madhuni2si@gmail.com

FRAMEWORK FOR ENSURING EFFECTIVENESS OF MAINTENANCE IN BUILDING SERVICES

D.P.S.D. Jayasinghe, P.A.P.V.D.S. Disaratna and R.P.N.P. Weerasinghe*

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Maintenance management of building services has become one of the critical issues among building sector professionals recently. The interruptions or damages to the building services extensively affect the core operation of the business. Therefore, appropriate maintenance management arrangements are required to sustain a proper building services system. Building practitioners tackle various issues and seek a variety of alternative solutions to deliver an effective maintenance strategy for the building services. However, the lack of consideration on the overall effectiveness of maintenance services has faced frequent problems such as human errors, health and safety issues, resource scarcities, and time delays. In order to address those problems, this research has been carried to develop a framework that ensures the effectiveness of maintenance activities of the building services in Sri Lanka.

An extensive literature review was mainly carried to discover the impact of effective maintenance activities towards the building services. Afterwards, a preliminary experts' survey was conducted to obtain the factors affecting to effectiveness of maintenance activities. Subsequently, a questionnaire survey was conducted among maintenance personals to rank identified factors according to their impact. Further, semi-structured interviews have been carried out mainly to identify the limitations of maintenance work.

The framework highlights the factors that affect the effectiveness of maintenance activities of building services. Further, the framework facilitates to address the limitations of maintenance activities of building services. The framework can be used as clear evidence to convince both top management and owners of organisations to ensure the effectiveness of maintenance activities as well.

Keywords: *Building Services; Commercial Buildings; Effectiveness; Maintenance Activities; Maintenance Staff*

* Corresponding Author: E-mail - nilminiweerasinghe@ymail.com

FRAMEWORK TO IMPROVE LABOUR PRODUCTIVITY FOR INDIAN BUILDING PROJECTS

Rahul Sahay*⁎, Ritesh Kumar Agarwal and Koshy Varghese

Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, India

ABSTRACT

This study explores the practice of planning and productivity measurement on Indian building construction sites and suggests a framework to improve the practice. An exploratory study based on observing several projects was initially undertaken and it was found that there was no structured method utilised to analyse and improve productivity during the construction phase. Further analysis of planning practices on 15 building construction projects revealed that while the overall milestone plan was appropriate, the critical path method schedule (macro schedule) had several limitations, which made its relevance for look-ahead planning and coordination of resources questionable. Without an appropriate model for medium term planning, the short-term plans became uncoordinated and resulted in significant wastages. Based on a comparison of observed practices with documented best practices, and constraints unique to projects in India, the gaps in developing CPM based schedule are enumerated and strategies to close the gaps are suggested.

In addition to this top-down approach to develop a realistic CPM based schedule, a bottom up approach to monitor the daily progress against the planned weekly targets is proposed. While the conventional monitoring framework mandates this approach, there were several gaps in practice that were observed. The causes for these gaps are analysed and suggestions to close the gaps are proposed. The proposed framework consisting of the top-down and bottom-up approach is expected to overcome several of the barriers to measure and improve labour productivity on Indian building projects.

Keywords: *Building Construction; Look-Ahead Planning; Productivity; Scheduling.*

* Corresponding Author: E-mail - rahul17sahay@gmail.com

HOW TO DESIGN DURABLE CONCRETE MIX FOR SUSTAINABILITY?

Lu Jin Ping*

Admaterials Technologies Pte. Ltd., Singapore

ABSTRACT

In order to achieve the sustainability of social development, low carbon emission has played more and more important role. In this complex world scenario, infrastructure regeneration and rehabilitation; cement and concrete materials have an undeniable part to play in enhancing the quality of human life. If we are to avoid unredeemable environmental degradation globally, sustainable development of the cement and concrete industry has to be the foundation for all construction activity in the next millennium. The durability of cement and concrete materials is closely related to low carbon emission and energy saving. High performance and high durable concrete materials can contribute to the saving of raw materials, reducing of cement usage as well as low maintenance for long life. In order to achieve the objective of low carbon emission for ready mix concrete products, the design of concrete mix should be reconsidered. In this paper, the principles of ready mix concrete design has been discussed based on the durability requirements according to the new concrete Standard SS EN206-1. In every step of the design, the requirement of low carbon emission and green materials has been considered. Examples of design procedures are also illustrated in this paper for easy reference.

Keywords: *Concrete Specification; Design; Durability; Sustainability; SS5441,*

* Corresponding Author: E-mail - jimpimg@admaterials.com.sgcom.

IDENTIFYING THE SUCCESS FACTORS AND FAILURE FACTORS OF GREEN BUILDING PROJECTS

Vignesh Venkataraman* and Jack C.P. Cheng

Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Hong Kong

ABSTRACT

There is a global trend of green building projects over the world. In mature green building markets like the United States and Australia, there are well established green building certification systems and advanced technologies are often used in green building projects. On the other hand, in developing green building markets such as India and Korea, green building certification systems are still evolving and there is a steady increase in the number of green building projects. Despite the difference in the two kinds of green building markets, green building projects may face similar needs and challenges for successful project execution. Through questionnaire survey, this study aims to identify the success factors and failure factors of green building projects, and to compare the factors in mature green building markets with those in developing green building markets. Over 37 green building experts have completed the survey in this study. The findings show that commitment from project participants and effective collaboration among participants are common key success factors for green building projects, whereas cost consideration and lack of incentives from government are major failure factors in both kinds of green building markets. The findings also show different perceived importance of issues like collaboration, green building technologies, and project delivery methods in the two kinds of markets. This study helps practitioners in the industry to strategize and manage their green building projects effectively.

Keywords: *Failure Factor; Green Buildings; Project Management; Success Factors.*

* Corresponding Author: E-mail - vvaa@ust.hk

INDOOR ENVIRONMENTAL QUALITY AND OCCUPANTS' PRODUCTIVITY: GREEN CERTIFIED OFFICE BUILDINGS IN SRI LANKA

Harshini Mallawaarachchi* and Lalith de Silva
Department of Building Economics, University of Moratuwa, Sri Lanka

R. Rameezedeen
School of Natural and Built Environments, University of South Australia, Australia

ABSTRACT

There is a potential link between indoor environment and occupants' productivity, which has identified in previous literature. Especially, there is an effect of the quality of indoor environment, where, people spend 90% of their time indoors. Indoor Environmental Quality is become a growing concern to ensure occupants' health, wellbeing, and personal productivity. However, the deficiency of research in this area gave an importance to conduct this study. Accordingly, this research is to determine the relationship between Indoor Environmental Quality and occupants' productivity in green buildings. Survey approach was selected under quantitative phenomenon, as this research is focused to determine the relationship between variables quantitatively. Both questionnaire survey and semi-structured interviews were conducted among occupants in green certified office buildings in Sri Lanka. The survey data was analysed using nonparametric statistical analysis techniques; significance testing and Spearman's Correlation. SPSSv.20 software was used in data analysis. The Indoor Environmental Quality factors identified through literature were evaluated to identify significant factors influencing occupants' productivity. According to the test statistics, seven significant factors were identified as the first stage of data analysis where they showed statistically significant correlation to the major Indoor Environmental Quality dimensions. As the second stage of analysis, the relationship between Indoor Environmental Quality factors and occupants' productivity was determined. As the test results showed, air quality and acoustical partitioning factors confirmed a statistically significant weakly positive monotonic correlation whilst system control showed strongly positive monotonic correlation to the occupants' productivity in green buildings. The test results were further discussed by stating the qualitative findings and extant literature. As the outcome of this research, the relationship between significant Indoor Environmental Quality factors and occupants' productivity was reviewed and evaluated. As per the findings of the research, facilitating more provisions on air quality and acoustic quality would effect to ensure the productivity improvements of green building occupants.

Keywords: *Green Buildings; Indoor Environmental Quality; Occupants' Productivity; Sri Lanka.*

* Corresponding Author: E-mail - hmallawarachchi@gmail.com

IS 'HUMAN RIGHTS' THE END OR THE MEANS OF SUSTAINABLE URBANIZATION?

Buddini Chatumaduri Dharmawardhana

Attorney-at-Law, Sri Lanka

Mahesh Devinda Abeynayake* and Nazeer Fathima Sabrina Aashik

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Urbanization is one of the inventible phenomena in the 21st century. People migrate to urban areas due to social, cultural, environmental, political and economic reasons. Rapid and unplanned urbanization lead to huge social, economic, cultural and environmental challenges. Therefore, sustainable development, more particularly sustainable urbanization is required in order to prevent adverse effects of rapid and unplanned urbanization. In other words development that meets the needs of the present generation without compromising future generations to meet their own needs as emphasized by the Brutl and Commission should be an essential feature in the urbanization process. It is apparent that urbanization causes serious violation of human rights including social, economic, cultural, civil and political rights which are indivisible and interdependent. These violations of human rights can be prevented through sustainable urbanization. In other words, achievement of sustainable development and sustainable urbanisation guarantees the human rights of people. Also on the other hand it is argued that rights-based approach is the best method to achieve sustainability. The objective of this paper is to evaluate as to whether the 'Human Rights' is the end result of sustainability or whether 'rights-based' approach is the way to achieve sustainability. In concluding the paper it is noted that 'human being' should be the paramount consideration and central concern of development and 'Human Rights' is the "END" as well as the "MEANS" of sustainable urbanization.

Keywords: *Human Rights; Sustainable Urbanisation.*

* Corresponding Author: E-mail – abey92@hotmail.com

ISSUES IN SUBMISSION AND CERTIFICATION OF VARIATIONS

Thuritha M. Karunathilake* , L.D. Indunil P. Seneviratne and Kaushalya Weththasinghe

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

The valuation of variation is a critical aspect in the post contract stage. The Contractor has to carry out the works according to issued variation order or on the instructions given by the Engineer even without having the approval. The Contractor might be paid a percentage on the submitted price until cost proposal is certified by the Engineer. The submission and certification process is delayed on most of the projects and this will lead the Contractor to suffer losses from the project.

The researcher attempted to review the time gap between variation submission and certification, using a documentary survey of completed building projects. Content analysis of the documents exposed delay in certification period of several variations, those had generated payment delay to Contractor, and identified the loss of opportunity cost as the ultimate effect. Further, the author identified the issues which caused delays in submission and certification of cost variations, and probable solutions to mitigate those issues. In order to achieve above facts, interview survey was carried out with professionals, who had experience in variation management of building construction field. The issues of delay in variation submission and certification procedure in Sri Lankan industry, and solutions for those issues were derived via analysis of the content of conducted interviews. Finally "Variation Procedure Guideline" was proposed and validated with the participation of experts.

Author recommended that a proper variation procedure is required to control and certify the value of variation according to the proposed guideline to manage the situation without conflicts. Further, maintain the positive relationship between project stakeholders and contribution of government as the regulatory body will be essential to overcome from mentioned issues.

Keywords: *Certification; Conflicts; Submission; Variation Management; Variation Procedure.*

* Corresponding Author: E-mail – thuritha.milinda@gmail.com

KNOWLEDGE MANAGEMENT STRATEGIES FOR SUSTAINABLE FACILITIES MANAGEMENT IN SRI LANKA

Sepani Senaratne*

School of Computing, Engineering and Mathematics, University of Western Sydney, Australia

N.S.D Abeysinghe and A.K Andaraweera

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

The profession of facilities management (FM) is becoming knowledge driven. In this regard, managing facilities managers' knowledge helps for sustainable outputs through the creation of supportive and cost effective physical environment that strongly supports the primary objectives of office buildings sector. This study attempts to bring in knowledge management insights into facilities management and explores strategies of managing facilities manger's knowledge. Case studies of three in-house FM teams occupied in three leading office buildings in Sri Lanka were used to approach the research problem. Data was collected using semi-structured interviews with three individuals from each case. The findings revealed that a wealth of knowledge is accumulated within a handful of FM practitioners as tacit knowledge in the form of experiences, intuitions and insights. Hence, a personalisation approach is preferred to a codification approach in managing FM knowledge within individual organisations and the profession as a whole. However, codification strategies are also suggested to complement the process in the long term due to the emerging nature of the profession and the need for transferring knowledge to future FM professionals. This research is of exploratory nature, which explored an emerging FM profession in Sri Lanka. Further research is required to fully understand how knowledge management concepts could be incorporated within FM professions worldwide for sustainable FM.

Keywords: *Case Studies; Codification Strategies; Facilities Management; Knowledge Management; Personalisation Strategies;*

* Corresponding Author: E-mail - s.senaratne@uws.edu.au

LABOUR PRODUCTIVITY NORMS FOR ALUMINIUM SYSTEM FORMWORK IN LOW-COST HOUSING CONSTRUCTION PROJECTS IN SRI LANKA

S.J.A.R.S. Jayasinghe*and Nirodha Gayani Fernando

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

In enhancing the living standards of the society advanced technologies can be used in gaining the labour productivity and competitive advantage. There the low-cost housing projects are facilitating a proper labour productivity adhering the effect of labour productivity factors. Thereby, Aluminium system formwork is a use of advanced methodology which enhance the labour productivity in low-cost housing projects while highlighting the significance and domain created within the industry.

Meanwhile, tendency of poor performance in Aluminium System Formwork is observed due to improper planning in high rise building construction. Consequently when maintaining productive advantage, productivity norms are number of labour hours required to complete a particular task while facilitating the efficient evaluation of labour performance in enhancing the merits of the Aluminium System Formwork. Hence, deficiency of researches have been done to establish particular standards or norms, this research aims at investigating the realistic measure of the labour performance for Aluminium System Formwork in low cost housing projects.

Accordingly, a case study was conducted using direct observations to prepare the labour productivity norms and collected data were analysed based on labour productivity factors. Finally conclusions were drawn and recommendations were put forward.

Findings proved the combination and varying effect of weather factors, crew factors, management and projects factors, site conditions represent different labour productivity norms in each four different occasions. Meanwhile within each occasion the effect of structural elements towards the norms is highlighted and facilities the realistic measurement of the labour performance in Aluminium system formwork while embossing low cast housing concept.

Keywords: *Aluminium System Formwork; Labour Productivity; Labour Productivity Factors; Labour Productivity Norms.*

*Corresponding Author: E-mail - jruchini@yahoo.com

MINIMISING VARIATIONS IN LUMP SUM CONTRACTS

N.H.A. Sampath, P.A.P.V.D.S. Disaratna and M. Francis*

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Construction industry is large, complex and uncertain in nature. Thus, variations have become an inevitable situation in construction projects irrespective of the type, size and complexity. This research therefore focuses on lump sum projects which account for a significant amount of variations in Sri Lanka. The research aimed at investigating the nature of variations in lump sum projects, significant effects of variations and the means of minimizing variations.

Semi-structured interviews and questionnaire survey were carried out to investigate the research phenomena. The professionals who involved in variation handling of lump sum projects were taken for collecting data. The results through questionnaires were analyzed using RII and interviewee outcome were analyzed using content analysis. It was found that there are a number of factors contributing to variations in lump sum contracts. The variations occur very often during the design stage of projects. The research findings revealed that delay in completion of project, increase in project cost, rework and demolition, quality standards enhancement and delay in payments are the most significant effects of variation. The research emphasized that identification of client's requirements is essential to minimize variations within the project.

The research recommended freezing design, preparation of detailed project brief, conducting comprehensive site investigations, involving owner at planning and design stage and reducing contingency sum could minimize the occurrence of variations. Further, the current study enables the professionals to assess and take proactive measures to mitigate the adverse impacts of variations through the identified controls for variations.

Keywords: *Effects; Lump Sum Contracts; Minimize; Variation.*

* Corresponding Author: E-mail - mathushaf@yahoo.com,

MITIGATING CLAIMS THROUGH CONFLICT AVOIDANCE IN CONSTRUCTION INDUSTRY

H.D. Sendanayake*, P.A.P.V.D.S. Disaratna and M. Francis

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Conflict is defined as a serious disagreement or argument about something important between parties. When there are differences, incompatibilities in interests among parties involved, it is obvious a conflict could be exist. Construction industry is a place where the conflicting situations arise very often and it continues to act as a high explosive character. When a conflict is not managed properly it will lead to claims and if these claims are not clearly resolved the claims may turn into disputes.

This study explored how to avoid conflicts in construction projects by addressing their types, causes and effects. Moreover the types and causes of claims were also addressed. The aim of the study was to develop a framework as a strategy that could reduce effectively the occurrences of conflicts to mitigate claims in construction projects in Sri Lanka. As a means to achieve the aim of this research, the study was structured into two main parts; the first part aimed at mapping up the nature of conflicts in construction projects by establishing types of conflicts, critical symptoms of conflicts, factors causing them and the strategies used in avoiding the conflicts. Moreover types of claims and causes of claims were also investigated. This was done through the literature synthesis. Secondly, a collection of data was done through a questionnaire survey and expert interviews.

Through the analysed data the framework for conflict avoidance to mitigate claims has been created for the Sri Lankan context. Notwithstanding, it can be recommended to use for the construction industry as a whole. The study provides field level experiences from which the inexperience construction site professionals could learn the instances of conflicts and claims and not repeat the mistakes in their projects.

Keywords: *Claims; Conflicts; Construction Projects; Sri Lanka.*

* Corresponding Author: E-mail - hasarads@gmail.com

PARTNERING TO BRIDGE THE GAP BETWEEN CONVENTIONAL AND BIM BASED PROJECT PROCUREMENT

K.A.R.V.D. Kahandawa*

VFORM Consultants (Pvt) Ltd, Nawala, Sri Lanka.

Himal Suranga Jayasena

Department of Building Economics, University of Moratuwa, Sri Lanka.

ABSTRACT

Building Information Modelling (BIM), has not yet been used in the Sri Lankan context. It has not yet become a clearly identified and proven standard method in building procurement. As a procurement method, Integrated Project Delivery (IPD) is key contender in BIM implementation process worldwide. But due to the lack of integrated projects in Sri Lanka and the reluctance of professional, changing their methods for the sake of BIM would be impractical. Therefore it is vital to identify the minimum requirement needed, to implement BIM. Partnering is a concept that is also alien to the Sri Lankan context; but is more of the intangible procurement method laid on top of the existing procurement system. This method creates the environment that dissolves the contractual boundaries, enabling working together to achieve mutual as well as individual goals. Therefore it could be used to create the collaborative environment needed for BIM, rather than changing the whole system. Through an extensive literature survey, the characteristics of partnering, including its benefits, barriers were identified. Thereafter the applicability of BIM to the current context was recognized. Then it was discovered of CIC BIM protocol to bridge the contractual gap, that would give out the smallest change required for BIM. Thereafter, the applicability of the BIM protocol and barriers that prevents BIM from implementation in the Sri Lankan context was analysed based on interview responses of the professionals. It was also identified that CIC BIM protocol is not covering all the barriers in concern. With the addition of partnering to the equation it was identified that partnering together with the BIM protocol creates the most suitable environment for BIM implementation in the Sri Lankan context.

Keywords: *Barriers; Building Information Modelling (BIM); BIM Protocol; CIC; Construction; Partnering; Sri Lanka.*

* Corresponding Author: E-mail – kad2ravindu@gamil.com

PAYMENT EVALUATION METHOD FOR CONTROLLING ENVIRONMENTAL DEFILEMENT IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA

W.M.P.C. Walimuni*, Lalith de Silva and Aparna Samaraweera
Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Various attempts have been taken in order to achieve the objective of environmental soundness in road construction activities. Effectiveness of allocating the funds and the due payment for the contractor can create a great influence in achieving such an objective. Thus, this study aims to identify what is the optimum payment evaluation method of contractor's due payment for controlling environmental defilement in road construction projects. The aforesaid research problem was approached through a multiple case study including three road construction projects in Sri Lanka. Different environmental hazards occurred due to different road construction activities, related hazard mitigation methods, fund allocation for environmental hazard controlling and the associated existing payment methods for contractors could be identified through the data collected by means of semi-structured interviews conducted with the professionals who are involved in the projects having knowledge on both environmental and monetary aspects. Further, direct observations and documentary survey strengthened these findings. Quantitative data was collected from each case through a questionnaire survey and prioritized the payment method under each specific hazard controlling method using Relative Importance Index in terms of effectiveness to identify the optimum payment method to the contractor for controlling environmental hazard. Findings revealed that there are four types of such payment methods available including; payments by unit rate, payments where a provisional sum established in the contract; payments where fixed amounts are assigned in the contract and payments made along with some main work item in the contract which were identified being the optimum method under different hazard controlling methods. These findings would be useful for bidders and estimators at the pre-construction stages to develop more effective modes of payment evaluation and to improve effectiveness in estimation.

Keywords: *Due Payment; Environmental Hazards; Fund Allocation; Hazard Mitigation; Payment Evolution Methods.*

* Corresponding Author: E-mail- pcwalimuni@gmail.com

PROJECT COMMUNICATION WITHIN SMALL AND MEDIUM-SIZED CONSTRUCTION FIRMS

B.M. Aidoo*, C.O. Aigbavboa and W.D. Thwala
Department of Construction Management and Quantity Surveying, Faculty of Engineering and Built Environment, University of Johannesburg, Johannesburg, South Africa

ABSTRACT

Communication is considered as a tool in the heart of management in enhancing project targets and Milestones not only in the construction sector but other sectors as well. The construction industry has however been characterized with its massive investment and associated risks. As a result, when main and sub-activities and tasks to be executed on project sites are not properly communicated among project teams and stakeholders, it will vehemently incur additional cost on the project, cause injury from accidents and may delay the entire project completion schedule amongst others. This exploratory study seek to establish the project communication structure used by construction SME's and also to develop a pattern within the communication structure of SME's that will avert uncertainties in a form of barriers to their communication. In order to accomplish the exploratory study, semi-structure interview sessions were conducted among construction professionals and clients via purposive sampling. The targeted population for the study was adequately prepared as a result of the prior notification for the interviews. Findings from the study revealed that most of the construction SME's do not have established communication structure in their operations. Further, the SME's only realized the need for a communication pattern when they encounter complex issues such as dispute on a claim with clients and stakeholders. The study recommends that prior to the execution of projects by SME's, the communication lines must be clearly defined as well as the reporting a system with an in-depth briefing for all team members and stakeholders to be privy.

Keywords: *Communication; Construction; Project; Small and Medium-Sized Firms.*

* Corresponding Author: E-mail – bemardmartins@hotmail.com

RE-EXAMINING CONTRACTOR'S BIM STRATEGIES: A CASE STUDY

Hongdi WANG, Leo Ke CHEN* and Weisheng LU

Department of Real Estate and Construction, The University of Hong Kong, Hong Kong

ABSTRACT

In the construction industry, building information modelling (BIM) is a promising technology to maintain a contractor's business competitive advantages. Although some BIM guides for contractors have been released by a set of countries or institutes, the BIM strategies as a part of contractors' business developmental strategies are rarely discussed. This paper aims to empirically investigate the BIM strategies for contractors from the institutional perspective. A case study of a German contractor is conducted. Data collected through interviews, site visit, and survey/questionnaire are analysed to identify the best practices in a leading contractor company in BIM lifecycle implementation. Suggestions are provided to better implement BIM in contractors' long-run business developmental strategies.

Keywords: *Building Information Modelling (BIM); BIM Strategies, Contractor.*

* Corresponding Author: E-mail - leochen@connecthku.hk

ROLE OF TECHNOLOGY IN PROVIDING BETTER BASIC FACILITIES FOR CONDOMINIUM PROPERTIES

M.D.O.M. Jayarathne and H. Chandanie*

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Sri Lanka, as a third world country, rapid urbanization has increased ranks of urban poor, creating demand for housing and urban services which has remained unsatisfied due to lack of resources and urban lands at reasonable prices. Hence, condominium construction has become popular in the present as a solution to provide accommodations for the increasing population. However, providing required facilities to its occupants is a major problem for the condominium management. According to the literature survey, two of condominium facilities, safety and security and ventilation have been identified as basic facilities which are having severe urge to be improved. Therefore the aim of the study was to explore how to improve the basic facilities in condominiums through the concepts of technology.

A comprehensive literature survey was carried out by referring books, journal articles, and relevant other publications leading to a case based field survey, where interviews and observations were used as the data collection techniques. Content analysis was used to analyse the qualitative data. Research has concluded that technology transfer will improve security and safety systems where the techniques identified being Condominium Elevator Safety, Finger Print Readers, Motion Sensors and Access Control. Further ventilation conditions were suggested to be improved through the Balance/Stack Ventilation, Solar Wall/Roof, Heat/ Energy Recovery Ventilators and Wind Catchers. However there are barriers in implementing new technologies which are identified as Lack of cost allocation, Poor mechanism of technology sourcing, transfer and management and Inadequate government or responsible parties' support and involvement.

Keywords: *BIM Strategies; Building Information Modelling (BIM); Contractor.*

*Corresponding Author: E-mail - chandanieqs@yahoo.com,

STRATEGIES TO ENHANCE SUSTAINABILITY OF PUBLIC PRIVATE PARTNERSHIP PROCUREMENT PROCESS FOR INFRASTRUCTURE DEVELOPMENT

Nilesh Agarchand Patil and Boeing Laishram*
Infrastructure Engineering and Management Division, Department of Civil Engineering, Indian Institute of Technology Guwahati, Guwahati, India

ABSTRACT

Public Private Partnerships (PPPs) have been used as one of the preferred modes for infrastructure development since the last two decades in India. The PPP programme in India, though, has stabilized significantly with lessons learnt from the experience of implementing PPP projects, but the PPPs in India still suffers from certain shortfalls which could be related to the failure to meet many aspects of sustainable development (SD) principles. One of the ways to overcome these shortfalls could to modify the procurement process so as to fulfil the principles of SD even through PPP route. The main aim of this paper is to develop a conceptual framework highlighting the strategies for integrating sustainability principles in procurement process of PPP projects.

Content analysis on existing literatures, research reports, and case studies on PPP projects has been adopted to first identify the shortfalls in PPP process and, secondly, examine the possible strategies from best practices being adopted in PPP projects executed all over the world. The preliminary framework on how to integrate the principles of sustainability is then conceptualized explaining how the formulated strategies can be integrated into PPP process. Finally, focused interviews with the key stakeholders of PPP projects have been undertaken to assess the feasibility of the preliminary framework.

The preliminary findings from the study indicate the opportunities to promote SD even through PPP route if procurement process is enhanced with respect to the following aspects by relooking the PPP process from the perspective of SD concepts and principles: stakeholder's participation, environment impact assessment, value for money analysis, user's charges and risk allocation policies, transaction and bidding cost, and bid evaluation criteria. The proposed framework will be a useful tool for the government to restructure the PPP procurement process in India to fulfil the SD goals, which are being currently pursued by the government rigorously.

Keywords: *Infrastructure Development; Procurement Process; Public Private Partnerships; Sustainability; Sustainable Development.*

* Corresponding Author: E-mail - boeing@ittg.ernet.in.com

STRENGTHENING THE SAFETY CULTURE IN RAW RUBBER PROCESSING STAGE THROUGH HUMAN CAPACITY BUILDING: A CONCEPTUAL FRAMEWORK

D.M.P.P. Dissanayake* and Nirodha Gayani Fernando
Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Safety and health in the raw rubber processing stage has been a neglected subject, though this sector is still a major foreign exchange contributor to the national economy in Sri Lanka. Occupational safety and health concerns in raw rubber processing organisations have always been and continue to be of the utmost importance. Thus, establishing and strengthening of the safety culture is most critical in raw rubber processing environments with a high risk of health and safety concerns. The cause analysis for failings related to safety culture in raw rubber processing sector are varied and far reaching; with each issue coming into play at one critical point in time. However, most of the weaknesses are related with 'Human factors: How people feel (Heart and Mind)', 'What people do (Daily Action)'. Thus, developing of human capacities such as attitudes, behaviours, skills and knowledge etc. on this perspective will be an effective tool in addressing those failures and strengthening the safety culture in raw rubber processing sector. This paper therefore aims to develop a conceptual framework for strengthening the safety culture in raw rubber processing stage through human capacity building. A comprehensive literature review was used as the research methodology for this paper. Research findings illustrated that yet, like in any other employment sector, workers involved in raw rubber processing activity run an equal if not higher risk of being injured as a result of the type of work they do. Due to management and worker ignorance and rubber products manufacturing chemicals and bad work practices in some factories, serious hazards have been created and many accidents have occurred. Strengthening the safety culture is about more than removing hazards and establishing safety procedures. It is about working with people of the organisation to change their attitudes, behaviours and thoughts, and improve their situational awareness. The finding of this research incorporated into a conceptual framework which proposes a better working condition so that the safety culture can be strengthen.

Keywords: *Human Capacity Building; Human Factors; Raw Rubber Processing Stage; Safety Culture.*

* Corresponding Author: E-mail - piumi2d@gmail.com

SUITABILITY OF CRITERIA FOR SELECTING A DELAY ANALYSIS TECHNIQUE SUITABLE TO ANALYSE DELAYS IN ROAD CONSTRUCTION PROJECTS IN SRI LANKA

E.M.K. Ekanayake*
Ministry of Infrastructure Audit, Oman

B.A.K.S. Perera
Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Delays in construction projects are inevitable and they are the most critical factor that affects the cost of a construction project. They have to be analyzed comprehensively using appropriate techniques so as to identify their impacts. This study was carried out to find out, the delay analysis techniques (DAT) that are used most commonly in road projects in Sri Lanka, the extent of their usage, problems that arises when they are used and the criteria for selecting a suitable technique. The research methodology adopted involved an extensive literature review, interviews and a questionnaire survey. The most commonly used DATSs were identified through the literature review and by interviewing four practitioners. A questionnaire survey was carried out among a group of 60 professionals selected through purposive sampling. It was found that five types of delay analysis techniques are mainly used in Sri Lanka to determine the delays encountered in road projects and the most commonly used such technique is the as-planned vs as-built analysis while the least used is the window analysis. The non-availability of professionals to analyze delays is found to be the main problem and acceptance by courts and tribunals is the most important criteria (out of nine identified criteria) used in selecting a delay analysis technique.

Keywords: *As-Planned vs As-Built Analysis; Criteria; Delay Analysis Techniques.*

* Corresponding Author: E-mail - gayuqs@yahoo.com

SUITABILITY OF GOVERNMENT BID EVALUATION PROCEDURE FOR BUILDING PROJECTS IN SRI LANKA

D.M.G.A.N.M. Sumanarathna* and B.A.K.S. Perera
Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

In Sri Lanka, a Contractor is selected through a bid evaluation procedure in construction projects and this is be a crucial step in the implementation of the project. The most frequently used bid evaluation procedure in Sri Lanka is the Government Bid Evaluation Procedure (GBEP), the Government being the client in most of the projects. Although GBEP is referred to in government publications, it has so far not been analysed in detail. This study therefore was conducted to identify the suitability of GBEP to local building projects.

Firstly, a literature synthesis and a desk study were carried out. The degree of use of GBEP identified from the literature synthesis was validated through semi structured interviews which also identified the advantages, disadvantages and limitations of GBEP.

The analysis reveals that a well-defined procedure, proper documentation, possibility of selecting the lowest evaluated bid are the major advantages of GBEP while the absence of a minimum eligibility criteria for preliminary bid evaluation, adjustments done by the evaluator, low accuracy of the Engineer's Estimate and non-consideration of the optimum bid are its major disadvantages and/or limitations. Suggestions are made to overcome the disadvantages and limitations. Flexibility on ICTAD registration, making allowance for discounts for variations, introduction of standard formats for reporting and prohibition of adjustments by the evaluator will enhance the transparency and accountability of GBEP.

Keywords: *Construction Industry; Contractor Selection; Engineer's Estimate; Government Bid Evaluation Procedure; Tender Evaluation.*

* Corresponding Author: E-mail - nipunisumanarathne@gmail.com

SUPERVISION OF FABRICATION OF PRECAST STEEL FIBRE REINFORCED CONCRETE (SFRC) SEGMENTAL LINING

George Varghees*
C@nspecs Pte Ltd., Singapore

ABSTRACT

Precast reinforced concrete (RC) segments have been widely used to construct tunnels for mass rapid transit lines in Singapore. However, the reinforcement bar cages are labour intensive to fabricate and install in moulds. Then the cages must be adjusted in moulds to achieve minimum cover at critical locations such as bolt sockets and cover to external face. Supervision has to be tight to achieve good quality segments.

However, with the use of steel fibre reinforced concrete (SFRC), steel reinforcement bars have been eliminated. Steel fibres are added during the batching of concrete. Concrete is then poured in moulds and compacted. Compaction is done by using external vibrators mounted on moulds. For downtown line stage 3 contract 933, SFRC segments were used as tunnel lining. C@nspecs Pte Ltd supervised the production of SFRC segments in the factory.

This paper outlines the quality control tests done on the fresh and hardened concrete.

Keywords: *Precast Reinforced Concrete; Steel Fibre Reinforced Concrete (SFRC).*

* Corresponding Author: E-mail - gv@conspecspl.com.sg

SUSTAINING THE FUTURE WITH LEGACY: A CASE STUDY ON THE UK GOVERNMENT CARBON EMISSION TARGETS 2025 AND LONDON OLYMPICS 2012

G.A.G.R. Godawatte*
School of Engineering and Built Environment, Glasgow Caledonian University, United Kingdom

ABSTRACT

The UK Construction 2025 Strategy states that the UK construction industry should be the world leader in sustainable construction by 2025. The Government views sustainable construction as an opportunity for growth within the UK as the industry seeks new markets across the globe. Mega projects such as the London Olympics 2012 and Glasgow Commonwealth Games 2014 have been viewed by Government as important drivers for innovation and an opportunity for demonstrating good practice to the wide industry. Lessons are emerging from these projects and have been incorporated into the development of the Government's vision for Construction 2025 with a view to further delivering sustainability in product and practice, but also with a view to establishing capacity. This paper mainly focuses on evaluating the Carbon Emission Reduction targets set by the UK Government in order to be in line with the current Sustainable Development practices. The study also includes an analysis of the Legacy set out by London Olympics 2012 which achieved a number of successful outcomes in terms of Sustainable Construction and Procurement. However, a number of traditional barriers within the construction industry are argued to be restricting the ability to progress the construction agenda at the rate intended. The evidence show that the UK is well within the Carbon Emission Reduction targets and the legacy from the London 2012 Olympic Games should provide for better construction practices in the future, provided that they are used in the correct context, and embraced by the key stakeholders from the outset.

Keywords: *Carbon Emissions; Construction; London Olympics; Sustainable Development; UK Government.*

* Corresponding Author: E-mail - gimhan.godawatte@yahoo.com

TEAM WORKING IN ROAD MAINTENANCE FUNCTIONS FOR SUSTAINABLE CONSTRUCTION IN SRI LANKA

H.G.N. Premakanthi

Department of Building Economics, University of Moratuwa, Sri Lanka

Sepani Senaratne*

School of Computing, Engineering and Mathematics, University of Western Sydney, Australia.

ABSTRACT

Road maintenance is a continuous process that ensures a proper road network with safe and comfortable riding facilities are available to the road users. Among the few research studies on road maintenance, most of them suggest better contractual arrangements to improve road maintenance performance. This paper takes a different stance by looking into the team working aspects of road maintenance teams and suggesting avenues to improve team performance for sustainable road maintenance in general. Literature lacks in discussing how teams perform in road maintenance activities. Hence, the aim of this research was to explore how team working takes place in road maintenance functions and how to improve team-working towards sustainable road maintenance in Sri Lanka. The case study research approach was selected for this study. Accordingly, three case studies with three Executive Engineer's Divisions within the Road Development Authority were undertaken. The findings revealed how maintenance personnel worked as teams during different phases of road maintenance. However, several areas needed improvement as suggested in the paper. These findings will be useful for performance improvements of road maintenance activities in general.

Keywords: *Case Studies; Road Maintenance; Team Performance; Team Working.*

* Corresponding Author: E-mail - s.senaratne@uws.edu.au

THE LEGAL FRAMEWORK FOR DESIGN LIABILITY IN BUILDING INFORMATION MODELLING

Thilina Laksiri Dissanayake*, Himal Suranga Jayasena and Mahesh Abeynayake

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Building Information Modelling (BIM) is a solution to achieve productivity, efficiency, life cycle enhancement and sustainability in the construction industry. It also promotes the two symbiotic factors information sharing and collaborative approach among the professionals. Transference from the conventional practice to BIM will make the design liabilities change and create legal uncertainties among the professionals. This was expected to be acting as an obstacle to achieve the desires in BIM's wider adoption and a suitable legal framework was found to be necessary. The solutions for the legal uncertainties arising from the new environment needs to be formulated and on the other hand in order to adopt BIM in an effective manner it requires identifying of these legal uncertainties and provides a clear vision for the client and the design team on how they should work in the changed environment. With this prime intention, this research was conducted adopting mixture of legal and scientific research methods. Initially preliminary literature synthesis was carried out which discussed the present legal environment with the expected change through BIM. The legal analysis was carried out following the flexible iterative style where the researchers' opinion blends with the experiences from primary sources of law to build up the tentative hypothesis. Through semi structured interviews with a group of experts representing different proficiencies in the construction industry, this tentative hypothesis was tested; the collected data from construction industry experts were subjected to content analysis based on opinions and suggestions, these findings were then interpreted to identify the suitable legal framework. The legal framework which was identified includes the preventive mechanism of negligent acts, liabilities of the human factor, process and enforceability, actions, proposed provisions and suggestion. Hence, this framework is recommended to be implemented in the BIM environment.

Keywords: *Building Information Modelling (BIM); Construction Industry; Design Liability.*

* Corresponding Author: E-mail-thilinal,dissanayake@gmail.com

TRAINING AND DEVELOPMENT FRAMEWORK TO IMPROVE EMPLOYEE JOB PERFORMANCE IN PUBLIC SECTOR BANKS IN SRI LANKA

M.L.Thilini Saubhagya Chandrasiri* and Nirodha Gayani Fernando

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Sri Lankan banking industry has grown rapidly due to the entrance of the new private banks other than the public banks. Consequently, customer attraction towards the private banks has been increased due to the customer dissatisfaction with employee job performance in public banks. This was revealed that training and development is one of human resource management strategy in enhancing the employee job performance. Therefore, the requirement of effective training and development is emerged in order to mitigate the discrepancies in employee job performance in public sector banks in Sri Lanka while overcoming the training gaps in prevailing procedure. Hence, the aim of this research is to develop an effective training and development framework to improve the employee job performance in Sri Lankan public sector banks. Accordingly, case study research was selected as the most suitable research approach for this study since in-depth investigation is required to identify the weaknesses in prevailing training and development procedure. Fourteen interviews were conducted, representing the senior managers, branch managers and banking assistants in public sector licensed commercial banks. The collected data through the interviews was analysed using content analysis. The research finding of this study revealed several weaknesses in prevailing training and development procedure such as poor design of orientation program, poor content of training program, poor choice of training, poor evaluation of training program and poor performance evaluation practice. Finally, a training and development framework was proposed in order to overcome those weaknesses in prevailing training and development procedure.

Keywords: *Employee Job Performance; Public Sector Banks; Training and Development.*

* Corresponding Author: E-mail - scthilini@gmail.com

USE OF LOCALLY AVAILABLE MATERIAL TO DEVELOP A TREATMENT TECHNIQUE TO REDUCE THE WATER ABSORPTION CAPACITY OF RECYCLED AGGREGATES

W.K.A. Madawa*, R.M.S.I.B. Rathnayake, D.B. Wijethunga,T.C. Gamage and S. Karunarathne

Department of Earth Resources Engineering, University of Moratuwa, Sri Lanka

ABSTRACT

This study was to find a treatment technique to reduce the water absorption of Recycled Aggregates (RA) which involved preparing a coating to reduce the water penetration. The materials considered for the preparation of coating was Termite Mound Soil (TMS) and ordinary Portland cement. The objective was to find their optimum proportions and the slurry thickness for a coating that gives the lowest absorption. TMS was tested for pozzolanic properties. Chemical composition was tested using Atomic Absorption Spectroscopy and other analytical techniques. Mainly water absorption, particle size distribution, AIV, LAAV of RA was tested to ensure the suitability for construction purposes. Slurry was prepared using cement replacement levels of 0, 20, 40, 60 and 80% of TMS. Three sets of coatings were prepared with water to solid ratios of 1, 1.25 and 1.5. Slurries were prepared in a concrete mixture in which the aggregates were coated for 10 minutes at a speed of 30rpm. After air drying, coated aggregates were tested for the absorption after 14 days. The absorption of treated aggregates was compared with those of natural and untreated recycled aggregates. From the successful aggregate batches three concrete test cubes were prepared from each and tested for the 28 day compressive strength after curing for 28 days. Strength values were compared with those prepared with natural aggregates. Aggregates Coated using 50% cement and 50% TMS showed a significant reduction in the water absorption up to 38.44%. The strength of concrete made from aggregates treated with 50% TMS replacement along with the water solid ratio 1 was 37.15N/mm2 whereas the value obtained from natural aggregates was 37.3N/mm2

Keywords: *Coating; Recycled aggregates; Termite mound soil; Water Absorption.*

* Corresponding Author: E-mail - mayouran@bimlab.net

VACANT BUILDINGS IN INFRASTRUCTURE PROJECTS: STRATEGIES FOR REUSE

Vaishali Anagal*, Dharati Sote and Shamishtha Ruikar

Dr. B. N. College of Architecture, Pune, India

ABSTRACT

Vacant Buildings in infrastructure projects has become a serious environmental and economic issue in Indian planning scenario. Several instances of newly constructed unoccupied buildings indicate wastage of financial and environmental resources such as virgin building materials and most importantly land resource. Vacant vegetable markets constructed as a part of public infrastructure projects by municipal authorities in many cities particularly in the city of Nasik is a glaring example of such redundant investments in Maharashtra state of India. Large scale presence of abandoned, vacant and unoccupied buildings is resulting into an ineffective use of resources and increasing risk to first responders and the community. Vacant and abandoned properties, whether residential or commercial, are a drain on city budgets in addition to detracting from the quality of life, as well as the economic opportunities, of those living around them. They are an impediment to individual neighbourhood redevelopment and, ultimately, to achievement of city wide economic development goals. Minimizing the harm done by vacant and abandoned properties and restoring these properties to productive use are priorities for city planners across the globe. This research attempts to quantify the amount of resources in terms of embodied energy invested into such projects using a case study method. It further evaluates the reuse potential of such built spaces to prompt the meaningful use of resources by investigating its structural capacity and architectural configuration. A spatial analysis with respect to adjacent land uses will also be done to identify the best suitable reuse of the case-study building. Finally, this research draws conclusions to suggest planning strategies to prevent building vacancy in public sector buildings and also reuse strategies for existing unoccupied buildings to evade wastage of environmental resources.

Keywords: *Building Reuse; Infrastructure Projects; Reuse strategies; Vacant Buildings.*

* Corresponding Author: E-mail - vmanagal@rediffmail.com

VALUE ENGINEERING PRACTICES AND ITS IMPACT TO CONSTRUCTION INDUSTRY

R.G. Kosala* and Gayani Karunasena

Department of Building Economics, University of Moratuwa, Sri Lanka

ABSTRACT

Value engineering (VE) is a systematic method to elevate the value of goods, products and services. Purpose of this paper is to investigate the current situation and real practice of VE technique in Sri Lankan construction sector and to give recommendations to construction organisations and national level construction regulatory bodies to standardize, VE practices toward achieving value for money for all stakeholders. A broad literature survey was carried out and seven case studies, thirty nine interviews and six expert interviews were conducted among construction professionals, who are having extensive knowledge on VE technique in Sri Lankan construction industry to gather facts. Content analysis and cognitive mapping were used in this research to analyze data and to identify the patterns of cases.

Findings of the research revealed that the application, knowledge and experience of construction professionals are not satisfactory in VE technique. Some recommendations can be mentioned as reduce contractor's design responsibility, introduce a proper VE guideline and regulate VE technique by law. This research is an ongoing research and a framework is going to build up which will help authorities to improve the applicability of VE technique. A formula is also going to form to determine a margin between contractor's portion due to VE technique and original profit of the contractor.

Keywords: *Construction Industry; Stakeholder; Value; Value Engineering.*

* Corresponding Author: E-mail - kosala.gamage.1989r@gmail.com

WATER EFFICIENCY TECHNIQUES AND STRATEGIES FOR SUSTAINABLE USE OF WATER DURING CONSTRUCTION PHASE OF BUILDING PROJECTS

K.G.A.S. Waidyasekara* and Lalith de Silva

Department of Building Economics, University of Moratuwa, Sri Lanka

R. Rameezdeen

School of Natural and Built Environment, University of South Australia, Australia

ABSTRACT

A significant wastage and misuse of water in construction sites has been identified as a critical problem by previous researchers. However this aspect has not been well explored in the current literature. Therefore, this paper aims to explore the appropriate techniques and strategies to be adopted in construction sites for efficient water use. Moreover, the ways and means of sustainable use of water in construction projects is suggested. Various techniques and strategies of efficient water use were identified through a literature review and taken to the professionals involved in construction through a structured questionnaire survey to identify and rank their relevance to construction. Data was analysed through descriptive statistics and non-parametric tests using SPSS software. The findings of this study highlight the top five applicable water efficiency techniques to be: water audits, water leak detection and monitoring systems, pressure reduction valves, high pressure trigger operated spray gun hoses and sub-metering.The top five applicable strategies were: monitoring and supervision, implement environmental policies on natural resources, enhance water awareness among workers, assign responsibility and targets among the site staff and introduce water action plan at the beginning of the project.In addition, the paper discusses the professionals' views on practical implications of improving the uptake of water efficiency techniques and strategies. Cost was identified as the main barrier for implementing water efficiency practices in Sri Lanka.

Keywords: *Construction; Strategies; Techniques; Water efficiency.*

* Corresponding Author: E-mail - anulk15@yahoo.com

ACKNOWLEDGEMENTS

The Organising Committee would like to express its sincere appreciation to the following individuals and organisations who have contributed to the success of the symposium:

Chief Guest
Guest of Honour
Keynote Speaker
All Distinguished Guests
All Distinguished Speakers

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

All the Associate Partners
Liverpool John Moores University (LIMU),
Centre for Infrastructure & Construction Industry Development, The University of Hong Kong,
Indian Institute of Technology Madras (IIT Madras),
CIB-TG 72 (Public Private Partnership), CIB- W092 (Procurement Systems) and
Colombo School of Construction Technology (CSCT)

Editor-in-Chief, Publisher and Editorial Assistant of Built Environment Project and Asset Management (BEPAM) Journal, Emerald Group Publishing Limited.

All the Government and other Institutions including
Ministry of Housing and Samurdhi,
Ministry of Highways and Investment Promotion,
Institute of Engineers, Sri Lanka (IESL),
Institute of Quantity Surveyors Sri Lanka (IQSSL),
Chamber of Construction Industry (CCI),
Organisation for Professional Associations of Sri Lanka (OPA),
Federation of Chambers of Commerce and Industry of Sri Lanka (FCCISL),
Urban Development Authority (UDA).

Scientific Committee Members
Symposium Session Chairs
All the Members of Panel Discussion
Session Coordinators
Symposium Secretariat
All Paper Presenters

All sponsors and supporting partners:

Silver Sponsors – Sierra Cables Plc., Ranjanas Ceremics (Pvt.) Ltd., Melwire Group, Abans Group of Companies, Kelani Cables Plc, GTB Colombo Corporation Pvt.

Bronze Sponsor - ACL Cables Plc

Supporting Partner: Investors Forum – Board of Investment (BOI)

Partners in Green Building Awards - True Value Product (Pvt) Ltd., Orange Electric, Reliable Group

Official Banker – Hatton National Bank Plc.

Print Media Sponsor – Associated Newspapers of Ceylon Ltd.

All Other Sponsors

Galadari Hotel

Printers - Senevi Creation

Web Designer – Aurora Systems

Creative Work – Seven Rays Creative Solutions

Event Management – Aura Event

AND all those who have helped in one way or another

Sponsors & Partners

Sponsors & Partners

Organised by

Ceylon Institute of Builders
CIOB
Institute for Building Professionals
Established 1961

International Sponsor

cib

Endorsed By

BCA

Associate Partners

LIVERPOOL JOHN MOORES UNIVERSITY

CIB 92

CIB 72

Silver Sponsors

sierra Cables

Abans

Ranjanas CERAMIC
MELWA

KELANI CABLES

Trust Yourself... Trust GTB
GTB STEEL
Corporation (Pvt) Ltd.

Bronze Sponsor

ACL CABLES

Official Banker

HNB

Media Sponsor

ANCL

Convention Partners

Partners

TRUE VALUE

RANGE ELECTRIC

Reliable Group

The Ceylon Institute of Builders (CIOB)

www.ciob.lk

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 lead to gaining corporate membership of the institute.

University of Moratuwa – Department of Building Economics

www.becon.mrt.ac.lk

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 specializes in research in Building Economics and Management in the country as well as internationally.

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

www.cibworld.nl

The CIB acts as a global network for international cooperation and information exchange in building and construction research and innovation. CIB collaborates with 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.

Liverpool John Moores University (LJMU)

www.ljmu.ac.uk

Ranked in the top 400 universities world-wide in the Times Higher Education World University Rankings 2013-14, the exceptional student experience LJMU offers is founded on high quality teaching, ground-breaking research and dedicated staff throughout the University.

Centre for Infrastructure & Construction Industry Development (CICID) of the Department of Civil Engineering of the University of Hong Kong

www.civil.hku.hk/cicid

The Centre for Infrastructure & Construction Industry Development (CICID) of the Department of Civil Engineering of the University of Hong Kong, was established in November 2002. The aims include fostering continuous improvements, while targeting excellence in the construction industry in general and infrastructure development in particular, through the development of innovative strategies and techniques.

CIB W92 & CIB TG72

CIB W92 and CIB TG72 brings knowledge and expertise in the fields of procurement systems and public-private partnerships respectively.

Indian Institute of Technology, Madras

www.iitm.ac.in

Indian Institute of Technology Madras is one among the foremost institutes of national importance in higher technological education, basic and applied research. The Institute has sixteen academic departments and a few advanced research centres in various disciplines of engineering and pure sciences, with nearly 100 laboratories organised in a unique pattern of functioning.

Colombo School of Construction Technology (CSCT)

csct.edu.lk

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.

Ceylon Institute of Builders
No: 4-1/2, Bamabalapitiya Drive, Colombo 04, Sri Lanka
T: +94 112 508 139, +94 113 140 355 | F: +94 112 506 491 | E: info@ciob.lk | W: 2015ciobwcs.com

9 772362 093006
ISSN 2362-0935