

# THE THIRD WORLD CONSTRUCTION SYMPOSIUM - 2014

Sustainability and Development in Built Environment: The Way Forward

# 20-22 JUNE 2014 | COLOMBO, SRI LANKA

GCU Glaspic Caledonian Glaspic Caledonian

# Programme & Abstracts









# THE 3<sup>RD</sup> WORLD CONSTRUCTION SYMPOSIUM 2014

# SUSTAINABILITY AND DEVELOPMENT IN BUILT ENVIRONMENT: THE WAY FORWARD

# 20 - 22 June 2014

at Galadari Hotel Colombo, Sri Lanka

Organised by

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

## With Associate Partners

Glasgow Caledonian University (GCU), Liverpool John Moores University (LJMU), Centre for Infrastructure & Construction Industry Development (CICID), The University of Hong Kong

#### Sponsored by

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

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# MESSAGES

The 3<sup>rd</sup> World Construction Symposium 2014

# Prof. Chitra Weddikkara Chairperson The 3<sup>rd</sup> World Construction Symposium 2014



It is with appreciation that I take up the invitation to give a message as the Chairperson of the 3<sup>rd</sup> World Construction Symposium 2014. It is with great pleasure that I welcome all participants to the event. This year's theme is "Sustainability and Development in Built Environment: The Way Forward".

As an event where academics and industry participants in construction gather to exchange views and findings, I believe this symposium is timely. After 30 years of civil war, our construction industry is experiencing great activity with government, being a facilitator and promoter of public and private partnerships.

Sri Lanka is poised to develop its built environment, infrastructure and socio-economic framework. Having understood the need to position ourselves, it is now important to discuss issues such as sustainability in construction practice, its implementation, the policy framework for the future development of our country.

We questioned ourselves 'How should we meet these challenges?' I am sure that all participants from around the world will look forward to identify challenges and understand how to face the issues pertaining to sustainability; unravelling the answers and their knowledge on various issue so that the Sri Lankan counterparts will be enriched in the knowledge rather them than reinventing the wheel.

In acting as a platform for knowledge sharing, it also offers Sri Lankan professionals and academics to meet specialists from overseas. In conducting the event, I believe ClOB, the professional body for Builders in Sri Lanka, who works to inspire, educate and train builders as professionals in Sri Lanka; will receive international exposure which they richly deserve. The event is also strengthened by the research excellence of its organizing partner; the Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics of the University of Moratuwa and Associate partners: Glasgow Caledonian University, Liverpool John Moores University, Centre for Infrastructure & Construction Industry Development, The University of Hong Kong who too will stand to gain much in the academic field.

I hope all invitees would take this opportunity to meet and learn from colleagues in the global construction industry, making it a stimulating and educative symposium.

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



The Ceylon Institute of Builders (CIOB) is pleased to organise the 'Sustainability and Development in Built Environment: The Way Forward' The Third (3<sup>rd</sup>) World Construction Symposium 2014, together with the CIB Netherlands and the University of Moratuwa, Sri Lanka. The CIOB with its roots in the year 1961 has a solid history of acting as the professional body in the building and construction industry in the island. Hence, we are honoured to be part of this symposium that would help industry stakeholders develop an understanding of challenges faced by the global industry, while having an opportunity to expand their international network.

Invitations for the symposium have been extended to professional and academic participants from over 30 countries, thereby bringing in various inputs from across the globe. Companies developing technologies to circumvent or meet these issues are expected to provide new insights. And leading academics and students have been invited to enlighten the audience on recent scientific findings. Therefore, I strongly believe that our invitees would find the symposium to be of great significance.

I would also like to take this opportunity to mention 'Construction Expo 2014', which will be held in parallel to the Symposium at the BMICH, Colombo. It would be the, largest international construction event to be held in Sri Lanka. I invite companies which are interested in adopting new technologies and innovations to come and visit Construction Expo 2014.

I take this opportunity to thank the ministries and professional institutions who have helped us in organising the Third World Construction Symposium 2014. I am much grateful to CIB Netherlands and the BEMRU, Department of Building Economics, University of Moratuwa who have been an integral part of the organising team.

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



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

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

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

I would also like to thank Ministry of Construction and Engineering Services, Housing and Common Amenities, Ministry of Economic Development, Ministry of Land and Land Development with other national bodies such as Institute of Engineers of Sri Lanka, Chamber of Construction Industries Sri Lanka, Institute of Quantity Surveyors Sri Lanka and other construction related Professional bodies, the management of BMICH, the management of Galadari Hotel for the assistance provided.

# Mr. Kalana Alwis Mr. Sagara Gunawardena Co-Chairmen The 3<sup>rd</sup> World Construction Symposium 2014



We warmly welcome all delegates to the Third (3<sup>rd</sup>) World Construction Symposium and International Construction Expo 2014 at the Galadari Hotel and BMICH respectively during the period of 20<sup>th</sup> June to 22<sup>nd</sup> June 2014. This is an exciting venture jointly organized by Ceylon Institute of Builders (CIOB), the International Council for Research and Innovation in Building and Construction (CIB), and The Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka.

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

The Third World Construction Symposium 2014 will be a platform for both Local and International delegates to share and exchange practice, policy and research initiatives on various issues related to socio-economic sustainability of the construction industry. This would further enable to carry back experiences of sharing new skills, technologies and lessons learnt from the current development projects in Sri Lanka.

# Ch. QS. Indunil Seneviratne Head of the Department Department of Building Economics University of Moratuwa



I warmly welcome all delegates to the 3<sup>rd</sup> World Construction Symposium and International Construction Expo 2014 at the Galadari Hotel and BMICH respectively during the period of 20 June to 22 June 2014. This is an exciting venture jointly organized by Ceylon Institute of Builders (CIOB), the International Council for Research and Innovation in Building and Construction (CIB), The Building Economics and Management Research Unit (BEMRU), Department of Building Economics, University of Moratuwa, Sri Lanka for the third successful time. Glasgow Caledonian University, Liverpool John Moores University, Centre for Infrastructure & Construction Industry Development, The University of Hong Kong are the associate partners of the symposium.

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The 3<sup>rd</sup> World Construction Symposium 2014 will be a platform for both Local and International delegates to share and exchange practice, policy and research initiatives on various issues related to sustainable development of the construction industry. This would further enable to carry back experiences of sharing new skills, technologies and lessons learnt from the current development projects in Sri Lanka.

# **KEYNOTE SPEAKER**

The 3<sup>rd</sup> World Construction Symposium 2014



Wim Bakens graduated in 1975 as Architectural Engineer from the University of Technology in Eindhoven, The Netherlands, where he in 1992 also successfully finalized his Ph.D. study with a dissertation on "The future of Construction".

After having been employed for about 7 years at the Dutch Ministry for Housing, Construction and Physical Planning, were he was responsible for building and construction related research and regulatory systems, he became first a Senior Consultant and later a partner with one of the biggest Dutch Management Consultancies. In that position that lasted for about 11 years, he was responsible for a group of consultants that focused on research and consultancy in the construction industry. During that time he also was Coordinator of the CIB Working Commission W082 - Future Studies in Construction - and in that position he was the main author of the CIB Publication entitled "Future Organisation of the Building Process"

Since 1994, he is the Secretary General of CIB - The International Council for Research and Innovation in Building and Construction.

Since 2010, he is appointed Visiting Professor at the University of Westminster in London, UK.

# **ORGANISING COMMITTEE**

Chairperson	Prof. Chitra Weddikkara
Co-Chairs	Mr. Sagara Gunawardena Mr. Kalana Alwis
Advisors	Dr. Rohan Karunaratne Eng. Saliya Kaluarachchi Ch. QS. Indunil Seneviratne
Organising Committee	Mr. Ruwan de Silva Eng. Jayakish Thudawe Mr. Rangi Hewage Eng. Ashoka Randeni Mr. Mahanama Jayamanne Mr. Sudath Amarasinghe Eng. Walter Perera Eng. Ravi Randeniya
Scientific Committee Chairs	Dr. Yasangika Sandanayake Dr. Nirodha Fernando Dr. Gayani Karunasena
Symposium Secretariat	Ms. Chandanie Hadiwattege Ms. Aparna Samaraweera Ms. Tharusha Ranadewa Ms. Chathuri Gunarathna Ms. Treshani Perera Ms. Mathusha Francis Mr. Rohana Balasuriya Mr. Siri Fernando
Symposium Event Director	Mr. Samantha Abeywickrama

# SCIENTIFIC COMMITTEE

#### Chairs

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

#### Members

Dr. Vasantha Abevsekara Prof. Dilanthi Amaratunga Assoc. Prof. Umberto Berardi Prof. Peter Brandon Prof. David Bryde Dr. Daniel W.M. Chan Prof. Edwin H. W. Chan Dr. Arun Chandramohan Dr. K.A.K. Devapriva Prof. Rohinton Emmanuel Dr. Hwang Bon-Gang Dr. Thayaparan Gajendran Prof. Jacqueline Glass Dr. Sachie Gunatilake Prof. Asanga Gunawansa Mr. Suranga Jayasena Prof. Mike Kagioglou Prof. Mohan Kumaraswamy

University of South Queensland, Australia University of Salford, United Kingdom Worcester Polytechnic Institute, USA University of Salford, United Kingdom Liverpool John Moores University, United Kingdom Hong Kong Polytechnic University, Hong Kong Hong Kong Polytechnic University, Hong Kong National Institute of Technology Calicut, India University of Moratuwa, Sri Lanka Glasgow Caledonian University, Scotland National University of Singapore, Singapore University of Newcastle, Australia Loughborough University, United Kingdom University of Moratuwa, Sri Lanka National University of Singapore, Singapore University of Moratuwa, Sri Lanka University of Huddersfield, United Kingdom University of Hong Kong, Hong Kong

The 3<sup>rd</sup> World Construction Symposium 2014

Dr. Cynthia Lee Glasgow Caledonian University, Scotland Prof. Florence Y.Y. Ling National University of Singapore, Singapore Dr. Jamie Mackee University of Newcastle, Australia Dr. Anupa Manewa Liverpool John Moores University, United Kingdom Mrs. Dianne Marsh Liverpool John Moores University, United Kingdom Dr. Edward Ochieng Liverpool John Moores University, United Kingdom Prof. George Ofori National University of Singapore, Singapore Dr. Wei Pan University of Hong Kong, Hong Kong Dr. Primali Paranagamage University of Lincoln, United Kingdom Ch. OS. Kanchana Perera University of Moratuwa, Sri Lanka Prof. Srinath Perera University of Northumbria, United Kingdom Dr. Raj Prasanna Massey University, New Zealand Dr. Thanuja Ramachandra University of Moratuwa, Sri Lanka Dr. Raufdeen Rameezdeen University of South Australia, Australia Dr. Andrew Ross Liverpool John Moores University, United Kingdom Dr. James Rotimi Auckland University of Technology, New Zealand Dr. Sepani Senaratne University of Western Sydney, Australia Ch. OS. Indunil Seneviratne University of Moratuwa, Sri Lanka Prof. Alfredo Serpell Catholic University of Chile, Chile Assoc. Prof. Lalith De Silva University of Moratuwa, Sri Lanka Dr. Nayanthara de Silva University of Moratuwa, Sri Lanka Dr. Gamini Weerasinghe University of Moratuwa, Sri Lanka Dr. Janaka Wijesundara University of Moratuwa, Sri Lanka

# SYMPOSIUM INFORMATION

#### International Construction EXPO

The International Construction EXPO inauguration is on 20 June 2014 from 09.30 am to 12.00 noon at the Bandaranaike Memorial International Conference Hall (BMICH), Bauddhaloka Mawatha, Colombo 07. Foreign participants those who have already requested transportation from Galadari to BMICH and the return, please assemble at the hotel lobby at 09.00 am. Inauguration will be end at 11.00 am and guests will be provided with one hour and 30 minutes to visit the exhibition. The guests will be transported back to the hotel at 12.30 pm from BMICH.

#### The 3<sup>rd</sup> World Construction Symposium

The Symposium is on 20 June 2014 from 05.00 pm to 07.30 pm, 21 June 2014 from 09.00am to 06.00 pm and on 22 June 2014 from 09.00 am to 06.00 pm at the Galdari Hotel, Lotus Road, Colombo 01.

#### Symposium Secretariat

Ceylon Institute of Builders (CIOB), No. 48, CSCT Building, Thalawathugoda Road, Pitakotte, Sri Lanka

Tel : 0094-11-3140355 (Samantha) or 0094-77-1227269 (Chandanie)

Fax : 0094-11-2885933

Email : ciob.2014@yahoo.com

Website : http://2014.ciobwcs.com

#### Language

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

#### **Dress Code**

Symposium - Business, Lounge or National Dinner - Smart Casual

#### Registration

Symposium delegates can collect their materials at the registration desk, located at the Salon Jasmine of the Galadari Hotel. Opening times of the registration desk will be from 03.00 pm to 09.00 pm on 20 June 2014 and from 8.00 am to 6.00 pm on 21 and 22 June 2014.

#### Secretariat Room

During the symposium, the secretariat room is located at the Salon Rose of the Galadari Hotel, where the main symposium is being held. The opening hours of the secretariat will be from 08.00 am to 07:00 pm on 20 - 22 June 2014.

#### Awards

Following awards will be presented to the winners during the symposium cultural dinner on 22 June 2014. Award winners will be announced during the symposium sum-up.

Emerald BEPAM Best Paper Award Emerald BEPAM Highly Commended Paper Award CIOB Best Paper Award CIOB Best Presenter Award

#### **Certificate of Attendance**

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

## Excursion to Sigiriya

The excursion to Sigiriya on 23 June 2014 starts from Galadari Hotel at 06.30 am and expected to be returned to the hotel at 09.00 pm. The excursion includes bus tour, breakfast, lunch, evening tea, guiding and visiting attraction. This offers only to foreign delegates with prior reservations. Please assemble at the hotel lobby at 06.30 am.

## Liability

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

## Disclaimer

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

# SYMPOSIUM PROGRAMME

# Friday, 20 June 2014

# International Construction EXPO 2014

09.30 am Opening Ceremony BMICH

# The 3<sup>rd</sup> World Construction Symposium 2014

04.00 pm	Symposium Registration	Grand Ball Room (Galadari Hotel)
05.00 pm	Symposium Inauguration	
05.10 pm	Welcome Address by Symposium Chairperso Prof. Chitra Weddikkara	วท
05.20 pm	Address by President, CIOB <b>Dr. Rohan Karunaratne</b>	
05.30 pm	Address by Representative from Associate F Dr. Andrew Ross	Partners
05.45 pm	Address by Vice Chancellor, University of Mo Prof. Ananda Jayawardena	oratuwa
06.00 pm	Keynote Address by General Secretary, CIB Dr. Wim Bakens	
07.00 pm	Presentation by <b>Seirra Cables Plc.</b> (Gold Sponsor)	
07.20 pm	Vote of Thanks by Hon. Secretary, CIOB <b>Eng. Saliya Kaluarachchi</b>	
07.25 pm	End of Symposium Inauguration	
07.30 pm	Welcome Cocktail	

#### The Second Construction Investors Forum 2014

09.00 am	Investors Forum 2014 Business Sessions	Grand Ball Room (Galadari Hotel)
10.30 am	Tea / Coffee Break	Pre Function Area B
11.00 am	Investors Forum 2014 Business Sessions	Grand Ball Room
01.00 pm	Lunch	Bougainvillea Room

# The 3<sup>rd</sup> World Construction Symposium 2014 – Parallel Sessions

02.00 pm	<b>Parallel Session 1</b> (There will be THREE parallel sessions)	Salon Orchid, Salon Jasmine, and VIP Lounge
03.30 pm	Tea / Coffee Break	Pre Function Area B
04.00 pm	<b>Parallel Session 2</b> (There will be THREE parallel sessions)	Salon Orchid, Salon Jasmine, and VIP Lounge
06.00 pm	End of Programme on 21.06.2014	

# Sunday, 22 June 2014

# The 3rd World Construction Symposium 2014 - Parallel Sessions

09.00 am	Parallel Session 3 (There will be THREE parallel sessions)	Salon Orchid, Salon Jasmine, and VIP Lounge	
10.30 am	Tea / Coffee Break	Pre Function Area B	
11.00 am	<b>Parallel Session 4</b> (There will be THREE parallel sessions)	Salon Orchid, Salon Jasmine, and VIP Lounge	
01.00 pm	Lunch	Bougainvillea Room	
02.00 pm	Panel Discussion on "Fulfilling Sustainable Developing Countries through Academic Re	Construction Needs in search"	
	Panel A: Academics Prof. Mohan Kumaraswamy Dr. Andrew Ross Assist. Prof. Shekhar Nagargoje		

#### Panel B: Industry Practitioners

Prof. Asanga Gunawansa Mr. Julian Lee Eng. Ranjith Gunatilleke

#### Panel Moderator

Ch. QS Lalith Rathnayake

03.15 pm Industry Presentations

Presentation by **Siemens Ltd.** (Silver Sponsor)

#### Presentation by **3M Lanka**

- 04.00 pm Tea / Coffee Break
- 04.30 pm Rapporteur's Report Dr. Thanuja Ramachandra Dr. Sachie Gunatilake

Pre Function Area B

Bougainvillea Room

- 05.00 pm Announcing Award Winners Prof. Mohan Kumaraswamy and Prof. Chitra Weddikkara
- 05.10 pm Vote of Thanks by Scientific Committee Co-Chairperson Dr. Yasangika Sandanayake
- 05.15 pm Awarding of Participation Certificates
- 06.00 pm End of Programme

#### Symposium Dinner

07.30 pm Cultural Dinner

Grand Ball Room (Galadari Hotel)

#### Monday, 23 June 2014

- 06.30 am Excursion to Sigiriya
- 09.00 pm Return to Hotel

Note: Please refer symposium information for further details

# SYMPOSIUM SESSION PLAN AT-A-GLANCE

	Saturday, 21 June 2014				Sunday, 22 June 2014								
08.00 - 09.00	Registration						Regist	ration					
09.00 - 09.15					Cossion	S7007	Cossion	S7010	Cossien	S7019			
09.15 - 09.30							34	\$7012	38	S7001	Session	S7054	
09.30 - 09.45			Investors F	orum 2014			54	S7033		S7025		S7041	
09.45 - 10.00								\$7023		S7011		S7071	
10.00 - 10.30							Qa	&A	Qa	&A	Q8	λA	
10.30 - 11.00			Tea / Cof	fee Break					Tea / Coff	ee Break			
11.00 - 11.15								S7018		S7031		S7022	
11.15 - 11.30								S7042		S7032	Session 4C	S7008	
11.30 - 11.45							Session	S7057	Session	S7066		S7028	
11.45 - 12.00			Investors F	orum 2014			4A	S7040	4B	S7021		S7030	
12.00 - 12.15								S7068		S7043		S7035	
12.15 - 12.30								T7003		S7067		S7050	
12.30 - 13.00							Q&A Q&A Q&A			λA			
13.00 - 14.00			Lui	nch					Lun	ich			
14.00 - 14.15		S7049	\$7027 \$7005										
14.15 - 14.30	Session	S7056	Session	S7053         Session         S706           S7044         1C         S706		S7062							
14.30 - 14.45	1A	S7048	1B			S7064			Panel Dis	scussion			
14.45 - 15.00		S7070		S7058	\$7058 \$7026								
15.00 - 15.15	0	<b>θ</b> ,Δ	0	θ,Δ	0	8.A							
15.15 - 15.30	4		4		Ŷ				Industry Pre	sentations			
15.30 - 16.00		-	Tea / Cof	fee Break					maasayira	Sentations			
16.00 - 16.15		S7063		S7003		S7002			Tea / Coff	ee Break			
16.15 - 16.30	Session	S7072	Session	S7004	Session	S7065							
16.30 - 16.45	2A	S7036	2B	S7013	20	S7059							
16.45 - 17.00		S7069		S7047		S7029			Symposium	n Sum-Un			
17.00 - 17.15		S7046		T7004		S7034			e)pee.a	n ouni op			
17.15 - 18.00	Q&A Q&A Q&A												
18.00 - 19.30													
19.30 - 22.00									Cultural	Dinner			

The 3<sup>rd</sup> World Construction Symposium 2014

# DETAILED SESSION PLAN

# Saturday, 21 June 2014

Session 1A

Theme	: ICT for Delivery and Operations of Buildings
Session Chair	: Dr. Goh Bee Hua
Venue/Time	: Salon Orchid - 02.00 pm - 03.30 pm
Time	Paper ID, Title and Author(s)
02.00 - 02.15 pm	S7049 - An Evaluation of BIM Enabled Cost Management in Meeting Sustainability Targets
	Dianne Marsh, David Bryde and Andrew Ross
02.15 - 02.30 pm	S7056 - Project Management Dashboard over Prevailing Tools and Software: A Study on Addressing Nine Knowledge Areas L.D. Paranamana, L.D. Indunil. P. Seneviratne and K.T.P.K. Perera
02.30 - 02.45 pm	S7048 - Equipment Selection Factors of Integrated Building Management Systems (IBMSs) in Sri Lanka M.V.D. Madhurangi, P.A.D. Rajini, C.S.P.K. Fernando and S.B.P.G.K. Samarakoon
02.45 – 03.00 pm	S7070 - BIM Software Environment for Projects in Sri Lanka
·	Himal Suranga Jayasena and Chitra Weddikkara
03.00 – 03.30 pm	Q&A

Session Coordinator : D.M.P.P. Dissanayake

#### Session 1B

Theme Session Chair Venue/Time	<ul> <li>Built Environment</li> <li>Prof. Mohan Kumaraswamy</li> <li>Salon Jasmine - 02.00 pm - 03.30 pm</li> </ul>
Time	Paper ID, Title and Author(s)
02.00 - 02.15 pm	S7027 - Sustainable Implications of Building Reuse and Adaptation Upeksha Hansini Madanayake and Anupa Manewa
02.15 - 02.30 pm	S7053 - Applicability of Reliability Centered Maintenance Approach for Thermal Power Plants in Sri Lanka G.K. Kalpage and K.M.G.K. Konara
02.30 - 02.45 pm	S7044 - Responding to the Built Environment Challenges: Design for Adaptation Anupa Manewa, Mohan Siriwardena and Andrew Ross
02.45 - 03.00 pm	S7058 - Developing a Framework to Evaluate Indoor Environmental Quality (IEQ) Performance of Industrial Buildings in Sri Lanka Dimuthu Thisna Vijerathne and L.D Indunil P. Seneviratne
03.00 – 03.30 pm	Q&A

Session Coordinator : K.A.D.N.C. Wijekoon

## Session 1C

Theme	: Urban Development
Session Chair	: Prof. P.K.S. Mahanama
Venue/Time	: VIP Lounge - 02.00 pm - 03.30 pm
Time	Paper ID, Title and Author(s)
02.00 - 02.15 pm	S7005 - Cultural Continuity as a Vital Factor in Delivering Identity, Memory and Sense of Place: A Critical Study of Urban Transformation with Special Reference to Pettah in Colombo Anoj Pathinayaka and Janaka Wijesundara
02.15 - 02.30 pm	S7062 - Integrated Approach for Future Sustainable Urbanisation Shekhar Nagargoje
02.30 - 02.45 pm	S7064 - Urban Design and Social Capital: Lessons from a Case Study in Braunstone, Leicester, United Kingdom Primali Paranagamage, Andrew Price, Fahmida Khandokar and Simon Austin
02.45 - 03.00 pm	S7026 - Living in Low Income Condominiums: End Users' Perspectives D. M. D. Wijayamali, K.G.A.S. Waidyasekara and K.W.D.C.K Dahanayake
03.00 - 03.30 pm	Q&A

Session Coordinator : M.A.C.L. Gunarathna

#### Session 2A

Theme Session Chair Venue/Time	<ul> <li>Project and Stakeholder Management in Construction</li> <li>Ch. QS. Indunil Seneviratne</li> <li>Salon Orchid - 04.00 pm - 06.00 pm</li> </ul>
Time	Paper ID, Title and Author(s)
04.00 - 04.15 pm	<b>S7063 - Strategies to Recruit and Retain Professional Quantity</b> <b>Surveyors in the Public Sector Construction Organisations</b> <i>R.A.H.C. Ranasinghe, Nirodha Gayani Fernando and</i> <i>M.A.C.L. Gunarathna</i>
04.15 - 04.30 pm	<b>S7072 - Conceptual Framework for Understanding Construction</b> <b>Project Culture: A Literature Review</b> <i>A.U.A.A. Samaraweera, Y.G. Sandanayake and</i> <i>Sepani Senaratne</i>
04.30 - 04.45 pm	S7036 - Factors that Influence the Formation of Construction Project Teams for Sustainability: Consideration of Specificity Andrew Ross, Augustine Blay Armah and Anupa Manewa
04.45 - 05.00 pm	S7069 - Merging Academic Research and Construction Industry Development Requirements: A Conceptual Framework Chandanie Hadiwattege, Nirodha Gayani Fernando and Sepani Senaratne
05.00 - 05.15 pm	S7046 - Role of Multi-Disciplinary Project studies in Promoting Sustainability within the Built Environment Degree Programmes Mohan Siriwardena, Anupa Manewa, Udayangani Kulatunga and Dianne Marsh
05.15 - 06.00 pm	Q&A

Session Coordinator : Pournima Sridarran

### Session 2B

Theme	: Sustainable Materials and Technologies
Session Chair	: Dr. Primali Paranagamage
Venue/Time	: Salon Jasmine - 04.00 pm - 06.00 pm
Time	Paper ID, Title and Author(s)
04.00 - 04.15 pm	S7003 - A Critical Review of Water Studies in Construction Industry
	K.G.A.S. Waidyasekara, M.L. De Silva and R. Rameezdeen
04.15 - 04.30 pm	S7004 - Effects of Varying Recycled Fine Aggregate Content and Water/Cement Ratio in Bedding Mortar
	S. Karunarathne, I.S. Subasinghe, V.P.S. Madusanka,
	V.R.D.K. Jayasinghe, S.M.A.P. Sundarapperuma,
	W.S.S.R. Fernando and S.A.K.N. Chandrasiri
04.30 - 04.45 pm	S7013 - Sustainable Structural Material Combining Recycled Aggregate and Steel Fibres
	Vivian W. Y. Tam, Olivia Mirza, Sepani Senaratne and
	Won-Hee Kang
04.45 - 05.00 pm	S7047 - Market Feasibility and Practicability Assessment of Rubberised Bitumen for Sri Lankan Road Pavements R.A.Y. Thiwanka, S.R.M.S.R. Chandrathilake and A.S. Asmone
05.00 - 05.15 pm	T7004 - Recent Development of Vertical Axis Wind Turbine: A
	Julian C.F. Lee and Paul H.F. Lam
05.15 - 06.00 pm	Q&A

Session Coordinator : D.M.P.P. Dissanayake

#### Session 2C

Theme Session Chair Venue/Time	<ul> <li>Construction Project Management</li> <li>Dr. Imriyas Kamardeen</li> <li>VIP Lounge - 04.00 pm - 06.00 pm</li> </ul>
Time	Paper ID, Title and Author(s)
04.00 - 04.15 pm	S7002 - Project Risk Management by Small Scale Contractors in Sri Lankan Building Construction N. Kamalanathan, B.A.K.S. Perera and K.A.T.O Ranadewa
04.15 - 04.30 pm	S7065 - Project Management Challenges in Implementing Foreign Funded Water Supply and Sanitation Projects in Sri Lanka Nishan Weerarathna and L.D Indunil P. Seneviratne
04.30 - 04.45 pm	S7059 - Risk of Catastrophic Events on Construction Supply Chain D.M.D.T.B. Dissanayake, Y.G. Sandanayake and K.A.D.N.C. Wijekoon
04.45 - 05.00 pm	S7029 - Sustainable Responsiveness for Recessionary Effects in the Construction Industry: A Study on Appraising Benefits K.T.P.K. Perera and K.G.A.S Waidyasekara
05.00 – 05.15 pm	S7034 - Investigating Current Construction Waste Management Practices in South Australia: A Preliminary Study Nilupa Udawatta, Jian Zuo, Keri Chiveralls and George Zillante
05.15 - 06.00 pm	Q&A

Session Coordinator : Uthpala Rathnayake

# Sunday, 22 June 2014

#### Session 3A

Theme	: Project Feasibility
Session Chair	: Assistant Professor Shekhar Nagargoje
Venue/Time	: Salon Orchid - 09.00 am - 10.30 am
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	S7007 - Life-Cycle Assessment for Construction Processes in Building Construction: A Proposed Conceptual Framework Malindu Sandanayake, Guomin Zhang and Sujeeva Setunge
09.15 - 09.30 am	S7012 - Designing a Whole-Life Cost Index for Non-Residential Buildings Goh Bee Hua
09.30 - 09.45 am	S7033 - Key Challenges in Conducting Development Appraisals in Sri Lanka Eshantha James Samarajiwa, P.A.P.V.D.S. Disaratne and Mathusha Francis
09.45 – 10.00 am	S7023 - Factors Affecting Construction Costs in Sri Lanka S.A.C. Hiroshan and Chandanie Hadiwattege
10.00 – 10.30 am	Q&A

Session Coordinator : D.M.P.P. Dissanayake
### Session 3B

Theme Session Chair Venue/Time	<ul> <li>Law in Construction and Professional Ethics</li> <li>Dr. Asanga Gunawansa</li> <li>Salon Jasmine - 09.00 am - 10.30 am</li> </ul>
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	S7010 - Critical Analysis of Alternative Dispute Resolution Methods Used in Sri Lanka Construction Industry Mahesh Abeynayake and Chitra Weddikkara
09.15 - 09.30 am	S7001 - Implications of Insufficient Awareness of Statutory Requirements for Building Construction on Consultant Team of Building Construction Projects M.A.N.M. Sarathchandra, B.A.K.S. Perera and R.A.G. Nawarathna
09.30 - 09.45 am	S7025 - Analyses of the Anti-Corruption Strategies in the Construction Sector of China Ming Shan, Albert P.C. Chan, Yun Le and Yi Hu
09.45 - 10.00 am	S7011 - Mediation as an Alternative Dispute Resolution Method in the Sri Lankan Construction Industry Mahesh Abeynayake and Chitra Weddikkara
10.00 – 10.30 am	Q&A

Session Coordinator : K.A.D.N.C. Wijekoon

### Session 3C

Theme	: Value Management
Session Chair	: Dr. Sepani Senaratne
Venue/Time	: VIP Lounge - 09.00 am - 10.30 am
Time	Paper ID, Title and Author(s)
09.00 - 09.15 am	S7019 - Applicability of Earned Value Management as a Performance Measurement Tool for Sri Lankan Construction Industry H.A.D.P. Hettipathirana and Gayani Karunasena
09.15 - 09.30 am	<b>S7054 - Enhancing the Value in Construction via Integration of Sustainable Construction to Value Planning</b> Dushan Senarathna, Gayani Karunasena and Uthpala Rathnayake
09.30 - 09.45 am	S7041 - Better Values and Characteristics in Relationally Integrated Value Networks to Enhance Total Asset Management Nayanthara De Silva, K.A.T.O. Ranadewa, Mohan Kumaraswamy and Malik Ranasinghe
09.45 – 10.00 am	S7071 - Developing a TBPE Scoring Framework for Assessing Total Building Performance Nazeer Fathima Sabrina and Nayanthara De Silva
10.00 – 10.30 am	Q&A

Session Coordinator : M.A.C.L. Gunarathna

### Session 4A

Theme Session Chair Venue/Time	<ul> <li>Sustainable Construction and Green Building</li> <li>Dr. Andrew Ross</li> <li>Salon Orchid - 11.00 am - 1.00 pm</li> </ul>
Time	Paper ID, Title and Author(s)
11.00 - 11.15 am	S7018 - Application of Green Building Concept to Enhancing Indoor Environmental Quality in Hospital Buildings in Sri Lanka Hasanthika Dilrukshi, Harshini Mallawarachchi and Gayani Karunasena
11.15 - 11.30 am	S7042 - A Literature Review on Marketing Green Buildings: Use of 4C Marketing Mix Approach D.A.S. Gunawardane, I.M.C.S. Illankoon and K.A.T.O. Ranadewa
11.30 - 11.45 am	S7057 - Differentiating Green Buildings from Conventional Buildings: Environmental Performance Perspective Harshini Mallawarachchi, Lalith De Silva and R. Rameezdeen
11.45 - 12.00 pm	<b>S7040 - Impact of Aesthetic Appearance to Facilitate Corporate</b> <b>Business Objectives in Organisations</b> <i>D.A.K. Chathuranga, Nayanthara De Silva,</i> <i>K.W.D.K.C. Dahanayake and Malik Ranasinghe</i>
12.00 - 12.15 pm	S7068 - Environmental Management System (EMS) Planning in Manufacturing: Facilities Management Prospects U. Gunaratne, Sepani Senaratne and S.B.R.G.K. Samarakoon
12.15 - 12.30 pm	<b>T7003 - Carbon Labelling Scheme for Construction Products: The Benchmark for Low Carbon Materials</b> Julian C.F. Lee, Judy J. Zhang, James M.W. Wong, Angus T.S. Ng and S. Thomas Ng
12.30 - 01.00 pm	Q&A

Coordinator : M.A.C.L. Gunarathna

### Session 4B

Theme	: Sustainable Procurement Strategies
Session Chair	: Dr. Anupa Manewa
Venue/Time	: Salon Jasmine - 11.00 am - 01.00 pm
Time	Paper ID, Title and Author(s)
11.00 - 11.15 am	S7031 - A Review of ICTAD Standard Bidding Document 02 (2007) for Major Contracts L.D.T. Dilshani and P.A.P.V.D.S. Disaratna
11.15 - 11.30 am	S7032 - Risk of Using Bidding Strategies for a Contractor H.L.S. Rasanthi, P.A.P.V.D.S. Disaratna, B.A.K.S. Perera and K.T.P.K. Perera
11.30 - 11.45 am	S7066 - Identification of Errors that are being Made Preparing BOQs in Sri Lankan Construction Industry A.A.U.S Gunathilaka and L.D Indunil P. Seneviratne
11.45 - 12.00 pm	S7021 - Sustainability Concerns to the Public Procurement Process in Construction: Literature Review K.A.P. Gunawardhana and Gayani Karunasena
12.00 - 12.15 pm	S7043 - Relational Contracting Approach for Improving Performance of Infrastructure Development Projects R.W.P.M.I.S. Rajapakshe and Nayanthara De Silva
12.15 - 12.30 pm	S7067 - Establishing an Integrated Model for Measuring the Site Safety Performance of Construction Projects: Literature Review and Future Research Agenda Daniel W.M. Chan and Tracy N.Y. Choi
12.30 - 01.00 pm	Q&A

Session Coordinator : K.A.D.N.C. Wijekoon

### Session 4C

Theme	: Health and Safety in Construction Projects and Built Environment
Session Chair	: Prof. Lalith De Silva
Venue/Time	: VIP Lounge - 11.00 am - 01.00 pm
Time	Paper ID, Title and Author(s)
11.00 - 11.15 am	S7022 - Operational Gap Analysis of Fire Safety Applications in Sri Lankan High-Rise Buildings Priyantha Gunarathna, Nirodha Gayani Fernando and Pournima Sridarran
11.15 - 11.30 am	S7008 - Factors Affecting the Psychological Health of Foreign Workers in the Saudi Construction Industry Haitham Alrasheed and Imriyas Kamardeen
11.30 - 11.45 am	S7028 - Establishing a Positive Safety Culture in Rubber Manufacturing Sector: Human Factors D.M.P.P. Dissanayake and Nirodha Gayani Fernando
11.45 - 12.00 pm	S7030 - Factors Influencing Safety Behaviours of Construction Workers N.H.C. Manjula and Nayanthara De Silva
12.00 - 12.15 pm	S7035 - Reporting Procedure of Construction Accidents in Sri Lanka Nayanthara De Silva and R.A.G. Nawarathna
12.15 - 12.30 pm	S7050 - A Research Paradigm for Developing a Fire Risk Assessment Model for New Construction Sites in Hong Kong Daniel W.M. Chan and Yuming Hong
12.30 - 01.00 pm	Q&A

Session Coordinator : A.U.A.A. Samaraweera

### Abstracts of the Proceedings

### The 3<sup>rd</sup> World Construction Symposium 2014

Theme: Sustainability and Development in Built Environment: The Way Forward

> Edited by: Dr. Y. G. Sandanayake Dr. N. G. Fernando Dr. G. I. Karunasena

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

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# PAPER ABSTRACTS

# A CRITICAL REVIEW ON WATER STUDIES IN CONSTRUCTION INDUSTRY

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### R. Rameezdeen

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### ABSTRACT

Water is not only a basic need of human beings, but also a strategic economic resource. However, the distribution of water throughout the earth is diverse. At present, water is a challengeable natural resource for many countries and some studies predicted that the world will face a water dilemma in 2025-2030, if not consumed in sustainable way. Moreover, population growth, climate change, and industrialisation are critical factors that impact on the water sector and ultimately result in freshwater shortage and continued water pollution. The current practice considers water as a separate sectoral box in many economic evaluations although water is an integrated resource in many industries. Therefore, the time has come to think out of the box with the cohesiveness of sustainable development. It is a known fact that the construction industry too uses water in almost all the activities and without water no more construction is possible. However, water management during construction is given less attention by the industry stakeholders at present. This is despite an upsurge in the demand for construction activities both in building and civil engineering projects due to speedy industrialisation to cater for the population growth. This paper is based on the literature review of an on-going PhD research. The paper critically reviews the secondary data on water studies conducted in the construction industry. The views and findings on water handling during the physical construction, and strategies towards sustainable water consumption in construction industry are also discussed. In addition, the paper identifies four critical drivers that impact on sustainable practices of water use during the physical construction phase.

*Keywords:* Construction Industry; Sustainable Use; Water Efficiency; Water Resource.

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# A LITERATURE REVIEW ON MARKETING GREEN BUILDINGS: USE OF 4C MARKETING MIX APPROACH

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### ABSTRACT

Green building is a concept, which is widely discussed in the present scenario. With the depletion of resources, spiralling up of energy costs, and the higher contribution of buildings to this unstoppable phenomenon, topic of green buildings is often heard in many construction platforms. However, in the real world context, green buildings are considered as a luxury and likewise there are many rooted myths which hinders the practical implementation of these greener buildings to a considerable extent. In such a situation, marketing is essential and should be carried out in such a way to promote and eradicate the misunderstandings of green buildings.

In general context, marketing green buildings refers to marketing the one off buildings which envisage the environmentally friendly concepts. Based on the marketing mix in order to market these buildings it is necessary to focus on the customer, his needs, cost and benefits communicating the value and focusing on the convenience.

Therefore, this research initially identifies the emergence of green buildings, its present context and concepts of green marketing. Then, it is followed by a brief identification of marketing mixes, whereas 4C marketing mix is identified to analyse the present context of marketing of green buildings.

Finally, it is concluded that key success is based on the customer satisfaction, which is applicable to three segments of clients namely the developer, owner and tenant. However, it was concluded that communication of facts and figures relating to the green buildings must be improved and so does the convenience in buying.

Keywords: Green Building; Green Marketing; Marketing Mix.

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# A RESEARCH PARADIGM FOR DEVELOPING A FIRE RISK ASSESSMENT MODEL FOR NEW CONSTRUCTION SITES IN HONG KONG

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### ABSTRACT

In Hong Kong, the construction industry is regarded as high-risk. Amongst all types of construction accidents, however, industrial practitioners tend to give less attention to those related to construction site fires, that is, fires which occur during new construction. Fire is perceived as a significant but common risk associated with construction projects which can lead to serious damage. Although construction site fires may not be frequent, the consequences are usually severe. This paper will present an overall research framework for developing a fire risk assessment model for new construction sites in Hong Kong. The research process mainly involves the identification of key fire risk factors and their associated sub factors contributing to fire risk for a construction site, and the development of a fuzzy fire risk assessment model based on the identified fire risk factors. The research methods to be adopted include desktop literature review, Delphi survey technique, empirical questionnaire survey and fuzzy set theory. The model can be used as an objective tool for measuring and comparing the overall fire risk levels existing at different construction sites. Therefore, high-risk areas could be identified and improved. The research findings from the developed fire risk assessment model will ultimately lead to the provision of remedial measures to reduce fire risk at new construction sites. Although the research study will primarily focus on the prevailing situation in Hong Kong, the research methodology will be applicable to many other parts of the world for facilitating international comparisons.

**Keywords:** Assessment Model; Construction Site; Fire Risk; Hong Kong; Research Framework.

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# A REVIEW OF ICTAD STANDARD BIDDING DOCUMENT 02 (2007) FOR MAJOR CONTRACTS

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### ABSTRACT

For every type of construction contract a set of Conditions of Contract is an essential constituent for its sustainability. Conditions of Contract create a legal framework with rights and obligations of the parties under which the parties are to operate. The two types of Conditions of Contract, i.e. a) Conditions of Contract drawn up by parties to the contract and b) Standard Conditions of Contract published by independent professional organisations have inherent advantages and disadvantages. A set of Standard Bidding Documents have been published by the Institute for Construction Training And Development (ICTAD) to be used within Sri Lankan construction industry out of which Standard Bidding Document 02 (SBD 02) is intended for major contracts. Since the usage of SBD 02 is only limited to construction industry of Sri Lanka, literature is somewhat scarce in regard to the limitations of Conditions of Contract of SBD 02. Therefore, the aim of this study is to explore the limitations of the Conditions of Contract of SBD 02.

Research problem was approached through a series of semi-structured interviews with local Consultant Quantity Surveyors who are currently practicing in private sector of Sri Lankan construction industry.

Findings of this research render that there are limitations associated with Conditions of Contract of SBD 02 which are affecting the sustainability of the application of SBD 02. Those limitations are required to be addressed in order to enhance the quality of SBD 02.

*Keywords:* Conditions of Contract; Consultant Quantity Surveyors; Standard Bidding Document.

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# AN EVALUATION OF BIM ENABLED COST MANAGEMENT IN MEETING SUSTAINABILITY TARGETS

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### ABSTRACT

With the current UK Government drive towards the adoption of Building Information Modelling (BIM), the Quantity Surveyor (QS) must possess the necessary knowledge and skills to use BIM as part of their cost management duties. For the purposes of this paper BIM contributes to Sustainable Construction Practices by facilitating efficient and effective integrated team working whereby, from the point of view of cost management, the process of planning and controlling maximises client value, minimises waste and optimises whole life cycle costs. The UK government expects cost management to utilise BIM automated quantity take-off where appropriate to facilitate Level 2 compliance by extracting 3D BIM model quantities into Excel and costing the quantities manually. BIM can directly benefit cost management by rapid and accurate automated quantity take-off; facilitating cost planning and Bill of Quantity production aimed at more effective use of resources. This paper will consider how the OS role will develop in relation to cost management in the new BIM era and how effective BIM will be in ensuring cost management helps meet sustainability-related targets. To inform the findings reported in this paper data was collected through exploratory interviews with OS's from three private practices, three contracting organisations and two experts in the field of BIM. This research suggests that whilst BIM is being utilised by the profession it is not standard in its application and not being utilised in relation to life cycle decisions thus limiting its impact on helping to meet sustainability targets.

Keywords: BIM; Cost Management; Role of a QS; Sustainability.

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# ANALYSIS OF THE ANTI-CORRUPTION STRATEGIES IN THE CONSTRUCTION SECTOR OF CHINA

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### ABSTRACT

While various anti-corruption strategies (ACSs) have been developed to curb the widespread corruption in the construction sector, effectiveness of these ACSs has seldom been investigated. This study, therefore, aims to identify and evaluate the ACSs being implemented in China. To achieve these objectives, a comprehensive literature review and a two-round Delphi survey of 14 experienced industry experts and academics were conducted. Survey results reveal that the most effective ACS is legal framework, followed by penal sanction, regulations, positive leadership, adequate institutions, transparency, economic sanction, administrative sanction, and education and training. Also, the results show that the effectiveness of raising the wage level as an anti-corruption strategy did not receive a high evaluation by the Delphi panel. Findings of this study can help enhance a better understanding of anti-corruption strategies and thus improve a corruption-free environment.

**Keywords:** Anti-Corruption Strategies; Construction Sector; China; Delphi Survey.

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# APPLICABILITY OF EARNED VALUE MANAGEMENT AS A PERFORMANCE MEASUREMENT TOOL FOR SRI LANKAN CONSTRUCTION INDUSTRY

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### ABSTRACT

This study is based on the Earned Value Management (EVM) performance measurement technique and its practice in Sri Lankan construction industry. Since the project success clearly depend on accuracy on evaluated performance measurement, EVM have emerged through various techniques, due to its higher degree of reliability, effectiveness, accuracy, and efficiency.

Data collection was done through the case study research approach and cross case analysis was used for data analysis. Four cases were selected to extract the current practice of EVM and its suitability as a performance measurement for the industry.

In traditional methods, physical progress is not taken into account when analysing cost performance. Instead, actual cost of a project up to date is simply compared to planned costs, often with misleading results. Therefore, as a mitigating measure, EVM can be applied for measuring a project's performance forecasting future trends and analysing variances in the schedule and budget as the project proceeds. EVM as a standard method can be considered more successful with better results in projects simple and direct with a detailed scope. As evidenced in the case study, projects with complex and incomplete final products show higher deviations in the use of the technique. The EVM suggests a cultural change in the process of projects control; therefore people who have experience in dealing with the tool are really necessary in this process. The way an organisation implements the tool, influences directly to the results. If it had an organisational support, provided by specialised resources, will have better results in terms of application.

*Keywords:* Construction; Earned Value Management; Performance Measurement; Sri Lanka; Traditional Methods.

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# APPLICABILITY OF RELIABILITY CENTERED MAINTENANCE APPROACH FOR THERMAL POWER PLANTS IN SRI LANKA

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#### ABSTRACT

More than 70% of entire power demand in Sri Lanka mainly caters through thermal power and oil base thermal power plants contributes to cater more than 55% of demand in the country. Even though plant reliability and efficiency should be maintained at higher value to cater this demand, sudden island wide power cuts and Ceylon electricity board (CEB) statistics has been revealed the prevailing plant performance issues of thermal power plants.

Reliability Centered Maintenance (RCM) approach has been adopted successfully for wide range of industries including thermal power industry in considerable number of countries to overcome plant performance issues while reducing maintenance cost. Therefore the focus of this research is to study applicability of RCM approach for maintenance planning of thermal power plants in Sri Lanka to overcome current issues relating to maintenance operation. Comprehensive literature review was conducted to explore RCM concept. Through the preliminary survey current maintenance practices, issues that directly related with maintenance practice, currently available resources that necessary for RCM base analysis and attitude of industry practitioner towards RCM implementation were identified. Streamline Reliability Centered Maintenance (SRCM) was identified as ideal type of RCM analysis method for thermal power plants in Sri Lanka through findings of literature review and preliminary survey.

Findings of single case study revealed criticality evaluation criteria and applicable maintenance strategies for critical and non-critical components of typical thermal power plants. A comprehensive maintenance plan was developed for fuel pre pressure system using currently available physical and human resources. Considering findings, the research suggests that thermal power industry in Sri Lanka should initiate SRCM base maintenance program to overcome existing performance issues using existing resources.

**Keywords:** Maintenance Optimisation; Performance Issues; Reliability Centered Maintenance; Thermal Power Plants.

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# APPLICATION OF GREEN BUILDING CONCEPT TO ENHANCE INDOOR ENVIRONMENTAL QUALITY IN HOSPITAL BUILDINGS IN SRI LANKA

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### Abstract

Through the number of factors, which can attract the occupants to the building, "quality" gets a predominant situate. Among the other buildings, hospitals are most important place which has to maintain quality in high standard. Hence, most of the countries are initiating various strategies to improve quality of hospitals because, it directly affects to the occupant satisfaction of the hospital. Further, hospital is mostly a public place which is extremely noisy, crowded and less indoor environment quality. It causes serious impacts on patient and staff outcomes ranging from sleep loss and elevates blood pressure among patients to emotional exhaustion and burnout among staff. Henceforth, poorly designed hospital environments pose a serious threat on building occupants. Literature findings further said that in current scenario, the majority of occupants are not satisfied with their indoor environment quality in a hospital.

Nowadays, most of hospitals are following various strategies to improve quality of indoor environment. Among those strategies, green building concept becomes most prominent which is easy to adapt to improve the indoor environment quality. Moreover, green hospital design has been linked to better patient outcomes and staff retention. Even though, in past few years many newly constructed and renovated buildings moved towards green, buildings in hospital sector in Sri Lanka has not much familiar with the green building concept. Therefore, this study is mainly focused on presenting the importance of applying green building concept in hospital buildings to improve indoor environmental quality. Two case studies consisting private and public hospitals were conducted to collect the data. Six semi-structured interviews were conducted who have caught up in operational and maintenance management process of selected hospitals. As revealed by research findings, there was no special attention to enhance indoor environment guality in Sri Lankan hospitals especially in public sector. Therefore, several issues were identified comply with the indoor air quality, thermal comfort, acoustic comfort, visual comfort and spatial comfort. Indoor Air quality is one of the major challenges faced by many hospital buildings as it creates several issues within hospital

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environment. Accordingly, probable green strategies were proposed to overcome identified indoor environment quality issues in hospital buildings to facilitate high quality indoor environment for building occupants in hospital buildings in Sri Lanka.

*Keywords:* Green Building Concept; Hospital Buildings; Indoor Environmental Quality; Occupants' Satisfaction.

# BETTER VALUES AND CHARACTERISTICS IN RELATIONALLY INTEGRATED VALUE NETWORKS TO ENHANCE TOTAL ASSET MANAGEMENT

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#### ABSTRACT

Construction contract types span a wide spectrum ranging from traditional contracting to relational contracting modes. Although weak collaborative supply chain networks exist even in widely practiced traditional contract modes, the potentially beneficial strong relational forces remain untapped and/or fragmented, lacking well-defined common goals among stakeholders. Apart from addressing this shortfall in the built asset planning, design and construction (project management) phase, relational contracts (RC) can also be extended to total asset management (TAM) by aiming at the relational integration of all stakeholders throughout the built asset lifecycle, by engaging them in cross linked value networks'. Such integrated networks were called 'relationally integrated value networks' (RIVANS) when initially proposed for the project management phase. 'RIVANS for TAM' were next proposed to provide a holistic approach to bridge the project management phase and the asset management phase in the lifecycle of assets. The study reported in this paper, contributes to knowledge by identifying better values through adapting RIVANS as a holistic beneficial approach to the whole built environment

A questionnaire survey was conducted to identify common better values in RIVANS. These identified better values were then clustered to form similar groups using factor analysis to establish synergetic characteristics of RIVANS. Four characteristics were extracted to identify and target embedded synergies in RIVANS, for enhanced total asset management.

*Keywords:* Better Values; Characteristics; Relational Contracts; Relationally Integrated Value Networks; Total Asset Management.

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### BIM SOFTWARE ENVIRONMENT FOR PROJECTS IN SRI LANKA

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#### ABSTRACT

The term Building Information Modelling, or BIM, is not alien to Sri Lanka anymore; yet BIM has not become a reality in its construction industry. Being a BIM infant industry, Sri Lanka may wait a long time to adopt BIM by its own initiative. But the scenario will be different if a client demands for BIM. This creates the need that industry is aware of the best strategies suite them to effectively implement a project based on BIM. One of the key questions being asked is; what software should we use? In absence of empirical local knowledge, the only option is to device a solution from published knowledge. In order to achieve this, this paper presents a literature synthesis aimed to identify a suitable BIM software environment for Sri Lanka. By reviewing various aspects such as capabilities of applications, accuracy and sharing of data, information documenting, popularity of software and affordability against the technological aspects, a Plural Software Environment based on IFC data exchange was found to be the preferred solution for Sri Lankan context.

*Keywords:* Building Information Modelling; Software Environment; Sri Lanka.

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# CARBON LABELLING SCHEME FOR CONSTRUCTION PRODUCTS: THE BENCHMARK FOR LOW CARBON MATERIALS

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### ABSTRACT

Climate change has become a global threat with worrying consequences for many countries. Among various economic sectors, the construction industry consumes 40% of materials entering the global economy and generates significant amounts of greenhouse gases (GHGs) - the main cause of climate change. Particular attention should be attributed to the embodied carbon of construction materials as it could contribute to 70% of GHG emissions at the construction stage and up to 25% of a building's life time energy consumption. It is thus highly desirable to select and use low carbon construction products so as to minimise the GHG emissions arising from the construction industry. In view of this, the Construction Industry Council (CIC) in Hong Kong has initiated a Carbon Labelling Scheme for Construction Products as part of its mission to promote green building practices and sustainable development. This paper introduces the carbon assessment framework of the Scheme, including the product categorisation, principles and system boundary of carbon footprint quantification, benchmarking mechanism, and certification process. The paper also presents the methodology of developing a GHG quantification tools for assessing carbon footprint of products (CFP). As a voluntary scheme in Hong Kong, it aims to provide verifiable and accurate information on the carbon footprint of construction products for industry practitioners to select 'low carbon' materials.

**Keywords:** Carbon Footprint; Carbon Labelling; Construction Products; Sustainable Development.

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# CONCEPTUAL FRAMEWORK FOR UNDERSTANDING CONSTRUCTION PROJECT CULTURE: A LITERATURE REVIEW

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### ABSTRACT

Complex human behaviours and thoughts bound by the complex construction activities have made the topic "construction project culture" an ambiguous area in the construction management literature. Despite of a several few attempts, definition of the construction project culture still remains as an area to be unveiled. This paper attempts to provide a conceptual framework for understanding construction project culture by highlighting few questions to be answered in the process of defining a project culture. The initial question raised is; 'what cultural manifestations in deed represent construction project culture?' next; 'how does construction project culture exists: its structure?' and, finally: 'how does construction project culture emerges?'. These questions have been answered by an extensive literature review emphasising; underlying assumptions to give the true representation of construction project culture which is structured in sub-cultural groups that could be analysed in integrated, differentiated and fragmented perspectives and arguing its emergence to be with the project team efforts of answering internal integration and external adaptation problems of the project team itself. Further research of this paper will aim developing methodological frameworks to carry out empirical studies to answer the highlighted research questions and to bring empirical evidence to what the construction project culture is.

Keywords: Construction; Project Culture; Project Team.

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# CRITICAL ANALYSIS OF ALTERNATIVE DISPUTE RESOLUTION METHODS USED IN SRI LANKAN CONSTRUCTION INDUSTRY

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### ABSTRACT

Construction disputes are of highly technical in nature and in fact intensive and multifaceted than other commercial disputes. The litigation method is the traditional way of dispute resolution and drawbacks of litigation have opened up the 'Alternative Dispute Resolution' (ADR) methods. The desirable features of ADR methods are fast, inexpensive, flexibility, confidentiality, minimum delay. This research attempts to address the issues and conflicting areas of ADR methods in the Sri Lankan construction industry. Attempts have been made to identify and analyse problematic areas which are highly influencing the ADR methods. The aim of this research is to evaluate ADR methods and suggest improvements to the ADR methods in the Sri Lankan construction industry.

This research is the result of surveys that were conducted to understand the experiences and usages of ADR methods. Two rounds of Delphi method surveys were conducted in order to identify problematic areas of ADR methods. Fifteen problematic areas and twelve potential improvements of ADR methods were identified during the Delphi survey round one. They were prioritised during Delphi method survey round two. Semi-structured interviews were used to get the extended view of the panel on top eight issues which were ranked in Delphi round two.

A pivotal conclusion of this research is that the stakeholders in the construction industry prefer "negotiation" method. Usages and awareness about negotiation were highly appreciated by the construction industry professionals. Professionals had a low level of satisfaction on the current practice of arbitration. Overall expectation of the construction industry by application of ADR methods is to provide best solutions within a minimal time and without damaging the reputation of involved parties. It was revealed that construction industry expects quick remedy than the less cost solution. It further revealed that the stair-step model of dispute resolution strategy is the best. The research further makes recommendations in order to make ADR methods more effective and efficient.

**Keywords:** ADR Methods; Disputes; Potential Improvements; Problematic Areas.

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# CULTURAL CONTINUITY AS A VITAL FACTOR IN DELIVERING IDENTITY, MEMORY AND SENSE OF PLACE: A CRITICAL STUDY OF URBAN TRANSFORMATION WITH SPECIAL REFERENCE TO PETTAH IN COLOMBO

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### ABSTRACT

Most Asian cities are characterised by rapid urban metamorphosis and mostly the urban changes are based on planning mechanisms through spatial and land use methodologies and supported by globalization. In Colonial-contemporary cities, it is often seen that recent planning and development approaches undermine the cultural representation and memory of the place in their transformation process.

The study is scoped within the discussion of morphology, in relation to urban transformation and planning, in the context of urban settings (places) in Pettah, Colombo. It aims to re-examine cultural continuity in relation to the memory of a place in transforming urban settings. Methodologically, urban-cultural morphological study couples with spatial anthropology for field investigation and data transcoded into urban design planning schemata. Referring the literature on this subject area, certain parameters to measure the appropriate cultural transformation have been identified and the analysis of this situation is supported by the observations and personal communications.

The research has identified the socio physical and socio cultural relationships of transforming urban settings which are meant to be regeneration of built masses but, mostly the renovations for irreplaceable urban settings where people celebrate the sense of place.

*Keywords:* Cultural Continuity; Sense of Place; Spatial Anthropology; Sustainable New World Encyclopaedia; Urban Transformation.

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### DESIGNING A WHOLE-LIFE COST INDEX FOR NON-RESIDENTIAL BUILDINGS

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### ABSTRACT

The study investigates the whole-life costs of non-residential Green Mark certified building developments in Singapore to derive useful information for teaching, research and practice. When industry stakeholders like building owners, architects, engineers, quantity surveyors, builders and facility managers have detailed information about the initial and operating costs of different types of buildings, they would be able to apply whole-life costing to their existing or new projects with the intention of achieving value for money, as well as environmental sustainability. Data is collected from Green Mark certified building projects starting from 2005. Statistical analysis is performed on the collected data to generate the information required to build the cost database. The Paasche Price Index method is used to produce a weighted composite index for Singapore's non-residential building sector by applying 2005 as the base year.

**Keywords:** BCA Green Mark Scheme; Price Index; Sustainability; Wholelife Costs.

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# DEVELOPING A FRAMEWORK TO EVALUATE INDOOR ENVIRONMENTAL QUALITY (IEQ) PERFORMANCE OF INDUSTRIAL BUILDINGS IN SRI LANKA

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### ABSTRACT

Indoor Environmental Quality (IEQ) can be considered as one of the main measure of total building performance. Even though there are various methods to evaluate IEQ of buildings, it is evident that there is no holistic approach, which considers every possible parameter which results in a more pragmatic and operational, mechanism especially for industrial buildings. Similarly in Sri Lanka, there is no comprehensive framework applied in buildings to evaluate IEQ performance and the situation is same with other countries as there is less regard to IEQ factors in measuring building performance. The industrial buildings also lacks total IEQ performance methods being utilised, however there are few which are only based on IEQ measurements such as indoor air quality, thermal, acoustic and lighting comfort.

When considering the global view, are some evaluation methods or techniques which are being used. However for the industrial buildings there are no methods with a holistic approach. This creates the need to identify existing IEQ practices with respect to industrial buildings in order to develop a comprehensive evaluation framework for total IEQ performance of industrial buildings.

Therefore, this paper attempts to establish the indicators and sub indicators proposed for the framework to evaluate IEQ performance of industrial buildings based on preliminary investigation and literature survey as part of an on-going research project. The available IEQ techniques have been identified which needs to be validated in the next step of this research study.

**Keywords:** Building Performance; IEQ Indicators; Indoor Environmental Quality; Industrial Buildings.

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# DEVELOPING A TBPE SCORING FRAMEWORK FOR ASSESSING TOTAL BUILDING PERFORMANCE

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#### ABSTRACT

Building Performance Evaluation (BPE) has received an increasing attention over the past two decades among the researchers to provide a comfortable and stable internal environment to increase and provide a better human potential. To determining how well the facilities are performing in order to support the organisational goals and user requirement, it is vital to conduct regular building evaluations which provide the current status quo of the building. Aiming to this, there are various BPE approaches developed around the world, and as evidenced there are no in-depth studies on Building Performance Evaluation (BPE) in tropical countries to evaluate the building performance. However, adapting these approaches might not necessarily be applicable in the context of tropical countries due to geographical, climatic, cultural and other differences. This has been identified as the gap in this research and aimed to formulate a holistic Total Building Performance Evaluation (TBPE) scoring framework, for the assessment of performance of buildings. First, a comprehensive literature survey was carried out. This was followed by an expert survey to sieve out the most significant BP factors identified in the literature survey. With that detailed questioner survey was carried out proposing a TBPE scoring framework compromising total of two hundred and sixty five points to evaluate buildings with 7 criteria and 57 dimensions in which energy management, reachability to the building, occupational hygiene, thermal comfort, unit costs savings, load bearing capacity etc. had higher contribution in evaluating building with relation to tropical context. Finally, this paper readdresses the need of evaluating the buildings and suggesting the paradigm to evaluate the buildings in an objective manner.

**Keywords:** Building Performance; Building Performance Evaluation; Total Building Performance Evaluation.

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# DIFFERENTIATING GREEN BUILDINGS FROM CONVENTIONAL BUILDINGS: ENVIRONMENTAL PERFORMANCE PERSPECTIVE

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### ABSTRACT

In the current situation, where people concerns about sustainability environment, building occupants seek to be comfortable and productive in their workplace. Occupants with local control over their environment generally have an improvement in their work effort and productivity. However, work productivity of occupants can be de-motivated and interrupted due to poor environmental conditions. Thus, the intervention to ensure a healthy working environment should always be the first step towards improving productivity. In the governing concern on improving occupant's working environment, Green Building movement is fast becoming a necessity. It is therefore impressive that there is already emerging national consensus on the definition of a green building and a rapidly increasing number of green projects in both the public and private sectors. Green buildings can be defined in various ways however, giving definition compared to 'conventional' buildings is a supplementary problem. There is no doubt that the term has a very positive connotation. Further, green buildings generate lot of benefits to people and the environment. However, no evidence that the level of occupant comfort and satisfaction are greater in 'green' rather than conventional buildings.

Hence, this study was aimed to identify facts for differentiating green buildings from conventional buildings in terms of environmental performance. The available literature was reviewed and preliminary investigation was conducted in selected green rated and non-green buildings. The indoor environment quality criteria which is developed based on GREENSL® rating system was evaluated in selected buildings to identify differences between green and conventional buildings. According to the results of literature survey and preliminary investigation, green buildings showed high environmental performance compared to conventional buildings in terms of indoor air quality, thermal comfort and lighting quality whilst there was a less satisfaction with acoustic comfort in green buildings. However, the success of green buildings depends on the quality and efficiency of the installed green systems. The rating system can be used as the common language and standards of

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measurement to define green buildings, differentiating from conventional buildings.

*Keywords:* Conventional Building; Environmental Performance; Green Building; GREENSL® Rating System.

### EFFECTS OF VARYING RECYCLED FINE AGGREGATE CONTENT AND WATER/CEMENT RATIO IN BEDDING MORTAR

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#### ABSTRACT

This paper presents the results from a research carried out with the aim of analysing the usability of Recycled Fine Aggregates (RFA) produced from Construction and Demolition Waste (CDW), in bedding mortar. Properties of RFA were compared to that of the Natural Fine Aggregates (NFA) in terms of Bulk Density, Fine Fraction, Particle Size Distribution, Water Absorption and Chloride Content and were tested for five mixed proportion scenarios of RFA and NFA at 0%, 25%, 50%, 75% and 100% RFA contents, RFA indicated a water absorption of 6.33% when compared to that of 0.71% for NFA (ordinary river sand). Mortar testing was further divided under three water/cement ratios at 0.5, 0.6 and 0.7. Bulk density gradually decreased with increased RFA content yet recorded an exceptional highest of 1476Kg/m3 at 75%RFA. Results from fine fraction and particle size distribution indicated compatibility of RFA to replace NFA up to 50% RFA. Chloride content analysis indicated allowable RFA replacement levels up to 99% and 44% for bedding mortar and plastering mortar applications, respectively. Though higher water absorption demanded for higher water content, Compressive Strength increased with the increasing RFA content, even above NFA values, reaching a maximum of 15.2 ± 0.50 N/mm2 at 75% RFA for 0.7 water/cement ratio while workability was within the acceptable range at 50% RFA at the same water content. The analysis in terms of fine aggregate properties and mortar properties showed that up to 50%. NFA can be substituted with RFA at water/cement ratio of 0.7 in bedding mortar which will also attribute to a cost reduction of minimum 50%, as well as to greatly reduce the disastrous environmental impacts from sand mining and waste disposal thus enhancing sustainability.

**Keywords:** Compressive Strength; Construction and Demolition Waste (CDW); Workability.

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# ENHANCING THE VALUE IN CONSTRUCTION VIA INTEGRATION OF SUSTAINABLE CONSTRUCTION TO VALUE PLANNING

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### ABSTRACT

Sustainable Concept (SC) has shed a spotlight towards the rapidly developing construction sector since concerns on SC principles are widely emerged recently which focused to ensure both present and future generations a good quality of life. Currently Sri Lanka is on construction boom which feeds the requirement of establishing sustainable concept to the construction projects. This paper aims to investigate the current situation of Value Planning (VP) and SC in local construction sector and to present a framework for integrating concept of value for money in sustainable construction.

A comprehensive literature survey was carried to observe the existing knowledge on SC and VP concepts to develop a conceptual linkage between the two disciplines. This was followed by an expert semi structured interview survey among experts having considerable knowledge on both aspects to ascertain the current situation of those concepts in Sri Lankan construction industry. Findings of the research revealed that the application, knowledge and experience of experts are not satisfactory in both of these concepts. It is established that there is a huge requirement of applying these concepts in local construction projects. In order to overcome the issues identified, a Framework has been developed to integrate SC and VP in Sri Lankan construction projects.

**Keywords:** Infrastructure Projects; Sri Lanka; Sustainable Construction; Value.

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### ENVIRONMENTAL MANAGEMENT SYSTEM (EMS) PLANNING IN MANUFACTURING: FACILITIES MANAGEMENT PROSPECTS

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#### ABSTRACT

The increasing consciousness of sustainable development and reconciling production with ecosystem conservation have fostered the adoption and implementation of Environmental Management System (EMS). This study investigates the process and factors that affect in EMS planning. Previous research mainly focuses on environmental management practices and its performance towards different sectors. It was identified that minimum attention is given to planning of EMS at corporate level. Thus, this study explored the corporate EMS planning process in Sri Lankan manufacturing industry. This is an area where facilities managers can contribute in manufacturing facilities. This paper reports on case studies of three private sector manufacturing industries. which were using up to date environmental management practices. Data was collected by interviewing three participants from each of selected manufacturing firms. Based on the case study findings, a framework was developed for EMS planning. This includes six stages starting from strategy formulation to system implementation and evaluation. The developed framework will lead to an effective EMS planning practice that could be used in Sri Lankan manufacturing industry.

Keywords: Corporate Environmental Management; Environmental Management System; EMS Planning; Manufacturing Industry; Sri Lanka.

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### EQUIPMENT SELECTION FACTORS OF INTEGRATED BUILDING MANAGEMENT SYSTEMS (IBMSS) IN SRI LANKA

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### Abstract

Management of facilities has become a complex task involving multitudes of disciplines. With increased awareness for efficient building operation. building owners and operators are looking for means to reduce the operational cost and to ensure the proper functionality of buildings and building services. To manage an organisation in an effective and costefficient way, these systems can be integrated into a single interface control solution called Integrated / Intelligent Building Management System (IBMS). Hence, in an intelligent building, IBMS acts as a complete information delivery system that monitors and controls a variety of mechanical and electrical systems and equipment such as such as lighting, Closed Circuit Television (CCTV), access control, fire detection, air conditioning, water management, elevator management, cark park management, etc. at an optimal level of efficiency. However, building systems and the equipment for the IBMSs should be carefully selected as those components have major contribution towards the overall performance of an IBMS. Hence, this research was carried out with the aim of investigating the factors that should be considered in selecting systems and equipment for IBMSs. A comprehensive literature survey, a preliminary survey and case study method was adopted to achieve the aim of the research. The required data were collected through semi structured interviews conducted among IBMS contractors of selected cases. The collected data were analysed, using code based content analysis. According to the findings, 'higher efficiency', 'cost, 'improved safety' and 'enhanced reliability' are the four major factors that should be considered in system and equipment selection. With the high demand and awareness of IBMS, it is fast becoming a part of facilities management and operational strategy in the organisations. Therefore,

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the careful consideration of above selection factors in designing would ensure the maximum performance of the IBMS.

*Keywords:* Integrated Building Management System (IBMS); Sub Systems and Equipment; Present Status; IBMS Selection Factors; Sri Lanka.

### ESTABLISHING A POSITIVE SAFETY CULTURE IN RUBBER MANUFACTURING SECTOR: HUMAN FACTORS

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### ABSTRACT

Safety and health in the rubber products manufacturing sector has been a neglected subject, though this sector is still a major foreign exchange contributor to the national economy in Sri Lanka, with significant contribution of Rs 72.3 billion in 2008. The rubber industry in the Sri Lanka employs many thousands of people and as it is a heavy industry, it poses a number of safety and health risks to workers employed in that sector. Occupational safety and health concerns in rubber manufacturing facilities have always been and continue to be of the utmost importance. Often the impact of serious workplace injuries overshadows the damage associated with illnesses which may be linked to workplace exposures. Thus, establishing of a positive safety culture is most critical in rubber manufacturing environments with a high risk of health and safety concerns. The cause analysis for failings related to safety culture in rubber manufacturing sector are varied and far reaching; with each issue coming into play at one critical point in time. However, these weaknesses include human and other factors such organisational, systems and processes etc. where majority of failures come under the category of human factors. Thus, understanding of these human aspects is crucial to establish and nurturing a safety culture that suits the organisation and the individuals within it. This paper therefore aims to investigate human factors which contribute towards establishing a positive safety culture in rubber manufacturing sector.

A comprehensive literature review and preliminary study were used as the research methodology for this paper. Key words; safety culture, definitions of safety culture, components of safety culture and way to establishing a good safety culture in rubber manufacturing sector were used to search the literature. Further, semi structured interviews were carried out with the industrial experts who are in charge of the concerned areas and with few shop floor level workers who are directly involved in production process. Research findings illustrated that yet, like in any other employment sector, workers in the rubber industry run an equal if not higher risk of being injured as a result of the type of work they do. Due to management and worker ignorance and rubber products manufacturing chemicals and bad work practices in some factories, serious hazards have been created and many accidents have occurred.

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Research findings illustrated that establishing a positive safety culture is about more than removing hazards and institutionalising safety procedures. It is about working with people of the organisation to change their attitudes, behaviours and thoughts, and improve their situational awareness. Research findings further illustrated that two key aspects under human factors to be considered when developing a safety culture in this sector namely; Psychological aspects and Behavioural aspects. These two aspects are inter-related where if something happens in one aspect it will influence the other aspect. Thus, each organisation needs to consider these aspects in establishing a positive safety culture that suits the organisation and the individuals within it. The finding of this research will be a guideline to propose a better working condition so that the safety culture can be created.

Keywords: Human Factors; Rubber Manufacturing Sector; Safety Culture.

# ESTABLISHING AN INTEGRATED MODEL FOR MEASURING THE SITE SAFETY PERFORMANCE OF CONSTRUCTION PROJECTS: LITERATURE REVIEW AND FUTURE RESEARCH AGENDA

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### ABSTRACT

Safety issues have always been a major problem besetting the construction industry in many countries because of the hazardous nature and complexity of the work. Previous government statistics have manifested that the highest number of accidents and fatalities are found in the construction industry when compared with other major industry sectors throughout the world. In Hong Kong, the construction industry is also regarded as high-risk. There are different construction site safety assessment methods proposed by some researchers. However, there is a lack of holistic assessment model for site safety performance of construction projects. In this study, the essential factors needed for safety assessment and their associated sub-factors are those which affect the level of safety performance. This paper aims to put forward a research framework for developing a holistic site safety assessment model for new construction projects in Hong Kong using the Delphi survey technique. It will be a multi-factor model where the core factors are expressed both in broad terms and as finer, more detailed, sub-factors. Successful development of the site safety assessment model can then enable the setting up of a benchmarking tool for measuring and comparing the overall safety standards of the various construction projects within an organisation, between organisations and within the construction industry as a whole leading to an improved site safety culture.

**Keywords:** Factors Affecting Site Safety; Hong Kong; Research Framework; Safety Performance; Site Safety Assessment Model.

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### FACTORS AFFECTING CONSTRUCTION COSTS IN SRI LANKA

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#### ABSTRACT

This study identifies severe cost factors that define the construction project cost in order to reduce costs and cost overruns in public sector building projects. A comprehensive literature survey was followed by two rounds of Delphi surveys to extract a set of exclusive cost factors and their levels of importance with the participation of a panel of 30 experts. Severity index (to rank the cost factors according to the importance), correlation analysis (to check the agreement between the parties), cross tabulation (to identify the linear relationships between the collected data) and hypothesis testing (to prove the agreements between the parties and to check the confident levels) were used to analyse the data.

According to the research study findings, 44 cost defining factors were identified for the public sector building projects. Further, the differences in perspectives upon significance of cost factors by the direct stakeholders of construction industry were also identified. Most significant cost factors were identified as; cost of materials, size of the projects, projects planning and the complexity of projects. Further, factors were categorised in to the five main categories. Construction parties' related factors contributed to the costs by 21%. Construction item related factors contributed to the costs by 20%. Environmental factors contributed to the 18% while political factors affecting to construction costs by 19%. Most significant cost factors of each category were identified separately and a guideline was formed to help minimize building construction cost in Sri Lanka leading to a better sustainable construction practice.

Keywords: Building Projects; Direct Stakeholders; Public Sector.

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### FACTORS AFFECTING THE PSYCHOLOGICAL HEALTH OF FOREIGN WORKERS IN THE SAUDI CONSTRUCTION INDUSTRY

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#### ABSTRACT

The Saudi construction industry is considered as the fastest growing and largest sector in the Gulf region with ongoing construction projects valued at US\$475 billion. The booming construction sector in Saudi Arabia portrays a positive impression. However, the occupational health and safety (OHS) situation paints a different picture. Particularly, the psychological health of foreign workers is at a great risk due to the unfavourable work conditions they are faced with. The OHS related studies conducted in this region so far have focused on technical, managerial and physical aspects of safety and have neglected the psychological health of foreign construction workers. This indicates an urgent need for research into this area. Hence, this research explored what factors affect the psychological health of migrant workers in the Saudi construction industry. An interview survey with 30 experts from the Saudi construction industry and other relevance sectors were conducted. A thematic analysis of the data collected from the interviews identified several critical factors that affect the psychological health of foreign construction workers, including: low wage; delay of payment; withholding workers passports; mistreatments by supervisors; long shifts without breaks; lack of vacations; poor accommodations conditions; and disregard for mental health of workers. The study lays the foundation for establishing a mechanism to combat the factors that deteriorate the psychological health of foreign workers in the Saudi construction industry.

**Keywords:** Foreign Construction Workers; Occupational Health and Safety; Psychological Health; Saudi Arabia.

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### FACTORS INFLUENCING SAFETY BEHAVIOURS OF CONSTRUCTION WORKERS

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#### ABSTRACT

Construction industry is known to be one of the most accident-prone of work sectors around the globe. Although the construction output is less in Sri Lanka, compared to developed countries in general, the magnitude of the accident rate in the construction industry is still significantly high. Most of the occupational accidents are due to the unsafe behaviours of the worker. Thus, studying the people factor in OSH is an effective way to manage OSH at work sites. The paper therefore focuses to investigate and prioritise the factors affecting construction workers' safety behaviours.

The study was structured in several steps. Initially in-depth knowledge gained regarding the research stream which was sorted upon the degree of relevance to the study. A total of 18 factors affecting construction workers' safety behaviours were identified through an extensive literature survey. Data collection was carried out through a survey which consisted of two rounds. The first round was conducted to validate the factors found in literature; to the Sri Lankan context and in the second round, experts were asked to rate those factors according to their degree of influence. Experts' rankings were used to calculate the Mean Score of Influence (MSI) of each factor and according to the MSI values, the factors were prioritised.

Findings of the study revealed the most influencing personal factor was age while the most influencing organisational factor was OSH incentives. The least influencing factors were work-mates' safety concern and provision of PPE respectively under the categories, personal and organisational. These findings could be helpful in better understanding the construction workforce and in designing OSH systems for the construction industry.

**Keywords:** Construction Industry; Construction Worker; Occupational Safety and Health; Safety Behaviours.

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# FACTORS THAT INFLUENCE THE FORMATION OF CONSTRUCTION PROJECT TEAMS FOR SUSTAINABILITY: CONSIDERATION OF SPECIFICITY

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#### ABSTRACT

The importance of effective multi-disciplinary organisational teams has been a central aim of management research in the construction industry for over 50 years. As design and construction processes are reconsidered to include sustainability there is a need to consider procurement approaches which facilitate more effective coordination between supply chain partners. Such procurement approaches require a strong theoretical basis and also need to consider parties other than the client, design team and contractor. This paper reports on ongoing research about the factors that influence the formation of construction project teams. The focus of the study was how buying organisations' collaborative procurement strategies interact with a range of specialised trade contractors and to identify those factors which affect their selection during the project development. The theoretical basis for the study was adapted from transaction cost economics and the research strategy was mixed. This paper reports upon the quantitative second phase which used a survey of 570 professionals working for UK contracting organisations. The findings of the research suggest a future approach is required which seeks to increase the specificity of trade contractors to the developing project which will facilitate an improvement in knowledge transfer relating to alternative low carbon approaches to design and construction.

Keywords: Knowledge Transfer; Supply Chain Integration; Sustainability.

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# IDENTIFICATION OF ERRORS THAT ARE BEING MADE IN PREPARING BOQS IN SRI LANKAN CONSTRUCTION INDUSTRY

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### ABSTRACT

The Bill of Quantities (BOQ) is a vital document in both pre contract stage and post contract stage of any construction project. The BOQ impacts three important aspects of a project namely time, cost and quality. Therefore, it is crystal clear that if there is any error in BOQ that would directly affect to the construction project. Since all the stakeholders involved in construction projects are extremely concerned on time, cost and quality aspects, it is critical that the BOQ for the project is error free.

Errors occur during both preparation stage and pricing stage of the BOQ. The BOQ preparation errors may relate to pricing errors as well as have an impact on the time, cost, and quality of the project. However the study is focused on identifying most common BOQ preparation errors and find solutions to minimise those errors to support sustainable procurement practice. Initially a semi structured interview was carried out to identify errors made in preparing BOQs and find reasons for the errors. Eventually, a questionnaire survey was done to identify the most significant errors that are made and how those errors would affect the project.

The surveys revealed that quantity errors as the most common error during the BOQ preparation stage, which becomes critical based on the type of the procurement method adopted. Employing experienced person as a reviver was identified as the most preferable solution for minimising preparation errors. Further it was found that people involved have a greater impact on the BOQ preparation process and its accuracy.

Keywords: Bill of Quantities; Cost; Errors; Quality; Time.

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### IMPACT OF AESTHETIC APPEARANCE TO FACILITATE CORPORATE BUSINESS OBJECTIVES IN ORGANISATIONS

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### ABSTRACT

Aesthetic appearance is a judgment of value based on the appearance of an object. Shapes, proportions, rhythms, scale, degree of complexity, colours, and illumination are the subject matter of formal aesthetics. Aesthetics appearance is an important field in psychology as aesthetics influences the human mind and can lead to psychological reactions, both positive and negative. Creating an aesthetically distinctive identity of development will become an integrated part of the community because user's state of mind and feeling affected by the emotional elements in design. However, this area has not been addressed in detail. Thus, this research focused to identify and analyse parameters of aesthetic appearance of buildings and their impact towards corporate business objectives of commercial organisations.

The research used case study approach and two commercial buildings were selected as cases. Data were collected using semi structured interviews. Data analysis was done using content analysis. Five parameters were established to analyse the aesthetic appearance. Findings revealed that all forms and elements of aesthetic appearance are full of potentially symbolic meanings and have considerable impact on corporate business objectives. Though, there are considerable aesthetic applications as mentioned above, still there are substantial deficiencies in current practices of adaptation of aesthetical appearance for building design in Sri Lankan context.

*Keywords:* Aesthetic Appearance; Business Objectives; Facilities Management.

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### IMPLICATIONS OF INSUFFICIENT AWARENESS OF STATUTORY REQUIREMENTS FOR BUILDING CONSTRUCTION ON CONSULTANT TEAM OF BUILDING CONSTRUCTION PROJECTS

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#### ABSTRACT

All over the world, the construction industry is inherently subjected to a wide range of statutory requirements which are empowered by various bodies. Though, it is vital to comply with these statutory requirements, the rate of non-conformity is still high in the Sri Lankan construction industry giving rise to punitive actions, cost increases and overruns of project schedules. The researchers assume that either insufficient or lack of awareness of statutory regulations among members of construction consultant team is the main reason for this state of affairs.

The present study therefore focuses on identifying the substantial statutory requirements laid by the Urban Development Authority, Sri Lanka, vis-à-vis building construction in the Colombo Municipal area and their implications for construction consultant team such as Architects, Quantity Surveyors and Engineers, who may be unaware of the existence of such statutory requirements. Accordingly, the research was approached through a document survey and semi-structured interviews respectively. The gathered data was subjected to a content analysis based on the findings of which conclusions were drawn regarding implications and possible strategies to address the perceived problems.

The research reveals that the City of Colombo Development Plan 1999 and its amendment in 2008 with regard to zoning regulations are the twin sources of statutory requirements that are applicable for the Colombo Municipal area. They lay down the zoning regulations, planning regulations, building regulations, and required development guide plans that should be considered by architects and specify the statutory requirements relating to sanitation, mechanical ventilation and airconditioning that engineers should adhere to when undertaking constructions in the area of the Colombo Municipal Council. The study findings also show how an understanding of Urban Development Authority regulations would help quantity surveyors to discharge their role as a

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member of consultant team better. On the basis of its findings, the study proposes strategies that could be implemented in order to overcome the identified problem of unawareness of statutory regulations in relation to the members of consultant team.

**Keywords:** Building Construction; Colombo Municipal Council Area, Sri Lanka; Design Professionals; Implications; Statutory Requirements; Urban Development Authority.

### INTEGRATED APPROACH FOR FUTURE SUSTAINABLE URBANISATION

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#### ABSTRACT

Maharashtra's urban communities are facing demographic, cultural and environmental challenges typical of many other urban communities across India. Increasing population, pressure on infrastructure, increase in migration and changes in social habits has affected many cities of Maharashtra; this change has been accompanied with stigma and neglect, all representative of the relative inflexibility of the urban form. A research study is conducted on sustainable community design and ideal residential housing from a global perspective in order to accumulate new insights and technical expertise that can be utilised in developing future urban settlements of Maharashtra.

The purpose of the study is to create a flexible set of guidelines that account for variability. It allows users to determine intervention points through condition resolution. This study illustrates how stated explicit infrastructure objectives can be translated into design interventions in a variety of conditions and multiple scales. In addition to outlining techniques and intervention points, the study also includes few permutations of how these techniques could be synthesised and employed at the neighbourhood scale.

As part of our overall approach to the study, following principles for design, planning, and development of urban communities are addressed in the study; Integrated infrastructure system, Energy efficiency, Waste water management, Balanced habitat, Sustainable community, etc.

**Keywords:** Ecological; Energy Efficiency; Future Urban Communities Sustainable; Integrated Infrastructure Systems.

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### INVESTIGATING CURRENT CONSTRUCTION WASTE MANAGEMENT PRACTICES IN SOUTH AUSTRALIA: A PRELIMINARY STUDY

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### ABSTRACT

The construction industry has been found to be a major generator of waste and the management of construction waste has become a pressing challenge. Due to persisting beliefs that construction waste generation is unavoidable and zero waste is not achievable, researchers have proposed different methods of waste management such as sustainable waste management, integrated waste management, holistic waste management and the waste management hierarchy during past decades. However, when it comes to the Australian context, construction and demolition waste contributes around 25.8% of overall landfill. Therefore, this research aims to identify current construction waste management practices in South Australia in order to find ways to improve them. Sixteen face to face semi-structured interviews were conducted covering major stakeholders in construction projects who had a minimum of ten years' experience in the construction industry and a minimum five years' experience in waste management. The findings reveal that while industry is going through a transition with regards to waste management, waste management practices vary from organisation to organisation. Site space was described as the main limiting factor to implementing onsite waste management practices and it was suggested that waste management should be an important part of project planning. Interviewees indicated that even though there are programmes like Green Star which aim to encourage recycling and waste minimisation; waste management was neglected in the design process. Findings also reveal the urgency of changing attitudes and behaviours towards waste and the importance of considering waste as a resource to encourage improvements in waste management practices. Issues associated with costs and financial management were highlighted as key in determining waste management practices. As such the findings of the study also point to the importance of considering systemic issues of political economy and how they impact on waste management practices.

*Keywords:* Construction Projects; Solid Waste; South Australia; Waste Management.

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# KEY CHALLENGES IN CONDUCTING DEVELOPMENT APPRAISALS IN SRI LANKA

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### ABSTRACT

Property development is an activity constituent with both huge returns and risks. Development appraisal is a method, primarily used to check the financial viability of a property development project. In Sri Lanka, it is known as feasibility study. Several development appraisal techniques are practised in association with risk analysis methods in the Sri Lankan property market. Development appraisal is subjected to many variables and therefore it is a challenging task. This research investigates the challenges in conducting development appraisal and suggests ways of resolving such challenges.

Survey approach with 32 sample questionnaires was adopted in investigating the research problem. The Relative Important Index was used to rank the challenges based on the magnitude and significance of challenges. The research found that discounted cash flow method is being used extensively in Sri Lanka. Top ranked key challenges are client's influence and estimating the variables. The research suggested carrying out detailed market survey to obtain relevant data, maintaining internal building cost database and practicing risk analysis techniques to overcome the challenges. Therefore, the research recommends that a Quantity Surveyor who involves in development appraisal could provide building, and determine the timing of cash inflows and outflows during construction period.

*Keywords:* Appraisal; Challenge; Development; Feasibility Study; Sri Lanka.

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# LIFE-CYCLE ASSESSMENT FOR CONSTRUCTION PROCESSES IN BUILDING CONSTRUCTION: A PROPOSED CONCEPTUAL FRAMEWORK

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#### ABSTRACT

Life Cycle Assessment (LCA) is a powerful tool which can be used to analyse the environmental effects associated with buildings. Even though there are numerous LCA studies carried out on buildings only a handful of studies have concentrated on the construction phase of buildings. The few studies that have considered the construction phase have been reluctant to investigate commercial buildings largely due to lack of data. Most of the studies either ignore or approximate the effects of the construction phase, stating the insignificance of them compared to the total environmental impacts of a building over its life cycle. Many studies have concluded a total effect of 3 to 11 percent in the construction phase compared that to the total effects. However, the large impacts at an aggregate level that would concern the designers and the builders have been ignored by these studies. Thus this paper attempts to comprehensively analyse the significance of the construction phase and suggest a methodology for analysing the environmental effects in the construction phase of a building. The outcome of this paper would provide a guideline for the researchers to concentrate on the construction phase in their analyses.

**Keywords:** Buildings; Construction Management; Construction Process; Environmental Emissions; Life Cycle Assessment.

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### LIVING IN LOW INCOME CONDOMINIUMS: END USERS' PERSPECTIVES

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#### ABSTRACT

The demand for low income condominiums in the city of Colombo has gradually increased in the past few decades in order to provide accommodation for low income earners and resettlement of shanty dwellers with the upsurge of land values in urban areas. Living in a condominium is considerably different from living in a sovereign house. In a condominium, personal ownership is limited to interior of the unit and requires sharing responsibilities with all the unit owners for the exterior of the complex. Identifying the issues in condominiums which have been designed for the low income community is essential to provide better living environment. Thus, it is vital to identify the satisfaction level of occupants who are settled in low income condominiums with respect to their living condition. Therefore, this study aims to fill the existing research gaps by investigating the existing living condition of condominiums which designed for low income families in terms of user satisfaction. First, a literature survey was carried out. This was followed by a comprehensive questionnaire survey as the data collection technique. Data were collected addressing the satisfaction on living condition under five main areas namely; social condition, facilities availability, management and maintenance of facilities, design and construction, and legal aspects. The results were analysed calculating the percentage values of each aspect. It was identified that 12% of occupants were only satisfied with the social condition in condominium living. In terms of satisfaction level on facilities availability, electricity, telecommunication and water received the highest percentage that is 65%, 62% and 57 % respectively. Moreover, the survey results show that occupants are dissatisfied with quality of construction work, maintenance and management aspects. Less awareness about the legal aspects was another issue among the occupants. Finally, this study suggested conducting post occupancy evaluation will provide stable and sustainable environment for future condominium developments.

*Keywords:* Condominiums; Living Condition; Low Income Families; Satisfaction Level.

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### MARKET FEASIBILITY AND PRACTICABILITY ASSESSMENT OF RUBBERISED BITUMEN FOR SRI LANKAN ROAD PAVEMENTS

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### ABSTRACT

Conventional Bitumen (CB) has limitations in Sri Lankan context due to its tropical climate, as CB's low stiffness modulus, low softening point, low viscosity, high temperature susceptibility and poor cohesion properties are aggravated in this environment. This leads to cracks on the road surfaces, which subsequently leads to surface failure because of frequent heavy rains in the region. Therefore, to avoid the adverse properties of CB, the technical feasibility of modifying bitumen with natural rubber and crumb rubber has been studied recently. However, the question remains whether these options are economically feasible in the Sri Lankan context.

This paper presents a study which was carried out focusing the above issue. The study was carried out based on a preliminary literature review on the use of Natural Rubber Modified Bitumen (NRMB) and Crumb Rubber Modified Bitumen (CRMB) to identify technical feasibility and impacts, and an expert opinion survey with academic and industrial experts in the Highway field to identify the impacts.

These impacts were identified in three categories, i.e. Economic, Social and Environmental. Comparing the economic impacts and lifecycle cost aspects it was concluded that NRMB and CRMB are more economically feasible over CB. Moreover, during the study NRMB and CRMB were found to be more environmentally and socially feasible as well. CRMB further provides additional benefits as it uses recycled rubber, which in turn reduces environmental and social issues created by waste tyres. Furthermore, CRMB has a lower cost of modification compared to the NRMB. Owing to these aspects and the prevailing market situation, it was concluded that CRMB is more appropriate to Sri Lanka.

**Keywords:** Conventional Bitumen; Crumb Rubber Modified Bitumen; Economical Feasibility; Natural Rubber Modified Bitumen.

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## MEDIATION AS AN ALTERNATIVE DISPUTE RESOLUTION METHOD IN SRI LANKAN CONSTRUCTION INDUSTRY

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#### ABSTRACT

Litigation is a traditional mode of dispute resolution; disadvantages of litigation have paved the way for the development of 'Alternative Dispute Resolution' (ADR) methods for settlement of construction disputes. Mediation can be identified as commonly practicing ADR method in international construction industry. However, the current experience of mediation method in the Sri Lankan construction industry is not that much popular with compared to the other ADR methods. Hence, it is essential to review the suitability of mediation method for resolving disputes in the Sri Lankan construction industry. Literature review was done together with the preliminary survey for the collection of information. Research problem was approached through interviews of experts in the construction dispute resolution. Findings of the research identified the mediation process, advantages, disadvantages, barriers for the implementation of mediation method and best ways of establishment by overcoming the barriers. Results of the research indicate the process, practice and establishment of construction mediation is suitable for the Sri Lankan context. Further, this research is limited to the evaluating the suitability of mediation only in resolving construction disputes in Sri Lanka. Data and information collection were limited to the experienced ADR practitioners who having analytical knowledge in mediation practice. It further revealed that the mediation method for the dispute resolution in the construction industry is suitable. The research further makes recommendations in order to make mediation method more effective and efficient in the Sri Lankan construction industry.

**Keywords:** ADR Methods; Construction Industry; Dispute Resolution; Mediation.

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### MERGING ACADEMIC RESEARCH AND CONSTRUCTION INDUSTRY DEVELOPMENT REQUIREMENTS: A CONCEPTUAL FRAMEWORK

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### ABSTRACT

Academic research in built environment consists of cognitive and affective, as well as behavioural components. There is a broad consensus in the literature that successful communication between researchers and research users is crucial for the effective utilisation of research in decision-making in policy and practice. It is argued that academic researchers and the construction industry practitioners do not collaborate closely in construction sector. The need for sharing knowledge between research institutions and industry has become increasingly evident in recent years. Therefore this study aims to uncover the strategies in merging academic research with industry development requirements where this paper presents the literature review findings in a form of a conceptual framework. The importance of transfer, barriers for transfer and way forward for both academia and construction industry is presented within the framework with highlighted inter-relationships. The framework will be developed into a model after analysing findings of a field study which is to be conducted in the future with the use of Delphi technique. In that, the model will be validated with an expert survey where the panel includes both the academics and industry practitioners. Results of the study therefore are expected to serve both academia and industry in merging their interests towards the development of the sector.

**Keywords:** Academic Research; Barriers: Construction Industry; Importance; Way Forward.

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# OPERATIONAL GAP ANALYSIS OF FIRE SAFETY APPLICATIONS IN SRI LANKAN HIGH-RISE BUILDINGS

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### ABSTRACT

Life style confined with working and living in high-risers is a new concept to the Sri Lankan context. Scarcity of lands and urban development with the economic growth has accelerated the growth and popularity of tall and complex buildings in Sri Lanka. As such, in the conceivable future too, the progress of construction industry is likely to be dominated by high rise buildings. Fire safety is the most critical component within any type of building. High-rise buildings involve high-risk in fire emergencies due to the combination of three risk factors, which are high population density and various levels of mobility, design configuration of high-rise buildings, and excessive amounts of fuel load. The consequences of high-rise fires include the fatal and serious injuries to occupants, damage or loss of property and severe interruption to normal business activities. Hence, it is clear that significance attention on the fire safety is necessary to continue the operations of a building. Accordingly, this study aims to analyse the operational gaps in the fire safety applications in Sri Lankan high-rise buildings.

Case study method was selected as the most suitable research method for this study as it can be applied to explain presumed casual links in real life interventions. Furthermore, the primary source of data was collected through semi-structured interviews among professionals who involved with the fire safety management in Sri Lankan high-rise buildings. Data were analysed adopting content analysis. The research findings revealed that, in Sri Lankan context organisations were endeavouring within the bounds of possibility to fulfil the minimum requirements. Nevertheless, there is no considerable attention has given to achieve the acceptable standard for fire safety. Those differences were identified as operational fire safety gaps in high-rise buildings. Key reasons for the malpractices are inefficient fire safety systems, lack of knowledge and commitment of the management, design failures and lack of government's commitment. Therefore, organisations need to adopt a measured approach to minimise the gap and to achieve the acceptable standard.

Keywords: Fire Safety; High-Rise Building; Operational Gap Analysis.

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## PROJECT MANAGEMENT CHALLENGES IN IMPLEMENTING FOREIGN FUNDED WATER SUPPLY AND SANITATION PROJECTS IN SRI LANKA

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#### ABSTRACT

National Water Supply and Drainage Board (NWSDB) is the principal authority providing safe drinking water and facilitating the provision of sanitation to the nation. Therefore, it is the responsibility of the NWSDB to ensure that the projects undertaken be completed within the prescribed period of time and budget to the prescribe quality in order to assure quality water and an uninterrupted availability of water supply.

Most water supply and sanitation contracts do not meet set cost or time targets as a result of improper assessment of project management challenges. The majority of time and cost overruns are attributable to either unforeseen or foreseen project management challenges for which uncertainties were not properly accommodated. The normal practice is not to have proper review or retrospect at the end of the projects. However, the project management challenges still prevail in the industry as lessons learned but as tacit knowledge.

Identification of the project management challenges was done through a comprehensive literature review and a questionnaire was developed to assess the importance and the severity of the effect of each challenge. Relative importance of the challenges were identified analysing the collected data.

The key project management challenges in implementing foreign funded water supply and sanitation projects are related to human resources and should be addressed as a developing nation. National policies shall be introduced, modified, altered and diversified towards building skilled human resources, which is the demand of the future world.

Additionally, findings will provide an opportunity to both the NWSDB and the contractors to forecast possible critical scenarios and identify common pitfalls so as to eliminate the avoidable and highlight them to the management to avoid recurrences of such phenomena.

*Keywords:* Human Resource; Project Management; Project Management Challenges; Water Supply and Sanitation.

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### PROJECT MANAGEMENT DASHBOARD OVER PREVAILING TOOLS AND SOFTWARE: A STUDY ON ADDRESSING NINE KNOWLEDGE AREAS

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### ABSTRACT

Construction projects represent unique and immensely complex array of interdependent activities that must take place to accomplish project goals. Thus, the nature of construction projects reasoned to complications and ambiguities in the construction process demands the need for Project Management (PM) to fruitful completion of projects. Construction PM uses a range of tools and software to assist the accomplishment of PM knowledge areas which define the critical constraints of a project such include the management of time, cost, quality, risk, integration, scope, communication, procurement and human resource. However, the selection of convenient PM tools and software which fulfil critical requisites in construction projects is problematic. Project Management Dashboard (PMD) is one of PM tools, which contains a variety of quality based project tracking and control metrics. Though PMD is widely practiced in other industries, a lacuna existed under the Sri Lankan construction context.

Hence, this study intended to assess the fulfilment of nine PM knowledge areas by PMD over prevailing PM tools and software. Thus, a hybrid survey approach, including questionnaire survey and the expert interview survey was conducted among PM professionals due to the fact that positivism in the research philosophy. The questionnaire survey analysis emphasised the ineffectiveness of most commonly used PM tools and software in fulfilling critical PM necessities and affirmed that an individual tool cannot effectively address on crucial PM needs. Subsequently, PMD was developed incorporating the essential elements (i.e. physical and financial progress, approval status, issues, risk, labour and general) based on the expert survey findings. Further, the interview survey confirmed the suitability of PMD in addressing critical PM requirements over conventional tools and software used in the Sri Lankan construction industry obtaining the results above the midpoint of the scale. Eventually, it is recommended to utilise PMD, in order to successfully manage construction projects.

*Keywords:* Project Management; Project Management Dashboard; Project Management Knowledge Areas.

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### PROJECT RISK MANAGEMENT BY SMALL-SCALE CONTRACTORS IN SRI LANKAN BUILDING CONSTRUCTION

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#### ABSTRACT

The construction industry remains one of the most dynamic and challenging industries in the world due to the complexity of its production process. This makes it subject to more risk and uncertainty than other industries that make it difficult for newcomers as well as small-scale contractors to be sustainable in the construction industry. The identification and assessment of new risks along with their interrelationships and coming up with the appropriate responses to new risks is a cumbersome process entailing some degree of complexity. The present research focuses on the identification of critical risks, the allocation of those risks among the small scale contracting parties, and the determination of appropriate response measures to managing the risks thus identified.

The study first elicited the views of senior construction professionals on risks in the small-scale contractors in a preliminary survey prior to carrying out a questionnaire survey among a selected group of small-scale contractors. Sixteen (16) significant risk factors were identified and evaluated by using the Relative Importance Index (RII). The research further worked out the allocation of risk among the contracting parties and the appropriate response measures. On the basis of the research outcomes, the study proposes a risk management framework for appropriate risk management among small-scale contractors. The findings reveal the importance of paying attention to risk aspects by small-scale contractors in construction projects and identifying the problems relating to inadequate knowledge or techniques of small-scale contractors that may pose barriers to it. The paper proposes proper education and training of such contractors as one measure to overcome the identified barriers. It recommends the hiring of risk management consultants and the bearing of the risk by the party that has most control over it rather than passing it on to the other party as ways to control risks.

**Keywords:** Response Measures; Risk Management; Significant Risk Factors; Small-Scale Contractors; Sri Lankan Building Construction Industry.

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# RECENT DEVELOPMENT OF VERTICAL AXIS WIND TURBINE: A PROMISING SOLUTION

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#### ABSTRACT

There is crucial need for clean and sustainable energy supplies nowadays. In recent years, wind energy is considered one of the most promising energy sources. Horizontal Axis Wind Turbines (HAWT) has been the widely practiced type, whereas Vertical Axis Wind Turbines (VAWT) is the lesser known type. To harvest wind energy at higher height, tremendous advancements have been progressed in the wind turbine technology with boosted size and capacity, as well as lighter components to achieve cost effectiveness and technical efficiency. Some of the recent findings revealed the potential of VAWT in future development. This paper aims to describe the recent development of VAWT and its merit over the conventional HAWT. The reasons driving the market to investigate the feasibility of using VAWT again are discussed, as well as the limitation of its future development. Finally, the feasibility of using VAWT in future wind power industry is evaluated. It is concluded that VAWT has significant development potential in future market of producing efficiency wind energy.

**Keywords:** Aerodynamics; HAWT; Structural Dynamics; VAWT; Wind Engineering; Wind Power.

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### RELATIONAL CONTRACTING APPROACH FOR IMPROVING PERFORMANCE OF INFRASTRUCTURE DEVELOPMENT PROJECTS

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#### ABSTRACT

Relational Contracting (RC) is a flexible procurement approach directed at optimising project performance through applying its principles; aiming at the relational integration of all stakeholders of a project, by engaging them in "cross linked value networks". Partnering, alliance, private-public partnerships and joint ventures are the common procurement types of such nature. Although RC have proven benefits especially for complex and uncertain infrastructure development projects, these are not well established in most developing countries including Sri Lanka. Therefore, understanding of industry practitioners on how RC systems bring in performance improvements to construction projects will definitely promote RC. In view of that, the research aims to provide related knowledge by identifying and subsequently assessing the impact of key parameters of RC on major performance areas of infrastructure development projects. A questionnaire survey was conducted based on the knowledge gained through literature and was followed by an interview survey to validate the questionnaire survey findings derived through statistical t-tests. Questionnaire findings identified nineteen significantly existent characteristics in RC types and were recognised as highly important for 'Time', 'Cost' and 'Quality' performance of infrastructure development projects. Thus, adopting of RC should be promoted to achieve better project outcome.

*Keywords:* Construction Performance; Infrastructure Development Projects; Procurement Methods; Relational Contracting.

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# REPORTING PROCEDURE OF CONSTRUCTION ACCIDENTS IN SRI LANKA

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#### ABSTRACT

A cohesive and centralised recording system of occupational accidents is a significant element of construction industry of any country which requires an effective reporting procedure to feed information into it. It is a valuable management tool that can be used as an aid to risk assessment, to prevent deaths, injuries and ill health conditions, and to minimise costs for accidental losses. However, the absence of an effective reporting procedure will form shortfalls in management of occupational accidents, Sri Lanka is one of the countries that suffers from lack of an efficient recording system. It is revealed that ineffectiveness of existing accident reporting procedure is the main cause for this gap. Therefore, it created a necessity to study the existing reporting procedure of construction accidents in Sri Lanka with the aim of upgrading it by addressing its gaps. Accordingly, the research problem was approached through a document survey and an expert survey which followed by semi structured interviews. Ten experts who are involved in industrial health and safety management were interviewed. The findings revealed that safety representatives of most of the construction organisations reluctant to report to the Labour Department through the district factory inspecting engineer when incidents occur, due to unawareness of legal provisions and burden of paper work. Further, other organisations such as workmen's compensation department; insurance companies; hospitals and police stations, where construction accidents are reported, are not properly linked with the Labour Department. Therefore, Labour Department as the ultimate data storekeeper does not get steady flow of information from any party. Owing to this, seven strategies were established to lift up the adeptness of the existing reporting system through establishing proper links for efficient information feeding.

*Keywords:* Accident Reporting Procedure; Centralised Accident Recording System; Construction Accidents; Construction Industry.

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## RESPONDING TO THE BUILT ENVIRONMENT CHALLENGES: DESIGN FOR ADAPTATION

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#### ABSTRACT

The current building stock in the UK only vaguely fits the evolving needs of businesses and users. This leads majority of existing buildings to be demolished, renewed, refurbished or redundant. However, maintaining a redundant building stock is economically unviable and a socially unacceptable solution, as these buildings generate no income while the building owners are responsible to pay taxes for the buildings. Also, scrapping and rebuilding relatively young buildings is neither economically nor socially desirable and does not correspond with the demand for durability and sustainability. Therefore, to survive a more complex array of needs, modern buildings are required to be designed to improve space, environmental and safety standards and adapt for potential change situations. In this sense, adaptable buildings focus on potential bespoke solutions that are flexible for varying customer needs. Buildings with adaptable potential may survive in the immediate future; however, the traditional maladaptive buildings will remain as redundant stock unless they find a correct use. This paper investigates the design strategies for adaptability in middle range buildings (4-12 storeys) while explaining the capacity of adaptable buildings to respond to the built environment challenges. A comprehensive literature review was undertaken to identify the strategies and design parameters for adaptability in buildings, and eleven interviews were carried out among the construction professionals to identify the practicality of promoting adaptable building strategies within the UK construction industry. NVivo-10 software was used to analyse the empirical data, and the results explained market demand, user requirement, stakeholder awareness and challenges like cost, risk, technology and existing planning policies are the key issues that need to be addressed when promoting adaptable buildings.

*Keywords:* Benefits and Challenges; Built Environment Challenges; Design for Adaptability; Strategies and Parameters; Sustainability.

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### **RISK OF CATASTROPHIC EVENTS ON CONSTRUCTION SUPPLY CHAIN**

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#### ABSTRACT

Construction supply chain flow through the entire business process initiated from the demand by the client to create the project, till the demolition of the construction. Catastrophic events are rare events which are difficult to predict its occurrence. However, catastrophic events take place within the construction supply chain; have a severe impact over the project.

Most of the researches on supply chain were keen to understand the factors increasing efficiency and reducing cost. As a result, many findings were there to keep the supply chain live at ordinary times, but at the cost of being vulnerable to disruptions. It was identified that catastrophic events take place in the construction supply chain have not been highlighted in supply chain researches. Therefore, the aim of this paper is to present the catastrophic events take place in construction supply chain and their risk levels.

A comprehensive literature review has laid the initial path to gather current knowledge on catastrophic events in construction supply chain. In order to fill the gaps in literature, a preliminary study has been carried out to gather further information on practical experience with catastrophic events in construction supply chain. The study revealed that although there are number of findings on catastrophic events on supply chain management, the risk levels of these catastrophic events change under different conditions. Therefore, through the findings of the above two phases and the survey carried out among construction industry experts, this paper list out the catastrophic events, ranked according to the risk level under a developing economic and tropical environment. This fascinating strategic finding is a great tool for construction decision makers to fight the risks in construction supply chain.

**Keywords:** Catastrophic Events; Construction Supply Chain; Likelihood; Risk Analysis; Severity.

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### **RISK OF USING BIDDING STRATEGIES FOR A CONTRACTOR**

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#### ABSTRACT

Construction contractors often procure projects through a competitive bidding process. Every contractor intends to bid competitively while dealing with the associated risks concurrently. Contractors have developed their own bidding strategies to retain their competitive edge. However, these strategies may carry an inherent risk component that is unforeseen leading to what is termed the 'winner's curse'. The aim of this study is to identify the risks entailed in the different bidding strategies and to explore solutions for the purpose of minimising risks. The research employs semi-structured interviews and a questionnaire survey which was administered to quantity surveying professionals with vast experience in the construction tendering process. Content analysis is used to analyse the qualitative data while statistical measures are used to analyse the quantitative data.

The results of the survey reveal that contractors use bidding strategies mainly for survival purposes that ensure continuous and sufficient work. However, in each bidding activity, their primary objective is a target return on the investment. In addition, fifteen bidding strategies are identified with their allied risk factors. These bidding strategies are ranked according to the risk significance which yields 'Bidding for repetitive jobs' as the one carrying the lowest risk while 'Intuitive manipulation' ranks as the one carrying the highest risk. The study offers a conceptual model that lists methods to minimise the risks of each bidding strategy which provides guidance for contractors to select better-suited bidding strategy rather than random or haphazard selection. Moreover, since some contractors may opt for a risk favourable approach in order to get a high return, the study examines the different risk perspectives of contractors so that they may adopt such bidding strategies with full knowledge of the attendant risks and what strategies are available to minimise risk exposure.

Keywords: Bidding Strategies; Contractor; Risk; Risk Management.

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# ROLE OF MULTI-DISCIPLINARY PROJECT STUDIES IN PROMOTING SUSTAINABILITY WITHIN THE BUILT ENVIRONMENT DEGREE PROGRAMMES

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### ABSTRACT

The need to contribute to the sustainability agenda is increasingly becoming a key requisite for both academics and practitioners in the built environment disciplines. The triple bottom line indicators of sustainability involve the consideration and collative optimisation of environmental, social and economic aspects of projects. Therefore, it is of vital importance that the current and future built environment professionals are able to ensure that they provide sustainable built environment solutions. Higher education institutions which offer built environment degree programmes use different approaches to achieve this requirement. Multi-Disciplinary Project Studies (MDPs) have been identified as a way of imparting such knowledge and practices for the built environment students.

The principal aim of this paper is to discuss two approaches in delivering multi-disciplinary projected studies adopted in two higher education organisations in the UK. Firstly, the paper aims to identify the key components of the sustainability agenda, while explaining how the delivery of multi-disciplinary project modules can be contributed to it. Secondly, it discusses two different approaches for multi-disciplinary projects and analyses how each approach contributes to imparting the skills and knowledge to develop sustainable built environment solutions. Finally the opportunities opened up challenges encountered in both models, and the implications to teaching and the industry practices are discussed. A literature review on pedagogical teaching and participant observations were the main methods used to collect data. The preliminary

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findings indicate the positive role of the MDPs in contributing to the sustainability agenda. Further research and innovation is required to overcome the challenges of organisation and assessment, and greater integration with Building Information Modelling (BIM).

**Keywords:** Built Environment; Collaboration; Higher Education; Multi-Disciplinary Projects; Sustainability; Teaching.

# STRATEGIES TO RECRUIT AND RETAIN PROFESSIONAL QUANTITY SURVEYORS IN THE PUBLIC SECTOR CONSTRUCTION ORGANISATIONS

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#### ABSTRACT

Construction industry has a direct link to the country's economy and development. It is the Quantity Surveyor's (QS) responsibility to ensure that the resources in the construction industry are utilised to the best advantage of the society by providing financial management for project and cost consultancy to the client during the whole construction process. Hence Quantity Surveying (QS) profession is significantly important for any building or civil engineering project. Due to the dynamic nature of the construction industry, an incessant battle has to be competed with the constraints of time, cost and quality. In this scenario, QS has the responsibility to utilise the monetary fund very efficiently and effectively to gain the optimum value for money without having the risk of losing control of money. Therefore, QSs are working as cost planners, cost controllers and cost managers. Their role and the practices are expanding day by day and the industry demands for QSs with variety of experience, distinctive competencies and skills. At present, a precarious shortage of QS professionals can be often evidenced in Sri Lankan construction industry. The tendency of having the aforementioned shortage is tremendously high in the public sector projects due to the extreme governmental influence. Moreover, the probability of government QS professionals leaving work places and join the public sector is highly increased in past few decades. Since QSs are one of the human resource inputs to the construction industry, it can be understood that employee turnover will barricade the sustainable construction practice in public sector by failing to preserve the human resource for the future. Therefore, the aim of this study was to investigate the strategies to recruit and retain professional QSs in public sector organisations.

The survey approach was used to investigate the research problem and questionnaires and semi-structured interviews were used as the data collection techniques. Data was collected from two samples; QSs working in public sector and Human Resource Managers (HRM) in public sector construction organisations respectively. Binomial test, Relative

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Importance Index (RII) and few simple arithmetic formulas were used to analyse quantitative data and content analysis was used to analyse qualitative data. According to the research findings, QSs in public sector are reluctant to retain due to low salary packages, less opportunity to develop their career and insufficient work under their scope. According to the binomial test, the majority of QSs think that proper human resource management will be a good solution to overcome this shortage. According to the perspective of human resource managers, although they have realised the problem, they have to implement the plans and strategies according to the government rules and regulations. As the final outcome of the research, a framework was developed to recruit and retain more QSs in public sector construction organisations.

*Keywords:* Human Resource Management; Public Sector; Quantity Surveyors; Recruitment; Retention.
# SUSTAINABILITY CONCERNING TO PUBLIC PROCUREMENT PROCESS IN CONSTRUCTION: LITERATURE REVIEW

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### ABSTRACT

In the year 1977, economy of Sri Lanka liberalised and opened up to foreign market with investment to deregulate domestic construction industry. Further, the economy has shown transition features since 2009, after end of 30 years' war. Public Procurement Process (PPP) mainly considers satisfaction of the stakeholders in line with development objectives of the country. Hence the PPP is the integral part of economic development of the country. However, the economic development of Sri Lanka has shown lagging features when compared to economic history of other developed countries due to the reasons that the existing PPP has not given fullest uplift in line with current global requirement.

Thus, the practitioners in the industry should find the way to enhance and upgrade the existing PPP to link with available challenges. Literature revealed that developed countries have utilised numbers of benefits by implementing Sustainable Public Procurement Process (SPPP). Accordingly, incorporate the sustainability concerns than the time, cost, and quality aspect to the existing PPP is one of the best practicable and cost effective possible alternative solutions to bridge the gap. Thus, this paper focused on detailed analysis on sustainable concerning to PPP with in Sri Lankan context base on secondary data.

Hence, relevant areas scrutinised through the comprehensive literature review to achieve the objectives of the study. Further, experts in the field of procurement also consulted to gather the opinions and views in order to evaluate the feasibility of desired outcomes.

**Keywords:** Construction Industry; Procurement; Public Procurement; Sustainable Public Procurement.

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### SUSTAINABLE IMPLICATIONS OF BUILDING REUSE AND ADAPTATION

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### ABSTRACT

Built environment products and processes are now biased more towards profitable markets while giving sustainability the first priority in achieving the same. Consequently, value has become one of the main concerns while seeking various cost reduction methods through sustainable implications. Building reuse is one distinctive way that reflects the aforementioned sustainability in multiple ways. The existing building stock in the UK does not support sufficient flexibility that can be used for future adaption. Demolition of those buildings and construction of new builds does not seem to be an optimum solution, unless it helps increasing the building redundancy. Thus, an effective and achievable solution is required to address this problem. Apparently, design for adaption and application of adaptable features from the initial stage of every new build seem to be the most sustainable way that can be endorsed with sustainable, flexible buildings that last long and resist the future potential changes.

The research has exploited qualitative methods to explore the aforementioned problem. The research itself is based on a case study of Liverpool City Centre. Ten Structured interviews were conducted to identify the sustainable implications of building reuse and adaptation while an Archival Analysis was undertaken to identify the patterns of building change of use and their ability to reuse. The findings illustrate that economic factors have immensely influenced towards building reuse and adaptation. The research findings would also help different stakeholders to make decisions on how reusable features could incorporate within the new building designs through sustainability.

Keywords: Adaptation; Building Reuse; Sustainable Implications.

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## SUSTAINABLE RESPONSIVENESS FOR RECESSIONARY EFFECTS IN THE CONSTRUCTION INDUSTRY: A STUDY ON APPRAISING BENEFITS

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### ABSTRACT

The construction industry is a significant source of revenue generation to the economy, contributing more than 9% of the Gross Domestic Production (GDP) in Sri Lanka in the year 2012 according to the Central Bank statistics. Thus, the construction industry is concurred a positive relationship with the cyclical economic fluctuations. Consequently, adverse economic conditions directly affect the industry and resulted in stagnation. In response to the recession, the construction practitioners adopt various strategies. However, the recession responsiveness must be aligned with the concept 'sustainability' which concerns beyond the profit oriented short-termism.

Hence, the aim of this research study is to investigate the benefits (Strengths) of sustainable responsiveness to minimise adverse effects (Threats) in the construction industry during the recession. An expert interview survey was conducted among different construction stakeholders to obtain multi rational perspectives. The survey analysis derived that social benefits associated with sustainability have contributed mainly to gain the benefits over recessional threat. However, many of the statements were neutralised stating that 'Sustainable benefits sometimes minimise recessional threats'. Henceforth, it can be concluded that the sustainable strategies favourably respond the recession to mitigate recessional threats and direct long term strategic establishment. In addition, public awareness is essential to gain the sustainable benefits. Finally, it is recommended to be aware of the recession adhering to the opportunistic way forward through sustainability rather beware of its appalling adverse effects.

*Keywords:* Adverse Effects; Construction Industry; Economic Recession; Sustainable Benefits; Sustainable Responsiveness.

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## SUSTAINABLE STRUCTURAL MATERIAL COMBINING RECYCLED AGGREGATE AND STEEL FIBRES

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Australia.

### ABSTRACT

Recyclable concrete is now increasingly recognised as a sustainable building material, which could be effectively used in building construction. However, at present, recycled concrete created from recycled aggregate has mainly been used for non-structural and sub-grade applications around the world because companies have long believed that it is inferior to the normal aggregate generation. This research was undertaken with the hypothesis that recycled concrete can be as strong as the normal concrete which is suitable for structural applications when incorporated with steel fibres. Previous research has shown that steel fibre can effectively improve the toughness, shrinkage, and durability characteristics of concrete. Recycled concrete, which is weak in shrinkage properties, can therefore be enhanced by incorporating steel fibres. This paper reports initial experimental results that aims to explore the behaviour of recycled concrete when steel fibre is added. The experiments considered varying steel fibre volumes of about 0%, 30% and 60% with recycled aggregate replacement ratios of about 0%, 30% and 100%. It is found that the more recycled aggregate replacement ratio of the recycled concrete, the lower the compressive strength is. However, the addition of steel fibre can improve the compressive strength of the concrete mixes. The initial experiments reveal the possibility of creating a new material for structural purposes and will thereby contribute to sustainability by resolving environmental issues such as carbon emissions and wasted management. Future research will be carried out to conduct further tests when the material is used in structural members.

*Keywords:* Australia; Recycled Aggregate; Recycled Aggregate Concrete; Shrinkage; Steel Fibre.

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# URBAN DESIGN AND SOCIAL CAPITAL: LESSONS FROM A CASE STUDY IN BRAUNSTONE, LEICESTER, UNITED KINGDOM

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### ABSTRACT

A valuable asset in sustainable regeneration is the 'community' in an area with their developed networks, bonds and ties or in other words its social capital. Braunstone in Leicester is typical of many disadvantaged areas in the UK, with persistent socio-economic problems exacerbated by a poor physical setting. With a large regeneration programme funded by the New Deal for Communities coming to a close, we conducted a case study to explore the impact of improved local facilities and the effect of walkability on social capital.

The lessons learnt suggest that responding to needs at a finer grain is vital in developing neighbourhoods for social capital. Such fine grain responses should include the needs of different user groups, local patterns of use and measures to improve the branded and stigmatised perceptions of neighbourhoods. Accessing services by walking and using public transport is vital to engage in social activities, while a poor physical environment and a lack of accessible services affects levels of participation. Local facilities provide a mediating role in developing social capital in a community by providing opportunity for social interaction that encourages people to reside in an area in the longer term. Integration of the neighbourhood in its wider context with easy connections to the outside world is a vital incentive for longer-term residency if social capital is to grow over a period of time.

*Keywords:* Braunstone; Community Development; Regeneration; Social Capital; Urban Design; Walkability.

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University of Moratuwa – Department of Building Economics

Building Economics and Management Research Unit (BEMRU), the research arm of the Department of Building Economics (DoBE) at the University of Moratuwa, Sri Lanka specializes in research in Building Economics and Management in the country as well as internationally. Established in 1990, the unit's specialization has strengthened and through collaboration with other organizations and institutes in the industry. BEMRU continued to develop and maintain close links with leading research institute around the world.



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



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GCU is the fifth largest university in Scotland which is also known as a deliverer of the highest quality education and research and to promote the "common weal". The School of Engineering and Built Environment of GCU provides undergraduate and postgraduate courses to suit the needs of industry and professions in the areas of construction, property and the natural environment.

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Liverpool John Moores University (LJMU)

LJMU was founded in 1825 and granted university status in 1992. The School of the Built Environment at LJMU is one of the leading providers of teaching, learning and business focused research in the UK. LJMU caters for the needs of government, industry, local communities and professional practice by providing different degree courses to help generate business success and to create a generally more sustainable built environment.



The Centre for Infrastructure & Construction Industry Development (CICID)

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CICID was set up by the Department of Civil Engineering of the University of Hong Kong in 2002 and is now internationally recognised for facilitating and disseminating interdisciplinary research into construction industry innovations and improvements, into the management of construction projects and into the management and sustenance of built infrastructure.

www.becon.mrt.ac.lk

www.gcu.ac.uk

www.ljmu.ac.uk

www.cibworld.nl