

The 7th World Construction Symposium - 2018

Built Asset Sustainability: Rethinking Design, Construction and Operations

29th June - 1st July 2018



GALADARI HOTEL COLOMBO

Programme & Abstracts

Organized by



CEYLON INSTITUTE OF BUILDERS (CIOB) SRI LANKA



DEPARTMENT OF BUILDING ECONOMICS UNIVERSITY OF MORATUWA

THE 7TH WORLD CONSTRUCTION SYMPOSIUM 2018

BUILT ASSET SUSTAINABILITY: RETHINKING DESIGN, CONSTRUCTION AND OPERATIONS

29 June - 01 July 2018

at Galadari Hotel Colombo, Sri Lanka

Organised by Ceylon Institute of Builders (CIOB), Sri Lanka &

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

With Associate Partners

Liverpool John Moores University (LJMU), United Kingdom Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Hong Kong Indian Institute of Technology Madras (IIT Madras), India Western Sydney University, Australia East Carolina University, United States of America CIB-W122: Public Private Partnership Colombo School of Construction Technology (CSCT), Sri Lanka Built Environment Project and Asset Management (BEPAM): Journal, published by Emerald Group Publishing

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MESSAGES

Prof. Chitra Weddikkara Chairperson The 7th World Construction Symposium 2018



It is a great pleasure to welcome all the participants for the 7th World Construction Symposium 2018 in Colombo, Sri Lanka on behalf of the organising committee. Ceylon Institute of Builders (CIOB) as the main organiser, is doing an incredible job to educate, train and motivate the Sri Lankan builders to be high ranking professionals in the industry with the collaboration of Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics, University of Moratuwa and other associate partners.

As a unique field, construction industry gets affected from numerous challenges due to climate change, technology changes and even changes of the human desires. All stakeholders in construction industry are therefore, required to explore innovations to overcome the challenges, while making the environment green and promoting sustainability aspects. At this 7th milestone of the journey, it is a great pleasure to note how far the symposium series have developed since our first World Construction Symposium on "Global Challenges in Construction Industry" in 2012. For this 7th symposium on "Built Asset Sustainability: Rethinking Design, Construction and Operations" we have received over 60 scientific papers, out of which, over 20 papers are from international delegates. All papers presented at the symposium are subjected to double blind peer review process of the panel of scientific committee members comprising of world class intellectuals in order to assure quality of knowledge dissemination. Authors discuss various aspects related to built environment sustainability over the design, construction and operations phases such as, carbon and energy management, cost management, procurement methods, green retrofitting, waste management, health and safety, innovative technologies, etc.

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

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



It gives me great pleasure in welcoming each one of you for this 7th World Construction Symposium 2018. This Symposium provides an opportunity for the participants to share their knowledge, new research findings and other developments in relation to Sustainable Built Environment.

Developments in other industrial sectors are enabling the construction industry to make great advancements in designing and managing construction projects. Advancements in Communication and information technologies are shaping collaboration and communication between multidisciplinary teams in construction industry in ways that were not possible a few years back. Therefore, it is imperative that we develop new techniques & methods that could be used in this evolving scenario. Considering this, the organising committee in consultation with the scientific committee for this year's symposium has selected the theme 'Built Asset Sustainability: Rethinking Design, Construction and Operations.

Collaboration between industry and academia supports improvement and innovation in the industry and helps to ensure industrial relevance in academic research. Academics, public sector and private sector involved in construction should forge new alliances and find ways to bridge the gap between research done in academia and its translation into implementable systems in the industry. It is our belief that this symposium will act as the spring board for successful industry academic partnerships in future.

I wish that every one of you would find the Symposium inspirational and rewarding, and I wish the symposium every success.

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



I take great pleasure in welcoming you to the World Construction Symposium 2018. It is a matter of pride that our institute, Ceylon Institute of Builders have been able to host the World Construction Symposium annually since 2012. The Symposium has become a popular event for both the academics and professionals in the Construction industry in Sri Lanka. I am sure that this Symposium will live up to their expectations and enable the participants to gain knowledge from the presentations and the discussion at the Symposium.

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

We are also thankful to Liverpool John Moores University - United Kingdom, Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Indian Institute of Technology Madras (IIT Madras), Western Sydney University - Australia, East Carolina University - USA, CIB-W122: Public Private Partnership, Colombo School of Construction Technology - Sri Lanka (CSCT) and Built Environment Project and Asset Management (BEPAM): Journal, published by Emerald Group Publishing for being the Associate Partners of the Symposium.

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

As in the previous Symposiums, this Symposium has been greatly supported by the ministries and professional institutions that have helped us in organizing this Symposium. We will fail in our duty, if we don't thank all of our Sponsors and well-wishers for your generous contribution. You had enabled us to successfully plan and organize this Symposium.

Mr. Sagara Gunawardena

Mr. Kalana Alwis

Co-Chairpersons The 7th World Construction Symposium



On behalf of the Organising Committee, we warmly welcome all the delegates to the 7th World Construction Symposium to be held from 29th June to 1st July 2018 at Hotel Galadari. This is an exciting venture organized jointly by the Ceylon Institute of Builders and Department of Building Economics, University of Moratuwa.

The purpose and vision of this symposium is the promotion of academic and research activities in the field of Sustainable Construction. The Symposium will bring like-minded individuals on one platform to discuss new trends and challenges in the field of Sustainable construction. In the Symposium, Sri Lankan academics, research scholars and practitioners will get the opportunity to interact with eminent experts in Green construction from other countries.

We are honoured to have a renowned team of academics and researchers to serve on the scientific committee, providing comprehensive reviews to the submissions. The extensive technical programme developed by the scientific committee, includes three concurrent papers/presentation tracks allowing opportunities for participants to earn professional development hours (PDHs) for professionals and researchers. The paper presenters will be sharing their knowledge, experience and findings on the above theme which I am sure will benefit all the participants.

The symposium also will feature a panel discussion on 'Liveable Cities' in which our participants could gain valuable insights in the management of modern cities.

Our sincere thanks to the members of the organizing committee and the scientific committee for working arduously to put together what promises to be a productive weekend. We would like to take this opportunity to thank the authors, who submitted their valuable research results to the symposium, and the symposium attendees participating in the sessions sharing research ideas.

We hope that the delegates will have an enjoyable and fruitful stay in Colombo and return home with fond memories.

We wish the Symposium grand success.



It is a privilege to send this message to the 7th World Construction Symposium 2018, jointly organised with the efforts of the Ceylon Institute of Builders (CIOB) and Department of Building Economics, University of Moratuwa.

With its focus on Built Asset Sustainability: Rethinking Design, Construction and Operations, this conference provides a platform for intellectuals, professionals, researchers and entrepreneurs worldwide to debate and exchange knowledge and ideas on a broad range of issues in construction. This is highly relevant to University of Moratuwa with its focus towards promoting nationally relevant and high-impact research to expand the boundaries of knowledge and to enhance the national technological capabilities. Thus, this international event makes a key contribution towards realising the University's vision of becoming the most globally recognised Knowledge Enterprise in South Asia. I expect that this conference would provide a great opportunity for the Sri Lankans to build networks with world community and vice versa for productive joint activities after the symposium in terms of research and knowledge sharing.

I wish all the success for 7th World Construction Symposium 2018, and wish all the conference contributors and participants an enjoyable and fruitful experience.

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 7th World Construction Symposium 2018. This is an imperative venture jointly organised by Cevlon Institute of Builders (CIOB) and the Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka for the seventh consecutive year. This year's symposium is further strengthened by the associate partnerships of Liverpool John Moores University, United Kingdom; Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Hong Kong; East Carolina University, USA; Western Sydney University, Australia; Indian Institute of Technology Madras (IIT Madras), India; Colombo School of Construction Technology (CSCT), Sri Lanka: CIB-W122: Public Private Partnership; and Built Environment Project and Asset Management (BEPAM): Journal, published by Emerald Group Publishing. The awards arranged by BEPAM as well as CIOB has further enriched the symposium. After the end of the 30-year civil war, the Sri Lankan construction industry is now experiencing significant growth in all its sectors rivaling many other countries in the region. The essence of sustainability and eco-innovations are emerging in modern constructions as a fundamental necessity to sustain the country's future. In this context, the symposium theme "Rethinking design, construction and operations for built asset sustainability" is timely.

The 7th World Construction Symposium provides a platform for both local participants and international delegates to share their knowledge and ideas with regard to the sustainable design, construction and operations of built assets. I hope all delegates would take this opportunity to share their knowledge, ideas and views on the theme of the year.

I wish the 7th World Construction Symposium 2018 every success.

KEYNOTE SPEAKER

Prof. Peter McDermott Professor of Construction Management School of the Built Environment University of Salford United Kingdom



Professor McDermott is a founder member and Joint Coordinator of the World CIB Working Commission (W92) into Construction Procurement. From this international perspective and from the academic base at Salford, Peter seeks to apply the results of research into the policy and practice nationally and regionally in the UK. Peter draws upon his own and others research work, demonstrating how effective procurement can be the lever for improved social and economic performance in the construction and infrastructure sectors. These ideas have been well rehearsed in the international literature, but are now playing out through public policy, with new developments around industrial strategy and an increasing emphasis on social value. Peter will draw upon his experiences from having developed procurement and performance management systems with major regional and national public sector clients, and working national and regional infrastructure strategies. He will especially draw upon his experience as a developer of and independent member of the Board for the North West Construction Hub (NWCH) strategic framework and from chairing the change agency that is Constructing Excellence in the North-West of England.

SYMPOSIUM ORGANISERS AND ASSOCIATE PARTNERS

SYMPOSIUM ORGANISERS

The Ceylon Institute of Builders (CIOB), Sri Lanka

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

www.ciob.lk

Department of Building Economics, University of Moratuwa, Sri Lanka

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

www.becon.mrt.ac.lk





ORGANISING COMMITTEE

Chairperson	Prof. Chitra Weddikkara
Co-Chairpersons	Eng. 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 Mr. Sudath Amarasinghe Mr. Sampath Thushara Wijesekera Dr. Tissa Meepe
Scientific Committee Chairpersons	Dr. Yasangika Sandanayake Dr. Sachie Gunatilake Dr. Anuradha Waidyasekara
Symposium Secretariat	Ms. Piumi Dissanayake Ms. Pavithra Ganeshu Mr. Rohana Balasuriya Ms. Malathi Piyasena Ms. Savindi Perera Ms. Damithri Melagoda Ms. Chamitha Wijewickrama Mr. Tharindu Karunaratne Mr. V. Ramanah

SYMPOSIUM ASSOCIATE PARTNERS

Liverpool John Moores University, United Kingdom

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

www.ljmu.ac.uk

Centre for Innovation in Construction and Infrastructure Development (CICID), The University of Hong Kong, Hong Kong

The Centre for Innovation in Construction and Infrastructure Development (CICID) based at 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.

www.civil.hku.hk/cicid

Indian Institute of Technology Madras (IIT Madras), India

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 unique pattern of functioning.

Western Sydney University, Australia

Western Sydney University is a world-class university with a growing international reach and reputation for academic excellence and impact-driven research. It is ranked amongst the top three percent of universities in the world, globally focused, researchled and committed to making a positive impact - at a regional, national and international level. It was established as a modern university in 1989 from its predecessors dating back to 1891. The WSU currently have over 40,000 students in a sprawling series of campuses across the Western Sydney region.

https://www.westernsvdnev.edu.au/





www.iitm.ac.in





East Carolina University, USA

East Carolina University is located in the coastal plains region of North Carolina in the city of Greenville. Greenville has a broad range of cultural, social, and community activities. East Carolina University is the fastest growing and third largest university among the 17 campuses in the University of North Carolina (UNC) system with over 29,000 students. The College of Engineering and Technology is comprised of four departments: Computer Science, Construction Management, Engineering, and Technology Systems. The College serves over 3,000 undergraduate and graduate students.

CIB-W122: Public Private Partnership

The CIB Working Commission on PPP was established in February 2017 to replace the former CIB Task Group TG72 - Public Private Partnership. The Commission will provide an international research and development platform for academics, practitioners and policy experts in the field at international, national and regional levels through seminars, meetings, other fora and publications.

http://site.cibworld.nl/db/commission/browserecord_comm.php?&commission_no=W122

Colombo School of Construction Technology (CSCT), Sri Lanka

The CSCT was established in 2008, with the motto 'Sapientia et Doctrina', which is Latin for Wisdom and 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.

Built Environment Project and Asset Management (BEPAM): Journal, published by Emerald Group Publishing

BEPAM provides, a unique one-stop forum that publishes peer-reviewed research and innovative developments in both project management and asset / facilities management of building and civil engineering infrastructure. The journal also targets important interface issues between the planning, design and construction activities on

Colombo School of Construction Technology



www.csct.edu.lk



CIB W122: Public Private Partnership



the one hand, and the management of the resulting built assets / facilities on the other. Launched in 2011, BEPAM is well established internationally, e.g., being encouraged by CIB, recognised by the Australian Business Deans Council and indexed in SCOPUS, EBSCO, INSPEC and the Emerging Sources Citation Index (ESCI) of Thomas Reuters.

www.emeraldinsight.com/bepam.htm

SCIENTIFIC COMMITTEE

Chairpersons

Dr. Yasangika Sandanayake	University of Moratuwa, Sri Lanka
Dr. Sachie Gunatilake	University of Moratuwa, Sri Lanka
Dr. Anuradha Waidyasekara	University of Moratuwa, Sri Lanka

Members

Prof. Alfredo Serpell	Universidad del Desarrollo, Chile
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Dr. Anupa Manewa	Liverpool John Moores University, United Kingdom
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Dr. Chandanie Hadiwattege	University of Moratuwa, Sri Lanka
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Dr. Nirodha Fernando	University of Salford, United Kingdom
Dr. S.B.A. Cooray	University of Moratuwa, Sri Lanka

Dr. Sepani Senaratne	University of Western Sydney, Australia
Assistant Prof. Sivakumar Palaniappan	Indian Institute of Technology, Madras, India
Prof. Srinath Perera	University of Western Sydney, Australia
Prof. Steve Rowlinson	The University of Hong Kong, Hong Kong
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Prof. Syed M. Ahmed	East Carolina University, United States of America
Dr. Thilini Jayawickrama	University of Moratuwa, Sri Lanka
Dr. Thanuja Ramachandra	University of Moratuwa, Sri Lanka
Dr. Udayangani Kulatunga	University of Moratuwa, Sri Lanka

SYMPOSIUM INFORMATION

The 7th World Construction Symposium

The symposium is on 29 June 2018 from 12.00 noon to 06.30 pm and on 30 June 2018 from 08.30 am to 04.30 pm at the Galadari Hotel, Lotus Road, Colombo 01. The inauguration is held at Grand Ballroom, Galadari Hotel.

Fellowship and Awards Night

The Fellowship and Awards Night is held on 30 June 2018 at Ramada Hotel, No. 30, Sir Mohamed Macan, Colombo 03 from 07.00 pm onwards. Foreign participants those who have requested transportation from Galadari to Ramada Hotel and the return, please assemble at the hotel lobby at 06.30 pm. The foreign guests will be transported back to the hotel at 10.30 pm from Ramada Hotel.

Symposium Secretariat

Ceylon Institute of Builders (CIOB), 4-1/2, Bambalapitiya Drive, Colombo 04, Sri Lanka

Tel : 0094-11-2508139 (Rohana)

Fax : 0094-11-2508139

Email : info@ciobwcs.com

Website : http://2018.ciobwcs.com

Language

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

Dress Code

Symposium - Business, Lounge or National Fellowship and Awards Night - 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:

 29 June 2018
 - 12.00 noon to 06.30 pm

 30 June 2018
 - 08.30 am to 04.00 pm

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 12.00 noon to 05.30 pm on 29 June and 8.30 am to 4.00 pm on 30 June 2018.

Awards

Following awards will be presented during the symposium Fellowship and Awards Night on 30 June 2018. Award winners will be announced during the symposium sum-up.

- BEPAM Best Paper Award (with a certificate and a prize of 12 months online subscription for the author(s))
- Two (02) BEPAM Highly Commended Paper Awards (with a certificate for the author(s) of each Highly Commended Paper)
- CIOB Best Paper Award
- CIOB Best Presenter Award

Certificate of Attendance

A certificate of attendance will be issued to all participants, after the symposium sumup.

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 AND SESSION PLAN

SYMPOSIUM PROGRAMME

International Construction EXPO 2018 at BMICH

- 09.00 am **Opening Ceremony** BMICH Friday, 29 June 2018 at Galadari Hotel 12.00 noon Symposium Registration 12.30 pm Lunch 01.30 pm Symposium Inauguration Grand Ballroom 01.40 pm Welcome address by President, CIOB Dr. Rohan Karunaratne Address by Conference Chairperson 01.50 pm Prof. Chitra Weddikkara Address by Guest of Honour, Vice Chancellor, 02.00 pm University of Moratuwa Prof. K.K.C.K. Perera 02.15 pm Address by Chief Guest 02.30 pm Keynote Address on "Putting sustainability at the heart of an industrial strategy: social value for the construction and infrastructure sectors" Prof. Peter McDermott 03.10 pm Address by Representative from Associate Partners Prof. Srinath Perera 03.20 pm Address by Editor-in-Chief, BEPAM Prof. Mohan Kumaraswamy 03.30 pm Address by Representative from Associate Partners Prof. Andrew Ross 03.40 pm Vote of Thanks by Hony. Secretary, CIOB Eng. Saliya Kaluarachchi
- 03.50 pm End of Symposium Inauguration

- 04.00 pm Tea / Coffee Break
- 04.30 pm Parallel Session 1 (There will be FOUR parallel sessions)

Salon Orchid 1 Salon Orchid 2 Salon Jasmine VIP Lounge

06.30 pm End of Day 1

Saturday, 30 June 2018 at Galadari Hotel

08.30 am	Registration	
09.00 am	Parallel Session 2 (There will be FOUR parallel sessions)	Salon Orchid 1 Salon Orchid 2 Salon Jasmine VIP Lounge
10.30 am	Tea / Coffee Break	
11.00 am	Parallel Session 3 (There will be FOUR parallel sessions)	Salon Orchid 1 Salon Orchid 2 Salon Jasmine VIP Lounge
12.30 pm	Lunch	
01.30 pm	Panel Discussion on: "Challenges for Creating Liveable Cities"	Bougainvillea Ballroom
03.30 pm	Tea / Coffee Break	
04.00 pm	Rapporteur's Report by Dr. Thilini Jayawickrama Dr. H. Chandanie	
04.15 pm	Announcing the Award Winners	
04.25 pm	Vote of Thanks by Scientific Committee Co-Chairperson	
04.30 pm	End of Programme	

Fellowship and Awards Night at Ramada Hotel

07.00 pm Fellowship and Awards Night

Liberty Ballroom

Sunday, 01 July 2018

06.30 am Cultural and Networking Tour

SYMPOSIUM SESSION PLAN AT-A-GLANCE																
	Friday, 29 June 2018					Saturday, 30 June 2018										
08.30 - 09.00							Registration									
09.00 - 09.15								S11130		S11132		S11104		S11144		
09.15 - 09.30								S11109		S11060		S11089	Session 2D	S11114		
09.30 - 09.45							Session 2A	S11087	Session 2B	S11057	Session 2C	S11058		S11052		
09.45 - 10.00									S11061			S11136		S11054	S11076	
10.00 - 10.15										S11069				S11093		S11145
10.15 -10.30				EX	PO				Q&A Q&A Q&A							
10.30 - 11.00				BM	ICH							Tea / Cot	ffee Break			
11.00 - 11.15										S11137		S11051		S11084		S11105
11.15 - 11.30										S11065		S11053		S11139		S11077
11.30 - 11.45								Session 3A	S11071	Session 3B	S11088	Session 3C	S11055	Session 3D	S11083	
11.45 - 12.00										S11129		S11146		S11082		S11103
12.00 - 12.15				Portic	tration					S11080		S11072		S11140		S11115
12.15 - 12.30	negistration						Q&A Q&A Q&A									
12.30 - 13.30								Lur	ich							
13.30 - 13.45																
13.45 - 14.00	14.00															
14.00 - 14.15	14.15						Panel Discussion on "Challenges for Creating Liveable Cities"									
14.15 - 14.30	14.30 Symposium Inauguration 14.45 Galadari Hotel															
14.30 - 14.45																
14.45 - 15.00	15.00															
15.00 - 15.30	5.30															
15.30 - 16.00									Tea / Coffee Break							
16.00 - 16.30	10 Tea / Coffee Break									Symposiu	m Sum-Up					
16.30 - 16.45		S11078		S11056		S11086		S11062								
16.45 - 17.00		S11094		S11066		S11102		S11081								
17.00 - 17.15	Session	S11106	Session	S11075	Session	S11113	Session	S11090								
17.15 - 17.30	1A	S11108	1B	S11135	10	S11064	1D	S11091								
17.30 - 17.45		S11079		\$11131		S11070]	S11138								
17.45 - 18.00		S11112		S11107		S11085		S11143								
18.00 - 18.30	Qa	&A	Q	&A	Qa	&A	Qá	&A								
19.00 - 22.30											Fe	ellowship an Ramad	d Awards N la Hotel	ight		

DETAILED SESSION PLAN

Friday, 29 June 2018

Session 1A

Theme Session Chair Venue/Time	FM for Sustainable Built Environment Prof. Kevin Zhang Salon Orchid 1 – 04.30 pm – 06.30 pm				
Time	Paper ID, Title and Author(s)				
04.30 - 04.45 pm	S11078 – Customer Relationship Management in Facilities Management: A Study of Office Buildings in Sri Lanka				
	H.M.P.K. Herath, Damitha Rajini, Uthpala Rathnayake and Nimesha Jayasena				
04.45 - 05.00 pm	S11094 – Managing Challenges of High-Rise Residential Buildings in Sri Lanka: A FM Framework				
	M.M.M. Rifas, N.H.C. Manjula, D.M.P.P. Dissanayake, and S.D.A. Soorige				
05.00 - 05.15 pm	S11106 – Key Performance Indicators for Measuring the Performance of Facilities Management Services in Hotel Buildings: A Literature Review				
	W.D.I.J. Fernando, D.M.P.P. Dissanayake, N.H.C. Manjula and A.S. Weerasinghe				
05.15 - 05.30 pm	S11108 - Integration of Sustainability into Facilities Management Practice in Healthcare Sector				
	Nazeer Fathima Sabrina, Thanuja Ramachandra and Sachie Gunatilake				
05.30 - 05.45 pm	S11079 – Environmental Sustainability Assessment of Facilities Management: A Case of Apparel Industry in Sri Lanka				
	Nimesha Jayasena and Harshini Mallawaarachchi				
05.45 - 06.00 pm	$\begin{array}{llllllllllllllllllllllllllllllllllll$				
	C.S. Suriyarachchi, K.G.A.S. Waidyasekara and Nandun Madhusanka				
06.00 - 06.30 pm	Q&A				

Session Coordinator: Ms. Devindi Geeganage

Friday, 29 June 2018

Session 1B

Theme Session Chair Venue/Time	Building Information Modelling and Information Management Prof. Andrew Ross Salon Orchid 2 – 04.30 pm – 06.30 pm		
Time	Paper ID, Title and Author(s)		
04.30 - 04.45 pm	S11056 – Perceived Negative Effects on Project Stakeholders from Adopting BIM in Sri Lanka		
	Mohammed Thanzeem Irshad and H.S. Jayasena		
04.45 - 05.00 pm	S11066 – BIM and Optimisation Techniques to Improve Sustainability in Green Certification Submission of Construction Projects		
	Guomin Zhang and Malindu Sandanayake		
05.00 - 05.15 pm	${\tt S11075-Compatibility}$ of BIM Based BOQ for Sri Lankan Construction Industry		
	M.W. Thiwanka Sandaruwan and H.S. Jayasena		
05.15 - 05.30 pm	S11135 – Value Considerations of Adopting BIM in FM		
	K.A.D.N.C. Wijekoon, Anupa Manewa, Andrew Ross and Mohan Siriwardena		
05.30 - 05.45 pm	S11131 – Suitable Government Initiative Strategy for BIM Implementation in Sri Lanka		
	M.S. Siriwardhana, H.S. Jayasena, M.K.C.S. Wijewickrama and L.M.B.N. Kolugala		
05.45 - 06.00 pm	S11107 - Towards Digital Delivery of Metro-Rail Projects in India		
	Madhumitha Senthilvel, Ranjith K. Soman, Ashwin Mahalingam, Jennifer Whyte, Benny Raphael, loannis Brilakis and Koshy Varghese		
06.00 - 06.30 pm	Q&A		

Session Coordinator: Ms. Pavithra Rathnasiri

Friday, 29 June 2018

Session 1C

Theme Session Chair Venue/Time	Project Financing and Procurement Dr. Udayangani Kulatunga VIP Lounge – 04.30 pm – 06.30 pm
Time	Paper ID, Title and Author(s)
04.30 - 04.45 pm	S11086 - SDGs: Islamic Project Finance for Infrastructure PPPs in Sub-Saharan Africa
	Abdullahi A. Umar, Mahadi Ahmad, Abdul Rashid Abdul Aziz and Zeenat Yusuf
04.45 - 05.00 pm	S11102 - <code>Stakeholders'</code> <code>Perception</code> on <code>Project</code> <code>Uncertainty</code> in <code>PPP</code> <code>Projects</code> in <code>India</code>
	C. Prathapmohan Nair and Ashwin Mahalingam
05.00 - 05.15 pm	S11113 - The Prospect of Implementing PF2 in Sri Lanka
	T. Ravishker, T.S. Jayawickrama and D.G. Melagoda
05.15 - 05.30 pm	$\ensuremath{\texttt{S11064}}$ - Analysing Complexities and Uncertainties in Indian Megaprojects
	Jay Mevada and Ganesh Devkar
05.30 - 05.45 pm	${\rm S11070}$ - Model for Analysing the Drivers and Barriers of E-procurement Adoption to Enhance the Performance of Procurement System in Sri Lanka
	A.F. Fayasa, Lalith De Silva and D.M.P.P. Dissanayake
05.45 - 06.00 pm	S11085 – <code>Effectiveness</code> of <code>Project Partnering</code> in the Sri Lankan Construction Industry
	N.A.R.U. Nissanka and Mahesh Abeynayake
06.00 - 06.30 pm	Q&A

Session Coordinator: Ms. Nirmala Kolugala
Friday, 29 June 2018

Session 1D

Theme Session Chair Venue/Time	Renewable Energy and Green Retrofitting Prof. Lalith de Silva Salon Jasmine – 04.30 pm – 06.30 pm
Time	Paper ID, Title and Author(s)
04.30 - 04.45 pm	S11062 – Techno-Economic Feasibility Study of Using Solar Energy for Operating Sewage Treatment Plants
	R.R. Omprakash, Sivakumar Palaniappan and Pandian Ganesh Kumar
04.45 - 05.00 pm	S11081 – Profitability Assessment of Solar PV Installations in Sri Lankan Residential Buildings
	S.R.M.P. Senevirathne
05.00 - 05.15 pm	S11090 – Factors Affecting the Successful Adoption and Implementation of Energy Retrofits in Existing Hotel Buildings
	M.F.F. Fasna and Sachie Gunatilake
05.15 - 05.30 pm	S11091 – Solar Net Zero Energy Buildings: A Review
	I.P. Udayanga, S.D.A. Soorige and N.H.C. Manjula
05.30 - 05.45 pm	S11138 - Assessment of Green Retrofit of Existing Mature Residential Estates in Singapore
	Bon-Gang Hwang, Ming Shan and Sijia Xie
05.45 - 06.00 pm	${\tt S11143}$ - Embodied Carbon Emissions of Buildings: A Case Study of an Apartment Building in the UK
	Nirodha Gayani Fernando, Damilola Ekundayo and Michele Florencia Victoria
06.00 - 06.30 pm	Q&A

Session Coordinator: Ms. Nishara Abdeen

Session 2A

Theme Session Chair Venue/Time	Construction Productivity and Research Challenges Prof. Kanchana Perera Salon Orchid 1 – 09.00 am – 10.30 am
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	S11130 - Construction Delays in Sri Lanka: Perspective of Major Participants
	B.N.M. Chathurangi, Lalith De Silva, and Mathusha Francis
09.15 - 09.30 am	${\bf S11109}$ – Analysis of Construction Delays in Mini Hydropower Projects in Sri Lanka
	lsuru Kasun Abeygunawardana, Thilina Laksiri Dissanayake and Nisal Indula Swarnachandra
09.30 - 09.45 am	S11087 – Review of Impact of Judicial Interference to Enhance Construction Arbitration in Sri Lanka
	D.R. Senarathna and Mahesh Abeynayake
09.45 - 10.00 am	S11061 – The Significance of Labour Factor in Integrating Sustainability Concept into Construction Industry Practice
	K. Imansha Dushmanthi Kumarasinghe and Chandanie Hadiwattege
10.00 – 10.15 am	S11069 – Collecting Primary Data for Academic Research in Crisis-Affected-Regions: Challenges and Recommendations
	Belqais Allali, Udayangani Kulatunga, Shahd Salha
10.15 – 10.30 am	Q&A

Session Coordinator: Ms. Nimesha Jayasena

Session 2B

Theme Session Chair Venue/Time	Project Performance and Process Improvement Dr. Thanuja Ramachandra Salon Orchid 2 – 09.00 am – 10.30 am
Time	Paper ID, Title and Author(s)
09.00 – 09.15 am	S11132 – Potential of Applying Earned Value Management (EVM) as a Performance Evaluation Technique in Building Construction Projects in Sri Lanka
	M.G.C. Ekanayake, H.S. Jayasena and L.M.B.N. Kolugala
09.15 - 09.30 am	$\ensuremath{\texttt{S11060}}$ – Impact of Sustainability Education on Quantity Surveyors in Sri Lanka
	V.G. Shanika and T.S. Jayawickrama
09.30 - 09.45 am	S11057 – Impact of Ineffective Tendering Processes on Construction Projects
	N.A.J.N. Srimal, Vijitha Disaratna and P. Ganeshu
09.45 - 10.00 am	S11136 – Impact of Using Minimum Preliminary Items for Building Works in Sri Lankan Construction Industry
	P.G.C. Pradeep, L.D. Indunil P. Seneviratne, Uthpala Rathnayake and D.G. Melagoda
10.00 - 10.30 am	Q&A

Session Coordinator: Ms. Savindi Perera

Session 2C

Theme Session Chair Venue/Time	Built Asset Operations and Management Dr. Nayanthara de Silva VIP Lounge - 09.00 am - 10.30 am
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	S11104 - Significant Factors Influencing Operational and Maintenance (O&M) Costs of Commercial Buildings
	Devindi Geekiyanage and Thanuja Ramachandra
09.15 - 09.30 am	S11089 – Risks Associated with Physical Asset Management: A Literature Review
	P. Thatshayini, Damitha Rajini and A.S. Weerasinghe
09.30 - 09.45 am	S11058 – Tendency of Sri Lankan Construction Organisations in Adopting Enterprise Resource Planning Systems
	K.G.G.D.V. Silva, Vijitha Disaratna and R. Dilakshan
09.45 – 10.00 am	S11054 - Adaptability of Shared Workspace Concept in Office Buildings in Sri Lanka
	W.Y. Perera, B.A.K.S. Perera and T.S. Jayawickrama
10.00 – 10.15 am	S11093 - Challenges in Hotel Building Refurbishment Projects in Sri Lanka
	B.J. Ekanayake, Y.G. Sandanayake and Thanuja Ramachandra
10.15 – 10.30 am	Q&A

Session Coordinator: Ms. Kushani Liyanage

Session 2D

Theme	Stakeholder Engagement in Design, Construction and Education
Session Chair	Ch. QS. Indunil Seneviratne
Venue/Time	Salon Jasmine - 09.00 am - 10.30 am
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	$\label{eq:sigma1144} \begin{array}{c} \mbox{-} \mbox{Collaboration in the Construction Industry: A View from the} \\ \mbox{Rail Sector} \end{array}$
	Thomas Dowd and Mohan Siriwardena
09.15 - 09.30 am	S11114 – Basic Assumptions of Contractor's Sub Culture in Public Sector Building Construction Projects in Sri Lanka
	Aparna Samaraweera, Sepani Senaratne and Y.G. Sandanayake
09.30 - 09.45 am	S11052 – Stakeholder Management in Complex Projects
	Tuan Son Nguyen and Sherif Mohamed
09.45 - 10.00 am	S11076 - Reflection on the Theory and Practice of Integral Sustainable Design in Rural Context: A Literature Review
	Susan Ang, Gayani Karunasena, Lalith De Silva and Sachie Gunatilake
10.00 - 10.15 am	S11145 - New Approaches to Employer Engagement Within Surveying Education: Degree Apprenticeships
	Andrew Ross and Mohan Siriwardena
10.15 - 10.30 am	Q&A

Session Coordinator: Ms. Chamitha Wijewickrama

Session 3A

Theme Session Chair Venue/Time	Business Continuity and Management Dr. Mohan Siriwardena Salon Orchid 1 - 11.00 am - 12.30 pm
Time	Paper ID, Title and Author(s)
11.00 – 11.15 am	S11137- A SWOT Analysis for Sri Lankan Construction SMEs
	K.A.T.O. Ranadewa, Y.G. Sandanayake and Mohan Siriwardena
11.15 - 11.30 am	S11065 - Business Model Concept for Construction Businesses: A Literature Synthesis
	D.N. Abeynayake, B.A.K.S. Perera and Chandanie Hadiwattege
11.30 - 11.45 am	S11071 - Evaluation of Marketing Practices and Marketing Performance Measurements Undertaken by Quantity Surveying Consultancy Firms in Sri Lanka
	P.K. Nethmini, K.G.A.S. Waidyasekara and D.G. Melagoda
11.45 - 12.00 pm	S11129 – Applicability of TQM for Construction Contracting Organisations in Sri Lanka
	W.D.A. Fernando, L.D. Indunil P. Seneviratne, Mathusha Francis and R. Dilakshan
12.00 - 12.15 pm	S11080 – Accessibility of Emergency Evacuation for Differently-abled People in Public Hospital Buildings in Sri Lanka: The National Policy Enhancements
	S. Manoj, Harshini Mallawaarachchi, S.D.A. Soorige and Nimesha Jayasena
12.15 - 12.30 pm	Q&A

Session Coordinator: Mr. R. Dilakshan

Session 3B

Theme Session Chair Venue/Time	Occupational Health and Safety Dr. Sepani Senaratne Salon Orchid 2 - 11.00 am - 12.30 pm
Time	Paper ID, Title and Author(s)
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	Rafidah Ismail, Roshani Palliyaguru, Gayani Karunasena and Norfaridatul Akmaliah Othman
11.15 - 11.30 am	S11053 – Can Leadership Styles Inform Safety Outcomes in Safety-Critical Organisations? A Review of Literature
	John Ojuola and Sherif Mohamed
11.30 - 11.45 am	$\ensuremath{\texttt{S11088}}$ – Health, Safety and Welfare Standards of Employees in the Sri Lankan Construction Industry
	K.P.L.B. Pathirana and Mahesh Abeynayake
11.45 - 12.00 pm	S11146 – Green Buildings and Well-Being of Employees in Commercial Spaces
	James Hartwell, Matthew Tucker and Mohan Siriwardena
12.00 - 12.15 pm	$\ensuremath{\texttt{S11072}}$ - Worker Awareness of Workmen's Compensation in the Sri Lankan Construction Industry
	Nethmi Amanda Wanigasekara, Thilina Laksiri Dissanayake and K.D. Hiruni Ridmika
12.15 - 12.30 pm	Q&A

Session Coordinator: Ms. Damithri Melagoda

Session 3C

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M.S. Soujanya and H.A.E.C. Jayasena
S11139 - Addressing Risks in Green Residential Building Construction Projects: The Case of Singapore
Bon-Gang Hwang, Ming Shan and Helena Phua
S11055 - Applicability of Green Roofs in Sri Lankan High-Rise Buildings: Drivers and Barriers
Charles Subaskar, Herath Vidyaratne and D.G. Melagoda
S11082 - Brownfield Redevelopment: A Dual Currency Analysis of Soil Stabilisation Methods
Lee Brown, Srinath Perera and M.N.N. Rodrigo
S11140 - Green Building Construction Projects in Singapore: Cost Premiums and Cost Performance
Ming Shan, Bon-Gang Hwang, Lei Zhu and Xinyi Cheong
Q&A

Session Coordinator: Ms. M.F.F. Fasna

Session 3D

Theme Session Chair Venue/Time	Waste Management and Lean Thinking Ch.QS. Suranga Jayasena Salon Jasmine - 11.00 am – 12.30 pm
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	K.L.A.K.T. Liyanage, K.G.A.S. Waidyasekara and Harshini Mallawaarachchi
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	P. Coomasaru, S.D.T.S. Wickramasuriya and B.A.K.S. Perera
11.30 - 11.45 am	S11083 - Tool for Assessing Lean Maturity in Construction Projects in Sri Lanka
	N. Thilakarathna and Lalith De Silva
11.45 - 12.00 pm	S11103 - Integrating Lean and Green Concepts: Sri Lankan Construction Industry Perspective
	T.P.W.S.I. Pandithawatta, Niza Zainudeen and C.S.R. Perera
12.00 - 12.15 pm	S11115 - Zero Landfill Framework for Apparel Industry Solid Waste
	K.L.A.K.T. Liyanage and Nayanthara De Silva
12.15 - 12.30 pm	Q&A

Session Coordinator: Ms. Biyanka Ekanayake

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The 7th World Construction Symposium 2018

Theme:

Built Asset Sustainability:

Rethinking Design, Construction and Operations

Edited by Dr. Y. G. Sandanayake Dr. S. Gunatilake Dr. K.G.A.S. Waidyasekara

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

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PAPER ABSTRACTS

The 7th World Construction Symposium 2018

A SWOT ANALYSIS FOR SRI LANKAN CONSTRUCTION SMES

K.A.T.O. Ranadewa^{1*}, Y.G. Sandanayake¹ and Mohan Siriwardena²

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ABSTRACT

The significant benefits that Small & Medium Enterprise (SME)s provide to the national economy, including their contributions to the economic development, industrial output, employment creation, and tax revenue marked as the reasons for examining the various aspects of SMEs around the world. The construction industry is usually described as being one of the riskiest business arenas and hence, SMEs needs to improve their capacities by analysing the possible opportunities as well as the threats in the market to sustain in the construction industry. Hence, this paper explored the SWOT analysis for SME contractors in Sri Lanka. A literature review followed by five case studies were carried out to collect data. The collected data were analysed and presented in a SWOT matrix to identify the advantage of positive facts over negative facts for construction SMEs. As per the research findings, the explored external and internal factors can be categorised under five main themes as financial. technical, managerial, legal and political and other. Findings of the case studies identified 21 internal factors as the strengths of construction SMEs and 48 internal factors as weaknesses of construction SMEs. Yet, the study further revealed 22 factors under opportunities for construction SMEs and identified 46 external factors as threats to their organisation. This study further proves that a detailed understanding of the processes and extensive explorations of all possible causes, reasons using the SWOT analysis will help overcoming the number of challenges faced by construction SMEs. In addition, it was evident that inexpensive or zero cost solutions could be implemented by identifying the strengths and opportunities of their organisations. This will mark for further researches to study the possible strategies for construction SMEs using SWOT analysis matrix.

Keywords: Construction SMEs; Sri Lanka; SWOT Analysis.

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ACCESSIBILITY OF EMERGENCY EVACUATION FOR DIFFERENTLY-ABLED PEOPLE IN PUBLIC HOSPITAL BUILDINGS IN SRI LANKA: THE NATIONAL POLICY ENHANCEMENTS

S. Manoj, Harshini Mallawaarachchi*, S.D.A. Soorige and Nimesha Jayasena

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ABSTRACT

It is very difficult task in nature and a prevailing issue in the world today to provide a reasonable access for differently abled people within any building. Specially, giving fair and impartial accessibility has become very complex and an ongoing global issue. However, various policies and guidelines have been developed in countries enabling buildings to be used by the differently abled people by building them in terms of ease of access for emergency evacuation. Among the other buildings, healthcare facility has obtained the first concern when considering its' heavy use by differently abled people. Thus, this research was conducted with the purpose of studying on the accessibility procedures of emergency evacuation for the differently abled people in public buildings with special emphasis to public hospitals since the current evacuation means in healthcare sector are not adequately developed based on the needs of differently abled people. The research was conducted using case study method under qualitative phenomenon. Semi-structured interviews were conducted among building professionals who had more than five years of experience in the field of accessibility to collect the data. Hence, three public hospital buildings in Sri Lanka were selected. Accessibility procedures of emergency evacuation and issues in existing practice were investigated related to safety and security, access to built environment and access to communication in line with the National Policy on Disability for Sri Lanka. Case study data revealed that not having predetermined procedure for evacuating differently abled people and less awareness on existing safety and security procedures thus need special attention. Accordingly, a framework was developed to propose the probable enhancements for the national policy. The enhanced policy can be used as a national strategy to assure the ease of accessibility of emergency evacuation for differently abled people in public hospital buildings in Sri Lanka.

Keywords: Accessibility; Differently-abled People; Emergency Evacuation; Public Hospital Buildings; Sri Lanka.

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ADAPTABILITY OF SHARED WORKSPACE CONCEPT IN OFFICE BUILDINGS IN SRI LANKA

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ABSTRACT

A well-organised, well-designed workspace in an organization will help it to fully achieve its goals. Although visiting staff are also considered as staff of an organisation, they often face difficulties in finding space within the organization for working as they are not generally assigned specific workspace to work from. In Sri Lanka, many office buildings have unutilised floor space. These unutilised spaces are quite costly to maintain. Moreover, an unutilized space will have an adverse impact on the sustainability of the organisation. This study addresses these issues by investigating the adaptability of shared workspace concept in office buildings in Sri Lanka. To achieve this aim, a literature review, 14 expert interviews and two case studies were conducted. Content analysis was used to analyse the findings. The study identifies the type of office spaces that can be used as shared workspaces. It is found that not all offices with unutilised space will be able to decide to adopt the shared workspace concept as that decision has to be based on the type and operating hours of the office, core business of the organisation, organisational culture and the support structure and the accessibility of the building in which the office is housed.

Keywords: Co-working; Flexible Spaces; Office Buildings; Shared Workspace; Sustainable Facilities.

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ADDRESSING RISKS IN GREEN RESIDENTIAL BUILDING CONSTRUCTION PROJECTS: THE CASE OF SINGAPORE

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ABSTRACT

Over the past decade, an increasing number of green residential buildings have been developed worldwide owing to active promotion from the authorities and the increasing interest from customers. However, in the same way as traditional residential buildings, the construction of green residential buildings has been facing various risks. The aims of this study are to identify and assess the diverse risks in green residential building construction projects, compare their risk criticalities with those in traditional counterparts, and propose helpful risk mitigation measures. To achieve these goals, a comprehensive literature review was conducted first, and then a questionnaire was administered to 30 construction companies in Singapore. The analysis results showed that "complex procedures to obtain approvals", "overlooked high initial cost", "unclear requirements of owners", "employment constraint", and "lack of availability of green materials and equipment" were the top five critical risks in green residential building construction projects. It also reported that green residential building projects were facing risks at a more critical level than those traditional residential building projects. Furthermore, this study proposed fourteen risk mitigation measures that can effectively tackle the risks in green residential building construction projects. This study contributes to the body of knowledge by identifying and evaluating the critical risks and the responding mitigation measures in green residential building construction projects. The findings from this study can also provide practitioners with an in-depth understanding of risk management in green residential building construction projects, and thereby benefiting the industry.

Keywords: Critical Risks; Green Residential Building Construction Projects; Mitigation Measures.

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ANALYSING COMPLEXITIES AND UNCERTAINTIES IN INDIAN MEGAPROJECTS

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ABSTRACT

In India, the demand of infrastructure has been burgeoning rapidly owing to economic development and rapid pace of urbanization. Increasingly, the infrastructure planning and implementation strategy indicates the policy makers are leaning towards fulfilling this demand with megaprojects, having large scope and size, in terms of cost and resource requirements. The performance of these megaprojects has been dismissal with substantial time and cost overruns. The uncertainties and complexities associated with megaprojects is recognized as a major hurdle in effective implementation of megaprojects. There has been diversity of mechanisms adopted for managing complexities in Indian megaprojects. This paper analyses the case studies of Indian megaprojects to determine the types of mechanisms followed managing complexities as well as their effectiveness. Based on this analysis, the areas of improvement in existing mechanisms have been suggested, which would be help to the policy makers and ensure smoother implementation of megaprojects.

Keywords: Complexity; India; Megaprojects; Uncertainty.

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ANALYSIS OF CONSTRUCTION DELAYS IN MINI HYDROPOWER PROJECTS IN SRI LANKA

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ABSTRACT

The share of mini hydropower plants in electricity generation is becoming more important in modern power generation due to the national policy targets to move from the fossil fuel brown energy to sustainable green energy. Therefore, the demand for construction of the mini hydropower plants has become higher but these projects show a significant rate of delays in project delivery. This research was carried out to identify the project delay phases and the main delay factors in mini hydropower projects. Furthermore, it was expected to derive mitigating measures for mini hydropower project delay based on the findings. The data collection process was based on multiple case studies where the project planning documents of three mini hydropower projects were reviewed to extract delay information. Here, projects managers validated the information in the documents to be correct and gave an overview of what has happened during the project. Here all information extracted was discussed under the headings of the case studies (P1, P2 and P3). With information extracted, delays in ten significant phases of the mini hydropower projects were identified with its delay percentages. The most delaying phase of the mini hydro project was the weir construction while least being the fore-bay construction. Delays in hydropower projects occur mainly due to the natural consequences such as adverse weather conditions and environmental conditions such as an earth slip. Protests by the interested parties were the next major concern when it comes to delays in mini hydropower projects. Proper management of the identified delay factors and awareness of delays in relevant phases is required. Nevertheless, it was found to be essential to make the interested parties fully aware about the environmental impact even before the initiation of the project in order to successfully mitigate the significance of delays.

Keywords: Construction Delays; Delay Mitigation Methods; Mini Hydropower Projects.

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APPLICABILITY OF GREEN ROOFS IN SRI LANKAN HIGH-RISE BUILDINGS: DRIVERS AND BARRIERS

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ABSTRACT

Sri Lanka is experiencing a construction boom and there are many high-rise building constructions coming up. Thus, many adverse effects are associated with high rise buildings. Greenery provides several benefits to the environment and reduces these effects. However due to limited space in urban areas it is impossible to plant new plants, trees and vegetation around the buildings. As a solution green roofs can be adopted as they provide many environmental and sustainable benefits from rooftops. Though this concept is more popular across many countries over the past few decades, still implementation of this technology in Sri Lanka is new and scant. Due to the lack of past researches, awareness on green roofs is very low for professionals, developers, government authorities, building owners and general public.

The aim of this research is to identify and analyse the potential of green roofs in high rise buildings in Sri Lanka. A comprehensive literature review was carried out on popularity of green roof in global context, types of green roofs, components of green roofs, barriers and drivers in implementing green roofs. The data collection was conducted through expert interviews and questionnaire survey. Expert interviews were carried out to validate the barriers and drivers identified through literature review in Sri Lankan context and questionnaire survey was used to identify the most significant barriers and drivers. Purposive sampling techniques was used for selection of the respondents. The data collected from expert interviews were analysed through manual content analysis and the data collected by questionnaire were analysed using RII method.

The final outcome of this study is that green roof is an applicable concept in Sri Lanka and in Sri Lankan high rise buildings.

Keywords: Barriers; Drivers; Green Roofs; High Rise Buildings.

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APPLICABILITY OF TQM FOR CONSTRUCTION CONTRACTING ORGANISATIONS IN SRI LANKA

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ABSTRACT

The construction industry in any country is a dominant, huge, complex and highly risky industry. In the Sri Lankan context, the construction industry has become a major component of rapid economic development over the past years. However, the industry itself suffers from many problems, such as defects in workmanship, defects in quality and overflow of time and cost. Thus, these industry problems have challenged the successful project performance and total quality of the output. Nevertheless, these problems will persist until every organization in the industry begins to take responsibility for developing new changes within its own organization. Such changes can be initiated via effectively implementing the philosophy of Total Quality Management (TQM). However, globally, the usage of TQM in the construction industry is not so popular than in the manufacturing industry. Therefore, the research aims to identify the applicability of TQM in Sri Lankan construction contracting organizations.

A qualitative research approach was followed in order to achieve the aim of the study. Thus, semi-structured interviews were conducted among a total of ten top management professionals are associated with contracting organisations and had indepth knowledge in TQM and its practice. A content analysis using NVivo 11 software was adopted to summarise and analyse the collected data. The findings revealed that TQM can be followed by the construction contracting organizations in Sri Lanka. However, it is not that much easy, because the TQM implementation process encompasses a series of barriers. Thus, the research found financial barrier, insufficient collaborative work, lack of skill, resistant to change, time barrier and less involvement of top management are such barriers in adopting TQM in Sri Lanka. Further the study suggest that barriers must be mitigated cautiously for a better consequence.

Keywords: Barriers; Solutions; Total Quality Management (TQM).

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ASSESSMENT OF GREEN RETROFIT OF EXISTING MATURE RESIDENTIAL ESTATES IN SINGAPORE

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ABSTRACT

While the authorities in many countries around the world launched green retrofit programs to upgrade the existing mature buildings during the past decade, limited was known about the residents' perceptions of those programs. As a result, this study aimed to investigate the residents' perceptions of the green retrofit programs in Singapore, which is one of the leading countries for green development, and to explore their willingness in extending green retrofit into their individual houses. A questionnaire was administered to 90 residents from a mature public residential estate in Singapore that just underwent a pilot green retrofit program. The results reported that 86 percent of the respondents were satisfied with the green retrofit program, and their most favourite green feature installed was the outdoor light emitting diode lighting. In addition, over 50 percent of the respondents were supportive of having their individual houses undergo green retrofit and were willing to bear an upfront cost up to SGD 5,000 (approximately USD 3,540). This study also found that achieving cost savings from lower utility bills in the long run was the top motivation that drives the residents to retrofit their houses. This study contributes to the body of knowledge by conducting a thorough investigation of residents' perceptions of green retrofit programs. Furthermore, the findings from this study provide the industry and the authorities running green retrofit programs with the opportunities to reveal respondents' preferences on different green features, and to upgrade their green retrofit programs accordingly, creating more sustainable benefits for the residents.

Keywords: Green Retrofit; Questionnaire; Respondents' Perceptions; Singapore.

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BASIC ASSUMPTIONS OF CONTRACTOR'S SUB CULTURE IN PUBLIC SECTOR BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

Contractor is considered as a dominant construction project participant, contributing to the construction project culture. Identifying the basic assumptions of contractor's professional sub-culture at project level could be worthwhile for better management of construction projects since, cultural differences among project participants could create risks of conflicts and dissatisfactions owing to underperformance of construction projects. Thus, this research aims to derive basic assumptions of contractor's sub culture in public sector building construction projects in Sri Lanka. The aim was approached through an exploratory case study research design. Three public sector building construction projects were selected as the cases using construction project culture as the unit of analysis. Cases were restricted to traditional method contracts and team setting to public sector clients and consultants and private sector contractors. Nine semi-structured interviews, observation of two progress review meetings and documentation review per case were used as the data collection techniques. Solutions for internal integration and external adaptation problems of each project team was questioned during data collection. Code based content analysis was used in data analysis. Findings revealed the existence of dominant professional sub-cultural groups of client, contractor and consultant within construction projects. Group boundaries were indicated by each party trying to defend themselves as a group and having matters which they thought not suitable disclosing to other parties. The basic assumptions of the contractor's sub culture were identified with regard to the eleven cultural dimensions of; nature of human relationships, nature of human nature, nature of reality and truth, nature of human activity, nature of time, acceptance on homogeneity or diversity, unknowable and uncontrollable, gender, motive for behaving, state-individual relationship and, organization's relationship to its environment. These findings are important for project managers for better understanding of the unique cultural behaviours of contractors to avoid any interpersonal conflicts among contractor's personnel and other team members.

Keywords: Basic Assumptions; Construction Projects; Contractor's Sub-Culture; Sri Lanka.

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BIM AND OPTIMISATION TECHNIQUES TO IMPROVE SUSTAINABILITY IN GREEN CERTIFICATION SUBMISSION OF CONSTRUCTION PROJECTS

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ABSTRACT

Green Buildings are gaining popularity in the construction industry as a result of strict environment protocols and carbon neutral policies by the governments across the globe. In Australia alone, since the introduction of Green Star Certification 5.5 million square metres of buildings have been certified as green buildings. With more stakeholders involved, the green certification submission process has become more complicated with less focus on triple bottom line approach of sustainability. Research has shown that 85% of the green submissions are concentrated on environmental sustainability with less significance on economic and social aspects. Building Information Modelling (BIM) is a cutting-edge technology that allows effective decision making. The proposed research aims to develop a BIM model that can improve the sustainable decision making during green certification processes. Multiobjective optimisation techniques were developed to optimise the best design solution for different design criteria. A case study is employed to verify the functions of the platform suggested in the study. The results of the case study indicated a combination of green design options provide a maximum of 4.54% GHG emission reduction per unit cost increase. The outcomes of the research will be important to organizations who are keen on improving the environmental sustainability while minimising the economic implications.

Keywords: Building Information Modelling; Cost; Green Buildings; Greenhouse Gas; Sustainability.

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BROWNFIELD REDEVELOPMENT: A DUAL CURRENCY ANALYSIS OF SOIL STABILISATION METHODS

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ABSTRACT

Evidence of climate change, such as rising sea levels and higher average temperatures, has made society become increasingly carbon conscious in recent years. Therefore, carbon estimating is becoming prominent and this research explores methods of quantifying embodied carbon of different soil stabilisation methods. This research aims at evaluating the different methods of soil stabilisation for the remediation of previously developed, brownfield sites, using a dual currency approach of investigating both cost and carbon. Therefore, the effect of using different cementitious binders such as Pulverised Fuel Ash (PFA) and Ground Granulated Blastfurnace Slag (GGBS), in lieu of Ordinary Portland Cement (OPC) was investigated.

Primary data, in the form of Bills of Quantities, was collected from a civil engineering contractor who has extensive experience in the land remediation sector in the UK. This enabled cost and carbon rates to be applied to the work items, to estimate in terms of cost and carbon inputs. This data was analysed using descriptive statistics to investigate if there is a correlation between cost and carbon inputs.

The study revealed that to stabilise soil, soil matrix changes from one binder to another, whereas a higher content of GGBS and PFA to lime in the alternative methods than there is for OPC. In lieu of OPC and PFA, GGBS was identified as the most cost effective and lowest carbon emitting cementitious binder. However, though PFA also signified a carbon saving, PFA was comparatively costly. Further, a perfectly positive correlation lies between the mean elemental unit rates for costs and carbon.

Keywords: Cementitious Binders; Correlation; Embodied Carbon; Soil Stabilisation.

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BUSINESS MODEL CONCEPT FOR CONSTRUCTION BUSINESSES: A LITERATURE SYNTHESIS

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ABSTRACT

Despite the importance of a business model (BM) to an organisation's success, clearing up the fuzziness of the concept of BM before applying it to any business or sector is worthwhile. Since definitions are expected to bring clarity, this paper attempts to analyse various definitions given to BM by different authors. Accordingly, eight notions around which 31 definitions of BM have been centred were identified. These notions are based on stakeholders, value, revenue, strategies, process, causality, elements and dynamicity of the business with which all the BM definitional views are associated. In addition to its two key roles, value creation and value capture, BM plays several other roles as well. Some of these roles relate to being an opportunity facilitator; a common language; a source of industry change; a source of competitive advantage and an exemplar. The paper also distinguishes the term BM from the other commonly used term in the business language, 'strategy'. Once the basis on which the preliminary views expressed by past researchers on the concept of BM is understood, it will be necessary to review the literature once again to get an understanding of the BM elements, BM design, BM changes and BM innovations, so that the concept of BM in the construction business environment and culture could be fully grasped.

Keywords: Business Model; Construction Business; Definitional Views; Strategy.

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CAN LEADERSHIP STYLES INFORM SAFETY OUTCOMES IN SAFETY-CRITICAL ORGANISATIONS? A REVIEW OF LITERATURE

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ABSTRACT

Safety-critical organisations (SCOs), such as the military, fire service, aviation, emergency services, and construction, are characterised by being organisations with high potential for stress, accidents, and injuries. Environments where safety is highly critical (i.e., high exposure to risk and likelihood of an accident) - poses particular leaders. Thus, such environments challenges for call for specific leadership/leadership style, which differ from those most effective in less safetycritical environments. Most research literature seems to associate leadership with traditional, linear models, which are incongruent with the behaviour of a complex system, such as the construction industry. Thus, the objective of this paper is to fill this research gap by: 1) critically reviewing relevant literature; 2) investigating the effect of leadership styles (LS) on safety outcomes, with emphasis on SCOs; and 3) developing a conceptual framework for empirical testing. A survey design will be applied to collect data from project managers in the construction industry within the Australian context. This paper presents a brief description of the effect of various LS on safety outcomes, using the principles of complexity science. The results of this study will present the effect of riding on the principles of complexity science to provide the premise for flexible responses to emerging patterns and opportunities in the construction industry.

Keywords: Complexity Science; Leadership Styles; Safety Leadership; Safety Outcomes.

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CHALLENGES IN HOTEL BUILDING REFURBISHMENT PROJECTS IN SRI LANKA

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ABSTRACT

Amongst the contemporary issues encountered by the buildings, deterioration and obsolescence are in the forefront. The refurbishment has been acknowledged as an avenue to deliver profound solutions to overcome these issues by upgrading, altering, extending, renovating and improving facilities and prolonging building lifespan. Nevertheless, refurbishment projects are uncertain and sophisticated with many challenges. Refurbishment projects in Sri Lanka are dominated in hotel buildings compared to other types of buildings because hotel buildings needed to be upgraded and modified frequently to maintain the tourist attraction intact. Nevertheless, the challenges in these projects remain unprecedented due to lack of in depth investigation. This research therefore, set out to explore the challenges in hotel building refurbishment projects in Sri Lanka. A qualitative approach was applied by focusing on three recently completed hotel building refurbishment projects. Subsequently, data collected through unstructured interviews with the participants involved in the refurbishment projects, document reviewing and observations were analysed using content analysis. The findings revealed topmost challenges as the budget overruns due to superficial designs and construction activities, time overruns due to refining designs to cater unanticipated building conditions, limitations to introduce changes to the existing building structures and the interruptions to building occupants due to simultaneous operations. The budget overruns for Case A, Case B and Case C were reported as 13.64%, 1.38% and 0.95% respectively. The time overruns were calculated as 55.56%, 25% and 50% respectively. These challenges adversely affected in achieving value for money in terms of cost, time, quality, customer satisfaction and sustainability.

Keywords: Challenges; Hotel Buildings; Refurbishment Projects; Sri Lanka.

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COLLABORATION IN THE CONSTRUCTION INDUSTRY: A VIEW FROM THE RAIL SECTOR

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ABSTRACT

Need for collaboration in the construction industry has been emphasized constantly in research literature. Several forms of procurement and other approaches were introduced towards promoting collaboration in the past two decades.

This paper reports on an investigation into the nature and extent of collaboration within the rail sector in the UK. Rail sector which is a growth area in the UK's construction industry, and several more projects planned for the near future. A literature review, a questionnaire survey and data analysis were conducted. Literature review identified key elements and dimensions of collaboration. Data analysis conducted following the receipt of the questionnaires revealed varying views between the client and the other parties in terms of the extent and the success of collaboration within the rail sector. The findings have also identified several areas that require further research and development.

Keywords: Attitudes; Collaboration; Processes; Rail Sector.

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COLLECTING PRIMARY DATA FOR ACADEMIC RESEARCH IN CRISIS-AFFECTED-REGIONS: CHALLENGES AND RECOMMENDATIONS

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ABSTRACT

Collecting primary data for research is one of the most critical stages in the research journey; it is the practical element of the research that requires access to data embedded in fieldwork. If the primary data is collected from a crisis-affected-regions, the fieldwork can generate a high risk to the researcher. The aim of this paper is to investigate the challenges of data collection in crisis-affected-regions. The personal experience of seven different PhD researchers who collected their primary data from crisis-affected-regions are presented and analysed in the paper. The findings suggest that the risks of collecting primary data from crisis-affected-regions can involve different challenges: some of them are related to the researcher, such as a lack of awareness around the aspects of the crisis context. Some other challenges are related to the research study, such as non-clarity of aims and objectives. Also, within the context of study the main challenge of collecting data is a lack of accessibility to data sources and documents. The paper provides different suggestions to improve the practices of collecting primary data from crisis-affected-regions. These are: providing supportive training to researchers who intend to research in crisis-affectedregions, networking with other researchers with the same interests, increased regular meetings with the supervisor, adapting an appropriate approach for collecting the data, and having a risk management plan.

Keywords: Challenges; Crisis-Affected-Regions; Data Collection; Primary Data; Research Methodology.

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COMPATIBILITY OF BIM BASED BOQ FOR SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Being a key contributor to the Sri Lankan GDP, it is paramount for the construction industry to maximize the productivity, accuracy and efficiency. In order achieve this, it should advance with adoption of modern technologies, computer software and concepts. Many construction industries around the world are getting benefits by implementing Building Information Modelling (BIM) in their projects. BIM has made significant improvement in productivity, accuracy and efficiency. BIM can significantly automate the BOQ preparation process primarily through automated Quantity Takeoff from BIM models. The process can deliver accurate quantities as per the model, but these quantities may deviate from quantities measured manually following a Standard Method of Measurement (SMM). But, not implementing automated BOO process would become wasteful in an effort to implement BIM seeking for its benefits. This research was conducted with the aim of identifying the acceptability of the BIM based BOO for the Sri Lankan construction industry. A literature survey was first carried out to identify the features of BIM based BOO. A desk study was followed to identify the deviations of BIM based BOQ from the Sri Lankan conventional BOQ. Based on collected details through these two methods contextualized semi structured interview sessions were conducted to identify the acceptability of deviations in BIM based BOQ for the Sri Lankan construction industry. From the findings through the analysis of collected data, it can be concluded that BIM based BOQ are acceptable to the Sri Lankan construction industry.

Keywords: Bills of Quantities; Building Information Modelling (BIM); Construction; Pricing; Sri Lanka.

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CONSTRUCTION DELAYS IN SRI LANKA: PERSPECTIVE OF MAJOR PARTICIPANTS

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ABSTRACT

Delay can be defined as a slipping over the scheduled construction duration beyond the agreed completion date. Notwithstanding the all project participants suffer from inevitable consequences originated from construction delays, they all themselves influence to engender delays in more or less portions while contractors, consultants and employers conclusively afford massive deal. Therefore, this research tends to investigate the causes of delays from the perspective of responsible parties thereby suggest solutions to avoid them.

Initially the researchers conducted a comprehensive literature review to identify the causes of project delay. A total of 50 previously conducted researches were examined and 130 delay causes were found. Thereafter, 59 of the delay causes which frequently stand in Sri Lankan building construction context were filtered and responsible parties were recognised through opinions of 15 experts. Thence, the main questionnaire survey was carried out adapting 30 samples for each perspective of contractor, consultant and employer in order to identify the significance of delay causes by ranking them in each of the perspectives of the ranking was obtained from Spearman's Rank Correlation Coefficient (rs) and Kendall's Correlation of Concordance (W). Thereafter, the preventive measures to enrich responsibilities of major participants in order to avoid delays were explored through ten interviews.

Consequently, the study revealed that the contractor is the most responsible party for construction delays. Eventually, the strategic framework was developed to enrich responsibilities of the major participants on avoiding construction delays ameliorating elicited facts from the study thereof.

Keywords: Construction Delays; Causes; Major Participants.

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CUSTOMER RELATIONSHIP MANAGEMENT IN FACILITIES MANAGEMENT: A STUDY OF OFFICE BUILDINGS IN SRI LANKA

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ABSTRACT

Customer Relationship Management (CRM) is a strategy used by the business organisations in order to optimise the service efficiency in the current competitive business environment. The aim of CRM in Facilities Management (FM) is to build an acceptable long-term relationship with customers and users of the facility for long term sustainability. Though CRM in FM is an area gaining importance, the CRM practices in FM is still unclear. Therefore, this study intends to develop an understanding of the current CRM practices in FM in Sri Lankan Office buildings focusing on the tenants, identify the issues and propose strategies to overcome them. The case study approach was adopted as the research method and the required data were collected from both the management and tenants of the selected cases. The data collection was done through semi structured interviews whereas the analysis was conducted through code-based content analysis. The results of the study showed that CRM in FM in Sri Lankan office buildings sector is at a low level and there are different issues related with CRM process, employees who involved in providing customer services and the technology used for CRM. The identified common issues were unavailability of a mechanism to evaluate CRM process or tenants to give their feedback, the FM employees' poor communication skills, ineffectiveness of manual processes used for some CRM activities and the like. Conducting customer satisfaction surveys, training and development on CRM practices, periodical tenant meeting, etc. are the proposed strategies to overcome those issues. It was also established that the current CRM practices can be enhanced by implementing the identified strategies, with the effort of all the parties involved in service provision for tenants in Sri Lankan office buildings. The results of the study guide the industry professionals to improve the CRM practices related to FM in Sri Lankan office buildings.

Keywords: Customer Relationship Management (CRM); Facilities Management (FM); Office Buildings; Tenants.

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EFFECTIVENESS OF PROJECT PARTNERING IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Complexity and disputes are some of the inherent features of the construction sector. Building up more effective and sustainable relationships as a means of avoiding such disputes would result in value addition to the final outcome of a project. Under these circumstances, concept of 'partnering' is emerging to play an essential role in terms of avoiding adverse relationships. The research anticipates to provide a comprehensive knowledge on reasons behind the concept of project partnering not being well practiced and its effectiveness within Sri Lanka. Quantitative research method was followed in attaining the research aim and objectives. Semi structured interviews and questionnaire survey were carried out in gathering required information for the purpose of analysis.

Information gathered via semi structured interviews revealed that project partnering is hardly or not used at all within Sri Lankan construction sector and considering current situations the need for such concept within industry is timely. Research identifies six major reasons behind project partnering not being broadly practiced in Sri Lankan context and highlights the strategies to be implemented in order to promote this concept within industry. Further suitability and effectiveness of project partnering concept within Sri Lankan context was evaluated based on the results of questionnaire survey. It revealed that time saving, increase in understanding between parties, less adversarial relationships as well as high customer satisfaction are highly possible if this is implemented in Sri Lanka. Further it highlights the government has a major role in identifying this concept and promoting it throughout the industry.

Keywords: Commitment; Construction Industry; Customer Satisfaction; Disputes and Conflicts; Mutual Benefits; Project Partnering; Trust-based Relationships.

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EMBODIED CARBON EMISSIONS OF BUILDINGS: A CASE STUDY OF AN APARTMENT BUILDING IN THE UK

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ABSTRACT

The UK government has set a target to significantly reduce UK greenhouse gas emissions by 2050, 47% of all UK CO2 emissions are linked to the construction and operation of the built environment. Buildings emit two types of carbon namely operational carbon (OC) and embodied carbon(EC). Operational carbon is regulated in the UK as it contributes up to 70-80% of total emissions. Further, EC reduction is top priority with the rise of demand for zero carbon buildings and EC is unregulated at present. EC can be controlled by vigilant building designs, selection of low carbon materials and technologies. Estimating EC of building will provide better understanding of the carbon significant elements and enable designers to make informed decisions. Accordingly, a case study of an apartment building located in Sunderland in the UK is selected for the study. EC estimates were prepared using priced Bill of Quantities of the building and carbon blackbook. Then, the building elements were classified as per BCIS (Building Cost Information Services) element classification and the carbon significant elements were identified in the case study building. Frame was identified as the most carbon significant element. External walls including windows and doors, upper floors, substructure, internal finishes, roof and internal walls & partitions were identified in descending order of carbon significant elements. Further, comparative analysis of EC between an apartment building and an office building was conducted. The office building carbon significant elements were found to be different from that of an apartment building. Findings of the case study building can inform designers about the elements that has an immense reduction potential and worth investing in low carbon technologies and materials. However, the findings are based on a single case study and, hence, cannot be generalised but can be seen as an exemplar for further research.

Keywords: Apartment Building; Building Elements; Carbon Significant; Embodied Carbon.

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ENABLING ZERO WASTE CONCEPT IN THE CONSTRUCTION INDUSTRY: A LITERATURE REVIEW

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ABSTRACT

The construction industry is one of the leading economic players in any region. However, the continuous construction and demolition activities have resulted in the generation of Construction and Demolition(C&D) waste. C&D waste management in the construction industry is still at an adolescent stage where effective reduction of C&D waste is considered as a challenging issue confronted by many economies in the world. Improper waste management has led to several issues related to environmental, economic, and social over the past years. Thus, C&D waste management is considered as a persuasive issue to be addressed. The "Zero Waste" concept has emerged as a solution to eliminate the C&D waste, which eradicates waste at the source and throughout the period of the construction activity. Many researchers have mentioned that efficient material management or waste minimisation plan is an essential process in zero waste. In this process, it is pertinent to consider the potential of which materials may generate less waste, re-useable, or recyclable, i.e., diverting materials from disposal to reuse or recycling during the construction. However, limited studies are available on zero waste management in construction industry. Therefore, this paper aims to review the importance of zero waste concept to the construction industry by critically reviewing the secondary data on waste management studies conducted in the construction industry. The paper further discusses the types of C&D waste, impacts of C&D waste, origins and causes of waste, the zero-waste concept, and the importance and its application in the construction industry. Strategies, enablers, and barriers to implementing zero waste are discussed, and finally, a conceptual framework is developed to achieve Zero Waste in the construction industry.

Keywords: Construction and Demolition (C&D) Waste; Construction Industry; Enablers; Zero Waste.

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ENVIRONMENTAL SUSTAINABILITY ASSESSMENT OF FACILITIES MANAGEMENT: A CASE OF APPAREL INDUSTRY IN SRI LANKA

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ABSTRACT

With the adaptation of businesses to sustainable approaches, facility manager's role has been expanded to be responsible for the sustainable performance of a building. Specially, escalating changes in the built environment has initiated the need of evaluating environmental sustainability (ES) of building facilities. Specially, apparel industry shows a significant impact to the environment, thus, it highlights the need of having a way to evaluate the environmental sustainability in facilities management (FM) in apparel sector. Therefore, this research was aimed to develop a model to evaluate the environmental sustainability of FM in apparel industry in Sri Lanka. By reviewing key literature, thirty-four (34) environmental sustainability indicators were identified under energy management, water management, waste management, asset management and maintenance management. Under the survey approach, pairwise comparison through structured questionnaire was used to evaluate the identified indicators. Analytical Hierarchy Process (AHP) tool was used to derive the relative performance scores of each ES indicator and ranked. Energy management was identified as the most significant FM function related to environmental sustainability. Energy sub-metering and application of sub-meter reading on identification of significant energy consumers, availability of waste management policy and availability of environmental impact assessment for the assets were determined as top priority indicators that need to be considered to ensure the ES of FM in apparel industry. Accordingly, the identified performance scores can be used as a basis to evaluate the ES of FM functions in order to formulate the suitable strategies to instigate the environmentally sustainable FM practices in apparel industry in Sri Lanka.

Keywords: Apparel Industry; Assessment; Environmental Sustainability; Facilities Management; Sri Lanka.

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EVALUATION OF MARKETING PRACTICES AND MARKETING PERFORMANCE MEASUREMENTS UNDERTAKEN BY QUANTITY SURVEYING CONSULTANCY FIRMS IN SRI LANKA

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ABSTRACT

Marketing is now recognised as one of the important functions necessary to meet the unprecedented challenges faced by a firm. This concept can be suggested as an answer to the professional firms to sustain demand, growth, and profitability. Although marketing is the management process responsible for identifying and satisfying clients' requests, and profitably, Quantity Surveyors (QSs) still have a limited understanding of marketing and how it is implemented in the changing and challenging market conditions to enhance business growth. Hence, this research paper aims to evaluate the formalised marketing practices and marketing performance measurement systems used in Quantity Surveying Consultancy Firms (QSCFs) in Sri Lanka. After a thorough literature review of formalised marketing practices, endeavours were made to discover the realism and their importance to OSCFs in Sri Lanka through a questionnaire survey. A total of 31 responses were accounted for the analysis of 12 QSCFs in Sri Lanka. The findings revealed that the adoption of the 'marketing practices' in the Quantity Surveying (OS) business is still in its formative stage. However, the majority of respondents recognised the importance of adopting marketing activities as a business development activity. Quality service delivery, measuring customer satisfaction, and personal relationship management activities seem to be the critical marketing practices for QSCFs in Sri Lanka. At present, the majority of QSCFs pay minimum attention to measuring the performance of marketing outcomes using advance measurement indicators, but most respondents strongly agreed on the performance measurement of marketing practices will help to enhance their business success.

Keywords: Management Process; Marketing; Performance Measurement; Quantity Surveying Consultancy Firms.

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FACTORS AFFECTING THE SUCCESSFUL ADOPTION AND IMPLEMENTATION OF ENERGY RETROFITS IN EXISTING HOTEL BUILDINGS

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ABSTRACT

Energy Efficiency (EE) of the existing buildings is identified as an important focal point for the reduction of total energy consumption and greenhouse gas emissions. Though there is a huge room for EE improvement in existing buildings, still the level of the adoption and implementation of Energy Retrofits (ER) in existing buildings is comparatively low. In fact, it has been ascertained that retrofitting existing buildings is more strenuous than constructing a new green building from scratch due to numerous factors at work that can either facilitate or hinder ER projects. Hence, this research explores the enablers and barriers for the adoption and implementation of ER projects.

Three case studies were conducted among hotel buildings that have implemented ER projects. Selected cases included two ER projects led by in-house teams and one project outsourced to an external Energy Service Company (ESCO). Altogether, 14 semi-structured interviews were conducted with different stakeholders to collect data. Findings of the research revealed 24 enablers and 42 barriers for the adoption and implementation of ER projects in existing hotel buildings. The enablers and barriers were identified for each of the three main phases of ER project implementation; i.e. pre-retrofit, retrofit implementation and post retrofit phases. 'Commitment, engagement and support from the involved parties' in all three phases of the project is ascertained as a crucial enabler that could support the successful adoption and implementation of any ER project. Conversely, 'lack of transparency about energy cost and use', 'lack of skills and experience', 'difficulties in establishing communication between parties' and 'occupancy type of the facility' were identified as the barriers that impede the ER project success in all three phases. Further, this paper argues that the party who execute the ER projects have significant impact on the enablers and barriers for the adoption and implementation of ER project. By providing a thorough understanding of the enablers and barriers, it is hoped that the findings of this study will provide a basis for more successful adoption and implementation of ER projects in the hotel sector.

Keywords: Barriers; Enablers; Energy Retrofits (ER); Existing Buildings; Hotel Buildings.

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GREEN BUILDINGS AND WELL-BEING OF EMPLOYEES IN COMMERCIAL SPACES

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ABSTRACT

As recently as forty years ago, the Facilities Management profession was relatively unknown in the built environment industry. Buildings were generally maintained serviced and cleaned. The Facilities Management profession is now one of the fastest growing professions in the UK and as a result, there is a growing list of services to provide, including delivering on environmental commitments and sustainable practices. This research adds to the growing body of literature on the profound effects sustainable buildings can have on its occupants and converts these benefits into financial metrics which benefit both landlords and tenants of commercial buildings. Although there is conclusive evidence of the benefits, there is still a perception that building green does not represent value for money. This paper aims to investigate to what extent facilities managers are responsible for introducing sustainable initiatives that enhance the health well-being and productivity of employees. To achieve this aim, primary data was gathered through face to face interviews with Facilities Management professionals.

The findings reveal that although sustainability was viewed as important and is highly valued by most organisations, there are more important priorities to focus on. The results from the interviews found that 100% percent of the organisations who participated had sustainability policies in place and the main drivers for introducing those policies was to comply with legislation and to provide a healthier, more attractive workplace for their employees. Although sustainability and the health, well-being and productivity of employees was a main driver, as well as being embraced and promoted by Facilities Managers, ultimately, they felt that they had more important responsibilities to focus on, hence it did not feature as a priority in their day to day job. This was also identified as one of the main barriers for sustainable Facilities Managers.

Keywords: Facilities Management; Green Buildings; Health, Well-being and Productivity; Sustainability.

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GREEN BUILDING CONSTRUCTION PROJECTS IN SINGAPORE: COST PREMIUMS AND COST PERFORMANCE

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ABSTRACT

While there has been a wealth of research on the life cycle cost of green buildings, few of them addressed the cost management performance of green building construction projects. As a result, this study aims to investigate the cost premiums and the cost performance of such projects in Singapore, which is an active global leader for green buildings, and to come up with feasible solutions that can help reduce the cost premiums and improve the cost performance. To achieve these goals, an extensive literature review and a questionnaire survey were conducted. Data collected from 121 green building construction projects showed that the green cost premiums in Singapore ranged from 5% to 10%, with different project type and size being significant factors affecting the premiums. It also reported that the majority of green building construction projects exhibited poor cost performances, with cost overruns ranging from 4.5% to 7%. Lastly, six strategic solutions that can reduce the cost premiums and improve the cost performance were proposed. This study contributes to the body of knowledge by adding the literature and findings in the context of the cost premiums and cost performance of green building construction projects. Furthermore, it can provide the industry professionals with an in-depth understanding of green cost premiums and performance as well as the responding control solutions, helping them make better decisions on cost-related management approaches from the beginning of such projects.

Keywords: Cost Management; Cost Performance; Cost Premiums; Green Building; Green Construction.

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HEALTH AND SAFETY (H&S) CHALLENGES CONFRONTED BY FOREIGN WORKERS IN THE MALAYSIAN CONSTRUCTION INDUSTRY: A BACKGROUND STUDY

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ABSTRACT

Many scholars indicated that the occupational accidents rate for foreign workers is higher than for domestic workers in Malaysia. In 2015, a total of 140 Malaysia construction workers have suffered fatal injuries, consisting of 47 locals and 93 foreigners and these statistics show that the number of foreign workers who were killed was 2 times more than the number of local workers who died. This paper will therefore aim to promote a better understanding of the role of health and safety practices through identification of the challenges among foreign workers in Malaysian construction industry. The main study to which this paper relates actually adopts a mixed approach for empirical data collection. Whereas this paper is entirely based on secondary data collated through an extensive critical literature review. Findings of this paper provides a general overview of the health and safety challenges faced by foreign workers such as human-rights related problems, difficulty of applying working permit, communication barriers, compensation and insurance scheme, equal treatment, working environment and accommodation issues in Malaysian construction industry which has the potential to lead the relevant authorities such as policy makers and governmental officials in taking necessary steps to improve the safety practices among the local and foreign workers.

Keywords: Foreign Workers; Health and Safety Challenges; Malaysian Construction Industry.

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HEALTH, SAFETY AND WELFARE STANDARDS OF EMPLOYEES IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Construction industry could be identified as one of the major employment opportunity providing sectors in the world wide. Due to larger operational time and use of large force of labour and machineries, risk is predominant in the construction industry. Many fatal accidents have been occurred during the project. Construction accidents are common in the Sri Lankan construction industry. Most prevailing reason in Sri Lanka when considering about the health, safety and welfare of the construction industry, could be identified as the improper safety culture. Furthermore, current Sri Lankan law do not comply with the present needs and they have become outdated.

Aim of this research is to uplift the health, safety, welfare (HS&W) standards of employees and make recommendations for effective development of construction industry. Current situation of HS&W of construction industry of Sri Lanka is identified using of expert survey research approach under quantitative research approach.

Factors contributing for the HS&W issues are examined and factors are properly ranked during the research. Then recommendations have been provided to mitigate factors. Furthermore, loopholes of current Sri Lankan Laws are identified. Overall expectation from the properly established health, safety and welfare culture is to uplift the working standards of the employer in a safe working environment. The extent of contribution from the government to achieve this expectation is well addressed through the research findings. Here amendments to be made for the out dated Sri Lankan legislation are elaborated through the findings. Contributions from the organizations to succeed the targets are also depicted.

Keywords: Construction Industry; Employees; Health, Safety and Welfare; Sri Lanka; Viability.

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IMPACT OF INEFFECTIVE TENDERING PROCESSES ON CONSTRUCTION PROJECTS

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ABSTRACT

Tendering process is the method adopting in procurement for the selection of the contractor, who is responsible for carrying out the construction works. The tendering process is built up with several functions, performed by main tendering stakeholders. Certain substandard practices of the stakeholders during the tendering process create an ineffective tendering process. It directly results in adverse outcomes during the post contract stage of a construction project. Due to the high involvement of these ineffective tendering outcomes, the construction project is impacted adversely and may fail in fulfilling the project objectives effectively. The research investigated the impact of the ineffective tendering process to the construction project and it was equipped by questionnaire survey while the analyses are carried out in a specific analysis method developed for this research.

Initially the research found the contribution of the substandard practices to cause the ineffective tendering process. Then the probabilistic impacts to the construction project were investigated through the probabilistic outcomes from the ineffective tendering process. Additionally, the research has brought some effective solutions to mitigate ineffective tendering process.

The findings of the research indicated that the effect from the ineffective tendering process to the construction project can be mitigated by properly following the governing tender rules, adhering to good codes of conduct & ethics, managing the future risks during the estimating process by the bidders and maintaining better communication during tendering.

Keywords: Ineffective Tendering Outcomes; Ineffective Tendering Process; Tendering Process; Tendering Stakeholders.

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IMPACT OF SUSTAINABILITY EDUCATION ON QUANTITY SURVEYORS IN SRI LANKA

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ABSTRACT

Sustainability Education (SE) is recognised as a lifelong learning process aiming towards sustainable development which spreads beyond the limitations of formal education. In order to ensure proper commitment towards sustainable development through sustainable construction (SC) concept, quantity surveyor (QS) as a leading professional in the construction industry should go through a proper SE. Even though certain HEIs (Higher Education Institutions) in Sri Lanka have incorporated SE up to a certain extent into their curriculum, their effectiveness is questionable. Addressing this gap, the research analyses perceived importance, level of SE received and the effectiveness of SE of Sri Lankan QSs while identifying the knowledge areas where improvements are required. A comprehensive literature review was executed identifying knowledge areas to be included in SE of QSs globally. Through a survey of experts, 39 knowledge areas related to quantity surveying education were identified under six main categories considering the local context. Even though Relative Important Index (RII) values denoted that SE is substantially important to OSs, overall SE level of Sri Lankan QSs was found to be in 'moderate level'. QSs perceived their SE more on 'economic sustainability' as it exhibited the highest mean and RII values. Moreover, the results found that curriculum contribution to deliver SE is currently lower and QSs gain more knowledge on sustainability through industry practice than through formal education. The created matrix plot indicated that certain knowledge areas require further attention in curricula in HEIs which is revealed as the strategy that needs improvements.

Keywords: Curriculum; Higher Education; Quantity Surveyor; Sustainability Education.

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IMPACT OF USING MINIMUM PRELIMINARY ITEMS FOR BUILDING WORKS IN SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Preliminary items section is one of the critical sections in a bill of quantities, though they are not direct parts of the permanent work. There are some preliminary items which are not included in the preliminary bill. In Sri Lankan construction industry employers are willing to pay for the preliminary items which mostly impact to the work items while ignoring the other items. Further, corporate consultants do not instigate employers to include preliminary items. There is a research gap in identifying the impact of minimum usage of preliminary items for building works. Hence, this research was aimed at investigating the impact of using non-detailed preliminary bill for building projects in Sri Lanka. Initially, a literature synthesis was carried out to identify the preliminary items commonly included in the preliminary bill for the building projects in locally and in global context. Furthermore, factors to be considered when pricing the preliminary bill and the importance of preliminary items were identified. Subsequently, the relationship between preliminary amount and the total contract amount was recognized. Data was collected through the semi structured expert interviews and a work study. Thirty building projects were selected for the work study. The collected data was analysed using content analysis with the use of Nvivo 11 software. The analysis revealed that there are negative impacts due to minimum usage of preliminary items in the preliminary bill such as; deterioration of standard and quality of the construction industry, lack of investments toward construction industry, impact to the employer and subsidence of involvement of labours in the construction industry name to few. Furthermore, the paper discussed the factors to be considered when preparing the preliminary bill. Among those factors size of the project is a critical factor when preparing the preliminary bill. Moreover, findings disclosed that average preliminary percentage of building projects is 4.98% and the percentage is increasing with the accretion of the contract amount in Sri Lankan construction industry.

Keywords: Building Projects; CIDA Standard Bill; Construction Industry; Preliminary Bill.

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INTEGRATING INTERNET OF THINGS (IOT) AND FACILITIES MANAGER IN SMART BUILDINGS: A CONCEPTUAL FRAMEWORK

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ABSTRACT

A Facilities Manager (FM) plays a key role in managing all non-core services of a building by integrating people, processes, places, technology, and etc. Considering the effective integration of aforementioned sectors, a facilities manager needs to deal with the evolving information and communication technology. Presently, the most emerging trend is the "Internet of Things" (IoT) which is developing rapidly throughout the world. Subsequently, IoT concept is apparent in the field of facilities management mainly in the sector of building automation with intelligent controls. This intelligent automation results in creating SMART buildings which has become a global trend in the building sector. In such a situation, Sri Lankan building traditions should also be updated with the emerging IoT based technological trends to gain competitive advantages. Even though this is a timely requirement, user acceptance of new technologies and other external factors directly affects new IoT trends in Sri Lankan building culture. Due to the lack of data available in practice, this research was adopted using qualitative approach to identify the existing limitations and challenges of the integration of IoT and FM in smart buildings. This paper presents a conceptual framework which was developed by critically reviewing the secondary data. The proposed framework represents the relationship between FM and IoT in SMART buildings.

Keywords: Facilities Manager; Internet of Things; Intelligent Buildings; Smart Buildings.

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INTEGRATING LEAN AND GREEN CONCEPTS: SRI LANKAN CONSTRUCTION INDUSTRY PERSPECTIVE

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ABSTRACT

Construction industry developers and project teams usually struggle to associate the concept of Green on building projects since it is generally resulting in high initial investment cost. Although this cost of investment can be saved back through operational stage, the current building project delivery methods implemented by most project teams are often laden with non- value adding activities. Lean construction principles have been convinced to eliminate flow activities and improve construction process performance in highly complicated building construction projects. Hence, the aim of this research is to explore and develop a framework to integrate Lean and Green concepts to the Sri Lankan construction industry.

At the outset, the key features and principles of Lean and Green construction were identified to build the conceptual relationship between the two concepts. Subsequently, a qualitative research approach was adopted through the means of expert opinion survey with unstructured interviews involving ten number of local expert professionals who have experience and exposure to both of these concepts. The findings were analysed through content analysis.

The perception of the Sri Lankan stakeholders towards the application of integrated Lean-Green concepts is focused on a positive direction. The identified enablers to implement the integrated concept supersede the barriers by confirming the appropriateness of the application in the local construction industry. The Green concept was integrated into the activities that are implemented under each Lean construction principle. Finally, a framework was developed through the findings to guide the implementation of integrated Lean- Green application in Sri Lankan context.

Keywords: Flow Activity Elimination; Green Construction Process; Integrated Lean-Green Application; Lean Construction Principles.

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INTEGRATION OF SUSTAINABILITY INTO FACILITIES MANAGEMENT PRACTICE IN HEALTHCARE SECTOR

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ABSTRACT

Built environment is recognised as one of the least sustainable industries in the world. Health Care (HC) sector is recognised as the second energy intensive sector in the built environment and is identified as one of the most vulnerable sectors and a potential threat in harming the environment. As Facilities Management (FM) is recognised as a "key actor" in addressing sustainability practices in the built environment, it has become a major concern to deliver FM practice in a sustainable manner. However, integrating sustainability is challenging as sustainable FM practice is firm specific and need consideration of economic, environment and social pillars of sustainability. Thus, this paper investigates how sustainability practices can be integrated in to the FM services and practices in the HC sector.

A Delphi survey was conducted among 10 experts to identify the significant FM services and FM practices to integrate sustainability in the health care sector. The first round of Delphi survey revealed that building services (BS), quality management (Q) and space planning (SP) are the top three FM services for integrating sustainability with RII values of 0.94, 0.9 and 0.9 respectively. In addition, 28 FM practices were identified significant, amongst, educating the work force on related standards, procedures, Strategic Facility Planning (SFP) for HC and deploy quality control and assurance practices with proper standards was identified as three top most FM practices with receiving an RII of 0.96, 0.96 and 0.94 respectively. A conceptual framework was developed for effective integration of sustainability into FM practices. This will further to be taken to the subsequent rounds of the Delphi survey to refine the conceptual integration of Sustainable practices into the FM practice in the HC sector.

Keywords: Facilities Management; Healthcare sector; Sustainable Facilities Management.

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KEY PERFORMANCE INDICATORS FOR MEASURING THE PERFORMANCE OF FACILITIES MANAGEMENT SERVICES IN HOTEL BUILDINGS: A LITERATURE REVIEW

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ABSTRACT

People travel across the world for leisure, business, and relaxation purposes and seek short term or long-term accommodation facilities. With the increase in globalisation and rapid development in technology, the hospitality industry is changing quite momentously in order to respond to the changing needs and expectations of the travellers. Similarly, hotels as one of the main pillars of the hospitality industry, have an important role in a country's economic development. Subsequently, Facilities Management (FM) has become a demanding profession in developing and developed economies, which maximise profits while reducing operation and maintenance costs. In this context, Facilities Managers support the functionality of non-core activities of the hotel sector in line with the core objectives. However, there is an inadequate performance in building services and maintenance of hotel buildings, which lead to loss of productivity, a reduction in profitability, a loss of clients and a general negative company image. To this end, the Performance Measurement (PM) is an essential requirement in hotel sector to increase the performance of FM services. Therefore, this paper synthesises the FM performance based on Key Performance Indicators (KPIs) that indicates how well the organisation is performing in accordance with their strategic objectives and goals. Further, the paper discusses the requirement of PM for FM services in hotel sector. Ultimately, a set of KPIs have been identified based on the available literature in order to measure the performance of FM services in hotel buildings.

Keywords: Facilities Management; Hotel Sector; Key Performance Indicators; Performance Measurement.

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LIFE CYCLE COST COMPARISON OF LEED CERTIFIED AND CONVENTIONAL OFFICE BUILDINGS IN SRI LANKA

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ABSTRACT

Green buildings are emerging concept to Sri Lankan construction industry. Although with a slow uptake, office building development is currently trending towards green buildings in the country. Lack of knowledge of the developers about advantages of green buildings in terms of the life cycle cost appears to be the largest obstacles which hinder green buildings in the country. In this context this study aims to compare the Life Cycle Cost of LEED certified office building with conventional office building in Sri Lanka in order to raise awareness of the advantages of green buildings mainly in terms of life cycle cost savings. Case study strategy was employed with semi-structured interviews and document survey as the data collection method. An expert survey was conducted to identify the life cycle cost components which are applicable to Sri Lankan context. Life Cycle Cost Analysis was carried out to evaluate the cost savings of green building over conventional building using Net Present Value method. The findings of this study reveal that although the construction cost of green building 5.33% higher of conventional building the cost is saved through operation and maintenance cost.

Keywords: Green building; LEED certified building; Life Cycle Cost; Office buildings; Sri Lanka.

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MANAGING CHALLENGES OF HIGH-RISE RESIDENTIAL BUILDINGS IN SRI LANKA: A FM FRAMEWORK

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ABSTRACT

High Rise Residential Building (HRRB) is a fast-growing trend in Sri Lanka. These are regulated and managed by the Management Corporation (MC). However, In Sri Lankan context MC is poor performance has led to various issues and challenges in HRRB. Hence, to better manage as well as overcome such issues and challenges by suitable professional concept in HRRB. Thus, the study was aimed to develop Facilities Management (FM) solutions to manage issues and challenges of the HRRB in Sri Lanka. To achieve the aim four objectives were formulated. As, to investigate the issues and challenges of managing the HRRB, current management practices, possible FM solutions to mitigate the identified issues and challenges and develop a framework to manage the HRRB in Sri Lanka. A qualitative research approach was followed to achieve the aim of the research wherein case study method was selected as the most appropriate research method. The required data were collected via semi structured interviews and analysed using cross case analysis. The findings of the study revealed issues and challenges in HRRB falls into three main categories, namely building management, finance and resident related issues. Subsequently, the issues and challenges faced by the MC of HRRB in Sri Lankan context, and FM solutions adapted to overcome such as issues and challenges were identified. Hence, a framework has been proposed in this study to successfully manage issues and challenges in HRRB in Sri Lanka. This research increases the present level of awareness and importance associated with effective management practices for HRRB management within the scope of FM. Further, it introduces a framework for well managed the HRRB.

Keywords: Facilities Management; High Rise Residential Buildings; Management Corporation; Sri Lanka.

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MINIMISING CONCRETE WASTAGE IN SRI LANKA USING LEAN CONSTRUCTION TECHNIQUES

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ABSTRACT

Concrete is a major component of construction waste. The amount of concrete wasted in Sri Lanka is significant compared to the amounts wasted in other countries. Traditional strategies adapted to minimise concrete wastage have not been successful. Although lean construction can eliminate waste, there is very little research that has been done on this subject. The aim of the study was therefore to identify the suitability of lean techniques in minimising concrete waste generated during pre and post contract stages of construction in Sri Lanka. Qualitative research methods were used to achieve this aim. A literature review and a set of structured interviews with fifteen experts working in the construction industry were used to collect the required data. The data collected were analysed using content analysis. Total quality management, just in time, process re-engineering, value-based management and total productive management were identified as the lean techniques that can be used to minimise the waste of construction.

Keywords: Building Construction Projects; Concrete Wastage; Lean construction; Pre and Post Contract Stages.

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MODEL FOR ANALYSING THE DRIVERS AND BARRIERS OF E-PROCUREMENT ADOPTION TO ENHANCE THE PERFORMANCE OF PROCUREMENT SYSTEM IN SRI LANKA

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ABSTRACT

The growing need and competitive nature of firms in the modern world have been directed the organisations in discovering new solution to improve their business value and performance. E-procurement (EP) system is realised as an innovative technique by most of the practitioners and rate of adaptation is intensely increasing around the world. However, key literature findings revealed that organisations are struggling with EP system due to the lack of knowledge on factors influencing the successful implementation. This situation is similar to the Sri Lankan context as well. In this context, it has become a timely requirement to develop a mechanism for analysing such factors to facilitate a successful implementation. Therefore, this study attempts to develop a model for analysing the drivers and barriers of EP adoption to enhance the performance of procurement system in Sri Lanka. A qualitative approach was followed in which multiple case study was selected as an appropriate method for the research which allows to analyse within each setting and the evidence created from this type of study is considered robust and reliable. Accordingly, semi-structured interviews were conducted among the selected three respondents from each case to collect the data. Captured data was structured and analysed by using manual content analysis method with the support of NVivo software. Empirical investigation validated twenty-four drivers and seventeen barriers which are influencing the successful EP adoption. The research findings further disclosed six strategies to strengthen the drivers and weaken the barriers of EP adoption. Finally, a model was developed based on the research findings in order to facilitate the adoption of EP system in Sri Lankan context.

Keywords: Barriers; Drivers; Electronic Procurement (EP) System; Strategies.

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New Approaches to Employer Engagement Within Surveying Education: Degree Apprenticeships

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ABSTRACT

Differing models of academia and the construction industry collaboration have evolved in the UK and internationally to develop a healthy skills supply chain. However, the increasingly popular Degree Apprenticeships in the UK has caused there to be much greater prominence of the issues around industry-academia interaction. Degree apprenticeships were part of an initiative introduced by the UK government in 2015 aimed at boosting employer investment in education and training. In April 2017, employers whose pay bill exceeded £3m had a 0.5% levy deducted, which was ring-fenced to support new apprentices.

This paper explores the tripartite structural issues that this new approach will need to address for the initiative to deliver the outcomes required by the Universities, employers and apprentices. The paper, inter alia, reports on an employer survey aimed at gathering opinion data. The data were collected from a survey designed to investigate employer's expectations of degree apprenticeships, their advantages and disadvantages and to ascertain the impact that the new approach might impact graduate recruitment in future. The survey findings and subsequent interpretation of results will be used to inform the strategic direction of the university's engagement with industry and with the degree apprenticeship initiative. Possible implications to future delivery of surveying education in the UK are also discussed including references to lifelong learning.

Keywords: Degree Apprenticeships; Lifelong Learning; Professional Bodies; Surveying Education; University Industry Collaboration.

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PERCEIVED NEGATIVE EFFECTS ON PROJECT STAKEHOLDERS FROM ADOPTING BIM IN SRI LANKA

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ABSTRACT

Many Asian countries have adopted Building Information Modelling (BIM) technology in their projects. But BIM Level 2 has not been adopted by Sri Lankan construction industry yet. While there are number of studies on BIM in and for Sri Lanka, there is no prior research focused on 'Perceived Negative Effects on Project Stakeholders from Adopting BIM'. Among many challenges and barriers in BIM adoption, negative perception is a significant challenge. Understanding the negative perception of each key stakeholder is very important to a successful BIM adoption. Without knowing how significant the perceived negative effects are, formulating effective BIM adoption strategies are impossible. There is a need to develop the understanding, of how these negative perceptions affect BIM adoption in Sri Lankan construction projects and among the key project stakeholders. Therefore, the purpose of this study is to identify the key project stakeholders for BIM adoption and to verify the status of perceived negative effects of BIM among Sri Lankan construction project stakeholders. In order to identify significant negative BIM perception among different disciplines, a deductive research method and quantitative approach was adopted. An online questionnaire survey was conducted among 316 key project stakeholders comprising clients, consultants and contractors, to identify the significant negative effects of BIM. 49 completed the questionnaire. Descriptive statistical analysis using percentiles method was used to rank the significant BIM perceptions. The study finds that the perceptions on BIM among different disciplines are widely different. However, all disciplines firmly agree that BIM will not replace their profession.

Keywords: BIM; Negative Effects; Perception; Sri Lanka; Stakeholders.

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POTENTIAL OF APPLYING EARNED VALUE MANAGEMENT (EVM) AS A PERFORMANCE EVALUATION TECHNIQUE IN BUILDING CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

Construction industry has some unique characteristics that brings specific challenges in achieving required performance. Currently majority of construction companies evaluate the project performance by program review method, which can identify the performance after the activity accomplishment or action is accomplished. The project should have begun to use the existing performance technique. Earned Value Management (EVM) is a more robust, internationally recognized and adhering process to evaluate the project performance. EVM considers the performance in Time, Cost and Quality aspects. EVM compares the project Planned Value (PV), Earned Value (EV) and Actual Cost (AC). Current knowledge showed no evidence of EVM in Sri Lankan construction projects. This research was conducted to identify the potential of applying Earned Value Management (EVM) as a Performance Evaluation Technique in Building Construction Project in Sri Lanka. The research followed a qualitative approach. The researcher could be able to identify the facilitators, barriers and the challenges of applying EVM in current context. Semi-structured interviews were conducted to investigate status and key challenges for the implementation. After analysing the data, the researcher could conclude major barriers and challenges on implementing EVM as a performance evaluation technique for Sri Lanka construction industry. Its consumption of considerable extra cost, need to train staff, reluctance of some qualified employees to adhere to the technique due to various constraints could be identify as common bottlenecks.

Keywords: Barriers; Earned Value Management (EVM); Facilitators; Sri Lanka.

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PROFITABILITY ASSESSMENT OF SOLAR PV INSTALLATIONS IN SRI LANKAN RESIDENTIAL BUILDINGS

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ABSTRACT

The study focused on developing a cost recovery model to evaluate the profitability of installing solar panels in buildings in Sri Lanka to address the growing demand on the electricity supplied from the national grid. The study aimed to make the buildings in Sri Lanka zero carbon buildings. A cost-benefit analysis model was developed using Microsoft Excel to assess the profitability of solar power panels. The model was applied for a sample consisting of 8 domestic (small to large) consumers, to identify the type of domestic consumers most suitable for installing solar panels. Using the standard electricity tariffs enforced by the Ceylon Electricity Board, the average annual costs of electricity consumed by eight consumers were computed along with their Net Present Values (NPV) for a period of 25 years based on the interest rates offered by banks in Sri Lanka, to identify the discounted annual cash flows and evaluate the recovery period of high initial costs of solar power panel installations. The model shows that when solar panels are installed in buildings with high power consumption their high initial installation costs could be recovered in a relatively short period of time. Therefore, the installation of solar penal in such buildings would be profitable.

Keywords: Cost Benefit Analysis; Net Present Value (NPV); Zero Carbon Buildings; Zero Carbon Economy.

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REFLECTION ON THE THEORY AND PRACTICE OF INTEGRAL SUSTAINABLE DESIGN IN RURAL CONTEXT: A LITERATURE REVIEW

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ABSTRACT

Sustainability is often discussed with regard to urban development. However, the prevailing system of developing rural areas with poor communities and numerous critical problems associated with the same are hardly in line with the concept of sustainability. In order to achieve a true rural development, the rural built environment should be provided with sustainability principles which produce economically, socially and environmentally responsible designs and constructions. In addition, the so called sustainable design and construction should respect the existing individual life style, cultural views, values and systems of the rural communities. Considering the need for addressing the aforementioned facts, this study aims at understanding the need for an integrated framework for sustainable building design and construction in the rural context. Accordingly, the Integral Sustainable Design theory is used to identify the multiple perspectives that should be addressed in sustainable rural development. The study is based on a comprehensive literature review on the rural community requirements and how they are adequately fulfilled with the application of sustainability in reference to the Integral Sustainability Design theory. The research findings reveal that an integrated framework for sustainable building design and construction can address a diverse range of issues available in the community such as poverty, lack of education, lack of protection for women and children, lack of protection in natural disasters and unstable living conditions while eliminating the prevailing short-termism and fragmentation of development. The research outcomes will provide a holistic view of application of sustainability in rural development through rethinking, design, construction and operation.

Keywords: Design and Construction; Integral Sustainability Design Theory; Rural Context; Sustainability.

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REVIEW OF IMPACT OF JUDICIAL INTERFERENCE TO ENHANCE CONSTRUCTION ARBITRATION IN SRI LANKA

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ABSTRACT

The basic characteristics of built environment activities are complexity and disputability in its own nature. This complexity drives most of the construction projects and contracts towards disputes between parties. Construction contracts in the industry are more complex than all other type of business contracts by its nature. This complexity itself has paved the path for disagreements between parties of such contracts. Although disputes are common in Sri Lankan construction industry as elsewhere in the world, dispute resolution mechanisms are not admired in Sri Lanka. The litigation process is the traditional mode of dispute resolution, drawbacks of litigation process have opened up the 'Alternative Dispute Resolution' (ADR) methods. Literature based on the process of Arbitration in Sri Lanka and other countries reveal that using Arbitration as an alternative method to the court system will be more beneficial than court litigation. It is evident that there would be a high possibility to ensure the efficacy of the process of Arbitration by minimising the interference of the judiciary. At present Arbitration as an ADR method does not efficiently resolve the disputes.

This research examines the usage of Arbitration as an ADR method to resolve the construction disputes instead of traditional litigation. However, the current arbitration method and its practice hinders the advantages by irregular judicial interferences which prolong its efficiency. The aim of this research is to recommend effective amendments for current Arbitration practice in Sri Lanka by reviewing the impact of judicial interference. This research proposes a well-planned Arbitration method which can avoid pitfalls in the current legal regime of the Arbitration practice in Sri Lanka. Further it seeks to suggest positive amendments for the Act to avoid loopholes and minimise the challenging grounds of arbitral awards.

Keywords: Arbitration; Construction Industry; Dispute Resolution; Judicial Interference.

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RISKS ASSOCIATED WITH PHYSICAL ASSET MANAGEMENT: A LITERATURE REVIEW

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ABSTRACT

Accelerated physical asset operations in organisations are necessitated in order to sustain within the competitive business environment. These asset operations involve a number of risks. The management of risks associated with physical assets as well as their operations is an essential element of Physical Asset Management (PAM). Although there is a growing interest in PAM around world, a lack of consideration of risks associated with PAM is evident. However, it is believed that a proper understanding of these risks is essential for effective Physical Asset Risk Management (PARM). Accordingly, the aim of this paper was to review the existing literature to investigate the risks associated with PAM. A comprehensive literature survey referring data sources, and a subsequent desk study were carried out in order to achieve the above aim. The study identified thirty-five risks, which could be categorised under six (06) groups as 'physical failure risks', 'operational risks', 'risks associated with natural environmental events', 'risks associated with the factors outside the organisations' control', 'stakeholders related risks' and the 'risks associated with different lifecycle phases of assets'. Giving a prior concern for the identified risks and reviewing the exposure level of each risk towards PAM will support the organisations to evaluate the risk levels and make decisions on risks mitigation. This will provide the organisations with a smooth operation of physical assets and numerous benefits associated with it

Keywords: Physical Assets; Physical Asset Management (PAM); Physical Asset Risk Management (PARM); Risks Associated with PAM.

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SDGS: ISLAMIC PROJECT FINANCE FOR INFRASTRUCTURE PPPS IN SUB-SAHARAN AFRICA

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ABSTRACT

Sub-Saharan Africa (SSA) is the region with the highest number of countries that did not meet the Millennium Development Goals (MDGs) which expired in 2015. Meeting the newly established Sustainable Development Goals (SDGs) is inextricably linked to the availability of quality infrastructure. The current slowdown of the post-global financial crisis economy is already threatening to hinder the ability of SSA to meet the new SDGs. Without investments in key infrastructures that support a modern economy such as roads, electricity and safe water and sanitation, SSA may not meet the new SDGs targets. The past PPP-based conventional debt-financed solutions to SSA infrastructure have failed to produce the desired results and are being terminated. A growing body of empirical studies points to the conventional debtfinance used as a major weakness of the PPP model. The pressure to meet lender's debt repayment covenants force Project companies to pushback scheduled maintenance, and critical infrastructure investments leading to contract breaches and eventual cancellations. This article seeks to highlight why SSA countries should adopt Islamic project finance for PPP financing. We argue that Islamic project finance will eliminate the pressure of meeting specific debt service covenants, lower the cost of services, ensure service sustainability, affordability, and will assist SSA countries meet the new SDG targets. Islamic project finance instruments are partnershiporiented, equity-based, share risks and are compatible with SDGs.

Keywords: Conventional Debt Finance; Islamic Project Finance; PPP; SDGs; Sub-Saharan Africa.

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SIGNIFICANT FACTORS INFLUENCING OPERATIONAL AND MAINTENANCE (O&M) COSTS OF COMMERCIAL BUILDINGS

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ABSTRACT

Usually, the costs incurred during the operational phase of a building are much greater than the initial construction cost. Amongst, the running cost of a typical commercial building varies between 70-80% of its total LCC depending on its determinants. However, the significance of those determinants could vary with building function, characteristics of location and economy where it is based. This paper, therefore, investigates the significance of factors influencing the running cost of commercial buildings in Sri Lanka. A questionnaire survey administered to a sample of 125 industry professionals who have more than 10 years of experience in building O&M indicates that O&M costs of a commercial building are influenced by 08 major determinants including building characteristics (BC), maintenance factors (MTF), managerial factors (MNF), environmental factors (EF), political factors (PF), tenant factors (TF), design and & construction defects (DCD), and social factors (SF). The relative significance index (RSI) analysis performed ranked EF as the top determinant influencing both operations and maintenance costs of commercial buildings with an RSI of 0.963 and 0.996 respectively. Further, all the respondents are of the view that building function, occupancy, and building services have a highly significant influence on operations costs whereas natural deterioration, failure to identify the true cause of defect, lack of preventive maintenance, and budget constraints are foremost factors influencing the maintenance costs. The impact of most of the sub-factors except very few namely, building function, age, and location on O&M costs can be controlled up to a greater extent. Thus, early consideration of these factors during the building design and construction will result in reduction of unnecessary costs to be incurred during the operational phase of a building.

Keywords: Commercial Buildings; Correlation; Determinants; O&M Costs; Relative Significance Index.

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SOLAR NET ZERO ENERGY BUILDINGS: A REVIEW

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ABSTRACT

Commercial and residential buildings account for almost 40% of the world total energy demand. In order to fulfil that energy requirement, large amount of fossil fuels are used and it has made a greater impact on the environmental sustainability and the economic stability of the society. Therefore, the industry gives more concern to create an environmentally friendly and economically viable renewable energy (RE) solution since last few decades. A number of environmentally friendly building design concepts have been established to promote the renewable energy (RE) usage in the building sector. Solar Net Zero Energy Building (Solar NZEB) can be identified as one such environmental friendly building design concept which has gained a significant global attention in the last decade. This study is focussed on reviewing the Solar NZEB concept and its applicability based on the literature. First the approaches to achieve zero energy balance in a building is explained in terms of energy efficiency measures and onsite renewable energy sources. Further, the design considerations of Solar Net Zero Energy Buildings are identified and following identification of the enablers and barriers for the Solar NZEB, the research concludes with a conceptual framework for Solar NZEB.

Keywords: Enablers and Barriers; Energy Efficiency Measures; Net Zero Energy Building (NZEB); Renewable Energy (RE); Solar Energy.

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STAKEHOLDER MANAGEMENT IN COMPLEX PROJECTS

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ABSTRACT

Effective stakeholder management is a critical success factor for all types of projects. The increasing complexity in construction projects makes the management of project stakeholder management increasingly challenging due to their diverse characteristics, including power, interests and attitudes. It appears that much of the literature has focused on stakeholder management with very limited or no regard to either the level of project complexity or the extent of meeting project success measures. The objective of this paper is, therefore, to fill these research gaps by: 1) critically reviewing relevant literature; 2) briefly presenting key effective stakeholder management strategies; and 3) developing a conceptual framework for empirical testing. The paper provides a concise description of the framework and its constructs, and outlines the proposed methodology for testing its relevant hypotheses.

Keywords: Complex Projects; Project Success; Stakeholder Management.

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STAKEHOLDERS' PERCEPTION ON PROJECT UNCERTAINTY IN PPP PROJECTS IN INDIA

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ABSTRACT

PPP projects are often complex, unique and dynamic due to high sunk-in costs and long concession period making it vulnerable to risks (known-unknowns) and uncertainties (unknown-unknowns). Previous researches focus on risks associated with PPP projects. But these projects are hit by uncertainties which surfaces as turbulences during the execution as well as the operation stage of the project. The extant literature does not focus much on the uncertainties manifested in these projects nor does it convey the stakeholders' outlook on uncertainties, which has a strong bearing on project management. In order to ensure sustainability of PPP projects, among other factors, it is important to identify uncertainties that affect their performance in various phases or leads to uncertain situations. A superset of uncertainties identified from literature was subsequently expanded and validated by PPP Experts. Stakeholders perceptions on the fifty-four identified uncertainties likely to manifest in various phases was assessed through a survey to identify and evaluate the uncertainties that affect the implementation of transport PPP infrastructure projects as well as explore the perception of stakeholders on project uncertainties for end-to-end sustainability. Differences in opinion among stakeholders on uncertainties often are found to act as a hurdle for effective implementation of PPPs. It is comforting to note that stakeholders have arrived at a general understanding on uncertainties since the inception of PPP projects in India, though there is long way to go. The comprehensive list of the uncertainties brought out in this paper validated by the experts in this field through their experience gained in managing PPP projects in India over the past two decades, when given due consideration while developing Concession Agreements in future will help to institutionalise addressing these unknown unknowns as well as keep the project officers prepared to effectively manage them as and when they unfold.

Keywords: Perception; Project Management; Public Private Partnerships (PPP); Stakeholders; Uncertainty.

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SUITABLE GOVERNMENT INITIATIVE STRATEGY FOR BIM IMPLEMENTATION IN SRI LANKA

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ABSTRACT

Construction industry has encountered various innovative technologies over the past decades. Growth of these innovative technologies has paved the way to improve the performance and productivity in the industry. Building Information Modeling (BIM) is a revolutionary paradigm which supports Architecture, Engineering, Construction and Operations (AECO) industry to improve its efficiency and effectiveness to deliver economical and quality products. AECO industries in many countries are gaining immense advantages by adapting BIM. There are six roles which foreign governments have played in BIM implementation strategy. Government authorities in other countries have adopted these roles in their BIM implementation strategy, while encouraging private sector to acclimate. Moreover, there are various BIM implementation strategies developed by different governments all around the world. Majority of successful BIM implementations rest with the improvement of the basic BIM competencies. In Sri Lankan perspective, fewer people aware on BIM and government has completely disregarded this novel technology which can contribute massive benefits to the local construction industry. There are numerous challenges which barricade the adaptation of BIM in Sri Lanka. This research aims to identify a suitable government initiative strategy that can be adapted to implement BIM in Sri Lanka. Espousing this suitable strategy will eliminate barriers against BIM and improve basic BIM competencies which are needed to improve BIM implementation in Sri Lanka.

Keywords: Building Information Modelling (BIM); Construction Industry; Sri Lanka.

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TECHNO-ECONOMIC FEASIBILITY STUDY OF USING SOLAR ENERGY FOR OPERATING SEWAGE TREATMENT PLANTS

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ABSTRACT

Sewage treatment plants are the major consumers of energy throughout the world and most of the studies consider completely self-sufficient treatment plants or offgrid solar PV. This study presents the findings of the techno-economic feasibility study of using on-grid fixed tilt polycrystalline solar photovoltaic (PV) modules to generate power for operating small capacity sewage treatment plants (STP) ranging from 1 to 10 MLD. Recent ongoing 4 STP projects in Rajasthan, India is considered for the study. With fixed-tilt solar PV system, the maximum PV array capacity need to be installed is found to be 99kWp, 131kWp, 172kWp and 403kWp for 1.5, 2, 3, 8 MLD STP's respectively. Life Cycle Cost Analysis of a base case scenario with 30 years of service life and 10% discount rate indicates that the Net Present Value (NPV) of the system comes around 3.7 Million INR, 5 Million INR, 6.5 Million INR and 15.3 Million INR for 1.5, 2, 3, 8 MLD respectively. The Internal rate of return (IRR) is found to be 18.5%, the normal payback period to be 5.4 years and Discounted Payback period to be 8 years for all 4 STP's. Life Cycle Assessment results of the Solar PV modules indicates that the energy payback period is coming around only 1.6 years with carbon payback period of 142 days in comparison with conventional coal-based power plants. It is found that application of Solar PV in operating STP's is highly favourable technically, economically as well as environmentally in a tropical Country like India.

Keywords: Life Cycle Cost; Power Generation; Sewage treatment plant; Solar photovoltaic.

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TENDENCY OF SRI LANKAN CONSTRUCTION ORGANISATIONS IN ADOPTING ENTERPRISE RESOURCE PLANNING SYSTEMS

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ABSTRACT

The popularity of Enterprise Resource Planning (ERP) system is increasing in many industries. Many researchers have conducted studies on ERP in relation with construction industry as well. The observations of some of the researches were contradictory, while most of them are observing positive tendency among the contractors. Nevertheless, the tendency of Sri Lankan contracting organisations to implement ERP systems has not been studied. Hence, this research aimed to find the tendency of Sri Lankan contracting organisations to implement ERP systems.

A mixed research approach along with an extensive literature review has been carried out to pursue the aim of this research. The concept of ERP has been identified along with the driving and restraining factors in implementing ERP system to contracting organisations.

It has been identified that ERP system is popular among the Sri Lankan construction industry professionals since most of them at least heard about the system. Nevertheless, as per the conclusion, even though there is a positive tendency among global contractors to implement ERP system to their organisations, Sri Lankan contracting organisations are still lacking in confidence to implement the system.

Keywords: Construction Industry; Driving Factors; Enterprise Resource Planning (ERP); Restraining Factors.

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THE PROSPECT OF IMPLEMENTING PF2 IN SRI LANKA

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ABSTRACT

The Private Finance Initiative (PFI) as a sub-set of broader procurement approach of Public Private Partnerships (PPP), uses private sector capacity and public resources in order to deliver public sector infrastructure and/or services. In 2012, the UK Government publicly launched the new model, called "Private Finance 2 (PF2)" with some significant reforms to the PFI model, which are particularly aimed at tackling inefficiency, increasing transparency, shortening procurement periods and attracting new sources of finance. PF2 can be used as an instrument for producing new and more effective ways of bringing public services. While other countries are moving from PFI model to PF2 and other variants of PFI model, in Sri Lanka, there is a dearth of PFI type projects. However, there is a considerable number of researches on PFI model in Sri Lanka, but there is no evidence for researches on PF2 model. Accordingly, this is an initial study aimed to determine the prospect of implementing PF2 model in Sri Lanka. Applicability of PF2 model in the Sri Lankan context was defined using the collected through expert interviews and suitable sectors to implement PF2 model were ranked based on Relative Importance Index (RII) value. Construction industry advisors of the government and construction organizations who are either familiar and knowledgeable with the model were selected for data collection. Results show that the PF2 model is generally applicable in Sri Lanka compared to PFI features. Transportation, provision of electricity and water, and health care were recognized as the most suitable sectors to apply PF2 model in Sri Lanka. On the other hand, real estate and educational sectors have been recognized as sectors which are not suitable to carry out under the PF2 model.

Keywords: Applicability; PFI; PF2; Sri Lanka.

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THE SIGNIFICANCE OF LABOUR FACTOR IN INTEGRATING SUSTAINABILITY CONCEPT INTO CONSTRUCTION INDUSTRY PRACTICE

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ABSTRACT

Sustainable Development (SD) has become a major consideration due to low responsiveness of industries to the natural environment and related social problems. The construction industry is a main natural resource consumer and a major contributor to country's economy. Hence, the sustainable performance of construction industry is essential to achieve SD goals. The construction industry is a labour incentive industry and therefore, the way construction works are planned, scheduled and controlled depends directly on the labours performance. This research is aimed to evaluate the influence of labour factor in integrating sustainability concept into construction industry practice. The literature review identified the mostly used Sustainable Construction (SC) principles and revealed that Most of identified SC practices were influenced by the labour performance. This research is conducted with a quantitative approach using a questionnaire survey in two phases. Phase I was conducted with construction industry professionals, the sample size was 75, and Phase II was conducted with 50 construction labours. Findings revealed, labour having a significant role in implementing SC successfully. Lack of awareness was identified as the main reason for a negative impact from labour in SC. When integrating sustainable concepts into construction, labour management strategies should be also focused apart from the sustainable building materials and technologies to provide the best outcome for the client or society.

Keywords: Construction Industry, Environmental Sustainable Construction, Economic Sustainable Construction, Labour Performance, Social Sustainable Construction

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TOOL FOR ASSESSING LEAN MATURITY IN CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

The Non-Value Adding Activities (NVAAs) generated in a construction process are recognised as one of its major weaknesses since they adversely affect performance and efficiency and produce unwanted cost. Lean construction applies lean production principles to the construction industry to minimise NVAAs in construction projects and maximise the value provided to clients. Lean is an innovative construction management approach which is linked closely to the overall life of a project to ensure its success. It is vital to measure the extent to which lean techniques have been applied in a certain project in order to implement more suitable lean techniques in future projects. This paper presents such a mechanism developed for assessing lean maturity in construction projects in Sri Lanka. A detailed literature review was carried out to identify the examples of NVAAs and to investigate the widely used lean techniques in construction projects. Quantitative research approach was adopted through three different surveys. Both surveys one and two were based on questionnaires and the data was collected from industry professionals. The first survey for project quantity surveyors, site engineers and construction engineers to identify NVAA, and the second survey for project managers in building construction projects to examine the application of lean techniques. The research technique for the third survey was semi-structured interviews for senior managers in top grade building construction companies. The data was then used to map NVAAs against lean techniques and emphasise the most suitable lean techniques in different stages of construction projects. Finally, a tool for assessing lean maturity of a construction project was developed to measure the lean implementation of completed projects in order to improve the application of lean techniques in future construction projects. The tool was thereafter validated through an expert survey and implemented in few recently completed projects.

Keywords: Assessment Tool; Construction Projects; Lean Implementation; NVAAs.

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TOWARDS DIGITAL DELIVERY OF METRO-RAIL PROJECTS IN INDIA

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ABSTRACT

There is a large programme of metro-rail construction in India, upgrading public transportation systems to provide rapid transit to millions of people in major Indian cities. The scale of this development makes it important to innovate as improvements in design, construction and operations can have a significant impact on built asset sustainability. As integrated digital delivery approaches are becoming used internationally in infrastructure projects, new questions arise about their application and suitability in these Indian metro-rail projects. This paper is based on a research collaboration involving desk-based study, site visits, and a hosted workshop with 40 participants including client representatives of six major Indian metro-rail projects along with technology providers and delivery teams. Findings are that - while Nagpur Metro project is most advanced in implemented Building Information Modelling (BIM) in its planning and design phase, translating practices from Crossrail in London into the Indian context - there are significant challenges in adopting digital practices in the delivery of new transportation schemes in Indian cities. These challenges include stakeholder awareness and education; integration and interoperability: standardization; cost implications and BIM strategy. The paper concludes with some potential directions for future research and discusses the potential for India to 'leapfrog' a generation of technology to implement low-cost effective digital solutions.

Keywords: Digitisation; Infrastructure; Innovation; Metro-rail Projects.

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VALUE CONSIDERATIONS OF ADOPTING BIM IN FM

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ABSTRACT

Building Information Modelling (BIM) is expected to streamline the key processes of construction, and promote innovation throughout the building/product life cycle. Since most buildings have been designed for long lifecycles, the facilities management (in-use) phase is significant. Therefore, use of BIM in facilities management (FM) offers the promise of much benefits to project stakeholders. Even though strategic level benefits of BIM to FM are recognised, limited attempt has been made to understand its application at operational level.

This paper aims to establish the "value" of BIM in FM. The study explores the key aspects of value theories through a thorough literature review and empirical data from 15 interviews to identify the human value consideration of BIM in FM. The background of this paper discusses the nature of built environment by bringing evidence for the value factor embedded in buildings beyond price. Wider benefits of BIM in facilities management are noted, however its implementation within FM phase is limited. The findings of research explain the critical value considerations for BIM in FM by considering the value of BIM at operational level. The research contributes to the current knowledge by presenting the key link of basic human values with operational level BIM expectations.

Keywords: Basic Human Value Theory; Building Information Modelling (BIM); Facilities Management (FM); Value In-use.

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WORKER AWARENESS OF WORKMEN'S COMPENSATION IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Work-related injuries and illnesses are common in the construction industry, which can lead to deaths, injuries or disabilities (temporary or permanent) to the workers and Workmen's Compensation Ordinance (WCO), deal specifically with employment injuries. There is no mandatory insurance clause in the WCO that requires employers to be insured against Worker injury risks. However, insurance companies offer Workmen's Compensation Insurance (WCI) policies to cover workmen's compensation liabilities and employer may opt to insure his liability at his own discretion. The aim of this research is to identify the awareness of Workmen's Compensation (WC) among Workers in the construction industry. This research has been carried out through literature review and data collected from a preliminary interview, questionnaire survey followed with semi structured interviews. Research findings show that most workers have a poor awareness about WC; therefore, benefaction from WC to the workers has to be improved. The main reasons for this matter is that the Workers are not retaining under same employer for long time duration and there are no awareness programs in the construction sites about WC. In order to overcome this issue, mainly safety officers can comprise short seminars about WC once in four months in the monthly meetings and safety officers should come across as an intermediary to make sure that the workmen's compensation process is being carried out as required in the site.

Keywords: Construction Industry; Worker Awareness; Workmen Compensation.

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ZERO LANDFILL FRAMEWORK FOR APPAREL INDUSTRY SOLID WASTE

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ABSTRACT

Apparel industry being one of the key economic players, mass production of textile and apparel take place, resulting in a considerable amount of solid waste generation which ultimately ended up in landfills. Shortfalls in solid waste management has created several issues related to environmental, economic and social and thus it has become a burning issue. Therefore, innovative approaches are timely, needed to overcome this national problem. The Zero landfill concept has been identified as one of the innovative approach. Therefore, this research is focused to study the applicability of the Zero landfill concept to the Sri Lankan Apparel industry. For the study, conceptual framework for zero landfilling was developed and further three case studies were selected for the identification of suitability of the framework for the solid waste management in the apparel industry. Documentary evidences, interviews with experts were carried out to achieve the relevant data. The study revealed that industry generates main types of solid waste, such as, fabric, paper, cardboard, food waste and considerable amount of such waste can be managed through this proposed framework. A considerable amount of plastic and polythene waste ended up in landfills causing difficulties in achieving zero landfill concept for the apparel industry. With the expert opinions, it was confirmed that zero landfill concept can be achieved in the apparel industry by zero landfilling of plastic and polythene waste. Thus, the zero-landfilling concept can be implemented successfully in the country. Further, as landfilling has become a burning issue in the Sri Lankan context, the Zero landfilling concept is a vibrant solution to eliminate the solid waste landfilling.

Keywords: Adaptability; Apparel Industry; Solid Waste Management; Zero Landfill.

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