The 8th World Construction Symposium - 2019

Towards a Smart, Sustainable and Resilient Built Environment

8th - 10th November 2019

GALADARI HOTEL
COLOMBO

Programme & Abstracts

Organised by

CEYLON INSTITUTE OF BUILDERS (CIOB) SRI LANKA

DEPARTMENT OF BUILDING ECONOMICS
UNIVERSITY OF MORATUWA

THE 8TH WORLD CONSTRUCTION SYMPOSIUM 2019

TOWARDS A SMART, SUSTAINABLE AND RESILIENT BUILT ENVIRONMENT

08 – 10 November 2019

at
Galadari Hotel
Colombo, Sri Lanka
&
University of Moratuwa

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
Colombo School of Construction Technology (CSCT), Sri Lanka
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Prof. Chitra Weddikkara
Chairperson
The 8th World Construction Symposium 2019

It is that time of the year once again to hold the 8th World Construction Symposium 2019, where the Ceylon Institute of Builders and Building Economics & Management Research unit of the Department of Building Economics of the Faculty of Architecture at the University of Moratuwa join hands with their national and international partners to host this important symposium. The theme of the symposium is "Smart, Sustainable and Resilient Built Environments'.

It is a very timely and pertinent theme that will be discussed since our country is poised for advice, constructive development, and expertise from researches and professionals who will be sharing their experiences at this forum. This will enable the policy makers to formulate sustainable development goals for our construction industry and other relevant industries, which in turn will lead to benefits for the Sri Lankan population.

I am indeed proud that this symposium, from its initial commencement to the present, has gained popularity as well as international recognition as a true scientific forum with many papers from various countries.

I like to congratulate our committees and all others who have become an intricate part of the forum and wish every researcher and paper presenter the very best at the symposium

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

I take great pride in welcoming the guests and attendees of the 8th World Construction Symposium 2019. This Symposium provides an opportunity for the partakers 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 communications between multidisciplinary teams in construction industry have become tremendously easy in the present setting. Therefore, it is vital that we progress with new techniques and methods that could be used in this growing situation. With this in mind, the organising committee together with the scientific committee has designated the theme "Towards a Smart, Sustainable & Resilient Built Environment" for the symposium this year.

I wish to extend a warm welcome especially to our international delegates who have traveled so far to be with us for this event. I wish the symposium every success.

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

I am delighted to welcome you to the 8th World Construction Symposium, 2019. It is a matter of pride that our institute, Ceylon Institute of Builders has 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 is the joint organizers of this Symposium. I would like to express gratitude to them for their unwavering dedication and support. We are also thankful to the Associate Partners of the Symposium.

As in the previous Symposiums, this Symposium has been greatly supported by the Government ministries and professional institutions which have helped us in organizing this Symposium. I wish to record my special thanks to all of our Sponsors and well-wishers for your generous contribution to make this symposium a success.

Mr. Sagara Gunawardena

Mr. Kalana Alwis

Co-Chairpersons
The 8th World Construction Symposium

On behalf of the Organizing Committee, we take great pleasure in welcoming all the delegates to the 8th World Construction Symposium 2019 to be held from 8th to 10th November 2019 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 from overseas on green construction and new trends in global sustainable built environment.

We are honored 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 four concurrent papers/presentation tracks.

We hope that the delegates will have a pleasant and productive stay in Colombo and return home safely.

We appreciate your commitment and active participation and wish the symposium to be a great success.

Prof. K.K.C.K. Perera
Vice Chancellor
University of Moratuwa

It is indeed a pleasure to convey a message for the 8th World Construction Symposium 2019. Progress of this esteemed symposium since its inception to this 8th version of the CIOB World Construction Symposium series which enabled in achieving international recognition is acknowledged and noteworthy.

With its focus on a 'Smart, Sustainable and Resilient Built Environment', this symposium offers an extraordinary platform for researchers and professionals around the world to share their expertise, experience and research findings in the field of sustainable construction.

There has been growing global trend in the recent years on ensuring that the built environment products and practices are sustainable. The United Nations has introduced 17 Sustainable Development Goals (SDGs), which are to be implemented and achieved by countries under its 2030 Agenda for Sustainable Development. It is, therefore, a matter of great pride to observe that our University is the main scientific contributor to a symposium with a focus on such a global issue. This symposium is also highly pertinent to the University of Moratuwa with its goal of promoting high-impact and nationally relevant research to expand knowledge. This international event thereby offers an important milestone in the realisation of the University's vision of becoming the most globally recognised Knowledge Enterprise in South Asia. Moreover, I genuinely believe that such an international event would provide a great opportunity for local researchers to have meaningful exposure to the global community and vice versa laying the foundation for productive joint research and knowledge sharing initiatives after the symposium.

On behalf of the University of Moratuwa, I would like to express my sincere appreciation to the organisers and the scientific committee members of the 8th World Construction Symposium 2019, the Ceylon Institute of Builders and the Department of Building Economics, University of Moratuwa for their hard work and relentless effort in bringing this symposium to fruition. Without their commitment and contributions, this event would not have been possible and successfully delivered at this time.

I wish the 8th World Construction Symposium 2019 every success and wish all symposium organisers and participants a pleasant and rewarding experience.

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

It is with great pleasure and enthusiasm that I send this message to extend my warm wishes for the 8th World Construction Symposium 2019. Ceylon Institute of Builders (CIOB) and the Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka are jointly organising this event for the eighth consecutive year.

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; Colombo School of Construction Technology (CSCT), Sri Lanka and the Built Environment Project and Asset Management (BEPAM): Journal, published by Emerald Group Publishing join hands as associate partners to further enrich this year's symposium.

As Sri Lanka is progressively moving into multitudinous initiatives on metropolitan development, improvement of quality of life in built environments is being emerged as an imperative subject of discussion. Therefore, this year's symposium theme, "Towards a Smart, Sustainable and Resilient Built Environment" provides an overarching and timely setting.

The 8th World Construction Symposium provides a platform for both local participants and international delegates to share their knowledge and ideas on advancing towards a smart, sustainable and resilient built environment. I hope all delegates would take this opportunity to share their knowledge, ideas and views on the theme of the year and also enjoy your stay in Colombo, Sri Lanka.

I wish all the success for the 8th World Construction Symposium 2019.

KEYNOTE SPEAKERS

Prof. Andrew Ross
Liverpool John Moores University
United Kingdom

Andrew Ross is Professor of Construction Project Management at LJMU and a Chartered Quantity Surveyor. His scholarly interests lie in the area of sustainability, organizational management with a focus on main contractor / supply chain relationships and procurement. He takes an interdisciplinary approach to his research and has been principal investigator for a research projects funded by Innovate UK, ERDF, Erasmus, British Council and RICS totaling over £2.0m. Over the last 30 years, his research students have investigated supply chain management, construction economics, cost modelling, cash management and cost value reconciliation. Andrew has published three textbooks, contributed book chapters and over 150 papers in peer-reviewed journals and conferences. A central theme of his research is to seek impact via collaboration with industrial partners. He has been instrumental in the national development of degree apprentice provision as a member of the construction trailblazer group. He has contributed to many national and international construction conferences and is a founder member of CIB TG 92 Wearable Sensor Technology.

Prof. Wei Pan
The University of Hong Kong
Hong Kong

Ir Dr. Wei Pan is Executive Director of Centre for Innovation in Construction and Infrastructure Development (CICID) and Associate Professor at The University of Hong Kong (HKU). He is specialized in construction engineering and innovation, with interest covering prefabrication, modular integrated construction (MiC), sustainable and zero carbon building. He developed the 'dialectical system theory' to lead research on zero carbon building and modular construction. Dr. Pan was awarded Distinguished Young Investigator of China Frontiers of Engineering by Chinese Academy of Engineering, and achieved HKU Engineering Knowledge Exchange Award 2019. Dr. Pan has authored over 200 publications and secured over HK$70million research grants. He is Chartered Builder, Chartered Environmentalist, Fellow of Higher Education Academy, and member of Institution of Civil Engineers and Hong Kong Institution of Engineers. He has 25 years of working experience in academia and practice internationally.

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 Mr. 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 Ms. Sonali Pandithawatta Ms. Shanika Vidanagamage Ms. Fayasa Aarifkhan Mr. Kanchuka Withanage Ms. Madhavee Mahinkanda Ms. Diani Sirimewan Mr. Gihan Tennakoon Mr. Akila Rathnasiri Ms. Kaveesha Dewagoda Mr. Rohana Balasuriya Ms. Malathi Piyasena Ms. Kusum de Silva

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.

www.iitm.ac.in

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, research-led 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.westernsydney.edu.au/

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.

www.csct.edu.lk

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 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. Andrew Ross	*Liverpool John Moores University, United Kingdom*
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Prof. Rupa Purasinghe	*California State University, United States of America*
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Dr. Sajani Jayasuriya	*RMIT University, Australia*
Prof. Sam Wamuziri	*A' Sharqiyah University, Sultanate of Oman*
Dr. Sepani Senaratne	*Western Sydney University, Australia*
Assistant Prof. Sivakumar Palaniappan	*Indian Institute of Technology, Madras, India*
Prof. Srinath Perera	*Western Sydney University, Australia*
Prof. Steve Rowlinson	*The University of Hong Kong, Hong Kong*
Ch. QS. Suranga Jayasena	*University of Moratuwa, Sri Lanka*
Prof. Syed M. Ahmed	*East Carolina University, United States of America*
Dr. Thanuja Ramachandra	*University of Moratuwa, Sri Lanka*
Associate Prof. Thayaparan Gajendran	*University of Newcastle, Australia*
Dr. Thilini Jayawickrama	*University of South Australia, Australia*
Dr. Udayangani Kulatunga	*University of Moratuwa, Sri Lanka*
Associate Prof. Umberto Berardi	*Ryerson University, Canada*
Prof. Wei Pan	*University of Hong Kong, Hong Kong*

SYMPOSIUM INFORMATION

The 8th World Construction Symposium

The symposium is on 08 November 2019 from 08.30 am to 05.30 pm at the Galadari Hotel, Lotus Road, Colombo 01. The inauguration is held at the Grand Ballroom, Galadari Hotel.

Fellowship and Awards Night

The Fellowship and Awards Night is on 08 November 2019 at the Galadari Hotel, Lotus Road, Colombo 01 from 06.30 pm onwards.

The Postgraduate Workshop

The postgraduate workshop is on 09 November 2019 from 08.30 am to 04.30 pm at the Faculty of Architecture Boardroom, University of Moratuwa, Katubedda, Moratuwa. Transport will be provided between Galadari Hotel and University of Moratuwa. Foreign participants, who have registered for the postgraduate workshop, are requested to assemble at the Hotel lobby at 7.30 am. Foreign guests will be transported back to the Galadari Hotel from University of Moratuwa at 4.30 pm after the workshop.

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://2019.ciobwcs.com

Language

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

Dress Code

Symposium/Postgraduate Workshop - 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:

08 November 2019 - 08.30 am to 05.30 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 08.30 am to 05.30 pm on 08 November 2019.

Awards

Following awards will be presented during the symposium Fellowship and Awards Night on 08 November 2019. 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 sum-up.

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

Friday, 08 November 2019 at Galadari Hotel

08.30 am	Symposium Registration	
09.00 am	Symposium Inauguration	**Grand Ballroom**
09.10 am	Welcome address by President, CIOB **Dr. Rohan Karunaratne**	
09.15 am	Address by Conference Chairperson **Prof. Chitra Weddikkara**	
09.20 am	Address by the Chief Guest, Vice Chancellor, University of Moratuwa **Prof. K.K.C.K. Perera**	
09.30 am	Keynote Address on *"Collaboration for a Sustainable Construction Industry"* **Prof. Andrew Ross**	
10.00 am	Address by Editor-in-Chief, Journal of Built Environment Project and Asset Management (BEPAM) on *"BEPAM and BEYOND"* **Prof. Mohan Kumaraswamy**	
10.10 am	Keynote Address on *"A Smart, Zero-carbon and Modular Future of Buildings"* **Prof. Wei Pan**	
10.40 am	Vote of Thanks by Hony. Secretary, CIOB **Eng. Saliya Kaluarachchi**	
10.45 am	End of Symposium Inauguration	
10.45 am	Tea / Coffee Break	
11.15 am	**Parallel Session 1** *(There will be FOUR parallel sessions)*	**Grand Ballroom** **Salon Orchid** **Salon Jasmine** **VIP Lounge**
01.00 pm	Lunch	

02.00 pm	**Parallel Session 2** *(There will be FOUR parallel sessions)*	**Grand Ballroom** **Salon Orchid** **Salon Jasmine** **VIP Lounge**
03.15 pm	Tea / Coffee Break	
03.30 pm	**Parallel Session 3** *(There will be FOUR parallel sessions)*	**Grand Ballroom** **Salon Orchid** **Salon Jasmine** **VIP Lounge**
04.45 pm	Tea / Coffee Break	
05.00 pm	Rapporteur's Report by **Dr. Kapila Devapriya** **Dr. H. Chandanie** **Dr. Pournima Sridarran**	**Grand Ballroom**
05.15 pm	Announcing the Award Winners	
05.25 pm	Vote of Thanks by Scientific Committee Co-Chairperson	
05.30 pm	End of Programme	

Fellowship and Awards Night

06.30 pm	Fellowship and Awards Night	**Grand Ballroom**

Saturday, 09 November 2019 at University of Moratuwa

08.30 am	Registration	**Boardroom – Faculty of Architecture, University of Moratuwa**
09.00 am	Welcome and Opening Remarks by **Dr. Yasangika Sandanayake**	
09.15 am	*Engaging with Literature* • *Writing a publishable literature review paper* • *Techniques and strategies used in literature review*	
10.30 am	Tea / Coffee Break	

11.00 am	*"How to Get Published"* by **Prof. Mohan Kumaraswamy** Editor-in-Chief, Journal of Built Environment Project and Asset Management (BEPAM)
12.30 pm	Lunch
01.30 pm	*Experience Sharing of PhD Journey*
02.30 pm	*Benefiting from Attending International Conferences*
03.30 pm	Sum-up of PG Workshop by **Dr. Thanuja Ramachandra** **Dr. Udayangani Kulatunga**
04.00 pm	Tea / Coffee Break
04.30 pm	End of Programme

Sunday, 10 November 2019

06.30 am	Cultural and Networking Tour

SYMPOSIUM SESSION PLAN AT-A-GLANCE								
08.30 - 09.00	**Registration**							
09.00 - 10.45	**Symposium Inauguration**							
10.45 – 11.15	Tea / Coffee Break							
11.15 – 13.00	**Session 1A**	S12023	**Session 1B**	S12086	**Session 1C**	S12010	**Session 1D**	S12061
		S12082		S12071		S12024		S12073
		S12030		S12046		S12054		S12056
		S12057		S12044		S12049		S12067
		S12079		S12045		S12035		S12053
		S12043		S12011		S12085		S12027
	Q&A		Q&A		Q&A		Q&A	
13.00 – 14.00	Lunch							
14.00 - 15.15	**Session 2A**	S12054	**Session 2B**	S12003	**Session 2C**	S12051	**Session 2D**	S12029
		S12047		S12040		S12008		S12028
		S12062		S12038		S12050		S12055
		S12080		S12089		S12074		S12006
		S12076		S12021		S12022		S12024
	Q&A		Q&A		Q&A		Q&A	
15.15 – 15.30	Tea / Coffee Break							
15.30 – 16.45	**Session 3A**	S12087	**Session 3B**	S12088	**Session 3C**	S12039	**Session 3D**	S12072
		S12065		S12048		S12042		S12058
		S12047		S12064		S12052		S12031
		S12075		S12066		S12078		S12032
		S12078				S12084		
	Q&A		Q&A		Q&A		Q&A	
16.45 – 17.00	Tea / Coffee Break							
17.00 - 17.30	**Symposium Sum-Up**							
18.30 - 22.30	**Fellowship and Awards Night**							

DETAILED SESSION PLAN

Friday, 08 November 2019

Session 1A

Theme	**Enhancing Value in Construction**
Session Chair	Prof. Mohan Kumaraswamy
Venue/Time	Salon Orchid – 11.15 am – 01.00 pm

Time	**Paper ID, Title and Author(s)**
11.15 – 11.25 am	**S12023: A Conceptual Knowledge Value Chain Model for Construction Organisations Engaged in Competitive Tendering**
	K.G. Dewagoda and B.A.K.S. Perera
11.25 – 11.35 am	**S12082: An Investigation into Value Addition Concept Correlated to Facilities Management**
	C.S. Udawatta, K.A.K. Devapriya, M. Gowsiga and P. Thatshayini
11.35 – 11.45 am	**S12030: Bridging the Theory-Practice Gap in Value Management in Sri Lankan Construction Industry**
	M.M.M.P. Mahinkanda, Y.G. Sandanayake and B.J. Ekanayake
11.45 – 11.55 am	**S12057: Use of BIM Solutions to Facilitate Value Management**
	J.A.G. Punnyasoma, H.S. Jayasena and T.M.M.P. Tennakoon
11.55 – 12.05 am	**S12079: Conceptual Framework for Effective Implementation of 'Project Management Institute's Standard for Earned Value Management' In Sri Lanka**
	C.J. Deniyage and R. Palliyaguru
12.05 – 12.15 pm	**S12043: The Concept of Value Engineering and its Assimilation in Sri Lankan Construction Industry: A Literature Review**
	Hammadh Hyderaly, Menaha Thayaparan and Fayasa Aarifkhan
12.15 – 01.00 pm	**Q&A**

Session Coordinator: Ms. Diani Sirimewan

Friday, 08 November 2019

Session 1B

Theme	**Waste Management**
Session Chair	Prof. Wei Pan
Venue/Time	Grand Ballroom – 11.15 am – 01.00 pm

Time	**Paper ID, Title and Author(s)**
11.15 – 11.25 am	**S12086: A Review of Smart Technology Usage in Construction and Demolition Waste Management**
	Shiyamini Ratnasabapathy, Srinath Perera and Ali Alashwal
11.25 – 11.35 am	**S12071: A Culture-Based Solution for Construction and Demolition Waste Management in Sri Lanka: A Literature Review**
	A.P.K.D. Mendis, Aparna Samaraweera, D.M.G.B.T. Kumarasiri, Damitha Rajini and H.A.S. Madhuwanthi
11.35 – 11.45 am	**S12046: Stakeholders' Involvement in Successful Implementation of Waste to Energy Projects: Case Studies in Sri Lanka**
	D.M.G.B.T. Kumarasiri and D.M.P.P. Dissanayake
11.45 – 11.55 am	**S12044: Typologies of Offsite Construction**
	Buddhini Ginigaddara, Srinath Perera, Yingbin Feng and Payam Rahnamayiezekavat
11.55 – 12.05 am	**S12045: Building Organisational Capacities for Effective E-Waste Management: A Conceptual Framework**
	A.H.A. Azeem, H. Mallawaarachchi and D. Geekiyanage
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	M.S. Kaluarachchi, K.G.A.S. Waidyasekara and R. Rameezdeen
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Session Coordinator: Mr. Dilakshan Rajarathnam

Friday, 08 November 2019

Session 1C

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Session Chair	Prof. Andrew Ross
Venue/Time	VIP Lounge – 11.15 am – 01.00 pm

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	Himesh Kavinda and Chandana Jayalath
11.35 – 11.45 am	**S12054: Energy Retrofits to Enhance Energy Performance of Existing Buildings: A Review**
	M.F.F. Fasna and Sachie Gunatilake
11.45 – 11.55 am	**S12049: Impact of Fly-Ash on Carbon Emissions in Different Concrete Grades**
	Jacob Paino, Srinath Perera, Ali Alashwal and M.N.N. Rodrigo
11.55 – 12.05 am	**S12035: Decision Making on Adaptive Reuse of Historic Buildings in Sri Lanka**
	R.A.D.I.U. Samaranayake, T.S. Jayawickrama, D.G. Melagoda and R.M.D.I.M. Rathnayake
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	Harshini Mallawaarachchi, Y.G. Sandanayake, Gayani Karunasena and Chunlu Liu
12.15 – 01.00 pm	**Q&A**

Session Coordinator: Mr. Gihan Tennakoon

Friday, 08 November 2019

Session 1D

Theme	**Smart and Resilient Built Environments**
Session Chair	Prof. P.K.S. Mahanama
Venue/Time	Salon Jasmine – 11.15 am – 01.00 pm

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	J.R.P. Ishan, Nayanathara De Silva and K.T. Withanage
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	K.T.W. Bandara, M.D.T.E. Abeynayake and T.P.W.S.I. Pandithawatta
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	Senuri Disara, Aparna Samaraweera and V.G. Shanika
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	A.P. Rathnasinghe and U. Kulatunga
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	Roshani Palliyaguru, Amalka Nawarathna and Chandana Jayalath
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Session Coordinator: Ms. Sonali Pandithawaththa

Friday, 08 November 2019

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	Thathsarani Hewavitharana, Samudaya Nanayakkara and Srinath Perera
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Session Coordinator: Mr. Akila Rathnasinghe

Friday, 08 November 2019

Session 2B

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Venue/Time	Salon Orchid – 02.00 pm – 03.15 pm

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Session Coordinator: Ms. Aravindi Samarakkody

Friday, 08 November 2019

Session 2C

Theme	**Procurement Solutions for Construction**
Session Chair	Prof. Kanchana Perera
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	A.S.M. Misbah, Vijitha Disaratna, Pavithra Ganeshu and F.S. Nazeer
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Session Coordinator: Ms. Maheshi Tennakoon

Friday, 08 November 2019

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Friday, 08 November 2019

Session 3A

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Friday, 08 November 2019

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Friday, 08 November 2019

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Session Coordinator: Ms. Binashi Kumarasiri

ABSTRACTS OF THE PROCEEDINGS

The 8th World Construction Symposium 2019

Theme:

Towards a Smart, Sustainable and Resilient Built Environment

Edited by
Dr. Y. G. Sandanayake
Dr. S. Gunatilake
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PAPER ABSTRACTS

A CONCEPTUAL KNOWLEDGE VALUE CHAIN MODEL FOR CONSTRUCTION ORGANISATIONS ENGAGED IN COMPETITIVE TENDERING

K.G. Dewagoda[1] and B.A.K.S. Perera[2]

ABSTRACT

With the world heading towards a knowledge economy, knowledge is contemplated as a critical organisational resource that creates competitive advantage for construction organisations, especially when they engage in competitive tendering. Knowledge Value Chain Model (KVCM) is a viable mechanism that employs organisational knowledge for the organisations to acquire competitive advantage in competitive tendering. However, it has yet not been adopted although there is a dire requirement for it in the construction industry. Hence, this study developed a conceptual KVCM to facilitate the full exploitation of the knowledge available in a construction organisation so that it can function with competitive advantage during competitive tendering. This conceptual KVCM was developed by analysing the generic KVCMs mentioned in the extant literature. The analysis was followed by 15 expert interviews. It is recommended that to facilitate its pragmatic implementation, the KVCM be customised in the future as a Knowledge Value Chain (KVC) Framework by incorporating organisational characteristics.

Keywords: *Competitive Advantage; Construction Organisations; Knowledge; Knowledge Management (KM); Knowledge Value Chain Model (KVCM).*

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A CULTURE-BASED SOLUTION FOR CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT IN SRI LANKA: A LITERATURE REVIEW

A.P.K.D. Mendis[1], Aparna Samaraweera[2], D.M.G.B.T. Kumarasiri[3], Damitha Rajini[4] and H.A.S. Madhuwanthi[5]

ABSTRACT

Construction projects consume bulky amounts of materials, natural resources, and energy and at the same time generate unacceptable level of solid wastes. There are strategies implemented in order manage the construction and demolition wastes in Sri Lanka. However, most of those have become unsuccessful due to the policy makers being unable to consider the cultural factors stemming from socio-economic factors, while implementing such strategies. Thus, this paper aims at deriving a culture-based solution for construction and demolition waste management in Sri Lanka. This aim is achieved through a broad literature review. As per the extent literature, the main cultural manifestations describing the cultural context of Construction and Demolition (C&D) waste management include values, attitudes and behaviours. Accordingly, Sri Lankans hold many positive values, however majority of attitudes and behaviours are of negative in nature. According to literature, these cultural manifestations exists in a hierarchical order with attitudes being influenced by values and behaviours being influenced by attitudes. Nevertheless, positive values of Sri Lankans are not reflected through the attitudes and behaviours of C&D waste management, requiring thorough empirical studies to justify the dynamisms of value-attitude-behaviour hierarchy in Sri Lankan context. In addition, if these cultural manifestations related to C&D waste to be managed, a reverse cycle to the value-attitude-behaviour hierarchy should be considered, which is introduced as 'cycle of culture management' through this paper.

Keywords: *Attitudes; Behaviours; Cultural Values; Construction and Demolition Waste; Waste Management.*

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A FRAMEWORK FOR REGULATORY BODIES TO CONTROL INFORMAL BUILDING CONSTRUCTION IN SRI LANKA

A.H.A.T.L. Atapattu[1], Mahesh Abenayake[2], R. Dilakshan[3] and A.V.P.U. Sandupama[4]

ABSTRACT

Socio financial and environmental affectability due to the construction improvements and its relativity with comprehension of building property advancement leads construction to become trendy activity in the society. In order to obtain the major roles in the economy of country construction conducted in to two segments called formal and informal. When render wider perspective on construction activities, there are highly considerable rate of failing, short coming, quality deficiencies etc. Building regulations facilitates to overcome and guarantee socially adequate levels of well-being, security, welfare and convenience for building tenants. This research undertaken using mixed method approach including pilot survey, questionnaire survey and expert interviews. From fifty (50) respondents to questionnaire survey, thirty eight (38) were identified as informal building constructions. It was employed to investigate the extend of obtaining the permits in building construction projects and discrepancies, deformations, laid significances on professional selection and considerations laid on design and construction stage. From the statistical analysis of the survey conducted identified addressable key areas to minimise informal construction activities, which causes deterioration in building constructions. In order to overcome that, eight (8) expert interviews were conducted among the professionals in relevant subject area. Gathered qualitative data were analysed using content analysis techniques. Consequently, the requirement of regulatory bodies to minimise the informal construction were identified which directly or indirectly influence positively on quality of buildings and defect free environment. Finally, framework demarcates the building informality, causation to building performance due to informal construction and building defects along with the remedial actions.

Keywords: *Building Collapse; Building Defects; Informal constructions; Regulatory Bodies.*

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A FRAMEWORK TO ENHANCE PRODUCTIVITY THROUGH HUMAN ATTITUDES

Danuka Koshitha[1] and Pournima Sridarran[2]

ABSTRACT

Government expenditure is rising yearly. Maintenance expenses of government building and their services also contributes to this expense. So, productive maintenance within the government sector is increasingly required in order to optimise the costs on maintenance and its output. Management of good attitudes within the human resource of public sector's maintenance departments is an essential factor to enhancing productivity of building maintenance. Thus, it is necessary to develop and manage good attitudes to achieve productive maintenance. Hence, the aim of the research is proposing a suitable framework for attitude management and development in public sector organizations in Sri Lanka. The importance of the attitudes and the reasons for difficulty in developing attitudes is discussed in the paper. The attitude of an employee has been identified under four basic categories and a qualitative research approach was adopted to accomplish the research objectives through semi-structured interviews involving 15 respondents under 3 cases. Cross-case analysis was used to analyse findings and finally a framework was developed to manage good attitudes of staff. Productive maintenance refers to maximum and optimum output from minimum resources and productive human resource plays the most important role. It is made up of three key competencies; good skills, good knowledge and good attitudes. Good attitudes are important in maintaining other two competencies. Finally, a framework for attitude management and development have been developed based on reliable suggestions for proper attitude management within maintenance departments of public sector organisations and several recommendations were suggested to overcome current barriers in the industry.

Keywords: *Human Attitudes; Maintenance Department; Productive Maintenance; Public Sector Organisations.*

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A REVIEW OF SMART TECHNOLOGY USAGE IN CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

Shiyamini Ratnasabapathy[1], Srinath Perera[2] and Ali Alashwal[3]

ABSTRACT

The management of construction and demolition (C&D) waste, a major part of solid waste, is increasingly become a critical challenge in the quest of social, environmental, and economic sustainability. Innovative and smart technologies are emerging to provide inevitable benefits because of their capacity to enable digitisation, automation, and integration of Solid Waste Management (SWM) processes. Nevertheless, the application of such technologies in Construction and Demolition Waste Management (CDWM) has not gained the appropriate attention. This study aims to draw insights into the current and potential use of smart technologies in CDWM. A literature review-based approach surveyed both academic and applied publications to analyse the current and potential use of smart technologies in both SWM and CDWM. Altogether, 75 peer-reviewed articles and technical white papers were analysed. It was found that the usage of smart technologies is much advanced in SWM and the adoption is still at the prototype stage in CDWM. The results emphasise that the integration of smart technologies into multiple processes of CDWM would overcome many issues related to waste minimisation and management including waste estimation, waste reporting, and data management and waste diversion. The framework developed in this study contributes to the understanding of the potential role of each category of technologies in improving the waste management processes in the C&D sector. This review is useful to waste management practitioners, regulatory bodies and the government to understand the benefits of emerging technologies and to the development of effective strategies and future training programmes.

Keywords: *Blockchain; Construction and Demolition Waste Management; Information and Communication Technologies (ICTs); Smart Technologies; Solid Waste Management.*

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AN INVESTIGATION INTO VALUE ADDITION CONCEPT CORRELATED TO FACILITIES MANAGEMENT

C.S. Udawatta[1], K.A.K. Devapriya[2], M. Gowsiga[3] and P. Thatshayini[4]

ABSTRACT

The purpose of this research is to enable Facilities Management (FM) decision makers to identify key FM interventions that add value to the organisations and to manage a successful implementation and to measure the outputs. This study inaugurated with literature review, and then a preliminary survey was carried out to validate the data gathered from the literature review. To inform the findings reported in this paper data was collected through semi structured interviews with expert from different industrial backgrounds. Empirical finding shows that most industrial professions think they should apply the concept of Adding Value in daily practice but there are constraints such as resistance from top management, limitations within the hierarchy, workload factor etc. Many experts identified that identifying a particular added value and the part FM played in is extremely complex and momentarily difficult. And the most acceptable interventions which were identified through interviews are changing the physical environment, changing the facilities services and strategic advice and planning. All the interviewees agreed that they only use Key Performance Indicators (KPIs) to measure the performance of facility related activities.

Keywords: *Added Values; Facilities Management; Interventions; Key Performance Indicators.*

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ANALYSIS OF SURVIVAL FACTORS OF SUBCONTRACTORS IN ECONOMIC RECESSION

A.S.M. Misbah[1], Vijitha Disaratna[2], Pavithra Ganeshu[3] and F.S. Nazeer[4]

ABSTRACT

Subcontracting is a term which means giving a portion of the work or obligations to another party called as subcontractor (SC) under a contract. This was used in several industries but in the construction industry, it plays a vital role to complete the project with a higher quality of output. In gross domestic product (GDP) calculation of the national economy, the significance of the construction industry is very high. When a country faces an economic recession, it has a direct impact on the construction industry and the stakeholders of that industry. A small number of researches was available regarding how the construction firms handle the external changes like economic recession. In this respect, this research analyses the key strategies used by the SCs when they face an economic recession. Purposive sampling method was used for data collection and a questionnaire survey was selected as the basic technique to collect data. The respondents were first asked about their profile and then about the effect of recession and survival strategies in economic recession. Relative Importance Index (RII) method was used to rank the effects and the strategies according to its importance given by the respondents. Findings of the research were that there are various strategies which are most important to the survival of subcontracting firms "Increasing the focus on forming relationship with main contractors", "maintain goodwill to get additional financial support from bank", "Implementing stricter site management to reduce material and time wastage", "Implementing stricter financial management on company cash flow", and "bidding for more projects that are within the firm's resources and capabilities". Finally, practicable suggestions were identified for SCs to survive in the construction industry during the economic recession period.

Keywords: *Economic Recession; Key Strategies; Subcontractors (SC); Survival Factors.*

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APPLICABILITY OF SMART BUILDING CONCEPT TO ENHANCE SUSTAINABLE BUILDING PRACTICE IN SRI LANKA

K.T.W. Bandara[1], M.D.T.E. Abeynayake[2] and T.P.W.S.I. Pandithawatta[3]

ABSTRACT

With the expansion of economic activities, sustainable development in construction industry got more attention worldwide. Hence, industry practitioners are more concerned on achieving sustainable construction goals to make more effective and efficient services. The Smart Building concept can be implemented with advanced building technologies to achieve clients' requirements with in the economic, environmental and social parameters while enhancing building performances efficiently. To explore the applicability of Smart Building concept to enhance sustainable building practices in Sri Lanka, the qualitative research approach was used in this research. The opinions of the smart and sustainable construction experts were obtained through semi-structured interviews. Smart Building concept is novel to the Sri Lankan construction industry and the implementation is still in the initial stage. However, the perception of the construction industry on the Smart Building concept is focused on a strong and positive direction. The recognised sustainable benefits of Smart Building concept implementation can be used as a promoting tool to make interest on Smart Buildings. Most of these benefits are long term and most of the clients do not recognise the value of Smart Buildings in terms of sustainability. Therefore, improving the knowledge and awareness of the developers is vital during the implementation process within the local context. Lack of financial resources, complex technology requirement, reluctant to commence new technologies and lack of knowledge of developers and owners are the main barriers that are existing within the local context. Mitigating these barriers will expedite the implementation process of Smart Building concept and will upgrade the performance of the local construction industry dramatically.

Keywords: *Applicability; Smart Buildings; Sustainable Development.*

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APPLICATIONS OF DIGITAL TECHNOLOGIES FOR HEALTH AND SAFETY MANAGEMENT IN CONSTRUCTION

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ABSTRACT

The construction industry has been known for many decades as a high-risk industry with low levels of innovation and reluctance to adopt change. Common causes of construction accidents are associated with human error, hazardous work activities, defective equipment and dangerous working environments. However, to provide a better and safe working environment, the industry can exploit the benefits of emerging health and safety technologies. The purpose of this study is to explore the application of various emerging technologies and how they can be used to improve construction health and safety management. The paper reviewed extensive literature from previous studies on emerging technologies and interventions for construction job site safety such as; Virtual Reality (VR), online databases, Geographic Information Systems (GIS), Building Information Modelling (BIM), Unmanned Aerial Vehicle (UAV), 4D Computer-Aided Design (4D CAD), wearables, robotics, laser scanning, photogrammetry and sensor-based technologies. Furthermore, these technologies were grouped into three categories; people technologies, process technologies and environmental technologies for better analysis. Keywords such as 'construction health and safety technologies', 'digital technologies' and 'emerging technologies' were used to search online databases. This study identified emerging technologies and their application in the construction industry to improve health and safety.

Keywords: *Construction; Digital; Emerging; Health and Safety; Technologies.*

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APPRENTICE PERCEPTIONS OF WORK BASED LEARNING: PRELIMINARY OBSERVATIONS

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ABSTRACT

The degree apprenticeships programme involves a tripartite agreement involving the student apprentice, employer and the university. The programme introduced few years ago in the UK, which now caters to a significant number of apprentices in built environment related degree programmes. Although the Degree Apprenticeships involve a significant component of work based learning, limited evidence exist to justify Chartered Surveying Degree Apprenticeships Standard as a successful work based learning facilitator, mainly due to the scarcity of research. The findings of this paper are based on an ongoing research project, therefore is limited to evaluating Degree Apprenticeships apprentice perception of work based learning. Research method comprised of a literature review and the inspection of the guidance documents related to the delivery of the Degree Apprenticeships programme, followed by seven semi-structured interviews with selected degree apprentices. Qualitative data analysis paved the way for identification of several success areas and the aspects that require further improvement. Lack of shared understanding among the three parties and the absence of explicit evidence of implementation of work based learning were noteworthy, and suggestions for improvement are proposed. Further research involving a wider sample of apprentices and employers suggested.

Keywords: *Apprentice Perception; Degree Apprenticeships; Surveying Education; Work Based Learning.*

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APPROPRIATENESS OF CIDA PRICE FLUCTUATION FORMULA FOR ROAD CONSTRUCTION IN SRI LANKA

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ABSTRACT

The use of the construction industry development authority (CIDA) formula of price fluctuation will help to claim unpredicted costs in construction projects at least up to a satisfying level. However, some limitations were made when preparing the formula to ease the calculation. Therefore, the project aims to find out the factors affecting the CIDA price fluctuation formula and to identify the appropriate use of the CIDA price fluctuation formula for road construction. A mixed approach was utilized for the study. A broad study of the literature review was intended to a price fluctuation concept and price fluctuation reclamation methods and the significance of road construction projects. The semi-structured and structured close-ended questionnaires were carried out to collect data to identify issues and factors affecting the formula. The qualitative data were analyzed through Qualitative Data Analysis (QDA) Miner lite software while quantitative data were analyzed through SPSS software. A framework was developed concerning outcomes. The price indices, coefficient (0.966), input percentage of construction inputs were found as internal factors which are affecting the formula with their issues and also the difficulties faced while calculation of those internal factors, type of the contract, assumptions which are used to make the formula were found as the external factors. This framework can be recommended to use as a tool before commencing the price fluctuation calculation using the CIDA formula for understanding which factors are mostly helping to increase the appropriateness of the CIDA formula in the road construction sector.

Keywords: *CIDA Price Fluctuation Formula; Price Fluctuation; Road Construction Project.*

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BARRIERS FOR RENEWABLE TECHNOLOGY IN COMMERCIAL BUILDINGS

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ABSTRACT

Policies within the United Kingdom (UK), such as the Renewable Energy Strategy, demand the construction sector to adopt renewable technology within buildings. Moreover, as commercial buildings are responsible for 14% of the total UK carbon emissions, building professionals are required to integrate renewable technology within these properties to assist the targets. Despite the policies, the UK renewable technology uptake remains low. Within this context, existing literature identifies the barriers to the adoption of renewable technology in buildings. There are few studies, however, concerning the current uptake of renewable technology in commercial buildings, in addition to little detail of solutions to the barriers experienced by the construction sector. A study was conducted to investigate the integration of renewable technology in UK commercial buildings. Data collection consisted of a literature review, a survey involving 30 construction professionals and two semi-structured interviews with an engineer and a programme manager. Findings evidenced a range of social, economic, and technical barriers for the adoption of renewable technology in buildings. Primary data results support concerns of the financial cost associated with the technology, along with greater detail to explain the barriers associated with awareness, a lack of experience and knowledge of renewable technology options for integration within commercial buildings. Finally, in contribution to theory, results evidence similar findings to existing literature published over 10 years ago, which indicates the need for future research to study solutions to the barriers of renewable technology adoption in commercial buildings.

Keywords: *Commercial Buildings; Renewable Technology; Renewable Technology Barriers; Sustainable Buildings.*

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BEYOND BARRIERS: EXPLORING THE CONSIDERATIONS HINDERING THE ADOPTION OF GREEN CONSTRUCTION FROM A BEHAVIOURAL ECONOMICS PERSPECTIVE

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ABSTRACT

Several academic researchers have investigated the barriers inhibiting the adoption of green construction. Numerous interventions including raising awareness through educational forums, monitoring and enforcement programmes, and financial incentives have been recommended as strategies to encourage the wider adoption of green construction. However, most of these interventions have failed to address the low adoption of green construction. This raises the question 'Why'? Drawing on the insights from Behavioural Economics, specifically Game Theory and Prospect Theory, and the broad social sciences, it is proposed that it is at the individual level of choice that building construction stakeholders are reluctant to adopt green construction, and building construction stakeholders' decision-making is influenced by the confluence of 'elements' which bring about the tendency for them to prefer non-adoption to adoption. Following this, this paper aimed at exploring the 'considerations' that can underlie the tendency for building construction stakeholders to prefer non-adoption to adoption through a literature review. Four key considerations were found. They are dilemma concern, trust in others' actions, fear of being a sucker, and short-term self-interest. It is concluded that, when given empirical support, policies to increase adoption of green construction should address whichever consideration(s) that strongly hinder green construction adoption in a particular setting.

Keywords: *Barriers; Behavioural Economics; Decision-Making; Game Theory; Green Construction; Policies; Prospect Theory.*

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BLOCKCHAIN AS A PROJECT MANAGEMENT PLATFORM

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ABSTRACT

The construction industry will continue to be a key driver of economic growth for any country. It is one of the biggest industries in the world which contributes heavily to the economic development of a country. However, the productivity and the effectiveness of the industry have often been called into a question. Therefore, a number of different modelling tools and software have introduced to upgrade the standards of the construction industry. This review seeks to identify how blockchain can address the project management perspectives of the construction industry with respect to the guidelines mentioned in the Project Management Body of Knowledge. Five major criterions namely purchase management, contract management, asset and inventory management, finance management and subcontractor management were selected for the analysis using the PMBOK guidelines. For that, literature review using articles in ScienceDirect which appeared the context "blockchain in construction", "blockchain and project management", "application of blockchain" were referred. It is identified that the blockchain technology can assist financial management without involving third parties, subcontractor management by linking derivable and payment schemes, contract administration by using smart contracts, inventory and asset management by tracking and tracing material movements and purchase management by linking key stakeholders in supply chains.

Keywords: *Blockchain; Construction Industry; Project Management; Smart Contract.*

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BRIDGING THE THEORY-PRACTICE GAP IN VALUE MANAGEMENT IN SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Construction process is one of the most complex and dynamic procedures. Therefore, it is vital to use resources efficiently and effectively. Considering this requirement of any construction project, creating value for money is becoming important. It contributes to the economic, social and environmental aspects of a country. The concept of value is based on the relationship between satisfying needs, expectations and the resources required to achieve them. Value Management (VM) is recognised as a suitable approach to ensure value for money in construction projects. Although, VM concept is significantly used in developed countries, its applications do not seem to be well established in the construction industry in most of the developing countries including Sri Lanka. This is mainly due to lack of understanding of VM concept. Hence, this study aims to investigate how to bridge the theory-practice gap in VM in Sri Lankan construction industry, through seven case studies. Case study data collection was based on interviews, document review and observations and analysed using content analysis. The research findings revealed that these projects employed different kinds of VM methodologies derived from standard VM methodologies with the focus of various VM objectives. The study further identified number of reasons for theory-practice gap in VM such as lack of a formal guideline and less knowledge on VM, which dilute successful VM implementation. The experts further proposed train in-house VM facilitators, proper project planning, motivate investors, train Sri Lankan professionals by foreign experts and govern VM knowledge sharing as strategies to bridge the gap in order to deliver best value for client's money.

Keywords: *Sri Lankan Construction Industry; Theory-Practice Gap; Value Management; Value Management Practice.*

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BUILDING ORGANISATIONAL CAPACITIES FOR EFFECTIVE E-WASTE MANAGEMENT: A CONCEPTUAL FRAMEWORK

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ABSTRACT

Globally, e-waste generation rises in parallel to the increased consumption of e-products. Management of this complex waste stream becomes a severe challenge, especially for developing countries. Sri Lanka also no exception to this problem due to the limited capacities of e-waste handling organisations in the country. Therefore, this study aims to develop a conceptual framework for effective e-waste management by integrating organisational capacities to improve the involvement of organisations for effective e-waste management. Initially, a comprehensive literature review was carried out on the state-of-art of the e-waste management, capacity buildings, and application of organisational capacities for e-waste management alike. The review of the literature revealed that there are eight dimensions to measure organisational capacities. They are mission and strategy, organisational structure, processes, human resources, financial resources, information resources, and infrastructure. The data collected from the literature review was manually analysed and finally, the conceptual framework was developed on organisational capacity buildings for effective e-waste management. The developed conceptual framework can be used as a guideline to implement organisational capacities for e-waste management. This framework will be a blueprint for individuals and organisations to incorporate dimensions of organisational capacity buildings to e-waste management by identifying the existing capacity gaps consequently, enhancing the organisational capacity for better managing the e-waste, especially in developing countries.

Keywords: *Capacity Buildings; Capacity Gaps; Developing Countries; E-Waste Management; Organisational Capacity.*

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CLIENT'S CONTRIBUTION TO ACHIEVE SUSTAINABILITY THROUGH CORPORATE SOCIAL RESPONSIBILITY IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

The Sri Lankan construction industry's impact on the environment, social and economy is inevitable; emphasising the need to adopt sustainability. Sustainability is distinguished in order to avoid depletion of natural resources as well as to maintain the ecological balance. Sustainability could result in a corporate level, based on construction business organisations further illustrating the concept of corporate social responsibility (CSR). CSR focuses on impact by organisations concerning the triple bottom line. CSR is identified as a path to achieve corporate sustainability. Stakeholders' participation is crucial to incorporate in a sustainable development plan which facilitates the identification of the clients who play a prominent role. This research followed a qualitative study by interviewing clients selected through snowball sampling in the Sri Lankan construction industry. Phenomenology was the approach followed for this research and bracketing was used as a method of analysis. Results of the research identified categories to achieve sustainability through CSR in the perception of clients as: cost constraint, government regulatory approach, consultants' intervention, client's apprehension on sustainability and their attitude on social and environmental aspects, thereby paving the path to develop recommendations.

Keywords: *Client; Construction Industry; Corporate Social Responsibility (CSR); Sustainability; Sri Lanka.*

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CLIENT'S IMPACT TO THE SCHEDULE DELAYS IN ROAD PROJECTS: CONTRACTOR'S PERSPECTIVE

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ABSTRACT

The problem of schedule delay is a frequent and regular phenomenon in the construction projects. Road construction of Sri Lanka is no exception. Client as a key project participant has a control on duration of construction phases. This makes client a casual cause for schedule delay. However, contractor also is a major suffering party due to unprecedented delays. Therefore, this research is aimed at investigating the contractor's perspective of client's impact to the schedule delay in rehabilitation and widening road projects (RWRP) in Sri Lanka. Initially, a comprehensive literature review aided to identify types and effects of delay in road construction projects. Further, identified literature was refined in the sense of Sri Lankan context through three number of preliminary interviews. Next, six cases were selected considering RWRPs in Sri Lanka and steered a document review to investigate the influence of the involvement of the client for delays. Then, a questionnaire survey was carried out to examine the significance of client's causes for delay on contractor's perspective and to identify the client's best practices including suggestions to minimize the delays in RWRPs in Sri Lanka. The analysed data confirmed that delayed interim payments to the contractors due to monetary difficulties of the client, change orders by the client throughout the construction period, delay in land acquisition and delay in handing over the site for construction work as key client causative factors. This study request client to adhere with the identified best practices to mitigate schedule delays in RWRP in Sri Lanka.

Keywords: *Client Initiated Delays; Rehabilitation and Widening Road Projects; Schedule Delays.*

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CONCEPTUAL FRAMEWORK FOR EFFECTIVE IMPLEMENTATION OF 'PROJECT MANAGEMENT INSTITUTE'S STANDARD FOR EARNED VALUE MANAGEMENT' IN SRI LANKA

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ABSTRACT

Successful accomplishment of a project requires effective management of its performance. The performance of the most construction projects is tracked utilizing planned cost vs. actual cost measures only. Earned Value Management (EVM) technique came into existence as an effective performance measurement and a feedback tool for managing projects by emphasizing more on the Earned Value (EV) of projects. Regardless of the immense benefits of EVM, there are significant deficiencies in the process of implementation of the EVM technique in Sri Lanka. Therefore, this study aims to develop a conceptual framework for effective implementation of EVM in the Sri Lankan construction industry with specific reference to the Project Management Institute's (PMI's) standard for EVM. A qualitative research approach was used to accomplish the aim of the study. The empirical findings were analyzed using the manual content analysis technique to determine the degree of implementation of the PMI's standard for EVM in Sri Lanka. The deficiency of professionals and inadequate conceptual knowledge were identified as the most critical barriers associated with the implementation process of the EVM technique. Allocating a separate team to execute the EVM technique, arranging short courses on EVM, developing a standard master format for project performance measurement are the measures that this study recommends promoting the adoption of the EVM technique in the Sri Lankan construction industry.

Keywords: *Earned Value Management; Performance Measurement; Project Management Institute; Standard.*

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CONCEPTUAL FRAMEWORK FOR GREEN SUPPLY CHAIN PRACTICES IN CONSTRUCTION INDUSTRY

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ABSTRACT

The construction industry plays an important role in improving quality of the environment. However, it was also found out that the construction activities create negative impacts on the environment. Reducing the negative environmental impact of the construction industry is one of the major challenges in the 21st century. However, regardless of the significance of this problem, limited efforts to deal with the negative effects have been largely fragmented and disjointed. Green Supply Chain Management is considered as one of the main efforts, which aim to integrate environmental parameters within the supply chain management. It reduces carbon emissions and improves environmental performances of organizations. The trend towards developing Green Supply Chain is now increasing among various industries. In the recent past, enterprises have started Green Supply Chain Management for the purpose of securing competitive advantages over other initiative due to the increase of international conventions related to the recent climate change, the global environmental protection regulations, the stakeholders and investors' need for environmental suitability and the consumer's choice for environmentally friendly products. Therefore, this paper aims to critically review the secondary data on Supply Chain Management, Sustainable Supply Chain Management, and Green Supply Chain Management in the construction industry. Finally, the paper presents a conceptual framework integrating concepts for Green Supply Chain Management practices to the construction sector.

Keywords: *Green Supply Chain Management; Supply Chain Management; Sustainable Supply Chain Management.*

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CONSTRUCTING PLASTIC ROADS USING POLYMER-MODIFIED BITUMEN: A LITERATURE REVIEW

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ABSTRACT

The flexible roads are the roads which are mainly constructed by using bitumen and asphalt. Flexible roads have problems due to their lack of durability, lack of strength etc. Therefore, this research was conducted to identify the possibility of using polymer-modified bitumen as a solution for those problems. The research methodology used was literature review. Plastic waste can be used to prepare polymer-modified bitumen. The applicability, cons and pros; the environmental aspect and economical aspect of the polymer-modified bitumen were identified in this research. Moreover, polymer-modified bitumen is identified as a solution for the flexible roads' problems. Using the polymer-modified bitumen in the road construction, addresses the problems of the flexible roads, by, increasing the roads' strength, avoiding breakage, facing the environmental conditions more effectively etc. Furthermore, it brings benefits such as the roads becoming more comfortable for the passengers. The most effective way of constructing the plastic roads is the dry process, over the wet process. Preparing the plastic roads is an environmentally friendly method, if only thermoplastics such as Low Density Polythene, High Density Polythene, Polyurethane and Polythene Terephthalate are used. So, the plastics which are recycled few times, Polyvinyl Chloride and thermosetting plastics usage needs to be avoided. This method is economical, because the bitumen content used in the road construction can be reduced and in long term, although the initial cost of implementing the method is high, the maintenance cost is reduced. Sri Lanka will be benefited, if this method is implemented in the construction industry.

Keywords: *Plastic Waste; Polymer-Modified Bitumen; Road Construction; Sri Lanka.*

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CORPORATE SOCIAL RESPONSIBILITY PRACTICES FOR SUSTAINABILITY: CASE OF SRI LANKAN CEMENT MANUFACTURING AND SUPPLYING ORGANISATIONS

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ABSTRACT

Construction industry is a booming industry worldwide and achieving sustainability in the construction industry has become a vital ambition. Nowadays, the concept of sustainability with its triple bottom line meaning is being adopted more and more by corporations and concerning construction trade, sustainability is about achieving a win-win output. Cement organisations' business is a crucial sub-segment of the construction industry. Apart from the frequent monetary benefits from the cement organisations, it is increasingly linked to various unethical business practices form numerous challenges that threaten sustainability in cement industry. Thus, in the direction to achieve corporate sustainability; Corporate Social Responsibility (CSR) was recognized as an effective tool. Sri Lankan cement manufacturing and supplying organizations usually publish details about CSR practices of the philanthropic, business environment and business process in their annual business reports. Therefore, this qualitative study based on five in-depth interviews focused on identifying the Sri Lankan cement companies' gap between their current practice and required practice of CSR within their business process. The results found could be categorised under three main sectors as CSR through philanthropic activities, CSR related to business environment and CSR related to business process. It was found that; Sri Lankan cement organizations' CSR practices related to philanthropic and business environment were at highest level. Even though there is a significant lacking point in the current practices of CSR linked to the business process and application of sustainable innovations for cement organisations' business process to achieve corporate sustainability.

Keywords: *Cement Organisation; Construction Industry; Corporate Social Responsibility (CSR); Sri Lanka; Sustainability.*

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DECIDING ON THE CONSULTANCY FEE FOR RE-MEASUREMENT CONTRACTS IN THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Construction industry is the necessary national backbone in developing countries. Consultants are the stakeholders who supplies objective and independent external service to the client. Consulting is gradually becoming a more standard service, price being the main factor in clients' contracting decision so consulting firms continually strives for cost reductions to provide a competitive pricing advantage. By conducting a comprehensive literature synthesis history about consulting fee decision criteria and IQSSL fee proposal were determined. Subsequently, expert interviews were conducted. Semi structured interviews and reviewing documents were used as data collection methods. Collected data was analysed using code based content analysis. It was revealed that, procurement methods and the consultancy fee have a relationship. Construction management contracts and the re-measurement contracts has the highest consultancy fee. There are number of factors to be considered when deciding on the consultancy fee. Findings suggested that independent quantity surveying consultancy fee is within the range between from 0.4% to 1.2% of the contract sum and IQSSL proposal has to accommodate number of improvements for it to be practiced in the Sri Lankan construction industry.

Keywords: *Consortium Service Fee; Consultancy Fee; Independent Quantity Surveying Service Fee; Re-measurement Contracts.*

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DECISION MAKING ON ADAPTIVE REUSE OF HISTORIC BUILDINGS IN SRI LANKA

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ABSTRACT

The construction industry is consistently involved with improving the economic, social and environmental parameters of sustainability. This has led the sustainability in construction to shift from an original focus on cleaner and leaner project delivery to a restorative and regenerative approach. Increasing demand for urban regeneration has driven the act of preserving and reusing parts of cities with historical significance for a variety of uses. Thereby, adaptive reuse serves as an attractive and superior alternative for reusing buildings with architectural and historical importance in terms of sustainability and a circular economy. However, many historic buildings are being disused or demolished due to the inability of determining viable new uses for historic buildings. Thus, this study aimed at providing systematic guidance for decision-making on Adaptive Reuse of Historic Buildings (ARHB) in Sri Lanka. A comprehensive literature review was conducted to explore the concept of adaptive reuse, related regulations, drivers and barriers, new uses for historic buildings and factors affecting decision-making on adaptive reuse of buildings. Finally, this paper proposes a conceptual framework to assist decision making on ARHB in Sri Lanka.

Keywords: *Adaptive Reuse; Decision-making; Historic Buildings; New Uses.*

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DERIVING A BASELINE SCORE FOR SELECTING ADAPTIVE REUSABLE PROJECTS: A QUANTITATIVE APPROACH

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ABSTRACT

Building Adaptive Reuse (BAR) has been recognized to be a viable option to deal with old building stock in spite of the trivial decision of either demolish or reuse. An objective scale to gauge the accuracy of this choice is however non-existent even there is a potential to do so. Hence, the aim of this research is to ease out this decision by developing a rational framework. A comprehensive literature survey, expert's interview and questionnaire survey was carried out. 35 experienced industry personnel participated in the questionnaire survey. The topics entailed were their exposure to BAR projects in Sri Lanka, BAR potential and drivers and barriers affecting BAR decision. Expert opinion was taken to verify the findings. In order to understand the importance level of each of the recognized factors, the Relative Important Index (RII) technique was used as the primary data analysis method. Analytical Hierarchical Process that involves pair-wise comparison, normalised comparison and consistency calculations was used to augment a baseline score in order to make the BAR decision rational. It was found that structural integrity is the highest priority acquiring 12.8% in the total factor score out of 36 globally important indices. The Overall Global Importance score has been considered in this decision making model against 5 successive adaptive reuse projects in Sri Lanka. A pass mark of 60 has to be the minimum threshold to proceed with adaptive reuse. The outcome offers a national benchmark.

Keywords: *Analytical Hierarchical Process; Building Adaptive Reuse; Relative Importance Index.*

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DEVELOPING A PRE-TASK PLAN FOR THE SRI LANKAN CONSTRUCTION INDUSTRY

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ABSTRACT

Earlier planning outputs a larger impact against unprecedented changes in construction projects. Pre-task planning (PTP) is a collaborative process that allied prior planning and safety together at the site in the daily basis. PTP allows task-based planning in the sense of associated hazard identification, mitigation and resource allocation. PTP starts with the task definition and moves with job hazard analysis while mandating the scheduling and a pre-job briefing. Therefore, the research was aimed at investigating the use of PTP in the construction projects in Sri Lanka. The study adopted a qualitative research approach. An extensive literature review was conducted and twelve, semi-structured interviews involving project managers, safety engineers, site supervisors and site engineers were carried out to investigate the application of PTP in the construction industry, process of PTP, responsible parties to conduct pre-task planning and proposing a suitable format for a pre-task plan. The collected data through the expert interviews were then subjected to a content analysis. Findings confirmed that Construction industry of Sri Lanka is practicing the pre-task planning as safety and resource allocating technique. Further, tasks identification, recognition of potential hazards associated with the tasks, mitigation measures, record, and report were identified as key steps in the process of pre-task planning. Site supervisor was the key responsible party over others in conducting pre-task planning. Primary components that need to be included in the pre-task plan as emphasized by the respondents are; equipment, material, labour, personal protective equipment, work plan and hazards and precautions.

Keywords: *Definition; Pre-task Planning; Pre-task Plans; Process; Responsible Parties.*

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DEVELOPMENT OF A COMPUTER MODEL FOR COST ESTIMATION IN EDUCATIONAL BUILDINGS

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ABSTRACT

Cost estimating in construction is critical at the early stage of the project in order to determine whether the project is feasible or not to the client. Cost estimators are facing numerous difficult moments due to incomplete project details and unavailability of cost estimation instruments in early stages of a project. This issue uplifts the necessity of novel and advanced cost model which would be simple, understandable and more reliable. Within the Sri Lankan context, the accuracy of the estimated amount is solely based on the experience and skills of the estimator due to unavailability of reliable cost estimation tool for educational institution buildings in Sri Lanka. Therefore, this paper aims to discuss about the development of a computer model for cost estimation in educational buildings with the current practices and related issues in preparing preliminary project estimates. Semi structured interviews were conducted between twelve experts from consultancy and contractor organisations and the necessary cost data were selected from twenty educational buildings. The Multiple Regression Analysis and Artificial Neural Network methods were utilised to analyse the collected data. Each method has a unique way of building relationships between predictors and responses. However, both the methods were succeeded only in estimating cost of limited number of sub-elements. Multiple Regression Analysis succeeded on five occasions and Artificial Neural Network method had presented efficacy in seven sub-elements only. Altogether eight elements were succeeded in estimating the cost of an educational institution buildings.

Keywords: *Artificial Neural Networks; Cost Estimation Models; Educational Buildings; Elemental Cost Estimation; Multiple Regression Analysis.*

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DEVELOPMENT OF A ROADMAP FOR OCCUPATIONAL HEALTH, SAFETY AND WELLBEING IN THE HONG KONG CONSTRUCTION INDUSTRY: AN INSTITUTIONAL ANALYSIS

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ABSTRACT

The industrial accident rate in Hong Kong has steadily declined over the past 20 years, but has plateaued over the past 5 years and worryingly the fatality rate has been flat for over 15 years. This clearly highlights a level of under reporting of accidents in that normally accidents and fatalities are in a roughly constant proportion to one another. This is corroborated by informal discussions with the insurance industry. Using an institutional analysis approach to the study, the research team has drawn the conclusion that institutional, contractual and policy factors adversely affect Hong Kong's OHSW statistics. This paper highlights the fact that many of these factors are not under Hong Kong contractor's control. However, there is always opportunity to improve performance and a series of potential initiatives are proposed that target industry-wide issues. An overarching issue for a company is the balance between the systems it operates and the culture within which it operates. A key issue in project-based organisations is to operate with rigid flexibility throughout the business. The goal is rigid conformance to safety standards but flexibility in how these standards are achieved. This characteristic is typical of high reliability organisations.

Keywords: *Construction Industry OHSW Roadmap; Hong Kong Contractor; Institutional Analysis; Policy; Safety Leadership.*

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DISPUTES BETWEEN MAIN CONTRACTOR AND SUBCONTRACTOR: CAUSES AND PREVENTIONS

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ABSTRACT

Disputes free subcontract is a key to success of modern construction industry which largely depends on subcontracting. Since this effort has to be made on the expense of time and cost, which can be used otherwise to add more value to the project, it is vital to decide an effective mechanism to mitigate subcontract disputes. Considering the need for addressing this fact, this paper aims to investigate causes of subcontract disputes and effective prevention measures. Mixed approach was followed in order to achieve the aim of the study. Thus, a preliminary survey was conducted to validate literature findings and a questionnaire survey was carried out with contractor and subcontractor representatives to identify causes of subcontract disputes and prevention measures. The findings of the preliminary survey were analysed using content analysis technique and data captured through questionnaire survey was evaluated using relative important index and weighted mean. Incompleteness of the contract was identified as the primary reason of disputes in subcontracts. Further, financial issues, risks and uncertainties, collaborative conflicts, opportunistic behaviours of contracting parties and wrong practices also have a significant impact on occurrence of disputes. Proper contract management and proper site management which includes scheduling and effective project management practices were identified as the most effective prevention measures. The contract administrators should identify the things they should necessarily address in the contract and project managers in dispute prevention regards should consider time and cost constraints to prioritize effective prevention measures.

Keywords: *Causes of Disputes; Disputes; Dispute Prevention Mechanisms; Sub-contracts.*

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EFFECTIVE PARTNER SELECTION MODEL FOR CONSTRUCTION JOINT VENTURES IN SRI LANKA

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ABSTRACT

Construction Joint Venture (CJV) is a response to the complex and competitive environment which characterised the nature of construction industry. However, various disputes arose in CJVs which impede the successful completion of the construction project especially as a result of the ineffective partner selection. Nevertheless, the literature thus far has failed to provide an effective partner selection for the CJVs since none of the studies subjected to partner selection in CJVs. Hence, the research is aimed to investigate the existing practice of partner selection in order to develop a model for avoiding disputes in CJVs in Sri Lanka. Three rounds of Delphi survey were conducted through the adoption of quantitative approach with the participation of experts who have plenty of experience and adequate knowledge on CJVs. The identified joint venture (JV) partner selection criteria from literature synthesis were the base for the adoption of the CJV partner selection criteria developed using the relative importance index. Consequently, effective CJV partner selection model was proposed based on the effect of dispute avoidance. The concern of literature and industry experts proved the absence of the standard partner selection criteria for the CJVs. However, guidelines for selecting partners provided in tender documents were followed by only contractors in order to fulfil the required criteria merely towards winning the project. Thus, the partner selection model proposed in this research provides a basis to select the most appropriate and the best partner for CJVs by evaluating all particular skills and capacities which may avoid having the future disputes.

Keywords: *Construction Joint Ventures; Disputes; Partner Selection; Selection Model.*

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ENERGY RETROFITS TO ENHANCE ENERGY PERFORMANCE OF EXISTING BUILDINGS: A REVIEW

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ABSTRACT

Inefficient buildings use three to five times the energy as efficient buildings. Herein, improving the Energy Efficiency (EE) of buildings, specifically existing buildings that account for a large part of the building sector, has become a major priority. Energy Retrofits (ER) are identified as the main approach to enhance energy performance of buildings to achieve energy reduction targets. Yet, a general lack of awareness exists with respect to ER, types of ER and the possible ER measures through which building EE could be enhanced. Thus, the aim of this paper is to fill this research gap by critically reviewing the relevant literature on ER. With the intention of avoiding the misperceptions on the concept of ER, the paper first analysed various definitions of ER provided by different authors. This had made it clear that in addition to enhancing EE, ER also result in upgraded functionality, improved architectural quality, increased aesthetic value, reduced resource consumption, decreased CO_2 emissions and improved indoor air quality. Besides, based on the critical review of literature, the paper also discusses different types of ER that could be adopted to retrofit a particular building and different ER measures that could be used to retrofit different building elements/systems. The findings of this study could be used by practitioners as a basis in understanding the available ER types and measures for the buildings that would be of use in making effective decisions during their endeavours to enhance the EE of existing buildings.

Keywords: *Definition; Energy Efficiency (EE); Energy Retrofits (ER); Existing Buildings; Retrofit Measures; Retrofit Types.*

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ESSENTIAL STAKEHOLDER CONTRIBUTIONS FOR ESTABLISHING LIFE CYCLE ASSESSMENT (LCA) IN THE CONSTRUCTION INDUSTRY: A DESK STUDY

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ABSTRACT

In recent times, Life Cycle Assessment (LCA) has been evolved in globally as an analytical tool that systematically and holistically investigates cumulative environmental impacts associated with the entire building lifecycle from its cradle-to grave. Moreover, LCA approach has become a well-rooted concept internationally as a decision making tool due to the collaborative activities between main five (05) stakeholders i.e. academia, government, construction industry, civil society, and the natural environment. In contrast, it is difficult to find evidence on the application of LCA in Sri Lankan construction industry. Also, there is increasing interest in applying LCA, as Sri Lankan construction industry has been criticised due to the environmental pollution with the escalation of upcoming building projects. Hence, this study aimed to conduct a desk study by reviewing existing literature to disclose the activities, which the developed countries followed to integrate LCA into construction practice pertaining to aforesaid five stakeholder's contributions. Literature findings highlighted that, academia have to undertake and disseminate fact-based and comprehensive research on the field of LCA in order to popularize the concept of LCA while government bodies, construction industry, civil society and natural environment have to take actions to embed LCA to the environmental regulations and environmental planning as a core element to take voluntary actions to build ecologically sustainable constructions by using LCA as a decision making technique. Environmental modeling software packages have to be introduced as a collaborative activity of academia, construction industry and natural environment to make it possible to integrate LCA to the construction industry.

Keywords: *Academia; Civil Society; Construction Industry; Government; Life Cycle Assessment; Natural Environment.*

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FACILITIES MANAGEMENT VALUE ADDITION IN CORPORATE SOCIAL RESPONSIBILITY

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ABSTRACT

Corporate activities have a major impact on society environment, thus the concern and pressure on corporate activities become a recurrent theme. Especially, the operations of corporates in the built environment is highly violated with the well-being of employee, customer, society, and environment. To overcome the impacts of the built environment operation, corporates need to adopt an effective management practice within the built environment as a part of their social responsibility. Facilities Management (FM) is a profession, which manages the built environment effectively. Therefore, this research aimed at assessing the value addition of FM in social responsibilities of the corporates through effective built environment management practices. Initially, situational analysis was conducted to identify the existing CSR practices in Sri Lanka and then the FM value added practices in key areas of CSR were found to achieve the aim. A qualitative research approach was adopted and seven (07) semi-structured expert interviews were carried out for data collection and two (02) interviews were carried out to validate the findings. The results of the content analysis revealed that CSR practices are relatively at a low level in Sri Lanka. As well as, most of FM professionals are involved in the operational and tactical level function. However, facilities managers perform energy management, water management, waste management, asset management and maintenance management, health and safety, stakeholder management, compliance management, risk management, procurement and contract management and workplace management roles in an organisation. Throughout those FM practices, part of CSR of an organization could be fulfilled.

Keywords: *Built Environment; Corporate Social Responsibility, Facilities Management; Social Well-being.*

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FACTORS AFFECTING THE SELECTION OF A PROCUREMENT METHOD FOR STEEL BUILDING CONSTRUCTION

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ABSTRACT

Construction procurement involves organizing processes of acquiring services and products for activities starting from project investigation to completion of a project. Along with the development of new concepts and technologies, construction procurement arrangements were also developed to draw the best value for construction organizations. Selecting the best procurement method for a specific project is a challenge since the availability of diverse procurement options and subjective factors affecting the selection of procurement methods. An inappropriate selection of a procurement method leads to project failure while adversely affecting the expectation of stakeholders and the economy. Since the number of steel building constructions are increasing in the Sri Lankan context this study aims to identify factors which highly influence the selection of a procurement method for steel building construction in Sri Lanka. In order to achieve the aim, initially, a comprehensive literature survey was carried out to identify factors which influence the procurement selection for building construction. Accordingly, 42 factors were identified. Subsequently, a quantitative research approach was followed to list down the factors on their significance in selecting procurement method for steel building construction in Sri Lanka. Consequently, 26 factors were concluded as the most significant factors, which influence the procurement selection of steel building construction through Relative Importance Index (RII). Procurement Path Decision Chart was used to analyses the procurement selection factor and construction management was identified as the most suitable procurement method for steel building construction in Sri Lanka.

Keywords: *Procurement Methods; Selection Criteria; Steel Building Construction.*

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FINANCIAL VIABILITY OF USING GREEN ROOFING IN RESIDENTIAL BUILDINGS

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ABSTRACT

As a result of increased attention towards sustainability worldwide, green concepts have become popular in the construction industry. Green roof is one of the essential elements in a green building that provide many advantages while creating a pleasant appearance for the total building. Green roofs play a major role in energy saving of a building. However, compared to a conventional roof, the initial and maintenance costs of a green roof is quite high due to the additional construction and high maintenance requirements. Thus, this paper compares the Life Cycle Cost (LCC) of a green roof with that of a conventional ceramic tile roof in order to determine the financial viability of green roofing. Findings were gathered from several cases and past researches under initial cost, maintenance cost and energy saving of green roofs and adopted to the selected case for the analysis. Findings of the study indicate that initial cost of the green roof was higher than conventional and represented 8.39:(-6.55) proportion of the total life cycle cost of the building. Similarly, maintenance, operational and replacement costs were also higher than the conventional representing 12.08:(-6.55) proportion of the total life cycle cost of the building. Green roof also had higher energy cost than the conventional, representing (-23.64):(-6.55) proportion of total life cycle cost of the building. As a result, it was found that (-Rs. 11,654.70)/m^2 net saving by a green roof is considerable despite of the high initial and the maintenance cost. According to the study, green roofing concept is financially and environmentally beneficial concept even though there are some barriers, like lack of knowledge, lack of techniques, lack of standards in implementing this concept in the Sri Lankan context. Hence, it is recommended to use green roofing in residential buildings.

Keywords: *Energy Saving; Green Roof; Green Roof Cost; Life Cycle Cost.*

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FUZZY LOGIC MODEL TO BENCHMARK MAINTENANCE STRATEGIES FOR CONCRETE STRUCTURES

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ABSTRACT

Maintenance of a building, which is of utmost importance, has become a burden to organisations worldwide, due to the unplanned approach towards it. Recently, views on building maintenance had undergone fundamental changes and are currently thought of as a crucial function in any organisation. Regrettably, around one-third of the allocated maintenance costs are wasted due to the ineffectiveness of maintenance planning. As a remedy to this loss, many organisations are currently shifting towards the incorporation of maintenance strategies such as corrective maintenance, preventive maintenance, and predictive maintenance. However, the implementation of these strategies itself will not solve the problem. Significant planning should be undergone in order to obtain the maximum benefit of executing these strategies. Introducing a tool to support planning and decision-making regarding maintenance strategy implementation will hence simplify this process. Therefore, the aim of this paper is to review existing literature on maintenance strategies and develop a fuzzy logic model to find the best combination of such maintenance strategies for concrete structures. Hence this paper portrays a conceptual model that can be adopted to benchmark maintenance strategies for concrete structures, by adapting the existing models which are commonly developed for maintenance of machinery and equipment.

Keywords: *Benchmarking of Maintenance; Building Defects; Concrete Structures; Fuzzy Logic; Maintenance Strategies.*

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IMPACT OF FLY-ASH ON CARBON EMISSIONS IN DIFFERENT CONCRETE GRADES

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ABSTRACT

Concrete is one of the most used construction materials; however, it contributes to about 7% of all carbon emissions. Various supplementary cementitious materials such as fly-ash have been considered to enhance concrete performance. There is a limitation of studies that address the influence of fly-ash on carbon reduction in different grades of concrete. Hence, the aim of this study is to analyse the impacts of fly-ash in concrete on carbon emissions in construction projects. A comparison between carbon emissions of portland cement concrete projects and fly-ash concrete projects was conducted using data collected from 20 construction projects in New South Wales, Australia. The results showed that higher the grade of concrete used, higher the carbon dioxide emissions, due to the increase of portland cement needed to achieve the higher grades of concrete. Introducing fly-ash to the concrete mix showed a significant reduction in carbon emissions. However, from the financial perspective, it was found that the rate per cubic metre of fly-ash concrete is 2.1% more expensive than standard concrete mixes. Therefore, the idea of adopting fly-ash into the concrete mix may not deliver cost savings as expected. Overall, this study provided clear insight into the effects of concrete usage on the environment and ways to reduce carbon emission.

Keywords: *Building Construction; Carbon Emissions; Concrete; Fly-Ash.*

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INVESTIGATING THE PROBLEMS IN HOTEL REFURBISHMENT PROJECTS

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ABSTRACT

Hotel industry is one of the major contributors to the national economy in most countries including Sri Lanka. Due to the high tourist attraction in Sri Lanka, demand for modifying and upgrading the hotel industry to keep pace with the trend is inevitable. Refurbishment thus covers a wide range of activities originating from decoration to conversion. However, numerous problems are encountered in refurbishment projects and further the industry lacks in-depth investigations on strategies to minimise such problems associated. Hence this research was aimed at studying the problems prevailing in hotel refurbishment projects and thereby suggesting strategies to minimise such. A qualitative research approach was followed inclusive of three cases of recently completed hotel refurbishment projects in order to explore the causes and respective strategies to curtail the problems in connection with hotel refurbishment projects. Accordingly, most common problems are the percentage of services work, obstruction by occupancy, unrealistic time pressure and risk in health and safety. Subsequently, the study explored the main causes for those to be guest disturbances, operation of the hotel, unforeseen work and reluctance to wear safety accessories. Key strategies that could be adopted are planning ahead, separating the noisy working areas, carrying out feasibility studies and making compulsory to wear safety accessories. Through this study, it is recommended to follow up the strategies to minimise the problems in hotel refurbishment projects in Sri Lanka to enhance the lifespan of a hotel building effectively.

Keywords: *Causes; Hotels; Refurbishment; Sri Lanka; Strategies.*

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ISSUES IN SUSTAINABLE WATER MANAGEMENT OF IRRIGATION SYSTEMS IN SRI LANKA

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ABSTRACT

As the largest consumer of water, the irrigation sector has to play a critical role in managing water resources. Nevertheless, the current water management practices of irrigation are not achieving the benefits of sustainable use of water. The failure in achieving the expected performance of irrigation infrastructures urges the need for Sustainable Water Management (SWM). Therefore, the purpose of this research is to investigate the issues in existing Irrigation Water Management (IWM) practices towards SWM of irrigation systems in Sri Lanka. The research aim was approached through a qualitative survey strategy. Expert interviews were conducted as the data collection technique. Twelve experts were selected through a purposive sampling strategy, who had experience in water management and technical development in irrigation systems. The collected data were analysed using the manual content analysis method. Findings of the research revealed that though numerous techniques are being practiced in IWM, there is a failure in water management in the current context. It was identified, water losses throughout the system, improper system operation and poor maintenance of structures, inefficient practices of irrigation, dis-integration of system components and lack of government intervention as major issues to achieve sustainable use of water in the case of irrigation. The identification and assessment of issues provide a range of their impacts to reveal the constraints in achieving SWM of irrigation.

Keywords: *Irrigation Systems; Irrigation Water Management; Sri Lanka; Sustainable Water Management.*

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LEAN ENABLING HUMAN CAPACITY BUILDING OF SMALL AND MEDIUM CONTRACTORS IN SRI LANKA

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ABSTRACT

Lean construction is still at the premature stage of the small and medium contractors (SMCs) in Sri Lanka. Lack of focus on human capacities required to implement lean has hindered its implementation. Thus, human capacity building is a paramount factor for successful lean implementation of SMCs in Sri Lanka. However, there is a lack of empirical investigation on human capacities and strategies to build human capacities for lean implementation in Sri Lankan SMCs. This paper investigates the lean enabling human capacities and strategies, and hence develops a framework to build those human capacities for successful lean implementation in Sri Lankan SMCs. The research adopts interpretivism stance and uses the qualitative survey strategy. The empirical data collection technique adopted is semi-structured interviews with 24 experts who are having experiences both in SMCs and lean implemented projects. The code based content analysis was used as the data collection technique, which was supported by NVivo10 and interactive data visualisation tool, Power Bi was used to present the analysed data. The research identified team working skills, critical thinking, leadership, communication skills, work ethics, knowledge and positive attitudes as lean enabling human capacities in SMCs. Training, learning and using existing capacities were identified as the most significant individual level strategies, where education and training, and financial support for SMCs were recognised as strategies that can be used by external environment entities to build the above capacities. The developed framework further highlighted that use of existing capacities, proper recruitment, proper investments, networking, maintain a lean culture and learning by doing as organisational strategies to build the lean enabling capacities. Industry practitioners can use this framework to develop lean enabling human capacities in order to accelerate the lean implementation in Sri Lankan SMCs.

Keywords: *Human Capacity Building; Lean Construction; Small and Medium Contractors; Sri Lanka.*

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MANAGEMENT OF PAYMENT DELAYS IN GOVERNMENT FUNDED CONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

The successful completion of a construction project will depend on the timeliness of the payments made by the employer, which benefits both the project as well as the parties involved in it. If the payments get delayed, the resulting financial burden will go down the supply chain to reach even the subcontractors and suppliers, thereby further complicating the situation. Since payment delays are common in Sri Lankan construction projects as well, especially when the projects are funded by the government, the proper management of payment delays is important. This research was, therefore, conducted to identify how the consequences of payment delays in government funded projects in Sri Lanka could be properly managed. A literature review and sixteen semi-structured expert interviews were carried out to collect the required data, which were subsequently analysed using manual content analysis. The study identified 77 causes of payment delays in government funded projects and 51 strategies that can minimise them. The study recommends the enactment of the Construction Industry Payment Act, enforcement of regulations that make it mandatory to have a sum of money deposited in an independent escrow account, getting the employers to work only within the stipulated budgets, and getting them to provide payment bonds.

Keywords: *Causes; Delayed Payments; Government Funded Projects; Strategies.*

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MANAGING KNOWLEDGE THROUGH SOCIAL NETWORKS WITHIN MULTI-NATIONAL REAL ESTATE CONSULTANCY FIRMS: A LITERATURE REVIEW

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ABSTRACT

Multinational Real Estate Consultancy Firms (MNRECF), as "knowledge-based entities", has progressively distributed their operations to their branches all around the world. Disseminated knowledge expertise across borders may, on the one h, benefit MNRECFs due to its' multiplicity, but, on the other h, may be difficult to orchestrate. Thus, orchestration of the knowledge across dispersed unit's conversion of those into innovation competences has become a crucial capability for MNRECFs. Transferring knowledge through one-to-one conversations has been threatened by the increasing movement of the consultants of MNRECFs across different countries. Since the evolution of network relationships has impacted most companies in the modern economy setting, Social Network concept has become the focus of many companies. Organizations' tacit knowledge sharing is mainly structurally supported by the social networking. In MNRECFs, members belong to one category or department dispersed in widespread locations. Therefore, there is a wide adoption of Enterprise Social Networking (ESN) as a collaborative Knowledge Management (KM) tool. The paper suggests the KM efforts within MNRECFs should identify the 'Influencers' in the social network in order to introduce encourage the participation of more actors to the ESN. Therefore, the paper details social networks' features provide an account of relevant combination of ESN SNA facilitated KM initiatives within MNRECFs.

Keywords: *Enterprise Social Networks; Influencers; Knowledge Management; Multinational Real Estate Consultancy Firms; Social Networks; Social Network Analysis.*

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MANAGING POST DISASTER RECONSTRUCTION PROJECTS THROUGH A CULTURAL PERSPECTIVE: A LITERATURE REVIEW

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ABSTRACT

Post Disaster Reconstruction (PDR) is a very important, complex and highly demanding process, including well planned set of activities done by well experienced construction professionals. Strength in terms of sustainability, particularly in the PDR of developing countries, is undoubtedly still not at an adequate level. One of the main challenges that affecting for the success of the PDR project performance is that not managing community cultural continuity properly while affording development opportunities in PDR projects which end up with cultural incompatible solutions, which are unsustainable in the long run. The success of PDR project performance is based on the success of their main 4 components: site, layout, construction and policies. The study identifies how those components of PDR projects are affected by the community culture with the lessons learned by past PDR project experiences all around the world. Further, the cultural factors which affect for each feature of PDR has been identified through the findings. Besides the thorough literature findings, the study has presented with proposed methodological aspects in order to continue the study in future.

Keywords: *Community Culture; Cultural Factors; Post Disaster Reconstruction.*

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MAPPING AND IMPROVING SUSTAINABLE CONSTRUCTION MANAGEMENT THROUGH SOCIAL NETWORK ANALYSIS: A REVIEW

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ABSTRACT

Social Network Analysis (SNA) has been used in multidisciplinary research during the past two decades due to the unique nature of network visualisation and extensive analytical capabilities. This tool has also gained increasing attention among the researchers in the sustainable construction arena in recent years. Nevertheless, a thorough review has not yet been done to review the application of SNA in the sector of sustainable construction. This paper attempts to address this gap through a comprehensive review of previous journal publications. Accordingly, 73 journal papers were initially identified for review through the "Web of Science "publications database. Subsequently, a bibliometric analysis was done through "VOS viewer" software package to identify the research trends throughout the past years. The results show significant progress in relevant publications during 2014-2018 and a major contribution to research from China. After an extensive filtration process, 17 particularly relevant journal papers were identified which have applied both social network visualisation and analysis techniques for the sustainability aspects of construction. The contents of these papers were comprehensively analysed in terms of data collection methods, network analysis techniques, network structures and sustainability knowledge areas. Finally, this paper contributes to theoretical knowledge in this domain, by suggesting a future research direction through a SNA conceptual model to analyse stakeholder collaborations for project life cycle sustainability initiatives. The findings of this paper will serve as a good source for future researchers to comprehensively identify, compare and contrast the applications of SNA techniques for sustainability related studies in the construction sector.

Keywords: *Social Network Analysis; Sustainable Construction; Sustainability.*

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MECHANICAL AND ELECTRICAL (M&E) TRAINING FOR QUANTITY SURVEYORS TO CONTRIBUTE TO CARBON REDUCTION IN BUILDINGS

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ABSTRACT

Estimates on the level of carbon emission varies but it is generally accepted that buildings consume about half of energy and contribute to greenhouse gas emissions. Mechanical and electrical (M&E) services accounts for a significant proportion of building projects. Apart from the cost effect, a reduction in carbon footprint can be achieved through M&E services as the capital allowances system and tax relief provides the mechanism to promote sustainability through innovation in green technologies and energy efficiency. However, the training of quantity surveyors in M&E is often ad hoc making it difficult to realise the maximum potential in carbon reduction. The aim of the study is to enhance the M&E trainings to the Quantity Surveyors (QSs) in order to better contribute to carbon reduction and sustainability of buildings. The objectives were formulated as to examine the opportunities for carbon reduction through capital allowances and tax relief and the training implications for QSs. Using an explorative survey and semi-structured interviews, the study found significant gaps in knowledge of the quantity surveyors as limited attention is given to training in M&E services. There is need for a review of training programmes to ensure that the QS professionals can maximise the potential in reducing carbon emission through the provision of appropriate cost advice on M&E services that will benefit from capital allowances and tax relief. Other countries can learn from the experience of the UK Government policy, statutory and regulatory framework that underpins the development of capital allowances and tax relief to change behaviour by providing tax and fiscal incentives that will have a positive impact on carbon reduction to mitigate climate change.

Keywords: *Capital Allowances; Carbon Emission; Mechanical and Electrical (M&E); Quantity Surveyor; Sustainability; Tax Relief.*

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OPTIMISING THE INDUSTRIAL SYMBIOSIS (IS): THE PROPOSED REDEVELOPMENT

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ABSTRACT

Industrial symbiosis (IS) has been emerged aiming the integration of industrial complexes, in which by-products of materials and energy are using as feedstock instead of being wasted. Since organisations cooperatively increase their mutual sustainable benefits simultaneously through IS, a number of IS projects have been initiated across the whole world. However, most of the projects have been failed and discontinued in long term undermining the expected collaborative gains and efficiencies. Hence, recent studies articulate the necessity of having a standardised mechanism towards implementing the resource efficiency optimised IS designs. Thus, this paper aims to present the issues in the current process of IS development in order to propose a mechanism for redeveloping the process through resource flow efficiency optimisation. A systematic review of key literature was conducted in the areas of IS, its design and implementation procedures. The data collected through the secondary survey was then analysed manually to identify the different stages of the IS development process and related issues. As many scholars recognised, most of IS projects have been discontinued due to the shortcomings and the inefficiencies of the IS development process. Thus, the necessity of having a standardised and more robust model for optimising IS is recognised. Finally, the proposed redevelopment is conceptualised by introducing a new phase of re-evaluation and optimisation modelling to evaluate the symbiosis relationships prior implementation to consider them either for implementing or for re-planning.

Keywords: *Industrial Symbiosis; Issues; Optimisation Modelling; Re-development.*

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OVERCOMING THE CHALLENGES OF SUSTAINABLE DEVELOPMENT IN SRI LANKA USING LEAN CONSTRUCTION PRINCIPLES

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ABSTRACT

Sustainability is gaining popularity in the construction industry because of the growing concern that the industry has on the serious negative impacts of construction activities on the environment. To achieve sustainable development through environmentally friendly practices, such as green building practices, construction waste management would be essential. However, the new construction philosophy lean, can be used to overcome the environmental challenges of sustainable development. Thus, the aim of this study was to investigate how the challenges of sustainable development could be overcome in Sri Lanka using the principles of lean construction. The study used a qualitative approach consisting of a literature review and 20 expert interviews. Interview findings were analyzed manually using content analysis. Specifying value and identifying the value stream were found to be the most suitable lean principles that can overcome the challenges of sustainable development. The research findings also reveal that there is an urgent requirement to practice lean principles in the construction industry in Sri Lanka.

Keywords: *Lean Construction Principles; Sustainability Challenges; Sustainable Development.*

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POLICY GAPS THAT DETER FOSTERING SUSTAINABLE CONSTRUCTION IN SRI LANKA

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ABSTRACT

One of the guiding principles used for structuring the policy of construction in Sri Lanka is to ensure achieving sustainable development. Though the construction practitioners in Sri Lanka are aware of sustainable construction practices, there is lack of verification as to enthusiasm of the state policy that has been extended to this noble cause. A desk review was carried out to demystify the existing policy directions. A comprehensive literature survey was carried out to identify the drivers and barriers of its implementation. A structured questionnaire survey was conducted among 100 individual practitioners to gauge their perception and experience. 80 responses were received, 62 were considered valid for analysis. Data collected were then analyzed using the relative importance index. It was revealed that the key driver is end user requirements and the crucial barrier is lack of policies. Only 3 out of 17 dimensions have been at least superficially earmarked within the policy framework. The study suggests that the uptake of enhanced policies would indeed help in fostering sustainability. The outcome will be valuable for the government officials to formulate a policy that truly promotes strategic direction. This is the first local research on identifying policy gaps related to the subject arena.

Keywords: *Barriers; Drivers; Policy Making; Sri Lanka; Sustainability.*

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POTENTIAL OF USING BIG DATA FOR DISASTER RESILIENCE: THE CASE OF SRI LANKA

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ABSTRACT

The epoch of big data is evolving new possibilities for Disaster Management (DM). The concept of Big Data has been constantly scrutinised in terms of data creation, storage, retrieval, and analysis where professionals have identified its significance upon the volume, velocity and variety. Big Data provides the opportunity to gather more information in less time. Hence, analysis of Big Data can substantially enhance various disaster resilience activities such as issuing early warnings for evacuations; help emergency response personnel to identify areas that need urgent attention; coordination of disaster management activities; and to identify the most effective response methods for various situations. Therefore, Big Data is identified as a great catalyst for disaster response and, for better understanding of the damage situation and decision-making. Moreover, Big Data has the potential to improve disaster resilience by connecting people, processes, data and technology. However, it is essential to understand the type of Big Data that needs to be generated, to develop the data analysis as in necessary to help with real time responses, decision making and tracking of disaster victim. In order to accomplish the aim, a qualitative research approach was followed. This topical study marked the importance of big data in predicting human behavioral patterns during a disaster. Accordingly, the effective management of human and physical resources in habitual disaster territories was appraised through existing case studies in developed countries. Further, the research has successfully identified the challenges in employing Big Data upon its legal and technological barriers.

Keywords: *Big Data (BD); Disaster Management (DM); Disaster Resilience.*

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REAL-VIRTUAL SYNCHRONISATION: A REVIEW ON THE STATE-OF-THE-ART GEOMETRIC DIGITAL TWINNING OF INFRASTRUCTURE

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ABSTRACT

In the United Kingdom (UK), recent developments in the construction industry have increased the demand for digitised infrastructure, which facilitates the investigation of the as-is performance of assets. This establishes the need to create and maintain up-to-date digital copies of infrastructure assets, often labelled as Digital Twins. Digital twins are obtained by converting the unstructured data formats of the real-world assets, such as point clouds, into high-level digital representations. Yet, only few assets today have usable digital twins because of the high costs of the latter. This counteracts the benefits of the twins and reduces dramatically their true potential. Hence, there is a pressuring need to automate the process of creating digital twins. Geometric digital twin, the most basic form of the twin, contains only the geometry of the physical asset. This paper reviews the work done in computer vision, geometry processing, and civil engineering fields to determine the potential that exists for automatically producing geometric digital twins of infrastructure.

Keywords: *Geometric Digital Twin (GDT); Infrastructure; Point Cloud Data (PCD).*

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SERVICE CONSISTENCY IMPROVEMENT OF FACILITIES MANAGEMENT SERVICE PROVIDING ORGANISATIONS IN SRI LANKA

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ABSTRACT

Service consistency acts as a key media to achieve sameness and fairness in service delivery. Service consistency is vital to attraction of new customers, enhanced corporate image, reduced costs, and increased business performance. Nonetheless, struggle in developing and applying measurements for service quality can be commonly identified with service consistency failure situations. Hence, to better manage changes as well as to overcome such issues, organization should adopt a proper methodology to improve service consistency for Facilities Management (FM). Thus, this study aims to improve the service consistency of FM service proving organizations in Sri Lanka. Case study method was adopted in qualitative phenomenon. Under the case study method, three cases (FM service providing organisations) were studied. Twelve (12) semi-structured interviews were conducted among the FM related professionals in the selected cases to collect the data. Case study data were analysed by using the content analysis and cross-case analysis techniques. Direct interaction with customers, complain handling procedures, conduct skill development programmes, collect customers feedback and recruit experienced professionals were identified as some of the existing strategies used for service consistency. Different customer expectations, employee turnover, communication errors and lack of customer experience about FM services were revealed as major issues for service consistency. Accordingly, the suggestions, including sharing information with each employee, improving decision making skills, developing customer care strategies and implementing better recruitment system, were proposed to overcome the identified issues of service consistency in FM service providing organisations in Sri Lanka.

Keywords: *Facilities Management; Service Consistency; Service Provider; Strategies; Sri Lanka.*

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SIGNIFICANCE OF CONSTRUCTION TECHNOLOGY KNOWLEDGE FOR QUANTITY SURVEYORS IN EXPRESSWAY CONSTRUCTION PROJECTS

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ABSTRACT

The degree of social responsibility of professionals towards public projects are naturally high. Recently, in Sri Lankan context, expressway construction is becoming one of the major public project types. Due to that, the responsibility of professionals towards a successful expressway construction seems very high. Among professionals, Quantity Surveyor (QS) is a significant team member in any kind of construction project in terms of managing cost and time aspects. Being highly technical and complex, expressway QSs essentially need a significant level of construction technology knowledge to perform the duties and responsibilities. Therefore, the research was focused on investigating the significance of expressway construction technology knowledge for QS practitioners. The scope of the research was narrowed down to Sri Lankan expressway projects. A comprehensive literature review was carried out to identify the duties and responsibilities of QSs in expressway project stages. The research methodology was mixed approached comprising a questionnaire survey and s expert interviews round. Quantitative data analysis was carried out using RII method and qualitative data subjected to content analysis. The research concludes feasibility stage as the most technical knowledge sensitive stage of an expressway construction project with respect to the QS's role. Further, QSs with less experience make projects vulnerable for more cost and time issues due to lack of technical knowledge and such scenarios may add black marks to the role of the QS in big picture, therefore it is essential for the QSs to keep updated with the changing construction technologies.

Keywords: *Construction Industry; Expressway Construction; Quantity Surveyor; Sri Lanka; Technological Knowledge.*

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STAKEHOLDERS' INVOLVEMENT IN SUCCESSFUL IMPLEMENTATION OF WASTE TO ENERGY PROJECTS: CASE STUDIES IN SRI LANKA

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ABSTRACT

Same as to many countries, Sri Lanka is also facing a waste crisis due to the issues in municipal solid waste management. As a solution, Waste to Energy (WtE) concept was aroused, which transforms waste to energy in the form of electricity. Although it was a successful strategy for many of the countries, in Sri Lanka, most of the instances, WtE projects were resulted in failures due to issues provoke in the implementation. Poor stakeholder management has been one of the key contributing issues behind these failures. Hence, there is a timely need of identifying key stakeholders and their role to pledge project success. Despite the abundance of research on WtE projects, a gap in literature could be identified, when it comes to exploring stakeholders' involvement in successful implementation of WtE projects in Sri Lanka. Thus, this study is aimed at bridging this knowledge gap. A qualitative research approach with two case studies were used in this study. A total of 12 interviews were conducted and collected data were analysed using content analysis. The empirical findings revealed that government, community, central environmental authority, engineering procurement and construction contractors, municipal council and central electricity board are the most influential stakeholders involved in the implementation of WtE projects. Although their level of contribution is varied to each other, all stakeholders along with their interests and involvement collectively thrive to assure the successful implementation of WtE projects in Sri Lanka. The knowledge generated through this research can be used by respective industry practitioners in Sri Lanka in implementing future WtE projects successfully.

Keywords: *Implementation Process; Municipal Solid Waste Management (MSWM); Stakeholders; Waste to Energy (WtE).*

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SUITABILITY OF TRADITIONAL PROCUREMENT SYSTEM FOR GREEN BUILDINGS IN SRI LANKA

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ABSTRACT

Green building construction is a momentous process of sustainability. It signifies the environmental credibility of sustainable. Further, it addresses the energy performance, overall cost of the construction product and conservation of natural resources. Therefore, green building concept has foremost influence on construction industry. Yet, it has core barriers in cost, knowledge, risk and government factors when involve the green construction to construction industry. Hence, procurement system can involve in reducing those barriers. Green procurement signifies both product and process of the construction. Concerning the process base, there are different procurement systems involved in different countries which depend on internal and external factors. There is high involvement in design and build procurement system worldwide which include Sri Lankan context as well. The status of applying traditional procurement system in green construction is significantly high even though it is not considered as highest. Therefore, it has high involvement on addressing the barriers through critical factors of traditional procurement system. It was carried out nine expert survey with qualitative analysis in order to identify involvement of traditional procurement system to green building construction. Accordingly, it focused on the critical factors of traditional procurement system specifically cost, time, complexity, client's involvement, project characteristics and technology. These success factors addressed the barriers which raised through high cost, lack of knowledge, risk and other influences of green building construction. Finally, this research subsidizes to knowledge, green procurement system provides the benefits to increment of green building construction in Sri Lanka.

Keywords: *Green Building Construction; Green Procurement; Procurement; Sustainability; Traditional Procurement System.*

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THE CONCEPT OF VALUE ENGINEERING AND ITS ASSIMILATION IN SRI LANKAN CONSTRUCTION INDUSTRY: A LITERATURE REVIEW

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ABSTRACT

Value is an ideational thought by which a worth of a good or service is expressed. Value Engineering is one of the tools used to evaluate such value and provide solutions for best fit value in real time. The core principle of practicing value engineering is to achieve value for money in construction projects, but it also bestows practitioners with added advantages such as innovative alternatives and enhanced quality. Even though value engineering is practiced globally, application of value engineering in Sri Lanka is highly limited due to lack of knowledge and awareness of the concept of value engineering, lack of realisation of the benefits it can bring to the construction projects and lack of government support. Hence, Sri Lankan construction industry lacks initiatives to pursue integration of value engineering in construction projects. The objective of this paper is to explore the idea behind the term "value" through value engineering and manifest previously identified causes and mitigation strategies to enhance value engineering practices within Sri Lanka. A comprehensive literature review has been carried out to disclose facts and cues of value engineering identified globally and to contextualise the concepts of value engineering within Sri Lankan construction industry. This paper emphasises that value engineering enhances the total value of the project while irradiating unnecessary costs associated with the projects. However, Sri Lankan construction industry is not practising value engineering in its full potential due to barriers identified above. Recommendations were, therefore, proposed to reveal the importance of standardising value engineering practice in Sri Lankan construction industry.

Keywords: *Construction Industry; Value; Value Engineering; Value Management; Sri Lanka.*

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TYPOLOGIES OF OFFSITE CONSTRUCTION

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ABSTRACT

In the 21st century, where smart and modern technologies are developed at an expeditious rate, construction industry has survived over centuries, despite its slow rate of technology adaptations, poor productivity, lower sustainability and vastly reported skill shortage. Technological advancement is the catalyst to solve these issues attaching extreme significance to transform the construction industry in line with industrialisation, digitalisation and globalisation. Sequential industrial revolutions have evolved to the present day's Fourth Industrial Revolution which is also known as Industry 4.0, under which offsite construction leads to the reduction of onsite labour intensity and shift the tasks to factory based manufacturing paradigms. Study on offsite construction revealed different types of offsite construction available in literature; none of which specified a logical method of offsite construction types development to suit the current technology advancements in the global construction arena. Available literature rather mention types of offsite construction based on examples and not the construction technology or combination of onsite to offsite work component. Therefore, this research was carried out to develop typologies of offsite construction using 10 available types of offsite construction. Literature was analysed using content analysis method through the NVivo 2012 (QSR) computer software. Findings revealed six typologies of offsite construction with incrementing portions of offsite construction in the order of; Components, Panels, Pods, Modules, Complete buildings and Flat pack. Therefore, this research contributes to knowledge by the development of typologies of offsite construction through a scientific approach while addressing the 21st century technology advancements available in the construction industry worldwide.

Keywords: *Offsite Construction; Technology Development; Typologies.*

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UNDERSTANDING LIVEABILITY: RELATED CONCEPTS AND DEFINITIONS

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ABSTRACT

The rapid unplanned urbanization of metropolitan areas has manifested number of challenges in terms of infrastructure, energy consumption, health care, waste management and resilience. Thus, forming "liveable" city for its citizens is an aspiration of the policy makers, designers and city planners. Yet, a detailed exploration of the concepts of liveability and liveability indicators has not been carried out. Thus, to this end, this paper advocates to define liveability and related concepts. For that an exhaustive literature synthesis has been conducted which simultaneously follows two different paths to define liveability. Firstly, it has reflected number of direct definitions from indexed literature related to liveability and contrasting the definitions of associate fragments of accustomed concepts such as sustainability and urbanization misapprehended as liveability. Secondly, a definition for liveability was derived through considering the liveability indicators of different liveability indexes According to the indicators, liveability represents social and economic approach. Yet, the concepts of sustainability was based on social, economic and environmental aspects when discussed along with liveability. Hence, Liveability is the balanced and favourable living conditions within a geographical area and liveable cities are such centralized communities with comparatively high population to the rest of the region. The policy making, planning, and political authorities need to ensure the balance of the habitats by defining liveability to reflect the social, economic aspects emerged through the existing indicators and the environmental focus of sustainability concepts.

Keywords: *Liveability; Liveable City; Liveability Index; Urbanisation.*

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UNTAPPED POTENTIALS OF BUILT ENVIRONMENT PROFESSIONALS IN NATIONAL DISASTER RESILIENCE ACTION PLANS IN SRI LANKA

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ABSTRACT

Even though many governments have ambitious plans for speedy and effective post disaster recovery a less success rate has been recorded in many parts of the World including Sri Lanka. In light of this situation, a growing call has been evident for greater engagement of the construction industry in the global effort of disaster resilience. This research is therefore aimed at recognizing the specific role(s) of built environment professionals previously unidentified in disaster resilience action plans in Sri Lanka. The research commenced with a literature review including the Sendai Framework which was the first major agreement of the post-2015 sustainable development agenda. A detailed desk review involved mapping the currently defined roles of the public sector in disaster resilience building in the National Disaster Management Plan (NDPM) in Sri Lanka with the open-source guideline called "The Built Environment Professions in Disaster Risk Reduction and Response" co-authored by Lloyd- Jones et al. (2009) that defines 29 distinct roles of built environment professionals. This research reveals that the built environment professionals in Sri Lanka have been heavily unrecognized and underutilized in the cause of disaster resilience where only 10 roles have been earmarked.

Keywords: *Built-environment Professionals; Disaster Resilience Building; National Disaster Management Plan (NDPM); Sendai Framework.*

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USE OF BIM SOLUTIONS TO FACILITATE VALUE MANAGEMENT

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ABSTRACT

Value management is a practice of generating innovate alternative ideas to improve the value of a project where the goals are to achieve a more efficient design, identify alternative methods of constructions, identify and omit unnecessary cost components and managing the whole life cycle cost of the project. The aim of this research is to find the ability of BIM in incrementing efficiencies of value management process within Sri Lankan context. Case study method was used. The selected case is considered as a benchmark on sustainable buildings of the Sri Lankan construction sector. The seven-step value management approach following the Client's requirements identified for the project was first documented. BIM tools and features applicable for each step of value management process was then identified followed by clarification of the effect and the efficiency of each step of the process. A value management plan was built up with the use of BIM solutions for the studied case. BIM was identified as one of the most efficient and accurate media to extract the basic and detailed project information for value management process. Simulating, comparing and contrasting the information of rainfall, wind flow, daylight, cost, designs and resources for the implementation of passive cooling systems, lighting control systems, green roofing and alternatives to reduce grey energy was effectively analysed in this paper using BIM solutions.

Keywords: *Building Information Modelling; Sustainable Buildings; Value Management.*

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USE OF SHIPPING CONTAINER HOUSING CONCEPT AS A LOW COST HOUSING SOLUTION FOR RESETTLEMENT PROJECTS IN URBAN AREAS

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ABSTRACT

Today, one-third of the world's urban population live in slums and shanties., while prioritizing adequate housing as their basic need. They face a lack of basic needs such as clean air, water, sanitation and healthy foods. Rapid urbanization leads to increased demand for condominiums and focused on slum-free cities to get maximum utilization of high potential prime lands. As a solution, shipping container housing (SCH) concept has been successfully practiced in many countries in all over the world to promote low cost housing (LCH) for resettlement projects. Therefore, this research intends to explore the use of SCH concept as a LCH for permanent resettlement projects in urban areas of Sri Lanka. A comprehensive literature synthesis emphasizes the suitability of SCH concept as a LCH solution and it proved that approximately 60% of construction cost can be saved by using this SCH concept over the traditional construction methods. Selected case study for this research was "low income permanent resettlement programme in Colombo city". Finally, the study revealed that use of SCH concept as a LCH solution for resettlement projects in Colombo will not be a feasible solution due to the specific retarding factors from the low income groups, specific characteristics of shipping container boxes and climatic conditions of Sri Lanka. Moreover, this study was very useful for the governing authorities to identify the leading alter factors between the theoretical concept and practical implementation of low income permanent resettlement projects in Sri Lanka.

Keywords: *City; Low Cost Housing; Resettlement Projects; Shipping Container Housing.*

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WHAT DIFFERENTIATES A SMART CITY? A COMPARISON WITH A BASIC CITY

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ABSTRACT

Distinctive nature of the problems a city holds, baptise a "smart city", which is a term, at the same time, is blamed for being befogged. Although defining the term "a smart city" is worth taking a risk, the maturity of the smart city definition in terms of practical use and research has not been reached. Even if it is defined, it would highly depend on the context and unique nature of cities. Yet there are city components that are only found in smart cities. A study of these components would be the most practical way of understanding "what make a smart city". Therefore, this study aims to analyse literature, review definitional elements of smart cities, and derive a comprehensive list of smart city components. Not being a one size fits all, smart city definitions are often interchangeable with other well-defined city conceptions. Those conceptions are a source to outline what smart cities are. Therefore, the terms digital city, intelligent city, ubiquitous city, global city, and sustainable city are compared with smart city characteristics. In the same way, definitional elements from ten latest literature sources were identified. Smart city components identified in the literature were then reviewed and combined to form a list of components under the themes; smart economy, smart people, smart living, smart environment, smart mobility, and smart governance which were supposed to integrate with Information and Communication Technology (ICT) infrastructure. While these components are the frontline, smart cities also intent to ensure urban, public services, and citizen development. With this, the paper presents a holistic summary of the characteristics that define the smartness of a smart city.

Keywords: *Definitional Elements, Smart Cities, Smart City Components.*

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WORKERS' BEHAVIOUR TOWARDS NOISE POLLUTION CONTROL ON CONSTRUCTION SITES

M.S. Kaluarachchi[1], K.G.A.S. Waidyasekara[2] and R. Rameezdeen[3]

ABSTRACT

Noise pollution is a noticeable hazard in construction sites, which can cause severe damage to the health and safety of workers and the neighbouring community. Number of studies have investigated control measures for noise pollution, majority proposing regulatory and engineering control, which are expensive and mostly ineffective. While behavioural changes of workers could contribute to effective noise control, very few past studies have dealt with behaviour of construction workers. To fill this knowledge gap, this study used a questionnaire survey and analysed the responses using structural equation modelling by testing several hypotheses developed using the Norm Activation Model that investigates the relationship between attitudes and behaviour of construction workers. The sample belonged to a wide range of worker categories of major construction firms in Colombo, Sri Lanka. Results revealed that a positive relationship exists between personal norms and environmental behaviour. Furthermore, these personal norms are significantly informed by the awareness of consequences and a sense of responsibility to act to mitigate noise pollution in their sites. Thus, while workers are aware of the negative consequences of noise pollution and are responsible to act, an increase in environmental behaviour will occur via the activation of personal norms. Hence, workers tend to alter their behaviour when having altruistic moral norms. As a practical implication arising out of this research, these worker attributes could be strategically used by construction companies to create a conducive work environment where workers themselves take initiatives to deal with environmental destruction caused by construction activities.

Keywords: *Construction projects; Health Issues; Noise Pollution; Norm Activation Model.*

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