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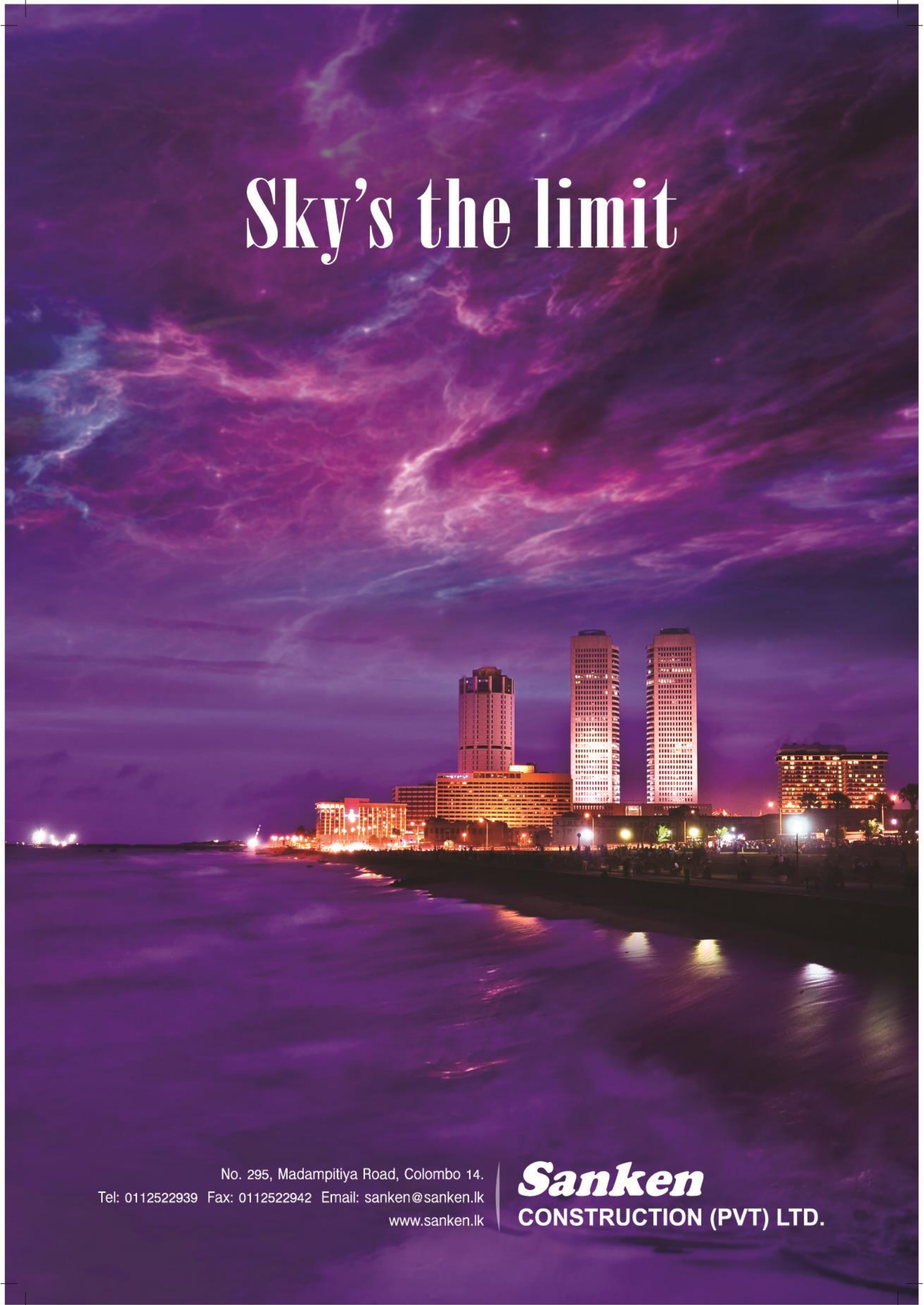

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MESSAGE FROM THE DIRECTOR GENERAL...

Construction Industry is the backbone of the national economy, contributing 1/10th of the Gross Domestic Product at present.

The industry is poised to take off under the policy of the unity government with the launching of mega development projects like Colombo Financial City, Western Megapolis Development Project and other Major Development projects planned to be launched soon.

The resource requirements of these major development drives need to be met in order that those projects are implemented in the way that it meets the needs of the country, augmenting the envisaged economic growth and uplifting the lives of the people.

In this backdrop, it is extremely vital to come up with innovative approaches and creative solutions to overcome the resource shortages presently being faced by the construction industry, driving the industry to make it more productive and sustainable.

The objective of this Journal being published in parallel to the National Construction Awards Ceremony is to make the construction community and general public aware of new approaches and innovative solutions widening the knowledge base, encouraging increased scientific dialogue and envisioning more research & development, to take the industry into new heights.

I would like to appreciate the directives and guidance provided by the Hon. Minister and the Ministry, making this Journal a success.

I must also extend my gratitude to the editorial panel and the professionals who wrote valuable articles to make this Journal for the benefit of the construction community.

Finally, I also thank Director (Development) and staff of Development Division of CIDA, for their untiring effort to publish this Journal parallel to the National Construction Awards Ceremony.

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

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Abstract
In construction projects in Sri Lanka, a Contractor is selected through a bid evaluation procedure which is a crucial step in the implementation of a project. The most frequently used bid evaluation procedure in Sri Lanka is the Government Bid Evaluation Procedure (GBEP), the Government being the client in most of the projects. Although GBEP is referred to in government publications, it has so far not been analyzed in detail. This study therefore was conducted to identify the suitability of GBEP to local building projects. A literature synthesis and a desk study were carried out to study GBEP and identify its extent of use in Sri Lanka. Ten semi structured interviews (expert interviews) were also conducted to identify the advantages, disadvantages and/or limitations of GBEP. The analysis reveals that a well-defined procedure, proper documentation, ability to select the lowest evaluated bid are the major advantages of GBEP while the absence of a minimum eligibility criteria for preliminary bid evaluation, adjustments done by the evaluator, low accuracy of the Engineer's Estimate and non-consideration of the optimum bid are the major disadvantages and/or limitations of GBEP. Expert suggestions such as; Flexibility on ICTAD registration, making allowance for discounts for variations, introduction of standard formats for reporting and prohibition of adjustments by the evaluator were used to develop a Modified GBEP in order to enhance the transparency and accountability of GBEP.

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

Introduction

The construction industry is quite complex in that it has both new projects and renovation projects (Wills and Ashworth, 1992). Fellows *et al*. (2002) state that having two separate stages for the design and construction is a unique characteristic of this industry. Before any construction work is undertaken, a suitable contractor has to be selected (Holt, 2010) through a tendering process (Janaka, 2011). Holt (1998) states that this process consists of two stages, i,e pre-qualification and tender evaluation. During tender evaluation (TE), tenders of pre-qualified contractors are evaluated (Wong *et al*., 2001).

In Sri Lanka, several TE procedures are being used (Aluvihare, 1998) and the GBEP published by the National Procurement Agency (NPA) is one of them (NPA, 2006a; NPA 2006b). According to NPA (2006) the purpose of the GBEP is to determine the lowest evaluated bid that is substantially responsive. The GBEP has four major stages, i.e preliminary examination of bids, detailed evaluation and comparison of bids, post qualification verification and writing of the bid evaluation report. It can be applied whenever open and selective tendering methods are used for the selection of a contractor (NPA, 2006).

2. Research Problem

Research done overseas in the last two decades has identified among others, the key factors to be considered in evaluating tenders (Watt *et al.*, 2009), clients preferences (Wong *et al*., 2001), public sector tender evaluation processes (Hampson and Kwok, 1997) and contractor selection criteria (Hatush and Skitmore, 1997). In Sri Lanka, research has been carried out on the evaluation of tenders for design and build contracts (Aluvihare, 1998), impact of ineffective tendering processes (Srimal, 2013) and on e-tendering frameworks suitable for public construction procurement (Amarapathy, Jayasena, and Ranadewa, 2013). Although, there is substantial research done on tender evaluation, there is a literature

gap on GBEP. In addition according to statistics published in the 2013 Annual Report of the Central Bank and in the Colombo Page (2013), the Government of Sri Lanka is the biggest client in the construction industry and it is mandatory to use GBEP in government projects. Therefore, a study about the suitability of existing GBEP for building projects in Sri Lanka is highly needed to fill the gap in literature and to face the demand which is going to boost the economy of Sri Lanka country in a fast paced manner.

3. Research Aim and Objectives

The aim of the research is to identify the suitability of Government Bid Evaluation Procedure for building construction projects in Sri Lanka. The targeted objectives for addressing the above aim are as follows;

Study the Government bid evaluation procedure
Identify the level of usage of the Government bid evaluation procedure in Sri Lanka
Identify the advantages, disadvantages and limitations of the Government bid evaluation procedure
Suggest the solutions in order to overcome the disadvantages and limitations of the Government bid evaluation procedure
Develop a suitable modified bid evaluation procedure

In this paper, re-measurement type building projects have been considered to identify the suitability of the Government Bid Evaluation Procedure for building projects in the Sri Lankan construction industry.

7. Research Methodology

Social constructionism was adopted as the research philosophy of the study, and a qualitative approach was used to assess subjective data (expert opinions). An extensive literature review and desk study were carried out with the use of Procurement Manual (2006) and Procurement Guidelines (2006) including twenty eight supplements published by the NPA, to study GBEP and identify the extent of its current usage in Sri Lanka. Four preliminary expert interviews were carried out to validate the literature and desk study findings. Ten semi-structured interviews were conducted with selected construction professionals who have extensive experience in GBEP to identify its advantages, disadvantages and/or limitations and make suggestions to overcome its disadvantages and/or limitations.

4. Government Bid Evaluation Procedure of Sri Lanka

GBEP of Sri Lanka was officially implemented in 1996 by the Ministry of Finance and Planning through the General Treasury when the Government issued guidelines on tender procedures (General Treasury, 1996). When in 1997, the General Treasury was made the National Procurement Agency (NPA), a revised version of the guidelines on the tender procedure was introduced (NPA, 2006). As stated by the Ministry of Finance and Planning (1997), the Government has published a procedure for tendering (bidding as used in Sri Lanka) especially for public sector projects.

4.1. Stages of Government Bid Evaluation Procedure

GBEP in Sri Lanka has the following steps as set out in the NPA Procurement Guidelines (2006) and Procurement Manual (2006).

Preliminary examination of bids
Detailed evaluation and comparison of bids
Post qualification verification
Writing of the bid evaluation report

Preliminary examination of bids

This very first stage of the bid evaluation process eliminates the bids that do not meet the minimum standards or requirements given in the bidding document (NPA, 2006). All bids received before the dead line for submission of bids are considered in the preliminary bid evaluation and the Procurement Entity (PE) has to establish reasonable criteria for the elimination of bids that do not meet the stated requirements (NPA, 2006).

Detailed evaluation and comparison of bids

All substantially responsive bids are evaluated during this stage to determine the lowest evaluated bid. A systematic and logical sequence is stated in the NPA Procurement Manual to carry out the detailed evaluation and comparison of bids (NPA, 2006).

Post qualification verification

This third stage becomes important when there is no requirement for pre-qualification (NPA, 2006). The North American Development Bank (NADB) (2012) recommends this highly for uncomplicated building contracts. Pre-qualification does not offer much advantage at this stage as its purpose is only to determine whether the lowest responsive evaluated bid can meet the contractual requirements.

Writing of the bid evaluation report

This final stage is carried out after the confirmation of the lowest responsive bid (NADB, 2012). Once the bid evaluation is completed, the PE has to prepare a bid evaluation report using standard formats (NPA, 2006).

5. Extent of Use of GBEP in Sri Lanka

In public sector projects, it is necessary to follow government bidding procedure which includes GBEP (Abeysinghe, 2006). The Government is the largest client of the local construction industry, with 73% of its total investment (Central Bank of Sri Lanka, 2012) in 2012 being on construction related activities. Colombo Page (2013) has confirmed that the Government's public sector investment was 5.9% of the GDP. Therefore, the use of GBEP in Sri Lanka is considerably high. As per the Department of Census and Statics (2011), the degree of use of GBEP in Sri Lanka is also high, as most public sector projects are in the construction sector.

6. Suitability of Government Bid Evaluation Procedure

Among several disadvantages and limitations, the main disadvantage of the existing GBEP is the 'Winner's Curse'. According to Abeysinghe (2006), 'Winner's Curse' occurs when a contract is awarded to the lowest responsive bidder whose bid price has a high estimating error. Jayasena and Uhanowitage (2008) define 'Winner's Curse' as the situation when a winning contract either carries negative profits or below average profits. Moreover, Abeysinghe (2006) state that, Winner's Curse makes construction firms insolvent. A contractor may also try to compensate his poor cash flow arising out of the Winner's Curse, by submitting claims that cause post contract difficulties to clients (Jayasena and Uhanowitage, 2008).

Abeysinghe (2006) has argued that there are disadvantages and limitations of GBEP other than 'Winner's Curse'. Eriksson and Westerberg (2001) have discussed that GBEP has a disadvantage of producing conflicts. Ngobeni (2001) has mentioned that corruption may exist during tender evaluation.

Expert opinions also indicate the necessity to examine the suitability of GBEP. Watt *et al*. (2009) have mentioned that many experts and academic institutions have made suggestions for contractor selection and evaluation. Mahdi *et al*. (2002), Rajaie *et al*. (1997) and Turskis (2008) have stated that the fact that

a particular contractor has submitted the lowest responsive bid should not be the only criteria for selecting him.

The strict bid evaluation procedures followed in other countries have encouraged the researchers to explore the suitability of the existing GBEP. The Republic of Kenya gives preference to best value for money and not to the lowest responsive bid (Public Procurement Oversight Authority, 2009). In South Africa, Finland and UK, it is the most advantageous bid that is selected (Ngobeni, 2001; Tikkanen and Kaleva, 2011 and Holt, Olomolaiye and Harris, 1995).

The construction industry requirements also make it necessary to examine the suitability of the existing GBEP. According to the 2013 Annual Report of the Central Bank and the report of the ColomboPage (2013), the largest client of the construction industry in Sri Lanka is the Government. ICRA Lanka (ICRA Lanka Limited) and IMaCS (ICRA Management Consulting Services Limited) (2011) as well as Amarapathy, Jayasena, and, Ranadewa (2013) stated that with the end of the war the construction activities initiated by the Government have increased during the last five years. Hence, there is a need to follow both the NPA guidelines and GBEP, as most of the construction projects are funded by the Government.

8. Research Findings

Research findings are discussed under four main headings, i.e study of GBEP, identification of the extent of current usage of GBEP, advantages, disadvantages and limitations of GBEP and expert suggestions.

8.1. Studying Government Bid Evaluation Procedure

There are four main stages and several sub stages in GBEP as can be seen in Table 1 which shows the results attained through the literature review and the desk study.

Table 01: Sub Stages of GBEP

Main stage	Sub stages
1.0 Preliminary bid evaluation	Checking preliminary requirements
	Identifying deviations
2.0 Detailed bid evaluation	Excluding VAT, contingencies and provisional sums
	Correcting arithmetical errors
	Applying discounts
	Adjusting for omissions
	Adjusting for deviations
	Adjusting for the delivery period
	Adjusting for inland transportation
	Computing operational and life cycle costs
	Converting to common currency
	Domestic preferences
	After sales services
	Examining unbalanced bids
	Comparing with Engineer's Estimate (EE)
	Rejecting all bids
	Seeking clarifications during evaluation
	Studying alternative bids
	Identifying the lowest evaluated bid
3.0 Post qualification verification	Checking technical feasibility
	Checking financial feasibility

Main stage	Sub stages
4.0 Writing of the bid evaluation report	

Subsequent to the desk study and the validation process carried out through four preliminary interviews with industry experts, 'Adjustment for delivery period' and 'Adjustment for inland transportation' were removed from the sub stages as they were found not to be relevant to the scope of the study. Table 2 below shows the profile of the participants of the preliminary interview all of whom were from the construction industry.

Table 02: Profile of the participants of the preliminary interview

Interviewee Code	Designation	Years of Experience	Category of Organization	Type of Organization
A	Chairman	40	Consultant	Private
B	Director	20	Consultant	Private
C	Deputy General Manager	18	Consultant and Contractor	Government
D	Chief Quantity Surveyor	18	Consultant and Contractor	Government

8.2. Identifying the Extent of Current Usage of Government Bid Evaluation Procedure

The objective of this section is to identify the degree of use of GBEP in building projects in both public and private sectors. Hence, ten semi-structured interviews were conducted and Table 3 presents the profile of the interviewees. Accordingly, it was found that the current of usage of GBEP is high and it confirmed the literature findings.

Table 03: Profile of Participants of Semi Structured Interviews

Interviewee Code	Designation	Years of Experience	Category of Organization	Type of Organization
E01	Deputy General Manager	18	Consultant and Contractor	Government
E02	Chief Quantity Surveyor	18	Consultant and Contractor	Government
E03	Director	20	Consultant	Private
E04	Project Manager	35	Client	Government
E05	Senior Quantity Surveyor	16	Consultant and Contractor	Government
E06	Asst. Director	28	Regulatory body	Government
E07	Asst. General Manager	30	Client and Consultant	Government
E08	Chartered Quantity Surveyor	12	Consultant and Contractor	Government
E09	Contracts Manager	19	Consultant	Private
E10	Commercial Director	22	Project Manager	Private

Percentage Use of Government Bid Evaluation Procedure

Even though GBEP is not adapted 100% in public and private sector construction projects, its degree of use is comparatively higher as shown by Figure 01.

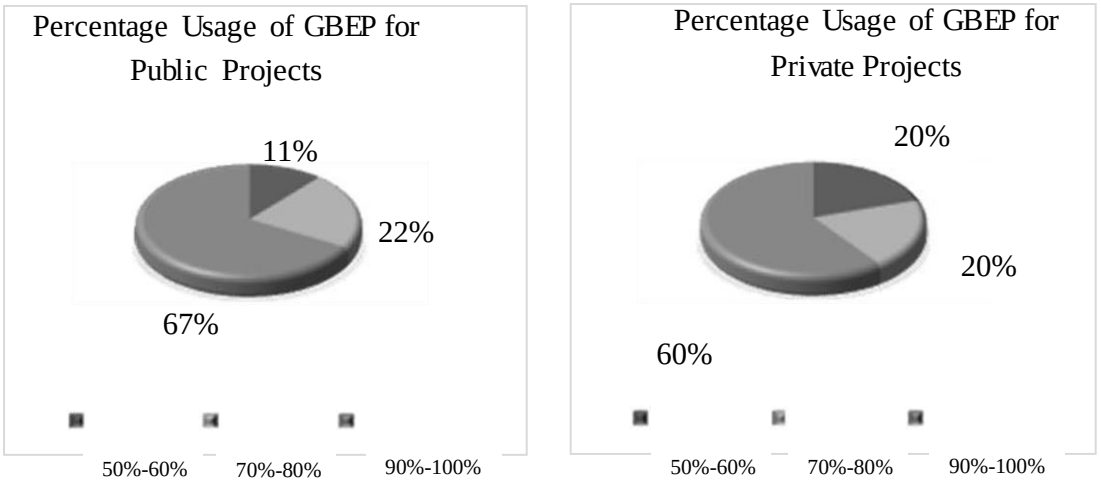

Figure 01: Percentage Usage Ranges of GBEP

Percentage of Deviations from Government Bid Evaluation Procedure

The extent of deviation from GBEP is higher in the private sector as shown by Figure 02.

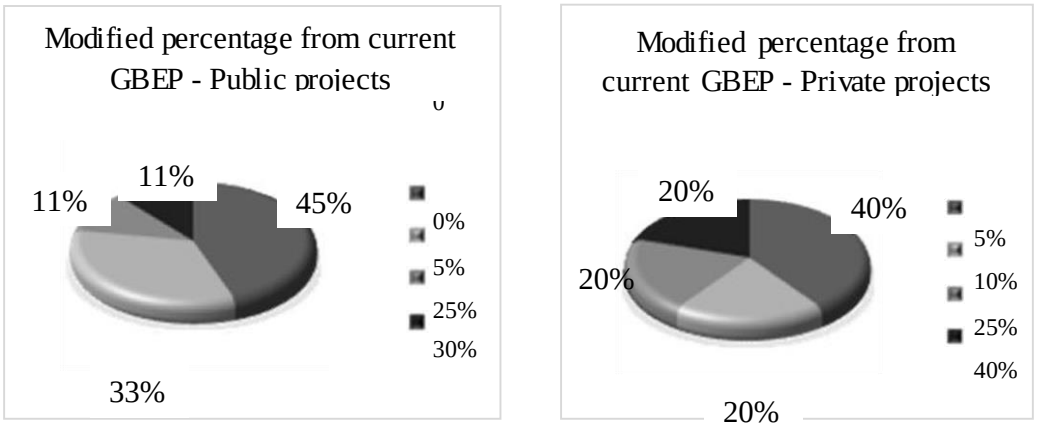

Figure 2: Modified Percentage from Current GBEP

Deviations from Government Bid Evaluation procedure

The areas of deviations are shown in Table 4 and Category 1 is found to be the most deviated area and Category 6 the least deviated area. Furthermore, the figure 3 shows the percentage deviations of public projects and the private projects under the scale of 'very often, seldom and no modifications' and the considered areas of deviations are shown by the Table 4.

Table 04: Areas Deviated from GBEP

Areas	**Category**
Extension of bid validity	1
Categorization of deviations	2
Preliminary bid evaluation	3

Detailed bid evaluation	4
Post qualification verification	5
Determination of substantially	6

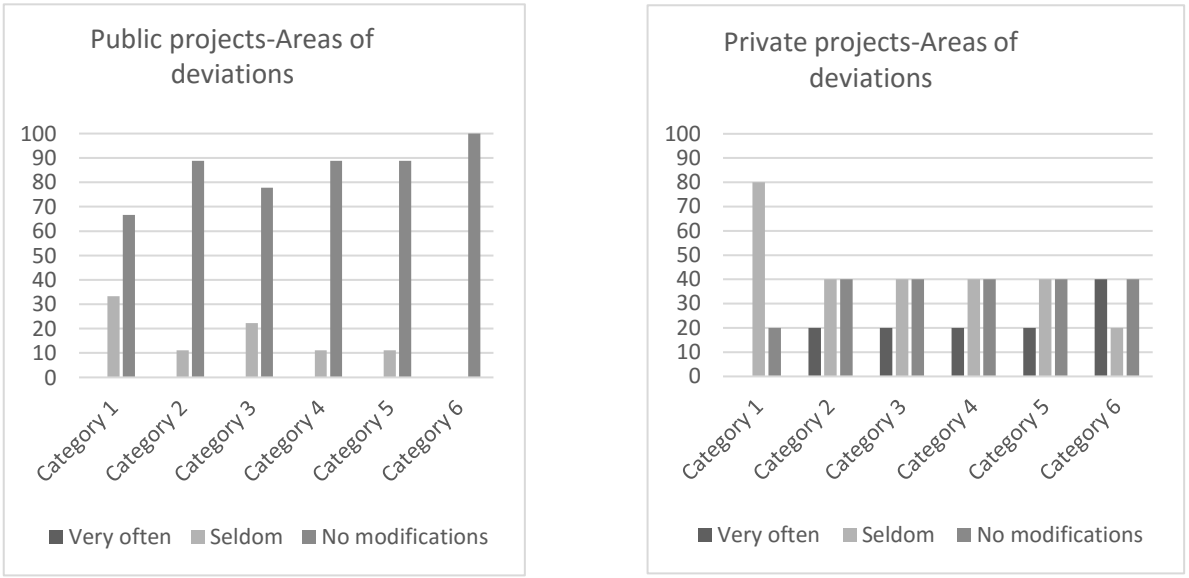

Figure 3: Percentage Deviations from GBEP

Reasons for deviating from Government Bid Evaluation Procedure

While GBEP is used strictly in state sector construction projects, ad-hoc bid evaluation procedures are used in private sector projects. Public accountability is a major requirement of the public sector whereas client's satisfaction is the primary concern of the private sector which can therefore afford to deviate from GBEP.

8.3 Advantages, Disadvantages and/or Limitations of Government Bid Evaluation Procedure

The advantages, disadvantages and limitations of each sub stage (refer table 1 for sub stages of each major stage) organized using NVIVO 10 coding structures are summarized in Tables 5, 6, 7 and 8. According to the literature findings as well as attained data of industry experts, it is found that the Winner's Curse exists because of the inaccuracies in the EE and also due to evaluation errors. The selection of the lowest evaluated bid also results in the Winner's Curse. Corruption of the selection procedure can be seen as well as the non-efficient nature due to highly dependency of documentation. In spite of the literature, experts have argued that the risk of conflicts is less since the GBEP is a well-defined procedure. Finally, it was accepted the necessity of a modified bid evaluation procedure due to considerable disadvantages and/or limitations of existing GBEP despite of certain advantages.

Preliminary Bid Evaluation Stage

Table 05: Advantages, Disadvantages and/or Limitations of GBEP

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
Checking preliminary requirements	Short listing of bids is possible Form of bid, validity of bid and power of attorney could be checked	Not all qualifications can be checked Setting up of a minimum qualification criteria is not possible ICTAD registration could be made mandatory

		Level of authority given to the Bid Opening Committee (BOC)
Identifying deviations	Non availability of historical data could be considered as a minor deviation All areas of deviations could be addressed	It is possible to be flexible in respect of bid validity It is not possible to be flexible with bids that provide shorter construction periods than what is specified

Detailed Bid Evaluation Stage

Table 06: Advantages, Disadvantages and/or Limitations of GBEP

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
Excluding VAT, contingencies and provisional sums	Reasonable when they have not been quoted by bidders this does not create differences among bidders they are not required for	
Correction of arithmetical errors	Bid price could be considered as the governing amount Words over figures could be considered to avoid manipulations The Form of Bid could be	Corrected bid price could be considered as the governing amount Amount quoted in the BOQ could be considered as the governing amount
Application of discounts	It is beneficial to the client It is similar to what is set out in World Bank and Asian Development Bank bid evaluation guidelines	Applicability for variations is not mentioned Mal functions could be possible Establishing and mentioning of the applicable parameters could be avoided
Adjustment for omissions	Items which are not quoted could be covered by rates quoted for other items Clarifications will not be permitted when certain items have not been quoted Rejection of bids is possible if	Average prices could be amended because of unquoted items Bids could be rejected without seeking rejection clarifications Applicability of the Invitation to bids (ITB) clause
Adjustments for departures	Clarifications could be sought in the absence of historical data	Adjustments could be done by the Technical Evaluation Committee (TEC)

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
Operational and Life Cycle Costing (LCC)	This will be applicable to only certain components of building projects This will be applicable only in building projects where there is a considerable quantity of Mechanical, Electrical and Plumbing (MEP) components	This will not be applicable for re-measurement building projects A common system for evaluation will not be available An evaluation format will not be available
Conversion to common currency	Mean of the selling and the buying prices could be considered Prejudices could be avoided This is similar to other bid evaluation guidelines A reference is possible	It will not be possible to convert to Sri Lankan Rupees It will be possible to quote in foreign currencies This will not be applicable to public re-measurement type projects as foreign bidders will not be involved
Domestic preferences	Local bidders are encouraged The percentage of 15% is sufficient National construction industry is promoted	Quality of output is disregarded The percentage of 15% is too high
After sales services	This is applicable to mechanical components of the buildings Maintenance is available after the Defects Liability Period (DLP)	This is applicable only to design and build projects Maintenance is considered only during DLP Minimum standards are mentioned in the bidding document
Examination of unbalanced bids	Separate methods are available for projects of different scales Provision is available for obtaining higher performance security	There will be high reliance on EE It will be possible to obtain a higher performance security

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
Comparison with Engineer's Estimate (EE)	A basis for evaluation will be available It will be possible to deviate from EE A validation process is available ICTAD price indices could be considered Dependence on the evaluator or the accuracy of EE could be avoided	There will be high reliance on EE There will be dependence on the accuracy of the EE There will be dependence on the evaluator A proper EE validation procedure is not available There will be a possibility of rejecting bids which have deviated considerably from EE An ICTAD standard is not available A reasonable margin is not available The schedules of rates could be non-logical There is no proper procedure for appointing the TEC Price fixing committees are not available Trend analysis for evaluation is not available
Rejection of all bids	A reasonable level of authority is vested with the client Saving of time and cost is possible Negotiations will not be possible during evaluation	Shortcomings of the procurement strategy will be highlighted Consultants can avoid liability All bids could be rejected unreasonably due to the absence of effective tendering All of the bids could be rejected due to unethical behaviour of bidders
Clarifications during evaluation	Historical data could be clarified Price modifications will be disallowed This will be beneficial for emergency projects	This will take a long time It will not be possible to avoid unethical clarifications completely
Alternate bids	This will be beneficial to the client Acceptance will not be mandatory when quality is substandard	This will not be applicable for re-measurement projects Quality could get reduced Only the lowest bidder will be successful

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
		Bidder will not be able to submit more than one bid security
Identifying the lowest evaluated bid	Only the lowest bidder having qualifications will be identified Winner's Curse could be avoided through a higher performance	Winner's Curse could be present Lowest will not always be the best The term 'responsiveness' will not be very clear

Post Qualification Verification Stage

Table 07: Advantages, Disadvantages and/or Limitations of GBEP

Sub Stage	Advantage/s	Disadvantage/s and/or Limitation/s
Checking technical feasibility	Separate stages will be available for short listing and detailed verification	There will be repetition of work Verifying the legal history will not be possible New contractors will not be able to enter the industry A procedure to verify the validity of the submitted details will not be available There will be a requirement for experience in similar work during previous five years
Checking financial feasibility	Separate stages will be available for short listing and detailed verification	There will be repetition of work A formula for the annual turnover will be available

Writing of the Bid Evaluation Report Stage

Table 08: Advantages, Disadvantages and/or Limitations of GBEP

Advantage/s	Disadvantage/s and/or Limitation/s
Non-disclosure of the evaluation report to bidders **A Standard format will not be necessary as;** **following the guideline will not be mandatory** **the report could vary from project to project**	A standard format will not be available Submission of technical literature and specifications will not be mandatory There will be insufficient input from the Quantity Surveyor

8.4 Expert Suggestions

Expert suggestions were collected in general as well as on each sub stage.

Suggestions for sub stages

Preliminary bid evaluation and establishment of a minimum qualification criteria were suggested for the first stage while ICTAD registration and bid validity were considered as minor deviations.

For the detailed bid evaluation stage, it was suggested to consider as the governing amount, the quoted bid price or the corrected bid price whichever is lower, setting out parameters for applying discounts, making provision for variations, obtaining an express understanding for unquoted items before rejecting a bid, avoiding the increase of the average prices for comparison purposes to account for unquoted items, avoiding adjustments by the TEC/evaluator, allowing bidding in foreign currencies and evaluation by using lowest fluctuated currency and/or in Sri Lankan rupees, reducing domestic preference from 15% to 4%, setting out criteria for after sales services, not requesting higher performance security in case of unbalanced bids, rejecting unbalanced bids or informing bidders to re-price, increasing the accuracy and reliability of EE and establishing a reasonable margin for the comparison of bids, establishing an accurate procurement strategy to avoid rejection of all bids, rejecting all bids when unethical behaviour of bidders is disclosed, introducing novel clarification procedures, evaluating all alternative bids and identifying the lowest evaluated optimum bid.

Checking the legal history of bidders and the validity of details submitted by them, reducing the requirement for experience in similar work in the preceding three to five years, establishing separate criteria to check the capability of new contractors and adjustments to annual turnover formula are the suggestions made for the post qualification verification stage. Similarly, suggestions made for the final stage of writing of the bid evaluation report, include the introduction of standard formats, getting the evaluator to justify his decisions and calculating the annual turnover. Further, it is suggested to make mandatory the requirement for technical literature and specifications and to have more input from QS to the report.

General Suggestions

It is suggested that the appointment of members to the TEC should be transparent and that their qualifications should be well established. The majority of them have to be technically qualified personnel. It is suggested to remove the authority devolved to Provincial Councils. The relevant Minister should clarify the decision pertaining to the award of the contract. The submission of the construction program and the method statement should be made mandatory.

8.5. Modified Bid Evaluation Procedure

The Modified Bid Evaluation Procedure (refer Appendix 1) has been developed using reliable expert suggestions.

9.0 Conclusions and Recommendations

There are four stages of GBEP, i.e preliminary bid evaluation, detailed bid evaluation and comparison of bids, post qualification verification and writing of the bid evaluation report. The extent of its use in both the public and private sectors was identified separately for convenience and it is confirmed that almost all organizations in the two sectors use GBEP with or without deviations from the existing procedure.

Advantages, disadvantages and/or limitations of each sub stage of GBEP were identified in general. Thereafter, reliable expert suggestions were collected to improve the bid evaluation procedure. Minimum qualification criteria, making clarifications in an accepted manner, checking the validity of details submitted by bidders, identifying the lowest evaluated optimum bid, use of standard formats wherever possible, justifications provided by the TEC/evaluators for each and every evaluation decision, making necessary calculations and submitting necessary evidence etc., are the critical suggestions made. The industry practitioners and regulatory and legal bodies in the construction industry are advised to appoint bid evaluation authorities in a transparent manner having a majority of technically qualified members. It was suggested to remove the authority devolved to

Provincial Councils to maintain consistency. The need to clarify the final decision with the TEC by the relevant Minister was discussed with a view to increasing the transparency of the bid evaluation procedure. One recommendation was to make the construction program and method statement mandatory to increase the accuracy and the reliability of bids even though this information is not contractually required.

These recommendations if implemented, would improve the quality and the standard of the construction industry. Hence, it is recommended that the stake holders consider these recommendations.

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Appendix 1

Modified Government Bid Evaluation Procedure

1.0 Preliminary Bid Evaluation	
1.1 Checking whether certain requirements have been fulfilled or not	A minimum qualification criteria to be established including the following: **The bidder is eligible** (should not have been blacklisted and in case of foreign funded projects, the bidder to be from the same country as the funding agency) **The bid has been signed by an authorized party** if necessary with Power of Attorney **Bid security** is in an acceptable format with the required validity and duration The bid contains all important documents with evidence to support bidder's eligibility and qualifications **The bid is complete** in that all items have been quoted for **Checking of the Technical and Financial Feasibility** ICTAD registration to be available at the **time of award of the Contract** **No bids other than late bids to be rejected by the Bid Opening Committee**
A1.2 Identifying deviations (Major, Minor & Debatable) & addressing those deviations	**Major or minor deviations** would depend on the following factors: Validity of the bid If it complies with the reasons for rejection as specified in the bidding document If it affects substantially the scope, quality, functionality or performance If it limits substantially the PE's rights or bidder's obligations If it is a deviation from the terms or the technical specifications in the bidding documents whose effect on the bid price is substantial although it cannot be given a monetary value **Debatable deviations** to be categorized as major or minor by the PE **Way of addressing most frequent deviations** When establishing the substantial responsiveness of bids, clauses in ITB should be given preference over general clauses Rejection of all incomplete bids after stating so in the bidding document Procedural deviations in the submission of bids to be considered as minor deviations except when the required signature is missing in the Form of Bid Although the failure to submit the proper bid security is to be considered as a major deviation, when specified validity is not available clarifications to be made Lack of supporting documents (The bidding document to state the way of addressing this. If no documents are available to substantiate the legitimacy of bid , it is to be considered a major deviation and if the bidder has not provided additional details pertaining to the technical part of the bids, it is to be considered a minor deviation) When bids are required at a firm price and when the bidder has

	applied an escalation clause to the bid, it is to be considered as a major deviation The way of addressing technical deviations to be stated in the bidding document as otherwise PE will make decisions on them. The bids to be rejected if the stated requirements of subcontracting are not complied with. If the extent of subcontract works is not defined, the PE to review the bid and make a decision Submission of an alternative bid based on a different design to be considered as a major deviation If the construction schedule of the bidder is not conforming to specified key dates, it is to be considered as a major deviation. However if the duration of construction schedule of the bidder is lower than what is specified, then it is to be considered as a minor deviation Conditional bids to be considered as non-responsive

2.0 Detailed Bid Evaluation and Comparison of Bids	
2.1 **Exclude VAT, contingencies and provisional sum amounts**	
2.2 **Correction of arithmetical errors**	Amount in words to prevail when there is a discrepancy between amounts in figures and in words. The unit rate to govern when there is a discrepancy between the unit rate and the total amount of a line item except when there is a misplacement of the decimal point in the unit rate. The amount stated in the Bills of Quantities to be equal to the amount stated in the Form of Bid by the bidder. The governing bid price to be the lesser amount of the quoted price by the bidder and the price corrected after the evaluation. If the corrected price is higher than the quoted price, the difference to be considered as a discount to the PE.
2.3 **Application of applicable discounts offered by the bidders**	Discounts offered by the bidders at the time of submission of bids to be considered Conditional discounts to be ignored Discounts to be considered in the manner the bidder has offered them (3ways) The parameters of applicable discounts to be stated in the bidding document The clause for applicable discounts for variations to be stated in the bidding document
2.4 **Adjustment to bid prices for omissions**	When there are bids in which some items have not been quoted for and when such omissions have been considered as minor deviations during the preliminary bid examination: Express understanding to be taken from bidders for unquoted items as to whether such items are covered by rates or not.

	Average prices for unquoted items to be not loaded for comparison purposes.
2.5 **Adjustments for acceptable departures**	Bids which have deviated from bidding document requirements and when such deviations have been considered as minor deviations during the preliminary bid examination The TEC to not make any adjustments
2.6 **Operational Costs and Life Cycle costing**	In order to determine the total cost during the life of a plant or equipment, the following are to be considered. The follow-on costs such as those related to fuel, spare parts, maintenance and depreciation to be discounted to their current net values. Initial purchase price Adjustments for extras, options, delivery, variations, deviations etc. Estimated operational costs (fuel, labour etc.) Estimated cost of spare parts and other consumables Efficiency and productivity A standard format should be used for the evaluation
2.7 **Conversion to common currency**	Even if bids in foreign currencies are allowed, they need to be converted in to Sri Lankan Rupees Conversions to be made using the mean rates established by the Central Bank of Sri Lanka or; Foreign bidders should price bids in Sri Lankan rupees.
2.8 **Domestic Preference**	This is with a view to promoting local industries by providing a realistic value addition to local raw material and domestic bidders when they compete with foreign bidders. Domestic bidders in Works contracts funded by GoSL are given a 4% margin of preference whereas World Bank and Asian Development Bank funded projects are given a 7.5% margin of preference The margin to be applied to domestic bidders who meet the following criteria: In case of sole proprietorship, when the bidder is a Sri Lankan In case of partnership, when 50% of the members are Sri Lankans In case of an individual firm registered in Sri Lanka with more than 50% of its shares owned by Sri Lankans and when not more than 10% of the contract price, excluding provisional sums to foreign contractors are sub contracted In case of a joint venture firm, when it is registered in Sri Lanka with more than 50% of its shares owned by Sri Lankans The bidder is registered in Sri Lanka Not more than 10% of the contract price, excluding provisional sums to be sub contracted to foreign contractors
2.9 **After sales Services**	If this is to be used as a factor for evaluation, the criteria for evaluation to be stated in the bidding documents. Since assigning a monetary value for after sales services is impracticable, non-monetary criteria to be developed to measure the services proposed by the bidders If the minimum standards have been established in the bidding document and if all the bids comply with them, they are to be treated

	on an equal basis. If the minimum standards have not been established in the bidding document, a point system to be used for evaluation by giving different ratings for different factors with these stated in the bidding document Examples of factors to be used are the proximity of service facilities to the location where equipment is to be installed, the number and the level of expertise of available staff, level of spare part stocks, duration of service etc. A Standard format to be used for the evaluation
2.10 **Examination for unbalance bids (front loading and back loading)**	Remedial actions to be taken in cases where unbalancing is substantial In contracts which exceed Rupees 500 Million in value, After calculating the values of the unbalanced items and the corresponding values in the Engineer's Estimate, add the difference of those two values to the unbalanced bid In contracts which do not exceed Rupees 500 Million in value, Bidder to provide a rate analysis and justification for such items and if it is acceptable, PE to proceed with it. If the bidder refuses to provide a justification, the bid to be rejected or the bidder to be requested to re-price his bid. If the bid has deviated substantially from the Engineer's Estimate, the Engineer's Estimate to be re-visited
2.11 **Comparison with the Engineer's Estimate**	Bids which are within +/- 30% of the Engineers Estimate to be rejected on reasonable grounds Reasonable grounds relate to factors such as market conditions, special terms in the bidding documents, prices in the recent past and / or any other relevant factors If the bid is reasonable under those factors, it is to be accepted If the bid prices are marginally low, Bidder has to justify them If the justification fails, the PE may reject the bid If all the bids are not within the margin, Engineer's Estimate to be re-visited and justifications made. The Engineer's Estimate to be realistic and accurate. It should be prepared considering prevailing market prices and geographical, environmental and social factors. The qualifications of the TEC members to be satisfactory and the appointment of the TEC to be done by the ICTAD Trend analysis to be adapted for the comparison and evaluation
2.12 **Rejection of all bids**	The procurement strategy to be accurate with a convenient time frame and the responsibilities of the Technical Evaluation Committees clearly listed out. Rejection of all bids can be effected when: There is no effective competition except when there is only one responsive bidder Not a single substantially responsive bid has been received There is inadequate competition (Unless, the only bidder is the

	lowest and the responsive bidder) All bid prices are unreasonably high and substantially above the PE's budget provision Bidding documents are found to be defective The requirements of the PE have changed
2.13 **Clarifications during evaluation**	Modifications are not allowed (Change of prices, delivery terms, conditions of contract or change of specifications as proposed by the bidder) The Bidder to make the clarifications to the TEC and the PE concurrently TEC to approve all the clarifications
2.14 **Alternate bids**	Provision for submitting alternative bids to be clearly stated in the bidding documents All alternative bids to be evaluated When the alternative bid price is lower than the original bid price, there should be no lowering of quality
2.15 **Identifying the lowest evaluated bid**	Post qualification verification to be done for the lowest evaluated bid The responsiveness of the bid to be determined by the TEC The lowest bid to be the optimum bid and the evaluation parameters to be defined accordingly

3.0 Post Qualification Verification	
3.1 **Checking Technical Feasibility**	Information on similar works carried out during the previous five years or three years in case of complex building projects; Resource availability/capacity, Knowledge of testing procedures. A detailed feasibility checking to be done in accordance with minimum qualification criteria establishedduring the preliminary bid evaluation The legal history of bidders to be checked. The validity of submitted documents to be checked. A separate criteria for checking the capacity of the new contractors to be set out.
3.2 **Checking Financial Feasibility**	Bank statements and business accounts of the three previous years Detailed feasibility checking to be done in accordance with minimum qualification criteria established during the preliminary bid evaluation Checking of the validity of submitted documents In case of complex and rare building projects , annual turnover of the bidder

4.0 Writing of the Bid Evaluation Report
A Standard format to be adopted in which the following factors and the recommendations of the TEC along with the justifications for the decisions are mentioned. Key dates and steps in the bidding process Bid opening information

Bidders' compliance with major commercial conditions (completeness, bid security, bid validity, completion period, payment terms)

Bidders' compliance with key provisions related to technical specifications

Technical literature and specifications sent by bidders

For all substantially responsive bids, a table showing

Arithmetical errors, discounts and currency conversions
Additions and adjustments
Domestic preferences
Various steps involved in the calculation of the evaluated bid price from the bid price announced

Comparison of rates

A record of clarifications made from bidders

In case of the lowest evaluated bidder, the post qualification verification

Names of the bidders who have been rejected and the reasons for their rejection

Proposed contract award recommendation

STRATEGIES FOR IMPLEMENTING A SAFETY CULTURE FOR CONSTRUCTION INDUSTRY IN SRI-LANKA

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ABSTRACT

Construction Industry basically involves in the activities of developing physical infrastructure related to all sectors of a country's economy. The Construction Industry Development Act No 33 of 2014 embraces the regulationary frame work, strategically developed for strengthening the operational machinery of the Construction Industry in Sri Lanka.

This paper describes findings based on an exploration of strategies that are suitable for adapting a safety culture in the Construction Industry of Sri Lanka. Presently, the majority of the local business is dominated by only a few players, while fierce global competition creep through back curtains of small and medium scale players around the country. Though this study was aimed at

finding strategies for the ultimate benefits of the entire country, due to its dynamic nature some aspects of this industry a policy framework has also been depicted, linking those local strategies with global strategies. 25 local construction companies were selected for the survey with a very good response rate of 80%. In the process comparisons were made with the other studies as well, in particular with Malaysia and Singapore, to identify our weaknesses and strengths. For the statistical analysis of group formations, the SPSS (*Statistical Product and Service Solutions*) cluster analysis techniques were used.

Results show that, most Sri Lankan Construction organizations do not use innovation as a strategy to focus on Safety. Yet no significant technology cum safety strategy is followed by the naturally formed clusters, thus pressurizing regulatory authorities to capitalize on creating a safety culture in the Industry.

INTRODUCTION

BACKGROUND

Sri Lankan Construction Industry, yet being the 2nd largest industry in the country, contracted by a marginal 0.9% during 2015, in comparison to 6.6 % growth recorded in the previous year, while its share in the GDP stood at moderate 7.5 %. This was mainly due to the incumbent government's policies on adhering to proper procuring procedures doing away with adhoc awarding of projects, followed by restructuring programmes on funding of projects avoiding debt financing to a minimal. Nevertheless financing the country's construction industry by commercial banks recorded an impressive growth of 36.1% in 2015, compared with the 22.3% growth for 2014, while considerable growth has indicated in the segments of importing Construction material and local production of Cement. In this backdrop the total number of employees in the sector including professionals, supervisory & management cadres, crafts persons of skilled, semi skilled and unskilled force, reached 559,000. Further with the recommencement of mega projects such as Port City (Colombo Financial City), which was temporary held up in order to be subjected to a heavy screening process, and with the proposed rapid development initiatives under the newly established Ministry of Megapolis & Western Development, a turnaround in growth rate may be expected within next few years, in the construction sector of Sri Lanka.

Construction Industry Development Act, no 33 of 2014, known as CID Act, transformed the industry to a different running mode. Gazette with effect from 28th December 2014, it transformed the Institute for Construction Training & Development (ICTAD) to Construction Industry Development Authority (CIDA), which is considered as a long felt need by all the stakeholders of the construction industry. The act is formulated with the specific object of the overall development of the construction industry in Sri Lanka and encompasses the key areas such as regulation, training and development with an institutional mechanism for funding of such activities. The overall objective is to make the Sri Lankan construction industry more efficient and globally competitive, while emerging as a hub of sustainable technology in South Asia.

As a major function of the Authority, CIDA has to recommend to the relevant authorities to regulate the health and safety standards and the use of hazardous material in construction industry. Under this recommendation it is vital to study the Sri Lankan players in the sector before

embarking on the move. As per CIDA records there are more than 3500 registered Construction Contractors in Sri Lanka in more than 20 categories varying from Building & Civil Engineering to Electrical & Mechanical Installations. There are approximately 50 key players and the majority being medium to small players meeting local requirements. CIDA has made it mandatory to posses Quality Management System Certification (ISO 9001-2008) for its top 03 grade C1, C2 and C3 categories in Main Construction fields and for EM 1 grade in Electrical Mechanical (specialized) fields. Recently CIDA has introduced another few grades above the C1 category, named CS1 and CS2, for which the possession of additional system certifications such as Environmental Management System (ISO 14001-2004) and Occupational Health & Safety Assessment System (OHSAS 1880-2007), are mandatory. Some of these key companies have ventured into overseas markets where there are no such organized entities as ours, adopting different marketing strategies. **Major foreign markets are Kenya, Bangladesh, Middle East and Maldives.**

In global competition, however, Innovation is considered to be the ultimate driver for business success thus they need to align Innovation Strategy with Business Strategy. In Sri Lankan context, Innovation capabilities, however, are less studied since most of them are originated in overseas and transferred to us through various mechanisms. In the face of fast growing Chinese Construction Industry, today, local players should be more reactive and adjustable to their highly technical but low cost strategies for a successful global entry.

Transfer of technology and introduction of new advanced methods have been identified as an essential component for the progress towards sustainable development in the Construction Industry. International technology transfer is a structural process of learning between nations and countries. The key component of a transfer is the knowledge derived from real world experience together with human expertise capable of transforming that knowledge into action. Transfer modes provides inputs to the functions of the firms that constitutes a technology transfer , which includes the coordination between technology developers and users, a facilitative environment that is supportive of entrepreneurship and networks and collaboration for information, finance and other pertinent resources.

Successful transfer of sound technologies is essential to the Construction Industry for facilitating development and enhancing sustainability, especially in developing countries and countries with economies in transition. Today’s Construction Industry has identified tools such as Lean Construction mechanisms and Building Information Modeling (BIM) as new advances in selecting their portfolios for successful transfers. Players in the industry use different strategies in upgrading the Operations Management systems of their organizations, leveraging on strengths and eliminating their weaknesses.

PROBLEM IDENTIFICATION

As the recent years' increase in the activities of Construction Industry have affected the general public's safety and health, it is high time to focus more attention on developing Safety concepts among its stakeholders. Construction accidents cause considerable damages to the contractor, client and the public. It has a direct financial cost to the contractor and indirect costs plus social costs to the country. With the enticing growth records experienced by the industry today, which is well and above 20%, the increase of construction accidents would also be inevitable unless some well thought proactive measures and actions are not looked upon. According to Industrial Safety Division of Department of Labor there had been 68 and 76 nos. of reported fatal accidents

in the industry sector, in the years 2014 and 2015 respectively. The records for non fatal accidents were 1361 and 1251 respectively for the years in review for the whole industry sector. On average, the Construction Sector contribution to those figures were identified as 30%. The most reported accidents where human and material both involved were in the category of "falling from heights". Next vulnerable area was recorded as the mishaps in material, machinery & equipment handling. The third and most dangerous category was the accidents reported from unprotected electrical contacts and from faulty circuits. The IEE regulations, specifies the use of standard of BS 7671 in installation of all electrical connections where safety has been focused as no 1 priority.

The true construction accidents would have been much higher as most had not been reported and gone under cover. Therefore introduction of Construction Safety & Occupational Health (CSOH) management training programme and establishment of such systems would be very vital for this synchronization of safety preparedness with the industry growth.

PROJECT OBJECTIVES

Identification of current status of Construction Safety & Occupational Health (CSOH) adaptations by players in the Construction Industry of Sri Lanka.
Proposing a Strategic framework for creating a Safety Culture in Sri Lankan Construction Industry.
Identification of capacity building requirements in CSOH activities.

SIGNIFICANCE OF THE STUDY

With the high intensive global competition, it is imperative for local Construction Industry players to be in compliance with international safety standards to boost their performance through strategically planned occupational health management procedures. This project intends to propose a strategic framework in creating a safety environment for industry players in their work sites and identify areas of improvements for the easy operationalization of such strategies, which are ultimately, be beneficial to the industry as a whole.

The rate of taking place of accidents in the construction related activities are on the rapid increase at present which aggressively stresses that construction industry increasingly require the establishment of proper occupational health and safety standards and management systems to ensure smooth flow of work increasing the productivity. The establishment of proper safety and health standards and adherence to those standards by the industry players are equally important to develop safety as a culture in the Sri Lankan Construction Industry.

In this scenario, it is very timely to start campaigns on Safety Culture and introduce awareness and capacity building programme in relation to Construction Safety & Occupational Health (CSOH) practices making the industry more sustainable offering adequate socio-economic benefits to the society. In the effort of introducing proper standards, it is vital to explore and share the experiences and best practices of our Asian counterparts. In most regional countries, the entry to construction sites by the craftsmen and other trades are controlled by introduction of a "Safety

Passport". In Sri Lanka it is assumed that more than 5,000 construction sites of varied sizes are operated in a year. Therefore it is essential to develop a similar number of safety passport holders during a year, subjected to a continuous assessment. No Training Institute produces adequate safety officers or supervisors to fulfill the demand in the construction sector, in Sri Lanka. According to Technical and Vocational Education and Training (TEVT) Guide 2014, published by the Tertiary and Vocational Education Commission, there are no specific courses dedicated for the Construction Industry. The National Institute of Occupational Safety & Health, which is under the purview of Ministry of Labour and Labour Relations, conducts few courses on general industry safety for the levels above NVQ 5. NVQ is the abbreviation for the National Vocational Qualification, which is identified as basis for identification of training level.

LITERATURE REVIEW

INTRODUCTION

De Silva and Wimalarathna (2012), found five main problems that exist in the industry to challenge enhancing OSH performance in the construction sites. They were Workers' reluctance to follow OSH rules, Poor budget allocations, Poor provision of regulations, Poor knowledge of workers and Lack of qualified S&H officers. Therefore, they suggested the timely need of a one strong body to take the leadership to overcome these challenges. Also in their study they have identified 35 OSH strategies and mechanisms in total, to enhance the OSH of workers.

According to Manjula and De Silva (2013), a safety culture is a subset of the corporate organizational culture that includes a set of enduring values and attitudes regarding safety issues, shared by every members of every level of an organization. They further elaborate that it can be regarded as "the product of individual and group values, attitudes , perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of , an organization's health and safety management". In conclusion these scholars argue that though OSH and Organizational Sustainability are two concepts, there cannot be an independent function, for any organization to be sustainable.

In a further study Manjula and De Silva (2014), have found that the most influencing personal factor for safety behavior was age while the most influencing organizational factor was OSH incentives. According to them, the least influencing factors were work-mates' safety concern and provision of PPE respectively under the categories, personal and organizational. They have also found that older workers exhibited more positive attitudes towards safety, than their younger counterparts. Further, work related pressures, exposure to previous accidents, knowledge on safety, educational level, experience and drinking habits were the other influencing personal factors while, OSH mechanisms, safety training and awareness, Management commitment, tidiness of the site and site layout were the other influencing organizational factors, according to them.

Daniel and Tracy (2014), two scholars of Hong Kong, describe that a practical safety model can be converted as a benchmarking tool, for measuring and comparing the overall safety standards of the different construction projects within an organization, between organizations and within the

construction industry. Therefore, this tool may be applied among cluster of Construction Groups who have different operations strategies, to identify their perceptions and attitudes towards Safety Strategies. In order to develop such a model mapping operations strategies and safety behavior, this study uses a model which has been used for manufacturing organizations. It is assumed that operations strategies adopted by Sri Lankan construction organizations are more or less similar to their manufacturing counterparts.

STRATEGIC GROUPS IN CONSTRUCTION

Miller and Roth (1994) have carried out a survey on a sample of Manufacturers in U.S. and identified three clusters of manufacturing groups, namely Caretakers, Marketeers and Innovators. This study attempts to map manufacturing firms with construction firms as most operations are similar in both industries. Though there is an industry effect, all three manufacturing strategy types have been observed in various industries. According to them, the two main dimensions along which the manufacturing strategy groups differ are the ability of the firms in them to differentiate themselves from competition with their products and services. A general method for mapping manufacturing strategies on these dimensions has been described by Miller and Roth. Furthermore for each manufacturing group, the relationships between the competitive capabilities, the business context, manufacturing activities and manufacturing performance measures have been explored and compared.

Unlike other scholars, the taxonomy developed by Miller and Roth**,** (1994) used techniques from the biological and social sciences to develop a "numerical" taxonomy using primary as opposed to secondary sources of information. The taxonomy has been developed by applying multivariate statistical procedures and grouping algorithms to measures of the perceptions of manufacturing managers. The research results produced by them goes beyond the formulation of a numerical taxonomy by attempting to identify the constructs that underlie its formation, and by observing the apparent relationships between group membership, business context, manufacturing choice, and manufacturing performance measures.

SAFETY STRATEGY VERSUS OPERATIONS STRATEGY

In achieving desired goals and objectives of operations strategies, it is imperative for a firm to be aligned with proper technology strategies. Technology capability is linked with technology-based strategic progression in business (Ramanathan, 1997). An overview of the existing classifications of technological capability shows that the ability of a firm to "buy, use , adapt and improve" technology can be placed in three convenient categories which may be called three legs namely Operative , Transaction and Innovative capabilities. However for these three to stand alone a good Supportive capability is required. Technology Strategy of a firm indicates its intention of how far they intend to go using a particular technology choice. A company's vision and mission together with the competitive environment and strategy will pave the way for an acquisition of a proper technology based development in the long run. Firms in late developing countries such as Sri Lanka, may follow the reverse order of technology life cycle stages namely emergence, growth, maturity and obsolescence. The set of strategies progresses, as given below.

(1) Extender Strategy – Price Minimization and survival are key features. Use cheap outdated technology in small scale as start ups.

(2) Exploiter Strategy – Quality Maximization and consolidation are focused in using mature technologies by relatively medium sized firms.

(3) Follower Strategy - Feature Optimization and use of advanced technologies are key norms of these large sized firms.

(4) Leader Strategy - Image Capitalization by high end, globalized market catching firms using state-of –the-art technologies.

This study on Construction Industry intends to map the safety strategies along with the technology strategies of Ramanathan model, as this taxonomy can be directly applied for both strategies.

METHODOLOGY

METHOD

There are many research designs available for empherical research, e.g. case studies, field experiments, panel studies, focus groups and surveys. Here a combination of literature survey and a questionnaire survey model was adopted because of its suitability for this type of research, where limited amounts of data are needed from a moderate sample. This requirement ruled out other methods which are implemented usually in small sample studies.

MEASURES

Measurement: Strategic Groups

The formation of Strategic groups was measured by having the respondents to rate the relative importance attributed to each of the following competitive priorities delineated in the five point likert scale, where "1 = Least Important" and "5 = Most Important".

Competitive Capability	**Defined as :**
Competitive Bidding Price	The capability to compete on price
Conformance quality	The capability to offer consistent quality
End Product performance	The capability to provide defect free products
Meeting Deadlines	The capability to deliver products within time
Defect Rectification Service	The capability to provide service of rectification
Participation in Award Schemes	The desire to excel in work
Value Engineering	The capability to introduce VE to process.
Variation Flexibility	The capability to respond to add work Broad Line
Use of Recyclable / Alt. Material	The desire to be sustainable
Benchmarking	The desire to compare and improve
Employee empowerment	The desire to empower the employees to make decisions
Quality Management System	The desire to stick to basic standard procedures
Environmental Management	The desire to protect Environment through rules Systems
Occupational Health & Safety Management Systems	The desire to be proactive through rules in S & H aspects

Deductive method – Roth & Miller Model

The depiction of popular Roth & Miller model of 1994, which interpretate three strategic groups, namely "Caretakers", "Marketeers" and "Innovators" for manufacturing organizations may be taken to map with construction organizations as well, as given below.

Group 1. Caretakers

They appear to have low relative emphasis on the development of competitive capabilities, and prepare themselves for the minimum standards for competition. Price is not significantly different in importance among the groups. Their ranks of competitive capabilities can be adjusted to represent construction companies in the following manner;

Competitive Bidding Price
Variation flexibility
Defect Rectification service
Quality Management System (QMS) certification

Group 2. Marketeers

They distinguish themselves from their group 1 and 3 members on several key market oriented competitive capabilities. Their ranks of competitive capabilities are,

Meeting deadlines
Conformance quality
Participation in Award schemes
End product performance
Environmental Management System certification

Group 3. Innovators

They are differentiated by the relative emphasis placed upon their ability to make changes in design and to introduce new products quickly. The innovators share certain characteristics with the marketeers. Relative ranks are,

Use of recyclable / Alternative material
Value Engineering
Benchmarking
Employee empowerment
OHSAS certification

The degree of importance, i.e. "4 = Very Important" and "5 = Most Important", are taken for ranking for particular groups. The rate "3 = Important" may not be taken as a priority, since it may not be the honest opinion of the respondents.

Measurement: Technology Strategy Stages for developing a Safety Culture Ramanathan Model

Defensive Strategies

Technology Extender Strategy

Players in the Construction Industry may follow this for survival. They may use these outdated and imported technologies in price sensitive markets.

Technology Exploiter Strategy

Medium sized firms may use modern and mature technologies in quality sensitive markets for consolidation.

(3) Technology Follower Strategy

Uses of growing technologies by some major players for feature sensitive markets are key issues in this catching up strategy.

Offensive Strategies

Technology Leader Strategy

The use of State-of –the-art technologies for global market competition by high technology key players in the local Construction industry fall into this category. These markets they perform are virtually high value markets, where they use cost focus and differentiation focus simultaneously.

However, according to Ramanathan (1997), the requirement of technological capabilities of an enterprise will vary depending on the strategy it is pursuing. For moving up from a lower to a higher level of strategy an enterprise not only needs the additional technological capability, but also needs a higher degree of sophistication of the technological capabilities.

Based on the above measures the following conceptual model can be derived (Figure 3.1)

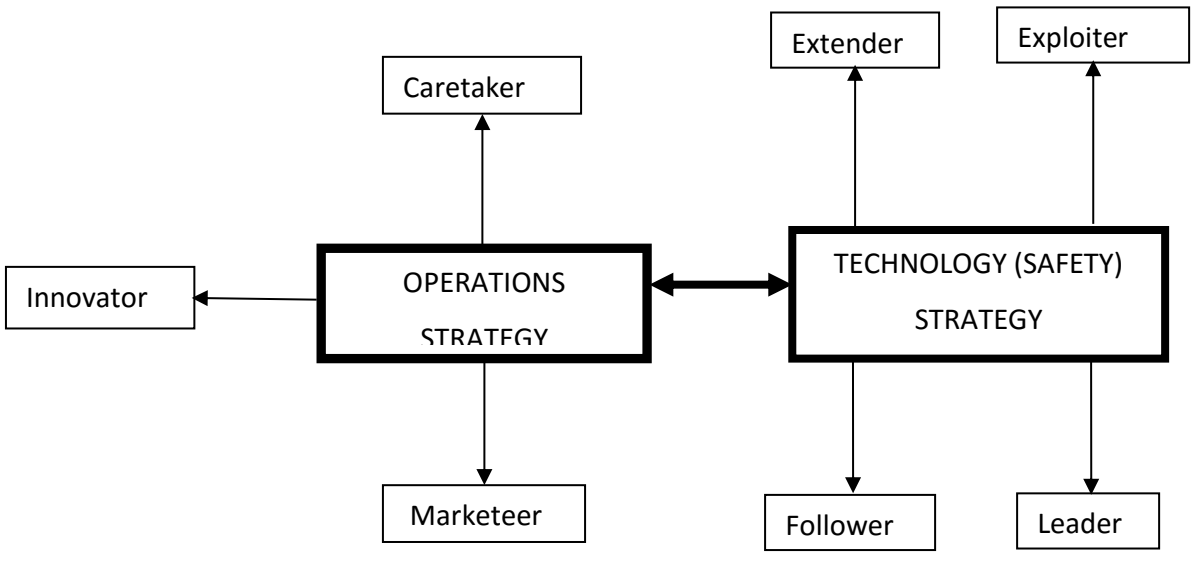

Figure 3.1: Proposed Model for mapping Operations Strategy & Safety Strategy

In this vein and in order to remain as true to the spirit of this proposed model as possible, a pattern of questionnaire developed by Hayes and Wheelwright (1984) was used. The Language of the questionnaire was carefully screened so that the questionnaire would be capable of being understood in construction organizations of all kinds. This required some amendments to the prevalent terminology for manufacturing organizations used by these scholars.

Each question was designed to test for a particular strategy of the Ramanathan model with a conversion of the pattern to suit the response being taken as indicative of one stage of the Hayes & Wheelwright model. They were presented as statements and respondents are required to answer each question by taking more sophisticated 5 point Likert scale (e.g. using 'strongly agree', ' strongly disagree' type responses) response-box after each statement. The statements were deliberately spread in a random manner rather than being organized according to the stages of the model. This was to deter respondents who might be tempted to offer responses that they thought might show their Construction organization in a good light. The random spread of questions would similarly also discourage socially described responses based on any pattern recognition of the underlying four-strategy model. Respondents were not asked for information about their organization (including its location, ownership, structure, culture and operating environment), but level of their CIDA grade, in an attempt to make it anonymous thereby to obtain an unbiased most correct set of information. The CIDA grade was requested to subsequently prepare suitable curriculum for capacity building activities.

The results were by no means conclusive and 'agree' responses were typically spread across all four strategic stages. Many respondents revealed inconsistencies by having, for example, an 'agree' response to more than one statement on a single factor. For example, on strategic process, a respondent might answer 'agree' to the stage 2 statements "Our Safety policy is mainly to keep up with the rest of our sector" and also the stage 4 statement "We have long-term policies to acquire a Safety Culture to enable us to be a leader in the Construction sector".

THE QUESTIONNAIRE

The survey instrument used in this study, shown in Appendix A, contains two sections. The first section, labeled section 1, was designed to measure the importance and performance of 14 competitive capabilities. A sample from the questionnaire is given in Table 3.1. In section 2, the respondents were asked to indicate the extent of individual emphasis and perceptions on the safety culture encircled by operations strategies followed by the firm, and adopting of improvement programmes in their firms. A sample of such questions raised is given in Table 3.2. This section also contained items that were designed to indicate the degree of how proactive a firm is: the level of coordination between sites and other functions: and whether safety policy was formally developed. Similarly, this section was designed using statements to measure the

attitudes of top managers towards safety culture. The OSH strategies and influencing factors identified by De Silva and Wimalarathna (2012), and Manjula and De Silva (2014), respectively, were also used in arriving at meaningful questions.

Table 3.1: Sample Questions -Section 1: Competitive Capabilities

	Not Important	Least Important	Important	Very Important	Most Important
7.Value Engineering	1	2	3	4	5
8.Variation Flexibility	1	2	3	4	5

Table 3.2: Sample Questions -Section 2: Safety strategy of organizations

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
15. We train our staff on safety when regulations require them.	1	2	3	4	5
16.We continually improve our quality while maintaining Safety standards so we raise the expectations of our customers.	1	2	3	4	5

The four-strategy framework of Ramanathan (1997) which was a multiple diagnostic tool was integrated with the Roth and Miller (1994) model to appraise constructor's position in the sector, The latter model described a classification of taxonomy of strategic groups, which had been a general method of mapping operational strategies on several dimensions .This study tried to map these models in construction firms as the technology, marketing and operations strategies were similar in nature in this sector.

THE SURVEY

Sample selection among the population

This sample is from the organizations solely engage in Construction for local & foreign soil. Two criteria were used for sampling the companies. Firms exceeding undertaking capacity of more than 150 million rupees (Above CIDA Grade C_3) were eligible to participate in the study. That was

necessary in order to eliminate small companies from the sample that were not likely to complete to questionnaire.

The key informant approach was used to pursue information from the 'key person' in the organization who is most capable of responding to the items in the questionnaire. In this case the key person was the Site Manager or the Project Manager or the person in charge of construction sites, regardless of his/her exact title within the company hierarchy.

Questionnaire and Response

The questionnaire was sent to twenty five (25) construction firms in early September 2015. This set of sample was selected from a population of approximately 200 players of CIDA C_1, C_2 & C_3 grades. However a total of twenty (20) filled questionnaires were received (05 from post and the rest were contacted through e-mails) for the analysis which resulted in a response rate of 80%.

DATA ANALYSIS

The Data Analysis was done using **SPSS** (*Statistical Product and Service Solutions*, formerly *Statistical Package for the Social Sciences*) software for the statistical analyses. Since in this research, the data used are quantitative, this package helped in a great manner to analyze the information in a comprehensive way to explain the Safety strategies suitable for strategic groups of Construction Contractors.

IDENTIFICATION OF STRATEGIC GROUPS & THEIR KEY ACTION ROGRAMMES

As per the deductive method described in the Chapter 3, the reliability of data, were measured using the SPSS reliability analysis.

Reliability of Competitive Capability variables

Cronbach's alpha is the most common measure of internal consistency ("reliability"). It is most commonly used when adapting multiple Likert questions in a survey/questionnaire that form a scale and when it is determined that the scale is reliable. In these cases, the Cronbach's alpha figures are **0.691**, **0.717 and 0.877** respectively for pre determined Cartaker, Marketeer and Innivator groups, which indicate a high level of internal consistency. (Note: A reliability coefficient in between 0.50 to 0.70 is considered "quite high, whereas a figure in between 0.7 to 0.9 indicates as "High" in most social science research situations.)

Table 4.1: Reliability Statistics of Competitive Capabilities

Strategic Group	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
(1) Caretaker	.691	.683	4
(2) Markeeter	.717	.746	5

(3) Innovator	.877	.880	5

ANALYSIS OF TECHNOLOGY STRATEGIES OF DIFFERENT GROUPS

Technological Capabilities of Strategic Groups of Roth & Miller Classification

Reliability of Action Programmes

According to the output for reliability statistics (Table 4.2) Cronbach's Alpha values of 0.713, 0.550, 0.775 and 0.792 are indicated on Extender, Exploiter, Follower and Leader respectively. Based on the decision-making in the reliability test, it can be concluded that this research instrument is reliable at a high level except for the case of Exploiter.

Table 4.2: Reliability Statistics of Action Programmes

Strategic Group	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
(1) Extender	.713	.739	6
(2) Exploiter	.550	.454	5
(3) Follower	.775	.792	5
(4) Leader	.792	.791	7

Group Statistics of Action Programmes of each group

Paired Sample T Test

In this study 14 competitive variables used to form the strategic groups in the construction industry were used along with the action programme variables. The Paired Samples *t* Test compares two means that are from the same individual, object, or related units. The two means typically represent two different times or two different but related conditions or units. The purpose of the test is to determine whether there is statistical evidence that the mean difference between paired observations on a strategic groups and action programs are significantly different from zero. The Paired Samples *t* Test is a parametric test. The Paired Samples Correlation summary (Table 4.3) shows that there are no any significant correlations with Caretaker, Markeeter and Innovator with Extender, Exploiter, Follower and Leader. (*Level of significant is* p>0.001). The detailed tests results are annexed in Appendix 2, for reference.

Table 4.3: Paired sample correlation -Summary ("r" = Correlation; "Sig." = Significance)

Action Programme	**Extender**		**Exploiter**		**Follower**		**Leader**	
	r	**Sig.**	**r**	**Sig.**	**r**	**Sig.**	**r**	**Sig.**
Caretaker	0.552	0.448	0.061	0.939	-0.477	0.523	0.644	0.356
Markeeter	0.304	0.620	-0.626	0.279	-0.243	0.693	0.248	0.688
Innovator	-0.024	0.969	0.087	0.889	-0.133	0.832	0.139	0.824

When applying the Ramanathan model of Technology strategies (mapped as Safety strategies), for the Construction Industry, it is seen that no significant strategy is followed by either of groups. Therefore it can be depicted as a mix of technology and operations strategies. However, some may argue that most Sri Lankan organizations posses “Follower” strategy where a global technology transfer would only drive such entities.

CONCLUSIONS & RECOMMENDATIONS

CONCLUSION

This chapter discusses the formations of strategic groups and the strategies to be adopted to develop safety culture in the context of the Sri Lankan Construction Industry. The proposed versions of so called clusters adapted from the point of view of many researchers are also given below for the readers to make judgments. Similarly the behaviour of local Construction Industry given due considerations to common lapses found in safety adaptations are also discussed in this chapter, which winds up with the future research suggestions. A framework integrating CSOH training programmes along with regulatory management techniques is best suited for all levels of players in this dynamic industry. Integration of all these with management commitment and continuous feedback & monitoring mechanisms can produce skilled and self disciplined personnel thereby creating a safety culture in most construction sites in Sri Lanka.

Strategic Groups

The study identifies three strategic groups based on the deduction of Roth & Miller model and 14 competitive priorities. They can be basically grouped as members with:

Cost and Final output consciousness & can be proposed as “Survivor”
Market and Final output consciousness & can be proposed as “Thriver”
Market and Final ouput consciousness, with some focus on "out of the box thinking" , who can be called as “Differentiator”

The taxonomy proposed here has much in common with the taxonomy of Roth & Miller (1994). Their “Caretakers” and “Marketeers” match with the “Survivor” and “Thriver” but do not match the “Differentiator” with “Innovator”. To the extent that their taxonomy identifies the same general categories of strategic behaviour, this research provide evidence on how construction operations strategies can be linked to the business units. The “differentiator” in this context shares much in common with the “Thriver” who has lots of marketing aspects, while the “Innovators” of Roth & Miller do focus on new scope developments and Innovation.

However, it is understood that, most Sri Lankan industries, especially Construction, do not deploy much innovations, as against their global counterparts. This is supported by the evidence in exploration of natural formation of groups in the local Construction arena, where only two clusters were seen to be reactive; one is based on “Final output Scope” and the other one with “Market Scope”. Construction Contractors in developing economies like ours may find it beneficial to follow the Chinese model by acquiring and adapting foreign technology as embodied

in machines and producing relatively low-quality products as China did during the early times of their industrialization. Since some key players fall into product development scope, they can acquire comparative advantages by concentrating on these available technologies first, rather than acquiring capital-intensive technologies.

Local Construction industry will continually be faced with the necessity to change their production structure to keep up with the dynamic comparative advantage. The markets for the Construction in which particular developing industry once had an advantage will disappear in near future, and the developing economy will either have to move out of the country seeking overseas ventures or switch their specialization. In other words it can be called as “hypercompetition” where the sustainability of adopting a mix of two different business strategies will come to an end. Thus Sri Lankan Construction contractors will find it beneficial to protect their industry, until the technological gap between them and the developed countries is closed in these new technologies.

Safety Strategy Stages

As per the results, no significant technology cum safety strategy is followed by the naturally formed strategic groups. This leads all the groups to a common platform, where the regulatory authorities may capitalize on designing a strategic framework in order to create a safety culture in the Construction Industry of Sri Lanka.

RECOMMENDATIONS

Developing a strategic framework for a safety culture

Though we cannot differentiate a significance in between Operations Strategies (basic competitive strategies) and Technology (Safety in this study) strategies, one might argue that in reality they need to work hard adopting both actions together, in order to remain sustainable.

When analyzing responses, most organizations were found to be inactive in making proactive commitments for a safety culture, showing signs of "followers" than "leaders". Capitalization on a Safety Policy and top management's dedication were given low priority by most counterparts making it further hampered. As found from the literature review as well, Sri Lankan Construction Industry needs a strong body to regulate the practices of Safety procedures, to improve the situation. To overcome the issue of Workers’ reluctance to follow OSH rules, a penalty mechanism coupled with motivational incentive schemes shall be in place. Working in inebriated conditions and using cell phones while working are further menacing issues faced by contracting organizations when deploying craftsmen. The regulating authorities responsible for the CSOH implementation, such as Department of Labor (Industrial Safety Division) , National Institute for Occupational Safety & Health (NIOSH) along with the apex body for the Construction Industry , CIDA shall develop CSOH Auditing & Monitoring mechanisms. Poor Budget allocation by Contracting Organizations for Safety Adaptations is a serious drawback in maintaining a healthy industry. Government Treasury allocations for public works such as buildings and other infrastructure developments shall carry a dedicated component for enhanced safety controls. For this CIDA shall revisit their "Preliminaries" document to provide an enhanced version for Safety Practices. Since this document is compulsory for "Identified Construction Works" (all public &

private works other than individual housing, of value more than Rs. 10.0 million) as per the CID Act, poor budgeting issue is expected to be diminished.

Department of Labour has initiated the establishing of Safety Regulations for all industries, while CIDA has a focused attention on the Construction Industry. In this vein, CIDA has introduced a section of disciplinary code for violation of basic safety adaptations in their Construction Contractor Registration Guidelines. Lack of knowledge among workers has been greatly affected filling the gaps in OSH practices in the local industry to be in par with other counterparts. Regular safety drills in construction sites are essential to maintain continuous attention on prevention of accidents, while strict disciplinary procedures and penalties for those who refrain from wearing PPEs and other violations shall be in place. Lack of qualified S&H officers who can give leadership to build up a safety mindset among workers, is another critical factor. Many organizations even faced financial difficulties in employing an S&H officer permanently. However CIDA has made it compulsory for the top grade contractors C 1, C2, and C 3 to possess CSOH Managers, Officers and Supervisors, thus inculcating an OSH culture among these players.

Capacity development for a safety culture

On-the-job (OJT) is a popular way of training focusing workers directly and this also acts as an incentive for the worker to remain with the organization. When deploying "contract" workers mostly supplied by manpower agencies etc, the benefits for the organization is not properly absorbed. Further, CIDA has already undertaken conducting site specific CSOH programmes when requests are forwarded. In addition, CIDA has already started development of curriculum for Certificate and Diploma Courses on CSOH based on following topics, in addition to generalized contents.

Stress management & Work Place Violence
Safety and Health Planning in Construction
Role of OSH Supervisor Traffic Control Devices Used in Road Works
Environmental Act (EPL & EIA)
Drug Prevention
Establish and Review Emergency preparedness and Response Plan.
Establish and Manage Incident and Accident Investigation
CS&OH Audit System.

FUTURE RESEARCH SUGGESTIONS

This research is a first step in empirically linking competitive priorities and safety strategies of Sri Lankan Construction organizations. Though the technology strategies could not be strategically linked with the firm's performances in the study, it is found that "Innovation" is the key capability most firms lack in reaching the so called "Leader" strategy status. Therefore it is suggested that the future research should focus on conceptualizing a framework on innovative capability versus safety strategies and actions programmes. Innovation should be the barometer of measuring the technology status with other factors.

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ASSESSMENT OF WHOLE BODY VIBRATION EXPOSURE LEVELS OFOPERATORS INCONSTRUCTION MACHINERIES

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ABSTRACT

Operator exposure to whole body vibration is involved in discomfort, health effects and interferences with activities. In order to reduce the vibration exposures, it is necessary to understand the existing level of Whole-Body-Vibration (WBV) exposure and to compare with the limits recommended instandards. Objective of this study is to investigate whole body vibration exposure levels of operators of construction machineries.

Ten operators of three types of construction machineries (i.e., excavators, backhoes and roller vibrators), which are vastly used in construction sector were selected. A questionnaire survey was carried out with each operator regarding their career, age, working experiences, health and exposure duration. The vibration exposure levels induced on operators body were measured using a tri axial vibration meter (SV 106) attached to a seat pad accelerometer. The operator was instructed to sit on seat-pad accelerometer and WBV exposures in three directions (i.e., vertical, fore-and-aft and lateral) were measured. It was found that the vibrational effect on vertical direction is more dominant than the other two directions (i.e., lateral and fore-and-aft). Measured vibration exposure levels were assessed based on recommendations given in ISO 2631:1997 and are presented in this paper.

Keywords: *Seat pad accelerometer, Occupational health, ISO 2631-1, Back pain*

1. INTRODUCTION

Field investigations showed that in Sri Lanka, construction workers and operators are frequently exposed to Whole body vibration (WBV) during their career (Vitharana et al, [1]). Number of mega scale construction projects in Sri Lanka has been increased during recent past few years. Hence the site workers have to use new technology as well as new machineries whenever they are engaging with the construction activities. Vibration is often used as an energy conveyer which is useful while doing some specific works such as breaking, drilling and compacting etc. However, operators of construction machineries and equipment are exposed to WBV. Employees may also not be aware of the health effects associated with long-term exposure to WBV. As a result, vibration related injuries seem to be neglected in Sri Lankan construction industry.

Operators of construction machineries are exposed to WBV while in standing posture but more often in seating postures (Subashi et al, [2]). Human body at seated posture shows resonance at about 5 Hz in vertical vibration and about 1-3 Hz in horizontal vibration, and attributed by significant motion of several parts of the human body (Subashi et al, [3]). This indicates that vibration can cause long-term painful damage. Shocks and jolts from driving certain types of vehicles can cause severe back pains, although workers and operators employed in construction industry, are not much aware on the health effects and risk associated with occupational vibration exposures (Vitharana et al,[4])

Exposure to high levels of WBV can increase risks to health of operators. When the vibration magnitudes are high, the damage can be severe and naturally irreversible. In addition to the magnitude, exposure durations, frequent, resting duration, and the vibration consisting with severe shocks or jolts are the major considerations when studying the risk associated with vibration exposure (Griffin, et al. [5]).Continuous exposure to WBV is one of the leading risk factors for the development of low back disorders. WBV can also humble other systems in the body suppressing the operation of the musculoskeletal, cardiopulmonary, metabolic, cardiovascular and gastrointestinal systems (Blood, et al. [6]). Comfort levels of the operators highly depend on the amount of vibration induced as well as long term effects. Unexpected shocks or jolts can also affect on the operators' concentration and interfere with activities, even can be a cause of occurring accidents.

For the quantitative analysis of the vibration exposure levels, it was required to identify well defined parameters that could be easily measured. Most commonly used orthogonal axis system for the whole-body vibration investigation is, the fore-and-aft direction is defined as the x-axis, vertical direction as the z-axis and lateral direction which is perpendicular to above both axis as the y-axis, rotation around the x-axis called as roll, rotation around the y-axis is called as pitch and rotation around the z-axis is called as yaw (Mansfield, [7], ISO 2631-1 [8]). To quantify the vibration exposures, Maryanne, [9] suggested few evaluating parameters and among them Root mean square value (RMS) and Vibration dose value (VDV) are recommended for analysing exposure levels with more variations.

Objective of this study is to investigate and assess the tri-axial whole body vibration exposure levels in operators of excavators, backhoes and roller vibrators, which are usedin construction industry.

2. METHODOLOGY

Sequence of the study is described with study group, questionnaire survey, instrument that was used to measure exposure levels, measuring procedure of exposure levels and analysis.

2.1. Study group

Ten operators were selected as the study group,which consists ofthree excavator operators, three backhoe operators and four vibrating roller operators. Before conducting the questionnaire survey and measurements, each operator was informed about the questionnaire survey and measuring procedure of exposure levels and what should be done. Age range of the operators participated in the current study was between 20 to50 years.

2.2. Questionnaire survey

Prior to the site visits, questionnaire survey forms were prepared according to the instructions published in a previous study (Griffin, et al. [5]). The survey was conducted for each operator to investigate their health levels and current situation of their profession. In addition, their work experience and age were recorded. Each operator was interviewed and the questionnaire survey was completedby the experimenter.

2.3. Instrument

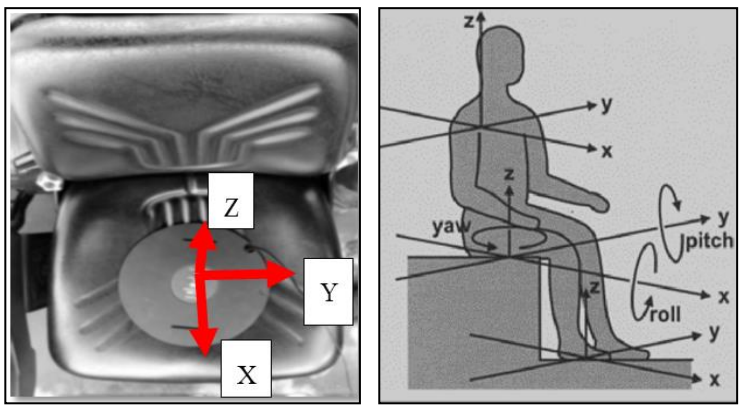
For investigation of vibration exposure levels that transmitted to operator's body, a tri- axial accelerometer was used (Figure 1). The tri axial accelerometer, SVANTEK 106, is a small size instrument and it is very easy to use at construction sites. The SV 106, which is a six-channel human vibration meter and analyser, was used to analyse the vibration exposure levels found in three different directions: vertical, for-and-aft and lateral.

2.4. Measuring WBV exposure levels.

Measurements were recorded, while operators were engaged in their regular tasks in the period between 9.00 am to 4.00 pm.

Basic instrumental setup including selection of suitable parameters was installed to the SV 106 before the measurement. In order to have desired measurements from the instrument, start delay time, measurement duration, weighting factor for each axis and repeat duration were initially set under instrumental setup. The measurement duration was decided in such a way that at least one typical working cycle should be included in the measurements while minimizing the disturbance of the operators' duty as much as possible.

The sensor of seat pad accelerometer was properly placed on the driver seat as shown in Figure: 1-(a). Three axes indicated on the seat pad should be coincided with the one specified (Figure 1-(b)).



(a) (b)

Figure 1: Seat pad sensor was placed (a) Seat pad accelerometer was placed on the seat (b) Specified axes of vibration

After placing the sensor, operator was instructed to seat on the sensor carefully and operate the machine as usual (Figure: 2-a). Measurements were recorded during the operation as shown in the Figure: 2-b.

(a) (b)

Figure 2: Measuring WBV exposure (a) Operator was instructed to seat on the sensor, (b) Recording measurement

2.5 Analysis

For each direction, measured vibration with weighting filter, a_w, was obtained from SV 106 analyser. Vector sum of frequency weighted rms accelerations (or vibration total values), av, was obtained from Equation 1 (ISO 2631-1 [8]).

$$av = \sqrt{(1.4 \times a_{wx})^2 + \left(1.4 \times a_{wy}\right)^2 + {a_{wz}}^2} - - - - - - (1)$$

Where a_{wx}, a_{wy} and a_{wz} are the frequency weighted rms acceleration in x, y, z orthogonal axes respectively

For x, y and z directions,daily vibration exposure of 8 hrs equivalent frequency weighted rms acceleration value was determined by using Equations 2, 3 and 4, respectively ((Griffin, et al. [5]).

$$A_X(8) = 1.4 \times a_{wx}\sqrt{\frac{T_{EXP}}{T_0}} \text{---------- (2)}$$

$$A_Y(8) = 1.4 \times a_{wy}\sqrt{\frac{T_{EXP}}{T_0}} \text{----------(3)}$$

$$A_Z(8) = a_{wz}\sqrt{\frac{T_{EXP}}{T_0}} \text{----------(4)}$$

Here,T_{EXP} is the duration of exposure to the vibration and T_0 is the reference duration of eight hours. The highest value of $A_x(8)$, $A_y(8)$ and $A_z(8)$ is considered as the daily vibration exposure, and was compared with exposure limits specified in ISO 2631-1 [8].

Summary of limits associated with different levels of predicted health risk according to the "Health Guidance Caution Zone (HGCZ)" values discussed in ISO 2631-1are given in Table 1.

Table 1: Health risks categorization with eight hour exposure levels A (8)

ISO 2631-1 Assessment of adverse health effect	A(8) (ms^{-2})
Below the zone (HGCZ) no health effects observed	<0.45
In the zone (HGCZ) Caution with respect to potential health risks is indicated	0.45-0.90
Above the zone (HGCZ) health risks are likely	>0.90

3. RESULTS AND DISCUSSION

3.1 Questionnaire survey

Age, experience, exposureduration and health issue of all operators are summarised in Table 2. It seems that age and past experience (number of years exposing to whole body vibration) are the most critical factors that could affect on the operators' health relative to the others. Among vibrating roller operators, OP1, who has one yearwork experience and age is 23 years does not feel any health issues in his career as an operator. All three backhoe operates were affected by the vibration (Table 2)perhaps, attributed by long term WBV exposures (i.e., experience of those operators relatively greater)(Table 2). Excavator operator, OP10,has not been affected by any difficulty as well. He is also a relatively young operator with two years work experience. Operators, who have been exposed to WBV in several years with fairly older age, have been suffered with health issues: 50% of operators have back pain and 30% of operators have Normal daily tiredness.

Table 2: Age, work experience, exposure duration and health issue of ten operators

Construction machinery	Operator	Age (year)	Work Experience (years)	Exposure Duration (hours)	Health Issue(regardingoperation)
Vibrating roller	OP 1	23	1	6	No
	OP 2	31	8	6	Back Pain
	OP 3	32	5	5	Normal daily tiredness
	OP 4	36	9	6	Back Pain
Backhoes	OP 5	37	10	5	Back Pain
	OP 6	32	10	5	Normal daily tiredness
	OP 7	37	12	5	Normal daily tiredness
Excavator	OP 8	30	6	4	Back Pain
	OP 9	35	15	3	Back Pain
	OP 10	23	2	6	No

3.2. WBV exposure levels

Figure 3 shows a_w (measured vibration with weighting filter) variation of backhoe operator (OP 6) for vertical, fore-and-aft and lateral directions. It can be seen that operator was exposed to number of shocks, although they are not in large magnitude. Frequency weighted rms value, $a_{wz,}$ for vertical direction is 0.45 ms^{-2}. However, for the fore –and-aft direction and lateral direction, it was 0.28 ms^{-2} and 0.3 ms^{-2}, respectively, which are lesser than the a_{wz} value found for the vertical direction.

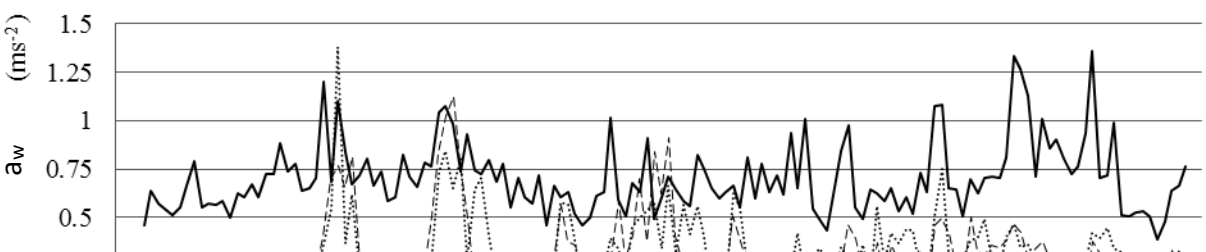


Figure 3: a_w variation for the backhoe operator (OP 6)

Table3: Range of Frequency weighted rms acceleration a_w in three orthogonal directions

Construction machinery	Range of a_w values (ms^{-2})		
	Fore and aftdirection	Lateral direction	Vertical direction
VibratingRoller	0.07-0.21	0.07-0.21	0.44-1.42
Backhoe	0.19-0.59	0.22-0.36	0.29-0.74
Excavator	0.13-0.37	0.09-0.47	0.07-0.94

Range of frequency weighted rms acceleration, a_w, for each type of vehicle is summarized in Table 3. It can be observed that the vibrational effect on vertical direction is more dominant than the other two directions (i.e., lateral and fore and aft).Vibration total value, a_v, variation with the time of vibration obtained from the same operator (OP6) is shown in Figure 4. Average of this variation is $0.83ms^{-2}$.

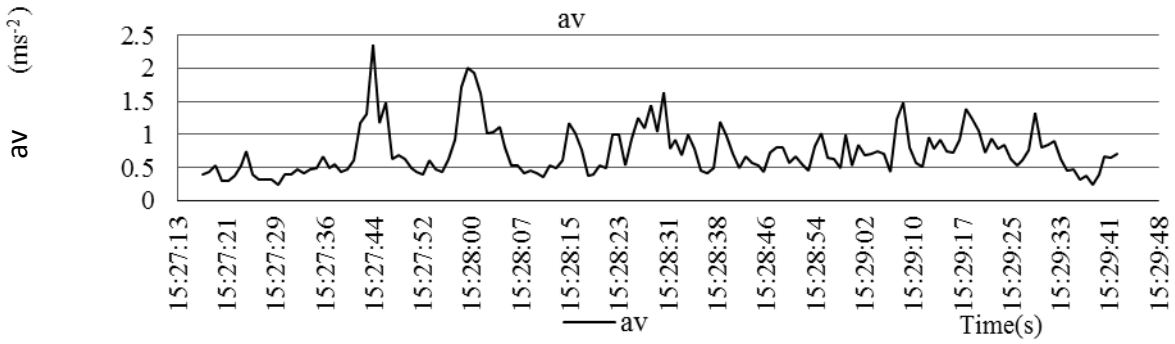


Figure 4: Vibration total value, av variation with time for the backhoe operator (OP6)

3.3 Assessment of WBV exposure levels

Table 4: Assessment of WBV based on ISO 2631-1(1997)

Construction machinery	Operator	Exposure Duration (hours)	Vector sum of frequency weighted r.m.s accelerations	Daily exposure A(8) ms^{-2}	Health Risk according ISO 2631-1

Vibrating roller	OP 1	6	0.83	0.56	In the zone
	OP 2	6	0.90	0.65	In the zone
	OP 3	5	0.49	0.35	Below the zone
	OP 4	6	1.42	1.23	Above the zone
Backhoes	OP 5	5	0.51	0.28	Below the zone
	OP 6	5	0.83	0.43	Below the zone
	OP 7	5	1.15	0.65	In the zone
Excavator	OP 8	4	0.24	0.11	Below the zone
	OP 9	3	1.28	0.66	In the zone
	OP10	6	0.91	0.47	In the zone

Vector sum of frequency weighted r.m.s acceleration values of each operator have characteristics which are related to the daily exposure value. Many of the operators are exposed to daily vibration exposure within or above the Health Guidance Caution Zone (HGCZ) (Table 4). One of vibrating roller operator, OP4, is exposed to daily vibration exposure above HGCZ and is in high danger than the other operators. Vibrating roller operator, OP 3, backhoe operators, OP 5, OP6 and excavator operator, OP 8 are exposed to daily exposure, which are below the caution zone. As mentioned in the ISO 2631-1 health risks on those operators may not be much concerned. Rest of the operators are exposed to daily exposures in the caution zone and there are possible potential to affect on the health levels of those operators. This indicates that an appropriate formalised preventive programme must be set up by the employer to reduce exposure to vibration and attendant risks.

5. CONCLUSIONS

Age and past work experience (number of years exposing to whole body vibration) are the most critical factors that could affect on the operators' health, in addition to the daily vibration exposure, which could be determined from Whole body vibration (WBV) measurements.

Vibration total value or Vector sum of frequency weighted r.m.s acceleration values of each operator has characteristics which are related to the daily exposure value. According to the ISO 2631:1997, vibrating roller operators have higher potential of facing health effect than other two category discussed in this study.Majority of operators in the study group are in Health Guidance Caution Zone (HGCZ).

When compare the vibration exposure levels of three axes (i.e. fore and aft, lateral and vertical), it was identified that highest average value is always found in the vertical axisfor each category of machineries. Therefore, to minimize the health risk on the operators, it is desired to damp the vibration that comes in vertical direction.

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INVESTIGATING DRIVERS FOR IMPLEMENTING FAÇADE RAINWATER HARVESTING IN HIGH-RISE BUILDINGS IN SRI LANKA

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ABSTRACT

Rainwater can be collected using various existing structures such as rooftops, parking lots, playgrounds, parks, ponds, and a building's façade. Even though other structural elements are highly integrated, less consideration and less priority is given to rainwater collected through a 'building's façade'. However, it is an existing researchable area in the built environment, and thus, this research aims to investigate the feasibility of implementing façade rainwater harvesting system in high-rise buildings in Sri Lanka. Initially, the available literature was critically reviewed and a structured questionnaire survey was conducted among industry practitioners involved with design and construction of rainwater harvesting (RWH) in building projects. The study adopted both descriptive and inferential statistics to analyse the questionnaire responses. During implementing facade RWH system, intensity of rainfall is the most significant driving factor to be considered. Climate (rainfall patterns) and size of façade are considered as second and third most significant driving factors when implementing façade RWH system, while location of the building, working hours, rainwater quality, geography of the area, user's age, and aesthetic appearance of the building are considered as non-significant driving factors. It recognised that most of these factors belong to technical and operational aspects. In addition, a case study strategy examined the current practice of implementing facade RWH system in Sri Lanka. The case study findings revealed that possibility of implementing rainwater harvesting in high-rise buildings in Sri Lanka as an alternative to reduce potable water consumption. Responsibility of implementing this system depends on the decision of the building owners, and the existing rules and regulations.

Keywords: *Façade; High-rise Buildings; Rainwater Harvesting; Sri Lanka.*

INTRODUCTION

Water is an essential natural resource for sustaining life and environment, and the demand of potable water is constantly increasing due to industrialisation and urbanisation. Within this context,

traditional or alternative forms of water resources such as rainwater are considered as attractive options to reduce the potable water consumption worldwide. Rainwater harvesting technique is the most traditional and sustainable method, since rain is a blessing of nature, which could be easily used for potable and non-potable purposes in any kind of building (Rahman *et al*., 2014). Parghane *et al.* (2006) defined Rainwater Harvesting (RWH) as a system that collects rainwater from roofs and the area around the buildings directed into open wells, bore wells, and tube wells through a filter tank specifically to serve the purpose.

Different types of methods and techniques are available to collect rainwater for the RWH system in buildings, such as rooftop water collection, capturing water run-off through wells, shafts, storm water drains, gabions, ponds, basins, or wells (Deshmukh, 2006). Compared to other structural elements used for RWH system, less consideration and less priority is given to the rainwater collected through 'building's façade' (Deshmukh, 2006). Frequently, building's façade is designed by considering the thermal impact (Sheweka and Mohamed, 2012) rather than rainwater collection through the façade. Canavan (2011) noted that in urban areas, the roof area is proportionally smaller in high-rise buildings and the opportunity of collecting rainwater is inadequate. As a result, rainwater falls on the vertical surfaces of buildings.
In Sri Lanka, the urban authorities have realized the extreme difficulty of expanding their water supply schemes, not only due to financial constraints, but also due to limited water resources (Ariyananda, 2007). The same author further explained the necessity of identifying alternative water sources in urban areas due to high demand for pipe borne water, with the upsurge of population. In this situation, RWH is considered as one of the most feasible solutions to reduce water consumption, since Sri Lanka receives an adequate rainfall to manage the total water requirement throughout the year (Ariyananda, 2007). However, only few buildings have implemented RWH systems in Sri Lanka yet, and among them, rooftops, ponds, or other structural elements collect rainwater (Fernando, *et al.*, 2014). Due to unawareness or technical issues among the community, less consideration is paid to the building facade. In high-rise buildings, a significant area of the building is covered by the building's façade, and therefore, it is important to seek the potential advantages of using rainwater harvesting systems in new developments or existing buildings. Hence, this untapped potential area leads to the research question as, "what are the drivers that impact on implementing façade RWH system in high-rise buildings in Sri Lanka?"

LITERATURE REVIEW

RAINWATER HARVESTING SYSTEM

RWH is the oldest method of securing water, practiced by ancient civilizations for over 4000 years, when the pipe-borne water system was not in existence (CEHI, 2009). The Cabell Brand Centre (2009) reported that RWH is suitable for all building types ranging from residential to commercial and industrial, and further can be retrofitted in the existing buildings or integrated into the new building designs. Ahmed *et al*. (2014) highlighted that rainwater is a freely available resource and harvesting rainwater can reduce the demand for main water supply. Further, same authors mentioned that it could help to reduce the pressure on urban drainage infrastructure as well.

Similarly, Gowland and Younos (2008) stated that RWH reduces the demand for potable water and it is most effective for the storm water drainage system in high-rise buildings. In addition, the collected rainwater can be simply used for water closets, urinals, irrigations, and fire suppression in high-rise buildings. Texas Water Development Board (2005) mentioned that, in buildings with extensive catchment surface, a high volume of rainwater can be collected and stored, which can serve several purposes, cost effectively. White (2009) indicated that RWH technologies are simple

to install and operate. The running cost is almost negligible. In the economic sense, it provides water at the point of consumption. Hence, there is a potential to increase sustainability and resilience of buildings and urban environment by reducing the extraction of underground water resources within urban areas (Ahmed *et al*., 2014; Pinzon, et al., 2012). Proenca and Ghisi (2010) mentioned that many countries conduct research on RWH systems to promote sustainable use of water.

FAÇADE RAINWATER HARVESTING SYSTEM

The building façade is one of the most important exterior elements for building functionality. Hadden and Lee (2005) mentioned that the façade of a building provides protection for its occupants against wind, rain, and the extremes of temperature and humidity. Therefore, a building's façade is designed by considering the thermal impacts and protection to its occupants, rather than considering rainwater collection. However, Canavan (2011) identified that building façade is one of the most important building elements for collecting rainwater, and defines Façade RWH system as 'collection of rainwater by using the building façade instead of roof collection and it directs the rainwater falling on the glazing panels into the vertical mullion and from there downward into a basement collection'.

Nowadays, the concept of high-rise building is globally becoming a fast growing phenomenon due to high cost of land price, limited land availability, increasing population, and the advancements in the field of structural engineering initiated to adopt vertical development in the core urban areas (Bhattacharya and Singh, 2013). Earlier, most building designers considered rooftop as the most suitable method for RWH. However, Canavan (2011) shows that urban buildings can reap benefits by collecting rainwater from building façade, since façade covers a significant building area.

Most tall buildings are presently constructed integrating typical requirement of sustainability concepts (Pank *et al*., 2002). They further stated that the earlier perception of tall buildings as large-scale energy consumers, with little regard for sustainable architecture; it is now changing, and energy conservation and sustainability are inbuilt with the design. The literature bears evidence that Façade RWH is one of the components need consideration to gain green and sustainable certification. Pank *et al*. (2002) stated an immense potential exist for improving the sustainable development of new high-rise buildings in the city.

RAINWATER HARVESTING IN SRI LANKA

Presently, Sri Lanka ranks high in the world in the annual renewable quantity of water, with an average annual rainfall of 2400 mm, ranging from 900mm in the dry zone to 5000mm in the wet zone; the rainfall is bi-modal and varies seasonally and spatially (Ariyananda, 2005). Further, Ariyananda (2005) described that due to the bi-modal pattern of rainfall in Sri Lanka, RWH systems that collection, storing, and saving rainwater during rainy seasons for usage during the dry season, are feasible. National Water Supply and Drainage Board (NWS&DB) (2013) report reveals that pipe-borne water demand is continuously increasing, mainly due to high population growth and rapid urbanisation. Moreover, the Western Province demands a higher water production, which is almost equal to 60.8%.

At present, the government of Sri Lanka confronts an issue with providing adequate amount of water for the people. Many researchers realized that in Sri Lanka, a significant volume of pipe-borne, i.e. purified water is used for toilet flushing, washing of clothes, and other activities such as cleaning vehicles, machineries, and equipment (Waidyasekara et al. 2014, 2015). Particularly, major institutions and industries where many people visit for work and for daily personal matters,

require the provision of mainly wash room facilities; here, thousands of litres of pipe borne water is wasted daily due to carelessness and negligence of the user (De Silva *et al*., 2007). As a result, the Sri Lankan government recognized the importance of having a RWH policy in Sri Lanka to meet these water challenges. In 2005, for the first time in Sri Lanka, the government established and approved a "National Policy on Rain Water Harvesting and Strategies" (Ariyananda, 2007). This policy highlighted that RWH is a mandatory for all areas under Urban Council, and Municipal Jurisdiction within the prescribed time period, and it should be integrated in to the building construction plans.

However, only few buildings have implemented the RWH systems in Sri Lanka yet, and mostly, it is collected through rooftop or gutters (Ariyananda, 2007). Even though other structural elements in buildings can collect rainwater, building's façade is given less consideration and less priority. Therefore, to retain rainwater and to solve the water problem, collection of rainwater through building façade in high-rise buildings in urban areas should be promoted. However, among the community, it is still an existing researchable area since few high-rise buildings use this innovative system in Sri Lanka.

CRITERIA THAT AFFECT ON FAÇADE RWH SYSTEM

Many individuals and local communities throughout the world have developed a variety of RWH systems. In addition to cost, a number of factors should be considered when designing and implementing an appropriate RWH system for high-rise buildings. According to the study of Water AID-Bangladesh (2006), the potential advantages of using water harvesting systems in new developments require an understanding of the relationships between a wide variety of factors, namely social, environmental, technological, and operational. Similarly, Teklehaimanot and Beshah (2006) identified factors affecting the utilization of RWH as institutional factors, psychological factors, social factors, economic factors, and physical factors. Conversely, Abdulal *et al*. (2006) and Worm and Hattum (2006) identified the technical, economic, environmental, and social factors as evaluating criteria for RWH system. The design, implementation, operation, and maintenance of a successful façade RWH system are determined by these factors. Literature bears evidence that these factors may vary among countries when implementing façade RWH. By considering all, this study adopted five (5) criteria, such as technical, economical, operational, environmental, and social. Following subsections discuss driving factors identified under each criterion.

2.4.1. TECHNICAL FACTORS

Technical factors were focused to gain an understanding of the present technical resources of the organization and their applicability to the expected needs of the proposed system. According to Worm and Hattum (2006), construction of a RWH system is determined by several critical technical factors, such as catchment material, capacity of the storage tank, water consumption rate, availability of water sources, and availability of labourers with technical skills.

2.4.2. ECONOMIC FACTORS

Purpose of economic factors is to determine the positive economic benefits that the proposed system will provide for the organization. Construction and maintenance cost are the most important information that should be considered during determining the designing aspects of rainwater harvesting system. Rahman (2014) stated that the associated costs of a RWH system are for installation, operation, and maintenance. According to Pinzon *et al*. (2012), cost of technology, payback period, water price, and maintenance cost are considered as economic factors.

2.4.3. OPERATIONAL FACTORS

Operational factors focus on the proposed development projects to identify whether the proposed development fits with the existing business environment and objectives. Jha *et al.* (2014) noted that water related laws, organizational policies, and government regulations considered as operational factors.

2.4.4. ENVIRONMENTAL FACTORS

Environmental feasibility depends on the amount and patterns of rainfall in the area, duration of dry periods, and the availability of other water sources. As per Ge and Krpan (2007), the amount of rain that fall on the vertical wall surface, wind speed and direction, rainfall intensity, and duration and frequency of rain event are considered as environmental factors. In addition, Abdulal *et al*. (2006) noted that sustainable water use and clean water supply are also considered as environmental factors.

2.4.5. SOCIAL FACTORS

When introducing any kind of a new system, social factors are considered as one of the most important entity for ensuring local appropriateness and sustainability of the system. When designing or implementing the façade RWH system, it is vital to focus on social factors as well. According to Jha *et al*. (2014), people's experience with RWH, public perception on RWH regarding the reliability and quality of the non-potable water, health and safety concerns, and attitudes of the people are considered as social factors.

A critical literature review and testing in the empirical survey identified forty one (41) driving factors that influence the implementation of façade RWH system in high-rise buildings.

RESEARCH METHOD

To achieve research objectives, available literature was reviewed critically, and quantitative and qualitative research approaches were adopted. The structured questionnaire survey was conducted initially to identify the feasibility aspects of the identified 41 driving factors that influence façade RWH system in high-rise buildings in Sri Lanka. The sample consists of thirty-five professionals involved during the design and construction stages of RWH systems for buildings. The respondents were requested to rank the driving factors according to their significance. These driving factors were analysed using RII, adopting the formula 1. The significant level of factors was evaluated with five-point Likert scale, ranging from 'not significant' (1) to 'most significant' (5). To identify the significant driving factors, the t-test was performed at 5% significance level (alpha = 0.05).

Next, a case study strategy was used to study in-depth analysis of implementing facade RWH system in high-rise buildings in Sri Lanka. Multiple sources of evidence were used during data collection and presented as a narrative form. Case selection and unit of analysis are discussed in Section 4.

$$\textbf{Relative Importance Index} = \frac{\sum (W \times n)}{A \times N} \times 100\% \qquad \text{.....(1)}$$

Where,

W = weighting as assigned by each respondent in a range 1 (Low) to 5 (High)

A = the highest weight (5)

N= total number in the sample

RESEARCH FINDINGS AND DATA ANALYSIS

The questionnaire survey sample consisted of twenty-four engineers, ten architects, and one hydro biologist. Out of the thirty-five individuals, only thirty-two responded to the questionnaire with 91.43% response rate as presented in Table 1. Majority of them had over 15 years of experience and represented 41% from the total sample. Furthermore, out of the selected sample, categories of 10-15 years, 5-10 years, and less than five years experience included 31%, 16%, and 13% respectively. Quantitative findings are presented in Section 4.1.

Table 1: Details of Questionnaire Respondents

Respondent's Profession	Distributed	Responded	Response Rate %
Engineers	24	22	91.66
Architects	10	9	90.00
Hydro Biologist	1	1	100.00
Total	**35**	**32**	**91.43**

Further, a single case study was conducted in an existing high-rise building in Sri Lanka, which has already implemented the façade RWH system. Three face-to-face interviews were conducted with two facility managers (FM-1 and FM-2) and one mechanical engineer (ME) involved in façade RWH system in the selected case; findings are presented in Section 4.2.

4.1 DRIVING FACTORS ACCORDING TO FEASIBILITY CRITERIA

Forty-one driving factors identified, which influence façade RWH system in high-rise buildings in Sri Lanka. These factors are grouped into five feasibility aspects: environmental, technical, economical, operational, and social. Results from the survey are summarised in Table 2. To identify significant driving factors, the t-test was administered at 5% significance level (alpha = 0.05).The critical t-value is considered as 1.6955 (from the table of critical t-values), when degrees of freedom is 30.

Table 2: Driving Factors Influencing on Facade Rainwater Harvesting According to Feasibility Criteria

Criteria	Factors	Analysis		
		RII %	**Rank**	***t*-value**
Environmental	**Intensity of rainfall**	93.75	1	17.841*
	Climate (rainfall pattern)	93.12	2	19.416*
	Sustainable impact to environment	83.75	7	12.555*
	Evaporation rate	71.25	29	6.313*
	Duration of dry period	69.37	33	2.792*
	Geography of area	60.00	38	0.000**
	Location of the building	65.00	35	1.293**
Technical	**Size of facade**	90.62	3	15.275*
	Designer's/ engineer's experience	86.25	5	13.876*
	Capacity of storage tank	85.00	6	16.073*

	Availability of space	83.12	8	14.603*
	Façade material type	82.50	10	10.449*
	Height of the building	82.50	10	8.470*
	Shape of the building	82.50	10	10.449*
	Availability of technology	81.25	14	11.925*
	Wind speed and direction	80.62	16	8.395*
	Government regulations	80.00	17	9.960*
	Height of the story	79.37	20	6.366*
	Runoff coefficient	78.75	22	7.927*
	Delivery system	78.75	22	11.012*
	Drainage pattern (guttering system for overflowing)	78.12	24	6.981*
	Availability of construction materials	72.50	28	5.805*
	Adjacent buildings	70.62	30	3.947*
	Water treatment methods	70.62	30	3.947*
	Rainwater quality	61.87	37	0.649**
Economical	**Reduction of potable water demand**	87.5	4	12.771*
	Design and construction cost	80.00	17	15.748*
	Payback period	65.62	34	2.183*
Operational	**Easy access to maintenance**	81.85	13	10.522*
	Water demand for non-potable water	81.25	14	11.925*
	Organizational policies	80.00	17	9.092*
	Operation and maintenance cost	79.37	20	7.407*
	Use of rainwater	75.62	25	7.266*
	Existing water sources	74.37	26	5.578*
	Water consumption pattern	74.37	26	5.268*
	Number of occupants	70.00	32	3.937*
	Working hours	63.12	36	1.222**
Social	**User's perception of rainwater use (attitudes)**	83.12	8	6.855*
	User's education level	52.50	39	-2.436**
	User's age	48.12	40	-4.013**
	Aesthetic appearance of the building	43.75	41	-3.820**

*- significant driving factors influencing façade RWH system

**- non significant driving factors influencing façade RWH system

It is apparent from Table 2, if the observed t- value is greater than the critical value, it is considered as a most significant factor, and thus, the null hypothesis is rejected and the alternate hypothesis is accepted.
Accordingly, forty-one driving factors were tested with SPSS, from which thirty-four factors identified as significant driving factors (bold in Table 2) to be considered when implementing façade RWH in high-rise buildings in Sri Lanka; seven factors were identified as non- significant. According to Table 2, intensity of rainfall, climate, sustainable impact to environment, evaporation rate, and duration of dry period are considered as significant driving factors. Geography of the area and location of the building are considered as non-significant driving factors influencing facade RWH system, since these are lower than the critical t-value 1.6955, relating to environmental feasibility criteria. Size of facade, designer's/ engineer's experience, and storage tank capacity are considered as the top three significant driving factors while rainwater quality is considered as the only non-significant driving factor relating to technical aspects

However, of economic criteria, all factors are considered as significant driving factors, namely, reduction of potable water demand, design and construction cost, and payback period. Easy access to maintenance, water demand for non-potable water, and organizational policies are considered as significant factors while working hours is considered as a non-significant factor in relation to operational feasibility criteria. User perception of rainwater use is the only significant factor while user's education level, age, and aesthetic appearance of the building are considered as non-significant driving factors in relation to social aspects.

4.2 ANALYSIS OF CASE STUDY

4.2.1 BACKGROUND TO THE CASE ANALYSIS

A case study was performed in an existing high-rise building located in the Colombo city, which already implemented the façade RWH system. A single case design was employed in this research study when selecting cases relating to the research area, due to a rare and unique circumstance of the research area during the study period. The unit of analysis of this study was "façade RWH system." Semi structured face-to-face interviews were selected for the study and interviews were conducted with individuals involved in façade RWH system in the selected organization. With permission of interviewees, the interviews were tape-recorded together with taking down notes to avoid data loss, and to secure an accurate account of the conversations.

Basically, following aspects were questioned from interview personnel: Purposes of integrating façade RWH system in the building, Design and technological aspects concerned, Operation and maintenance aspects of façade RWH system in the building, Benefits, Constraints, and General opinion of implementing façade RWH system in high-rise buildings.

4.2.2 PURPOSE OF INTEGRATING FACADE RWH

Based on the individual opinions, it revealed that main purposes of implementing façade RWH system were to reduce wastage of water and to reduce water bill in the organization by recycling and reusing rainwater for different purposes. FM-1 stated, "*Rain water is something that has been wasted right throughout building operations. So, we have realized, if we harvest rainwater up to a certain quality, then we can use this water to satisfy various requirements in the building.*" Similarly, the Mechanical Engineer (ME) commented that the purpose of implementing façade RWH system was, *"To reduce the municipal water usage and rainwater that can be used for*

irrigation and cleaning purposes in the building and ultimately it significantly affects the monthly water bill."

4.2.3 DESIGN AND TECHNICAL ASPECTS

In terms of design aspects, all interviewees (FM-1, FM-2, ME) indicated that space availability was one of the main constraints when implementing façade RWH system in the building. FM-2 mentioned that, "*Based on the space availability, we decided on the capacity that we can maintain. And we had to go all around the building to find a location for a storage tank*." In addition to space availability, all interviewees indicated that height of the building was another design aspect that was considered. FM-1 declared that "*We decided to eliminate rooftop water collection, mainly due to limited space availability, and the potential of collecting rainwater through building façade. This building height is about 150 meters. Therefore, it has a high potential to collect rainwater through the building façade than handling water coming from rooftop towers, which needs lot of modification to the building. So, we decided to avoid it and not to take that risk. Considering the rain pattern and all that, we realized the water collected from rooftop is not purely the water falling on the rooftop, but mainly from facade of the building."*

In addition to the above-mentioned design aspects, FM-2 explained, "*We have studied the amount of rainfall and rainfall pattern initially. The reason for that was, without having proper rainfall, this system would not be worth; because façade RWH system totally depends on the amount of rainfall"*. FM-2 further commented, *"The annual rainfall is adequate in this area. The issue is the spreading of the rain. Sometimes we get highly intensified rain, where a huge amount of water just cause out of the rain, because we do not have a capacity to collect a large volume of water. Consequently, sometimes we do not get sufficient rain for a longer period. It may be very intensifying for only half an hour or one hour, which is not sufficient to collect the required amount of the total rainfall water for a year. As stated by FM-1, FM-2, and ME, if intensity of rain and period of rain is very irregular, this system may not be very efficient."*

During the interviews, FM-2 and ME viewed that when designing the storage tank, space availability and the structural stability are identified as two important elements. FM-2 revealed, *"When we decide on rainwater harvesting system, first option was to decide what will be the capacity of that we want to collect. Capacity means storage capacity of the collecting tanks. Six tanks of 2000 litre capacity and three tanks of 1000 litre capacity were used to collect rainwater."*In addition to storage tank capacity, empirical findings demonstrated that rainwater quality was an important factor to be considered for the façade RWH system. Moreover ME explained, "*In this system, we have installed the first flush system, i.e. sand filter, which removes the particles up to 100 microns and fine filters."* In the selected building, the treated harvest façade rainwater has been used only to satisfy the non-potable water needs such as gardening, cooling towers, fire system, car park washing, and cleaning purposes. The purification level of harvested water was up to the satisfactory level for drinking purposes. In addition, availability of resources, technology, and skill were considered when implementing this system, because without proper technology and skill, the design and installation of the system will fail. FM-1 stated, *"We had engineering knowledge to implement this system, and we have consulted relevant outsource service providers, especially in case of designing the filtering mechanism to improve the water quality up to the standard. The most important thing is we have a dedicated staff with the commitment to get it done."*

4.2.4 BENEFITS OF THE SYSTEM

Many benefits associated with implementing a façade RWH system in a building are identified. FM-1 commented, "*The system is fully automated. In the filtering system, first flush system concept is integrated where it takes off the sand and other large particles that come with the rainwater.*

*After that, system consists of sand filters and fine filters where it removes small particles of the rainwater. The only maintenance that we do is cleaning filters using back washing. That is something we do regularly using our shift engineering staff. So cost wise, it is very low."*The Mechanical Engineer (ME) revealed, *"For this system we do not need to spend a large amount of money for operation. The only cost we have to bear is running cost of the pump. It is only Rs 40/= per day during the working hours of the pump. However, it depends on the rain pattern".* Therefore, according to the above statements, the operational cost is very low for façade RWH system in the building.

Alternatively, the empirical data proved that, by implementing façade RWH system, it reduces usage of municipal water and ultimately reduces the water bill in the organization. Mechanical engineer proved that, *"We have already reduced the water bill by 20%. Before implementing this system, we had a water bill of 1.1 billion. Now it is reduced to 0.8 – 0.9 billion. So we have saved a huge amount of water as well as money".* Therefore, this system reduced water extraction from the municipal water line, which saves a huge cost to the organization while conserving the water resource. Moreover, as per empirical findings, the building had some other benefits such as reducing the storm water runoff and obtaining the Green building certification for the building.

4.2.5 CONSTRAINS OF THE SYSTEM AND HOW TO OVERCOME THE CONSTRAINS

In addition to the benefits, empirical findings demonstrated certain issues of the system. According to the analysis, all the interviewees' emphasized lack of interest by the people, the building owners, and all other people, to implement this system due to less saving compared with saving of electricity. Further, FM-1 stated, *"Most people do not give much consideration to protect water. The reason is, in Sri Lanka, we can get 1000L potable water for a cost of Rs. 75/=. It is very cheap compared with any other country. Thus, people tend to waste water."*Mechanical Engineer (ME) indicated that space was another major constraint they faced when implementing façade RWH system, especially when designing the storage tank. Further, he mentioned, *"We can cater to massive amount of rains. But the problem is we do not have enough space and capacity to cater to this rain water."* The empirical findings revealed that façade RWH system totally depends on the amount of rainfall the system receive. Moreover, Mechanical engineer indicated that, *"When compared to the last year rainfall according to the data of Meteorology Department, there was less amount of rain after installing this system. When there is no rain, then façade RWH system won't be worthy."* Similarly, according to FM- 2, although annual rainfall is sufficient, the issue is, spreading of the rain. Due to the intensity and irregular pattern of the rain, collection may not be very efficient in certain periods.

Dedication and commitment of the staff, acquiring technical knowledge from the experts, close relation with other industries, performing self-studies, and gaining practical knowledge regarding the façade RWH system, were identified as positive actions to overcome the above issues faced in the RWH system.

4.2.6 GENERAL VIEWS OF IMPLEMENTATION OF FACADE RWH IN HIGH-RISE BUILDINGS

Finally, the interviewees were questioned about the implementation of façade RWH system in high-rise buildings in Sri Lanka. Mechanical engineer explained, *"In Sri Lankan context, RWH is not considered as a very profitable process because the water cost is low compared to other countries. Thus, most people do not implement this system unless it is considered as a mandatory function." More over, m*echanical engineer mentioned that most people do their business, expecting a return. People may not anticipate much return by installing this system. On the other hand, most buildings

in Colombo area are integrated with RWH system, if the organizations wish to receive green building certification. Similarly, FM-2 mentioned, *"Currently, I do not think we are doing it that great. I have seen areas where there is less rain and they have their own small RWH tanks. But in the urban areas, especially in Colombo, I think our effort is not enough". FM- 1* stated, "*When we apply for green building certification, during the presentation, some valuable comments were added by the green building council members of this system. This was highly appreciated within the organization and green building council, and by some of the building engineers and other professionals who visited the building. However, I think we did not receive many comments from the general public."*

The mechanical engineer (ME) stated, "*Façade RWH system is mostly implemented by thinking about the environment rather than considering a return. But people do not see any benefit directly attributable to their life. So, it is time to make the people aware on this matter, and, everybody looks at this as a financially viable project. In addition to that, since cost of water is low, we cannot expect people to be volunteers to use RWH mechanism. However, since it is now in regulations, implementing the regulation will ensure that people think differently*. *Then it will become a practice and a standard or benchmark for the country."* Mechanical engineer (ME) mentioned, *"The first thing can be done is to conduct awareness programmes among people about this system."* Mechanical engineer further revealed a policy in Sri Lanka regarding the RWH system and according to that installing a RWH system is a mandatory requirement for newly constructed buildings.

However, as per the empirical findings, interviewees viewed that although there is a regulation relating to RWH system, government involvement regarding RWH is not sufficient, because the published National Rainwater Harvesting Policy and strategies are not properly functioning. Conversely, people may design the rainwater harvesting system in their buildings, but whether it is effectively used is doubtful. The findings indicated that it is necessary to have raising awareness programmes and motivate people about implementing façade RWH system in a sustainable and effective manner. Otherwise, no one will implement this system in their buildings.

CONCLUSIONS

Many countries struggle with the supply of fresh water, not only due to financial constraints but also due to scarcity of water. Even though people in Sri Lanka think that water is an unlimited resource, and consider it as a cheap material, definitely this attitude will change and water issue will challenge the country in near future. Therefore, it is vital to seek alternative resources such as rain water harvesting.

Different types of methods and techniques are available for collecting rainwater in buildings. However, less consideration and less priority has been given to the rainwater collected through 'building's façade'.The concept of high-rise building is becoming a fast growing phenomenon nowadays, and façade is an important component for collecting rainwater, since a significant area of the building is covered from the building's façade. Moreover, in urban areas with high-rise buildings, the roof area is proportionally smaller and often the opportunity available for rainwater collection on roof area is considered inadequate.

It revealed that the design, implementation, operation, and maintenance of a successful façade RWH system are determined by many significant driving factors. The survey analysis indicated, the respondents identified top ten driving factors for implementing façade RWH system in high-rise buildings in Sri Lanka; intensity of rainfall, climate (rainfall pattern), size of façade, reduction

of potable water demand, experience of designers/ engineers, capacity of storage tank, sustainable impact on environment, user's perception on rainwater use, availability of space, and façade material type. In addition, according to t-test, seven factors were rejected, namely, location of the building, working hours, rainwater quality, geography of the area, user's education level, user's age, and aesthetic appearance of the building.

According to opinions of the interviewees, though facade RWH is possible in high-rise buildings, it is not yet popular in Sri Lanka, because RWH is not considered as a very profitable process because the water cost is low, compared to other countries. It revealed less return to be expected by implementing facade RWH system. One of the main reasons behind implementing this in urban areas is to gain the green building certification. However, in Colombo area, the effort is not sufficient. In addition, government involvement on RWH is not adequate and it was noted that the published National Rainwater Harvesting Policies and Strategies are not properly functioning.
Lack of awareness programmes of rainwater harvesting is one main problem. Raising awareness programmes are important to change the attitude and wrong perceptions of this concept. According to the research findings, it can be concluded, that despite lack of proper involvement of the government, building owners have the responsibility to implement rainwater harvesting in the existing or new buildings.

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MANUFACTURED SAND (M-SAND) FOR HIGH STRENGTH / HIGH PERFORMANCE CONCRETE

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ABSTRACT:
This study focus on use of manufactured sand (m-sand) for high strength and high performance concrete. A complete technical analysis is done for both river sand (r-sand) and m-sand which include analysis of Sieve Analysis for Particle size distribution, Holcim Shape test for shape factor, Holcim Blue test for reactive clay content, Holcim Cone test for flowability, Slump and slump losses of concrete, Compressive strength of medium strength concrete (G40, G50) and high strength concrete (G85) with river sand and manufactured sand. It found that, high performance concrete can be produced up to 100% manufactured sand, but optimum performances are demonstrated with 50%-50% river sand-manufactured sand combination in concrete.

Key Words: *manufactured sand, high strength concrete, high performance concrete, m-sand.*

INTRODUCTION

In the recent past rapid development has led to an increased demand for river sand as a construction material. Sand is required for development of the country, but at the same time the threats posed due to sand mining cannot be ignored. Uncontrolled illicit river sand mining creates a level of damage to rivers that are ecologically irreversible even in the long run; an urgent and sustainable solution is now needed for the affected rivers and communities in Sri Lanka. Hence decisive steps have to be taken and alternate solutions found for sand mining, without disturbing the environment [1]. Sand is one of the key materials used in the construction industry in Sri Lanka. After the tsunami disaster the demand for sand increased significantly. The demand for sand for building construction within the country is approximately 7-7.5 million cubic meters (~30 million metric tons) per year [2]. It has estimated that the annual sand requirement is growing at an annualrate of 10 per cent [3]. As an alternative, cabinet approval has been given for sea sand mining in 2011. The sea sand mining and washing will be done as a joint venture of the Central Environment Authority, the Geological Survey and Mines Bureau and the SLRDC [4].According to British Standards, the seashell content in sand should be - for less than 5mm has no limit, between 5mm and 10mm should be less than 20%, and more than 10mm should be less than 8%. An estimated amount of 8-10% of seashells in sand is said to make concrete stronger.

Off-shore sand is not suitable for immediate use due to high salinity. sand from the beaches are not good for constriction due to high chloride content and off-shore sand is pumped from a distance of

about 10 kilometers away from the shore. It was found that when subjected to 1000mm of rainfall yearly, the salt content in the sand is naturally washed away. If not, the sand should be washed out using artificial methods but such methods are not necessary as the rainfall in Sri Lanka exceeds 2500mm per annum. After being pumped out, being left to wash by rain for a period of 5-6 months is perfectly sufficient [5]. However, usage of sea sand in ready-mix concrete is limited as many specifies are still not recommending for structural applications.

Quarry dust, washed quarry dust and m-sand are directly linked to the coarse aggregate industry (crushed stones) whereas Quarry dust and washed quarry dust are byproducts and m-sand needs additional processing to obtain more circular particle shape. Due to the lesser price compared to river sand Ready-mix industry uses these products to mix with river sand to reduce cost.

This study focus on use of manufactured sand (m-sand) on performance of high strength and high performance concrete. A complete technical analysis is done for both river sand (r-sand) and m-sand which include analysis of Sieve Analysis for Particle size distribution, Holcim Shape test for shape factor, Holcim Blue test for reactive clay content, Holcim Cone test for flowability, Slump and slump losses of concrete, Compressive strength of concrete (G40, G50) and High strength concrete (G85) with r-sand and m-sand.

EXPERIMENTAL PROGRAM

Particle size distribution is studied using sieve analysis according to BS 882:1992 standards [6]. Reactive clay content is studied using Holcim Blue equipment, shape factor of different sand are studied using Holcim Shape equipment and flowability of mortar are studied using Holcim Cone equipment. These three Holcim special equipments were developed in Holcim Switzerland and they are widely used by its companies worldwide to monitor effect of different materials on performance of concrete. This equipment seems are more performance based and can be directly used in the industry for high end performance trials. Further, other cement and concrete manufactures use similar equipment (with different names) for performance trials worldwide.

Usual slump cone was used to measure the slump and slump retention of concrete with different mixes according to BS EN 12350-2:2009 Standards [7]. Compressive strength of medium strength concrete (G40, G50) and high strength concrete (G85) are carried out according to BS EN 12390-3:2009 standards [8].

Figure 1: from left to right; Holcim shape, Holcim Blue and Holcim Cone

Mix design used for G40 and G50 concrete are; Grade 40 concrete mix design is 435Kg of cementitious, 174kg of water, 774kg of sand, 1026kg of 20mm aggregatesand grade 50 concrete mix design is 465Kg of cementitious, 46.6kg of silica fume, 175kg of water, 770kg of sand, 985kg of 20mm. Mix design used for high performance concrete (G85) are given in Table 1.

Table 1: Mix design used for high strength/ high performance concrete (G85)

Cement type	Cement content (kg)	Silica fume (kg)	Water cement ratio*	River sand (kg)	M sand (kg)	Coarse aggregate (kg)	Admixture* (ml)
PPC 3 (~20%FA)	604.5	62.5	0.21	586	-	1087	7000
PPC 3 (~20%FA)	629.5	37.5	0.21	293	293	1087	8350
PPC 1 (25% FA)	604.5	62.5	0.21	586	-	1087	7350
PPC 1 (25% FA)	629.5	37.5	0.21	293	293	1087	8600
PPC 2 (15% FA)	604.5	62.5	0.21	586	-	1087	7000
PPC 2 (15% FA)	629.5	37.5	0.21	293	293	1087	8350

* Water/cement (W/C) ratio kept quite low with addition of extra amount of high end super plastizicer in these trials to get required high strength.

Finally a cost comparison of concrete with river sand and manufactured sand with blended cements is carried. As many high strength/ high performance concrete are done using a combination of fly ash and micro silica, comparison was limited to fly ash blended cement with micro silica.

RESULTS AND DISCUSSIONS

Results are tabulated in Tables 2-5 and graphically represented figures 2-6.

Particle size distribution

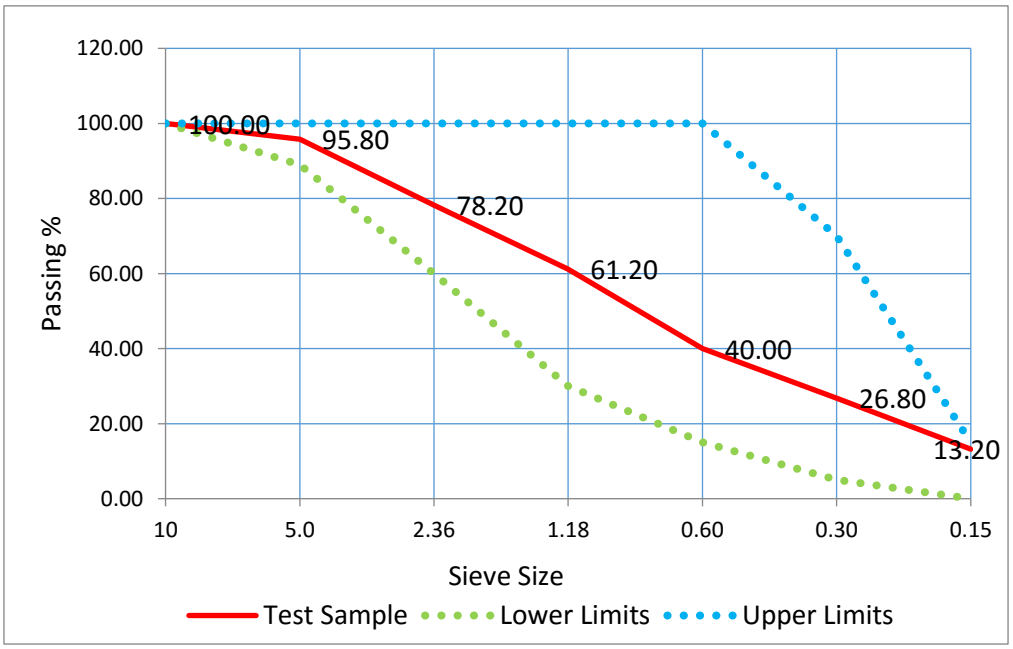

Figure 2: Particle size distribution of manufactured sand (m-sand)

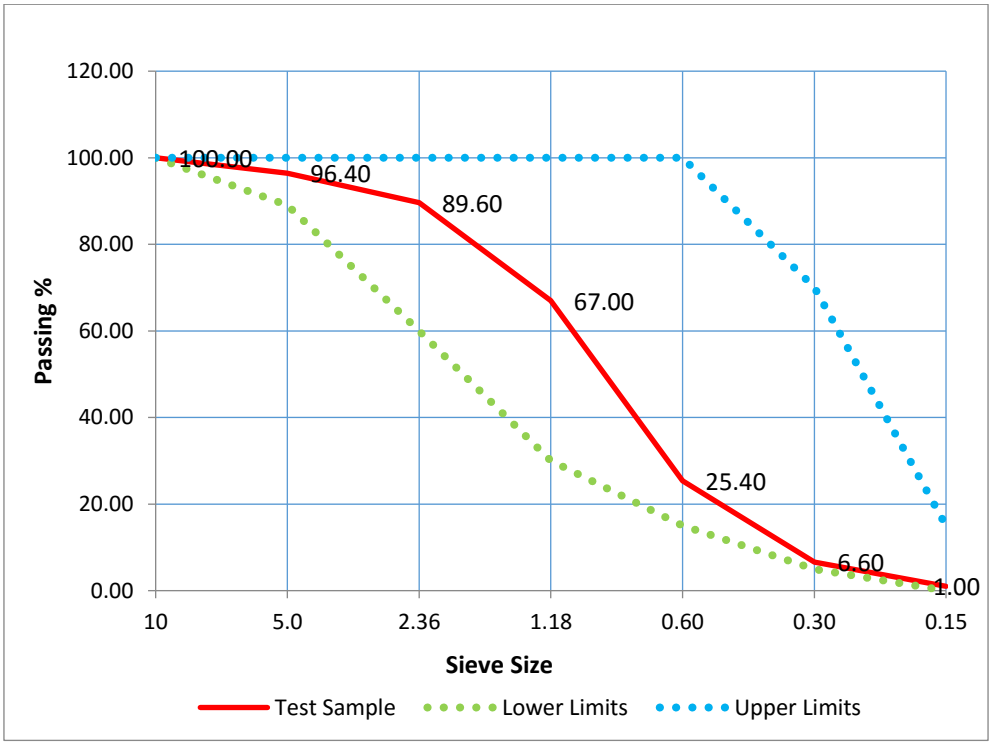

Figure 3: Particle size distribution of river sand (r-sand)

According to Figure 2 and 3, it can be concluded that, m-sand has better particle size distribution compared to r-sand. Finer particles (<0.6mm is very low) in river sand. As total particle size distribution (PSD) is important for proper compaction, this poor PSD in r-sand will lead to poor compaction and high permeability in concrete. To correct this need additional fines from cement to get workability. On the other hand, if not corrected workability of concrete by fine particles in cement (or cementitious additions like fly ash or nano silica), the corrections to be done by adding more chemical admixtures.

Reactive clay content

The results taken from Holcim Blue are given in table 2.

Table 2: Total clay content and reactive clay content in r sand and m sand

Sand	Total clay content (%)	Reactive clay content (mg/g)	Remarks
River sand	0.5	3.02	High probability of clay related negative impacts (>2mg/g)
Manufactured sand	1.0	0.95	Low risk of negative impacts (<1mg/g)

Reactive clay content in fine aggregate plays a significant role and it is more important in high strength/ high performance concrete as most of the time low water to cement ratio is maintained to get high strength/ high performance by adding chemical admixtures.

According to results given in the Table 2, river sand has higher reactive clay content (3.02 mg/g) compare to very low reactive clay content in manufactured sand (0.95 mg/g). This high reactive clay content in river sand may lead to high probability of clay related negative impacts on concrete; especiallythis is very bad for admixture performance.

Shape of sand particles (Flowability)

The shape factor observed with Holcim Shape is shown in table 3.

Table 3: Flow ability of different sand

Sand	Flow ability (s)	Remarks
River sand	16.48	High flow ability (15+/-3s)
Manufactured sand	17.75	High flow ability (15+/-3s), slightly lower than river sand

Flowability of both materials is in same range (high flowability 15~18s), not much difference. This is because of m-sand used this study are manufactured using jaw crushers (mostly end up rounded shape particles).

Initial slump and slump loss of concrete

Use of alternative materials as fine aggregates mostly increase workability issues and some cementitious materials like fly ash support to regain workability while adding nano silica or micro silica into such a system may worsen the situation. The cost of correction of workability in grade 40 concrete (435Kg of cementitious, 174kg of water, 774kg of sand, 1026kg of 20mm aggregates) with 25% fly ash blended cement is shown in Figure 4.

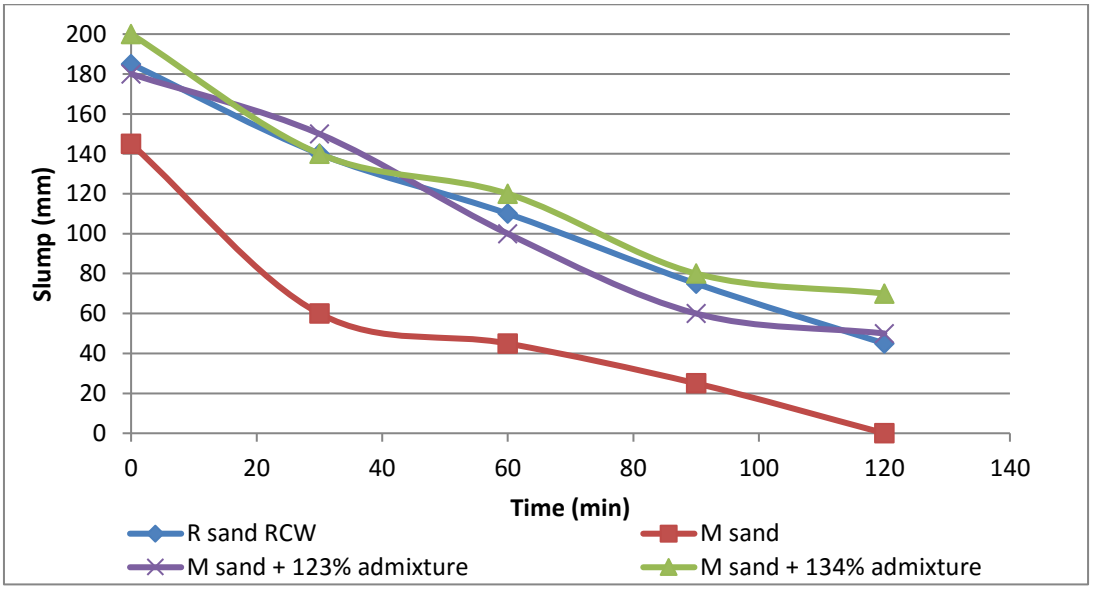

Figure 4: slump of concrete with river sand and m-sand, correction of slump by adding more admixtures

Initial slump of concrete with m-sand has 40mm lower than concrete with river sand, this is very significant. Slump loss of concrete with m-sand is higher compared to concrete with river sand. Slump and slump losses can be corrected with addition of 25~30% additional admixtures (Supercrete), additional cost for cubic meter of concrete is LKR 275~330. If ordinary Portland cement is used the flowaility is even worse. Adding micro silica or nano silica may reduce further.

Compressive strength of medium strength concrete (G40,G50)

Compressive strength of medium strength concrete (G40 and G50) are presented in Table 4 and Figure 5 and 6.

Table 4: Properties of medium strength concrete with r-sand and m-sand

Concrete Grade	Concessive strength (MPa) 01day	07day	28day	Slump (mm)	Density (Kg/m3)	Temp ($_0$C)	Flow using Holcim Cone (mm)
G40 m-sand	28.6	39.5	47.7	70	2566	31.6	360
G40 r-sand	25.1	37.8	44.9	55	2498	31.7	310
G50 m-sand	32.2	48.4	57.4	65	2554	31.3	365
G50 r-sand	26.5	38.5	52.2	70	2489	31.5	365

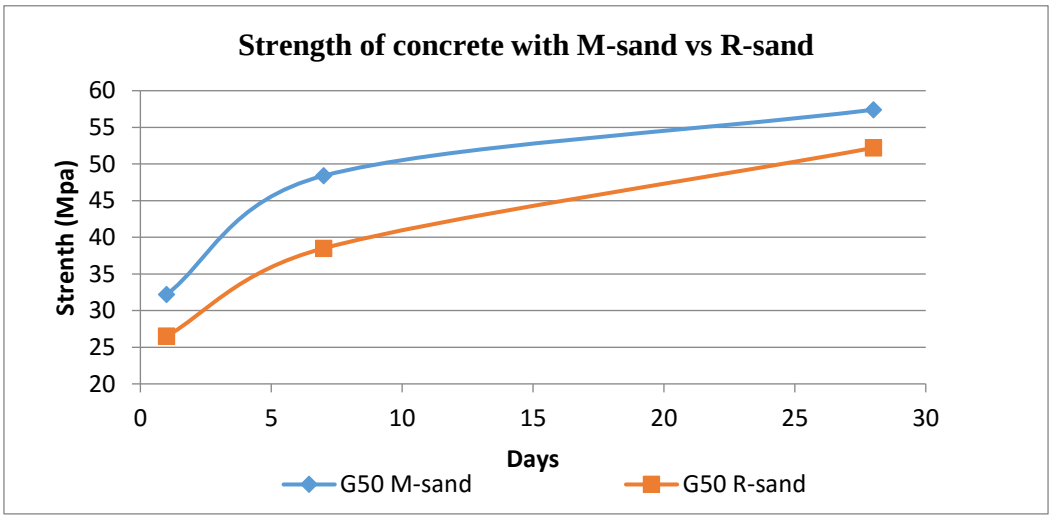

Figure 5: Compressive strength of concrete (G50) with river sand and m-sand

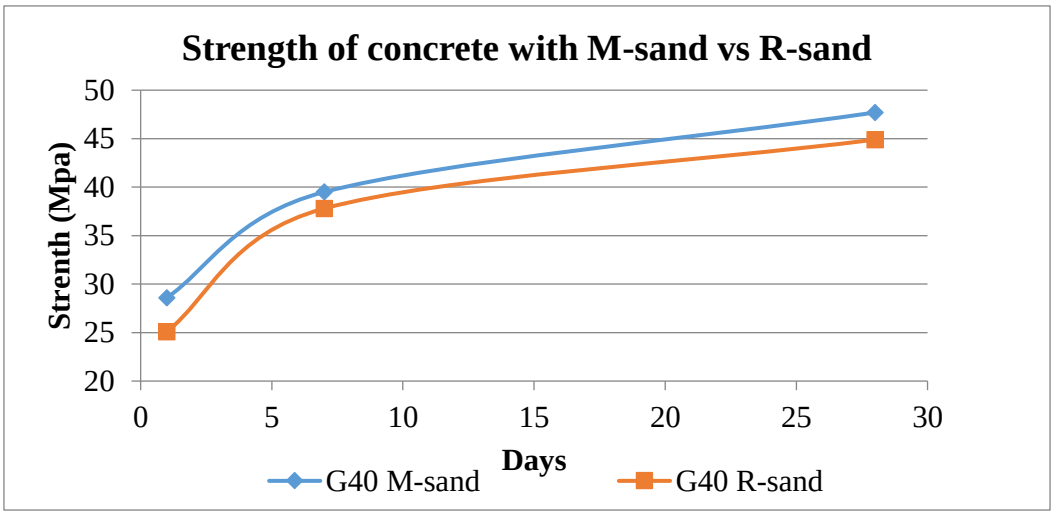

Figure 6: Compressive strength of concrete (G40) with river sand and m-sand

High Strength and High Performance Concrete (G85)

Producing high strength high performance concrete is even challenging due to poor workability performance at low water to cement ratio which mainly require for high strength concrete. Table 5 shows a cost comparison of grade 85 concrete (1087Kg of 20mm coarse aggregates, 586Kg of fine aggregates, 667Kg of total cementitious, 140Kg of water to maintain 0.21 w/c ratio). Results show that;

Table 5: compressive strength (very low w/c ratio mixes)

Cement type	Compressive strength (MPa)			Cost of Mix (LKR)	Savings/ m3 (LKR)	Cost/ Mpa (LKR)	Cost for 90Mpa, m3 (LKR)	Savings for 90MPa, m3 (LKR)
	3 days	7 days	14 days					
PPC 3 (~20%FA)	63.9	83.09	90.8	24,871.45	-	273.91	24,652.31	-
PPC 3 (~20%FA)	69.1	75.5	84.1	23,261.64	1,609.80	276.60	24,893.55	(241.24)
PPC 1 (25% FA)	69.8	95.6	98.7	25,116.45	(245.00)	254.47	22,902.53	1,749.78
PPC 1 (25% FA)	72.7	95.4	96.3	23,436.64	1,434.80	243.37	21,903.40	2,748.91
PPC 2 (15% FA)	70.3	88.7	91.4	24,871.45	-	272.12	24,490.48	161.83
PPC 2 (15% FA)	72.7	83.0	93.8	23,261.64	1,609.80	247.99	22,319.27	2,333.04

* Admixtures Hypercrete HS for a Constant flow of 550mm

Above cost are calculated based on market prices of materials as of October 2015 as given in Table 6.

Table 6:Market prices of different sand and other raw materials

Sand	Price of one cube (Rs)	Price of one Mt* (Rs)
River sand (Mahiyanganaya)	9750.00	1300.00
Washed sand	8500.00	1133.50
Crusher dust (quarry dust)	5100.00	680.00
Manufactured sand	8250.00	1100.00
Sea sand	6590.00	879.00
Gravel (5~20mm)	5410.00	708.50
Cement		17000.00

* Calculated based on assumption; One Cube = 2.83 m^3, Bulk density of gravel = 1.4 kg/ m^3, Bulk density of Sand = 1.4 kg/ m^3

It can be concluded that, high strength concrete are possible and cost effective with m-sand (50%). 50% river sand + 50% m-sand are more cost effective than 100% river sand always. Best performance is demonstrated with PPC1 (with 25% fly ash) and 50% river sand + 50% m-sand. Many ready mix concrete suppliers tend to use more manufactured sand instead of river sand due to its low cost compared to river sand, high purity compared to wash sand and they expect to get high performance concrete with available materials, especially high rise building projects like waterfront project (G80 concrete), Krish tower (G90), Altair project (G50).

CONCLUSIONS AND RECOMMENDATIONS

High strength and high performance concrete can be produced usingmanufactured sand up to 100% replacement of river sand. However, optimums performances are demonstrated with

combination of 50% river sand + 50% manufactured sand, and are more cost effective than 100% river sand always.

Initial slump is low and slump loss with manufactured sand is higher to concrete with river sand. Slump and slump losses can be corrected with addition of 25~30% additional admixtures with additional cost of LKR 275~330for cubic meter. M-sand is most cost effective in all mixes of high strength concrete. If same material is used, LKR 2200~2350 per cubic meter without admixture correction can be saved. As usually LKR 300 needed for correction of workability, a total saving of LKR 1900~2050 with admixture correction are possible.

Fly ash blended cement compensate some of the workability issues of manufactured sand in concrete. So, Best performances are demonstrated with the combination of Portland fly ash cement (PPC1) and 50% river sand + 50% m-sand.

Most of the time, river sand has higher reactive clay content (3.02 mg/g), this could lead to high probability of clay related negative impacts. This is very bad for admixture performance in high performance concrete.

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SUSTAINABLE CITIES; THE ROLE OF URBAN DESIGN IN CREATING 'PEOPLE'S CITIES'- CASE OF SRI LANKA

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ABSTRACT

Today some cities have experienced the signs of becoming less popular and in extreme cases, the people have abandoned them because of the mismatches of socio-economic aspirations, incompatible values and the absence of meaningful life. The desires to socially interact, live safely, be an active part of the city, and stand for their identity are priorities of people at all time. In this, urban design involves with a vital role in creating environments that support community sustainability by successfully integrating urban spaces into businesses, living and leisure.

Cities in South Asia are formed with unique socio-cultural living models. However with the effects of globalization, these cities got started to loose with their community identity, people's confidence, their aspirations and the distinctiveness. The contemporary planning and development trends have made these cities a rather typical space with lesser diversity and spirit. The observations prove that generally, the Sri Lankan contemporary urban centers, being stereotyped, do not foster the communication between urban space and city users, and thus fails to happen to be a livable space. In this, what sustainable city strategies can offer? Can effective urban design bring answers for managing the livability issues? What are the current trends of Sri Lankan city?

This paper reviews the eco-city living concepts, specially focusing the urban design ideas and strategies for sustainable urban developments in viewing the social dimensions of the city. This will also review the contemporary public realm development trends in Sri Lankan cities.

Keywords: *Urban design, people's cities & Places, sustainable cities, Asian Cities, Sri Lankan Cities*

1. INTRODUCTION

The concept of eco cities is introduced as a popular strategy in dealing with sustainable issues in cities. Though the term "eco-city" emerged during the latter part of the 1980s, the ideas related to the concept of eco-city such as "Garden City" or "Green City" concept have been around for many years. During the past, the meaning of eco-city has changed, with the expanding concerns of environmental issues, and with changing priorities in national and international environmental policy (Glasbergen P. And Blowers A, 1996). During the 1960s and 1970s, the objective of the eco-city was simply to make the air, water, and soil clean again. At present in the 21st century, the realization of eco-city requires the integration of multiple environmental objectives such as mitigation of climatic change, bio-diversity conservation, and sound material cycles with the objectives of economic growth and livability in cities.

However in the context of today's sustainability, the community sustainability, particularly the people's dimension, mostly associated with community values, the cultural identity, social uniqueness, ethnic distinctiveness, sense of place, people's friendly streets, and the community belongingness have been severely affected within the process of globalisation (Butterworth Iain, 2000). This situation has resulted high crime rates and violence in cities, for example as observed

in number of cities in USA recently (Buzzle, 2012). Though those cities deliberate having environmentally and economically sustainable concepts, they may not be seen as 'people's cities'. Those built environments create segregation and self-segregation, contributing to social exclusion Rogers Richard (1997). This has impacted the overall achievement of the sustainability. Maureen Williams writes: "Socially sustainable communities have the capacity to deal with the change and to adapt to new situations, attributes that are now becoming increasingly essential in a globalized world" (Maureen Williams, 2003).

In that, how the eco city concepts and strategies should address such issues? What would be the role of urban design in impacting with the community sustainability, livability and the continuity of social and cultural bearings?

2. NEED OF SUSTAINABLE CITY STRATEGIES; SOUTH ASIAN CONTEXT

Demographics show that the number of urban dwellers in South Asia over the last quarter-century, has more than doubled to almost 500 million while in India alone, the number of city dwellers has grown by 122 million. South East Asian cities experience numerous issues in terms of their large population, services and basic necessities, infrastructure, housing shelters, community disparities, living standards, traffic, transportation and jobs. In Delhi around 600,000 households with a population of around 3 million (and ever on the increase) inhabit shanties on prime public land, amounting to about 4,000 hectares (Anil Laul, 2002). Pakistan which has 50% of people residing in towns of 5,000 people or more has 1.6% annual population growth rate.
Nonetheless, the records confirm that urbanization in South Asia is yet to begun and which is the least urbanized region in the world with its 30% of urban population (Yue Li, 2012). In the future years to come, it is predicted that South Asia will have a much faster urbanization rate than any other region of the world, with the exception of East Asia. This rapid urbanization can be a powerful engine in accelerating poverty alleviation. In addition to this, the vibrancy of cities, socio-economic dynamics, and the kinetics of cities will be an enormous lead for this.

In spite of this, most cities in the region are struggling to cope with even the current level of urbanization which has impacted on the unique living patterns of city people. During the past, though planners, administrators, sociologists and architects have attempted to tackle with the urban issues intermittently, the only way to embark upon it is to comprehend it completely and above all, to have a holistic approach, together with the backing of a multidisciplinary team of professionals with a strong community participatory planning and development process. In this, one has much to learn from the past and the underlying principles of "living with nature" as practiced in the Asian traditional cultures and described in ancient texts, known as the "Vastu Vidya" and "Artha Shastra" (Shamasastry, R. 1915). These forms of principles and guidelines for Sustainable Development, though mystified, exist in most developing countries, specially South East Asia and have a strong understanding of climatology, behavior of building materials and their appropriate application, respect for the natural elements and most importantly, the control of human aspirations (Anil Laul, 2002).

It is also noticeable that some South Asian cities have dramatically transformed during the past few decades. They have acquired a completely radical face mostly pursuing the western urban design and development models that seem very flashy and distant from their inherent features of social and cultural milieus and tropical environmental conditions. For instance, some parts of Kuala Lumpur and Singapore are seen with such changes. The planning and urban design principles, built

form designs, scale, street characters, facades, textures of transformed cities seem alien to their social contexts. In developing countries the increasing dominance of Western values and economic systems has threatened the sustainability of traditional production systems (Glasbergen P. and Blowers A, 1996). There the social dimension will have to be one of the most important criteria that provide a sound base for the sustainability of cities. The connections between social and environmental change needs to be well-regarded in its local, social and cultural context.

3. URBAN DESIGN AND CREATING LIVABLE CITIES

Typically Eco City, also termed as Sustainable City, will be walkable city which is supported with efficient public transit systems and provided with mix of uses and services. People will have a range of housing options and live in safe and clean environments. The energy required by the city is produced by renewable energy sources and at all levels precautions are taken to minimize the emissions. It also a city of human scale, public space for everyday life, cultural identity and social diversity, sustainable lifestyles and a city managed by the city inhabitants (Ecocity Builders, 2012).

One of the key features of a sustainable city is that it can feed itself with minimal dependence on the surrounding countryside. The sustainable development requires a balance between environmental, social and economic sustainability, and the features referred to here should be acceptable to the people and should be in harmony with their economic development aspirations. The World Bank defines eco-cities as "cities that create economic opportunities for their citizens in an inclusive, sustainable, and resource-efficient way, while also protecting and nurturing the local ecology and global public goods, such as the environment, for future generations" (World Bank, 2009).

Urban design aims to produce good quality and livable (responsive) urban environment. It can bring-in improvements to socio-economic and physical environments. As of today, the consideration of ecological issues in urban design is worldwide becoming a common requirement than before (Martokusumo, W, 2011). Together with the aspect of gestalt and socio-culture, ecological dimensions play a significant role in implementing sustainable urban design. A "livable city" means vastly different things for many people. In Hong Kong it might mean that one's family is in a comfortable apartment while he entertains in the exciting commercial world in a glass tower overlooking the harbor. Livability in a North American city, like Dallas, might imply living near an expressway and running the car in most days. For some, it is the possibility of lucky and lucrative business opportunities and plenty of entertaining places. Yet generally the things needed to make a city 'livable' would be the size of the city, density, sensibility, attitude, security, chaos, accessibility, human scale, mixed use, public spaces (Byrne David, 2009). It must be the people visible in cities - not the tall buildings, cars, highways, communication towers. Some of the key urban design considerations promoting social sustainability and livability of cities are;

a) Make people – their habits, routines, actions and needs for a high quality everyday life more visible in the planning process.
b) Develop data to be referred by decision makers in making choices that affect people in cities.
c) Re-imagine the role of the street, as not only corridors of mobility flow but also as a place for the flow of social, financial and political resources as well as a place of knowledge exchange. Make the street again become a valued meeting place, as it seen in older city parts.
d) Make public spaces as a platform of encouraging interaction and the exchange of ideas and networks.

e) Develop a new growth model for urban expansion that is based on streets
f) Develop new funding streams for public realm expansions realized through large public and private ventures with an equally extensive but more diversified, contextual, and incremental form of growth and expansion.
g) Apply site specificity and context when designing cities with buildings.
h) Re-discover the human scale in cities – old and newly built.
i) Learn from modern vernacular form in terms of density, proximity and scale and not purely aesthetic.

Innovative urban environments that sustain urban growth can be achieved by;
a) Setting up hybrid urban environments that bring different business types and activities together with the neighboring public realm
b) Businesses that represent and brand themselves in public through interacting architecture
c) Creating a mix of businesses, housing and culture in a vibrant and novel environment
d) Create possibilities for places of work in public spaces through innovative street designs and the creation of informal meeting spaces
e) Providing accessible facilities that can reduce the costs for businesses and
f) Providing possibilities for connections with other such shared facilities.

4. SRI LANKAN CITIES AND SUSTAINABILITY

In Sri Lanka, majority of cities have been built as political cum religious hubs since historic times. Although the cities have evolved from their historic nature to industrial and post industrial, the Sri Lankan city form virtually remains politically or religious centered. In Sri Lanka, the cities got started to expand and populated due to the urban migration from rural areas that emerged mainly during 1960's and expanded in 1980's (Mongabay). Currently Sri Lanka has 22% of urban population and around 85% of rural population from the total population (World Bank). While the country is experiencing a population increase rate of 1.6% in year 2011(World Bank), the proliferation of slums and increasing shanty population significantly contributes to the built form and social landscape of cities.

The majority of current generation of Sri Lankan city inhabitants, specially in Colombo, is originally from rural and suburban backgrounds thus their aspirations and living styles are differed to the western concepts of city living. Therefore the social and cultural perceptions of those people are mainly rooted to the rural or village milieu. At the same time many Sri Lankan cities got randomly expanded with suburban centers, like Boralasgamuwa, Nugegoda, Malambe, Thalawathugoda near Colombo, as polis of new immigrants to Colombo. It would be vital to see whether the things offered in them are complimentary to the community living. During past decades, it is seen that rather than developing the city in a planned manner, it is left to grow with lack of direction, on piece meal basis without conforming to the essence of its true values, reasons for its origin, its character, the socio-economic and cultural distinctiveness. Whereas the early suburbs of Colombo such as Slave

Old residential streets in Colombo North – Diminishing the interactions with the street due to the functional changes.
Source: Author

Island, Kotahena, and Mattakuliya yet retain with such identities and seeing as vibrant community nodes of urban kinetics. There the streets are much colorful with high degree of people's presence, and quite interesting to see how they manage themselves with contemporary changes. Many sustainable community features that make a 'people's city' can be visible in these areas.

Bustling street Colombo Pettah –to be re-examined as a place of knowledge & cultural exchange
Source: Author

Planning of a new city or a complete redevelopment of an existing town is a rare happening in Sri Lanka. Presently there can be seen vast improvements to the infrastructure networks in the country as a whole, with a determined effort by the current regime and a massive urban area development in the city of Colombo. However we are yet to experience any strenuous effort towards the planning of a new city or a comprehensive upgrading of an existing town to make it conducive with the present needs and lifestyles of the people.

5. THE RECENT TRENDS; CREATING PEOPLE'S CITIES

The contemporary building and community development practices seen in many Sri Lankan towns across the country lack the holistic approaches which consider environment friendliness and contextual compatibility-specially lifestyles which are the key contributing factors in achieving sustainability in designs. The urban planning and development control is the prime responsibility coming under the Urban Development Authority (UDA, 1978), further to its regulatory functions. The urban area development efforts of UDA have been limited to the preparation and implementation of local development plans, regional land use and structure plans, mainly based on the demographic and physical data of the region. Although there have been physical development plans prepared for Greater Colombo Region, there have not been any comprehensive urban design exercise done for the towns outside Colombo, going beyond the piece meal development of isolated buildings and facilities.

It is commendable that previously the Ministry of Urban Development has taken a lead role endeavoring Colombo to transform to a clean, safe and attractive city by exploiting the powers and resources of relevant development and planning authorities such as UDA, Road Development Authority, Land Reclamation and Development Board, Environmental Authority. Such an ambitious effort had never been taken place before. At the same time, it is suspicious whether these efforts would bring full results as anticipate, particularly in the areas of urban sustainability, local's socio-economic improvement within the realm of identity, spirit of the place, life style and livability.


Re-discover the human scale of old streets – Slave Island in Colombo.
Source: Author


'Maintenance-free' street plants, Saint-Jean Avenue Honoré-Mercier Québec City, Canada.
Source: Author

In this, some recent public realm improvement programs seem to have less contextual significances

and seen as more of beautifications rather than their meaningful use and the authentic need by city people. Moreover they seem like fragmented solutions with exaggerated built concepts - apart from realities and local people's fashion. Typically public realm facility projects are to be realized as a result of the socio-economic growth of the locality. Many American cities today make all efforts to cut down the public realm maintenance costs, hence urban design does not promote creation of more cut grass areas in cities and neighborhoods given that it is not sustainable (Pinna S, 2012). Some Canadian cities, like Quebec City, use 'maintenance-free' urban landscape methods innovatively. In that context, it is uncertain for introducing more urban grass areas in the city while it makes city maintenance a burden. On the other hand, as tropical countries, our cities should have different landscape concepts mainly with flora and fauna which is not possible in western cities where grass is the only answer to maintain the urban surfaces green during winters.

Sri Jayawardenapura Kotte –A city dominated by nature.
Source: Author

The character and amenity improvement projects are to be based on meaningful planning and urban design concepts. City of Sri Jayewardenepura Kotte is a rare and unique situation of creating an ecological city – as an administrative capital which always to be a city where nature systems dominate. Predominantly around the Parliament along the lake it is supposed to be natural water's edge. However, it has now been transformed into a mediocre urban lakefront with cut grass areas, equidistantly aligned trees, and over-designed illumination with exposed light globes. Instead, would it have been more sensible to use shrubs and bushes as surface cover, trees in varieties conforming to create a more nature front with windows of vistas towards lake and parliament, and a low level illumination system that does not disturb the beauty of the nature? The car park area with huge concreted surfaces -very typical to North American style, has been placed at the most exciting corner of the lakefront whereas it would have been more sensible to maintain the green lakefront allowing full view across the lake by designing a car park strategically.

It is also important to relook at the previously implemented key projects such as Independence Arcade which is considered as a place for exclusive crowd though the independence square is an attraction for all levels of social groups including local visitors including school children as a place of attraction. This was a missing opportunity to create an active place of people.

The majority of streets and roads and ongoing road improvement projects in busy urban areas are not provided even with minimum facilities for public walking. In general, setting up of specific basic design standards of the public realm such as -'street sidewalk with trees for every street', and their implementation must be an important task of the planning authorities.

It shows that there is a clear gap between the preparation of local town plans and the detail strategic plans of city revival while strengthening the town's social and physical identity, which has to be bridged through a strenuous urban design visionary based on community values with the ensured implementation at the end.

6. CONCLUSIONS

It is seen that developing countries are faced with trade-offs between different objectives, such as poverty alleviation, economic growth and environmental protection, which does not predict well for the future of sustainable cities. The urban design visionary process also is not taking place necessarily. Institutional and regulatory limitations, such as lack of good governance, effective policy support in the form of financial subsidies or tax preferences, competition for limited resources and scarcity of efficient supervision, implementation strategies and enforcement mechanisms, also act as barriers. At the local level, detailed local planning and performance indicators are also absent.

It is realized that Eco city concepts should meet local economic, social and cultural priorities, and involve with stakeholders at all levels; local community, private and state sectors. The adoption of an integrated approach – within the eco-city as well as with its surrounding environment and the country side – is also necessary. Therefore any real solutions to the global environmental crisis and livability of the present era must necessarily begin with changes in lifestyle.The process of constant measuring, assessing on how the city performs for people and creating new tasks has embedded the values of a 'people first city' at every level.

While reconsidering city's role, rather than acting as an imposing authority-negatively, the city must perform cleverly responding to people's needs with an amicable attitude. Gehl (Gehl,J, 2012) finds an example in a Denmark city where it confronted with the problem of pizza boxes over-flowing out of the bins near a popular pizza restaurant in a city, and rather than putting up signs saying 'No Pizza Boxes!', the city took an initiation of designing new bins with an extra-large pizza sized slat to accommodate them. It sees most importantly a fundamental re-calibration of the role of the architect, politician, planner and citizen is required. Gehl (Gehl,J, 2012) further stresses that for designers it will mean a greater focus on culture than on form and greater skill in facilitating than convincing, while for planners it will mean less control and more flexibility and an ability to provide a framework for messiness and diversity rather than a plan for uniformity and control. For politicians and civic administrators it will demand more attention to various forms of civic expression. This change will require that city people continue to demand more from the public realm and brave to imagine what streets and spaces can turn out to be rather than satisfying with the existing situation.

After all, people feel affection for cities not only for their landmarks, beautiful sites, and the range of public buildings from shopping, community to religious, but also for the people's spirit, vibrant life, feeling of intimacy, safety and the culture of the place. At present the Sri Lanka is planning to embark with an urban revival program for a number of towns across the country. Scholars believe the current mega polis plan of Colombo is another mediocre exercise with not much concerns on urban development realities, particularly with the lack of proper urban design and planning inputs. It also lacks the implementation strategies- also with the much weaker planning and implementation system of our local authorities and development agencies. At this juncture it is a task to ensure such initiations are strongly backed with sustainable urban design and realization strategies with firm design standards understanding the kinetics of the society with a greater care of people's desires and aspirations. Undeniably those will be 'people's cities'.

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AFFORDABLE HOUSES IN SRI LANKA

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ABSTRACT

A shelter and a house mean two different requirements of a human being. Shelter comes as a solution to a very basic human need to protect from the environmental hazards and attacks of animals. But, a house is a more sophisticated version of a shelter creating physical and mental peace for the occupied human being.

Moreover, a significant percentage of world population lives in shelters, which may barely be called as houses. People are facing many issues during the process of house construction. Low income, illegal land transactions, court cases, mortgage issues, loss of investment, delayed construction, uncompleted houses, long procedural bank loans are some of the critical issues that house owners frequently face. Therefore, owning a "house" has become a burden to many.

This paper discuss about affordable house which satisfy standard of living that fulfills the requirements complying with regulations. In addition, it includes government support extended, resilience in affordable houses in disaster prone area, cost reducing technology. Further, it elaborates the government support to be extended to this sector to develop more suitable affordable houses.

BACKGROUND

A housing demand of 700,000 in Sri Lanka was identified by a survey carried out in the year 2012(Conference of World Habitat Day, 2014).) Sri Lanka has 5.9 Million housing units. Housing demand has approximately increased by a hundred thousand numbers per year. According to the survey, new houses constructed in the period of 2000-2010 were 250,000. But, it is found that 318,884 housing units were constructed in the year 2011 indicating a sudden rising demand of houses. Therefore, it is evident that high demand for housing prevailing in the country.

Out of 5.9 M housing units, 81.7% are permanent type, 17.6% are under repairing stage and 0.7% are slumps and temporary shelters. Further, it is revealed that 83% of house owners live in their own houses and 6.4% houses are used on rental basis.

Construction of houses has become a challenge to many people in the country. Starting from conceptualization and to finish, it takes years. Due to high land prices, shortage of lands, construction materials and labour, unemployment, long procedures of government approvals and poor performance of contractors, this task has become complex.

Nevertheless, a house is a need for a comfortable human life and it is the responsibility of professionals to facilitate for a comfortable life of each individual. Therefore, determining a cost effective, easy mechanism for constructing an affordable house and introducing it to the public is essential.

1.0 DIFFERENT SEGMENTS THAT NEEDS AFFORDABLE HOUSING

MIDDLE INCOME GROUPS

The Middle Income Groups (MIGs) of Sri Lanka is one of the groups facing the housing problem. They cannot afford to construct a house on their own due to high construction & land costs. Most Government and private sector parties implement housing programs solely with the objective of

profit generation. Most MIGs cannot afford to buy such a house as they have to invest their income for day today life maintenance. Therefore, they keep on postponing one of their primary needs, having a decent house.

The main reason for high land prices is Urbanization. e.g. Land prices have been increased up to Rs. 20 Million per perch in Colombo suburbs which is not affordable to MIGs. Secondly, non-availability of regular income, home based income generation, price variations due to inflation and high transport cost area also become significant reasons that affect for MIGs.

WAR DISPLACED PEOPLE

Thirty years of conflict has left communities in the Northern &Eastern provinces of Sri Lanka with their houses damaged or destroyed. Further, physical infrastructure also had been severally damaged. War controlled livelihood opportunities generated no productivity in those areas. Around 160,000 houses were affected only in Northern Province (Indian Housing Project, 2015). This is another group that needs advice on affordable houses.

It is known that affordable houses are more popular in Northern & Eastern areas of the country than in Colombo. Because, in Northern Province, lot of displaced families are returning to their houses of origin continuously and temporary shelters were being introduced as an immediate and intermediate solution. Government is responsible for providing at least an affordable house to each family to continue their lives with security and other facilities such as minimum security, hygienic facilities and space for studying.

From 2012 to 2015 UN-Habitat worked closely with the people in the Northern Province, village reconstruction committees, the Government of Sri Lanka and the Indian High Commission to construct 17,945 damaged houses in the districts of Jaffna, Killinochchi & Mullaitive. A grant of LKR 550,000 was provided to each beneficiary family in four installments to construct a new house while a grant of LKR 250,000 was provided to repair a partially damaged house. All families built their homes with a minimum floor area of 550 sq ft as stipulated by the guidelines.

SLUMPS

Another area of housing to be focused is Slums. According to the statistics there are 123,000 slumps in Sri Lanka(Conference of World Habitat Day, 2014).People who cannot afford for a house due to high land costs, non-availability of suitable lands for their home based income generation method of employment, difficulties in obtain banking facilities etc. force them to live in slumps. As this problem can also generate very complex issues such as drug dealing, disturbances to educational purposes, social issues etc as professionals who work in this area, we have to find sustainable solutions to solve this issue.

2.0 AFFORDABLE HOUSING CONCEPT AND GOVERNMENT SUPPORT

Therefore, affordable housing concept is proposed as a solution for the housing issue. If a person can afford to construct a house that suits to his income, fulfilling his requirements and also complying with the regulations governed is called an affordable house.

As a developing country, this concept had been applied by many Sri Lankan Governments and some of the statistics are mentioned below; since 2006, Government had spent millions of rupees investing on affordable housing sector in all over Sri Lanka since 2006 and details of the programs undertaken are given in Table 1.

Table 1: Government Investment for housing programs (Conference of World Habitat Day, 2014)

	Program (2006-2013)	Investment, Rs Millions
1	Housing program by Ministry of Construction, Engineering Services, Housing and Common Amenities	6,009
2	Housing program at Northern Province, Resettlement of war displaced people	24,193
3	Housing program(For replacement of slums and temporary shelters)	20,701
4	Housing program for slums at tea estates (Estate houses)	2,028
5	Refurbishment work at multi story housing schemes	4,130
	Total	57,061

At present, housing program under the Ministry of Housing and Construction is called "Uda Gammanna" is being implemented. This program is for low income generation people who cannot afford for lands. As such, Lands are provided to them through District Secretiat Offices at no cost. This project consist of construction of affordable houses with a 550 sqftminimum floor area . The house is estimated at Rs.575,000 and essential components of the house such as roof, main door and rear door is to be completed as the stage one.

3.0 ISSUES

In Sri Lanka, affordable housing price can be varied between LKR 1000 to LKR 2500 per sqft without the land cost as it can be constructed using cost effective alternative materials and technologies. Nevertheless, people are still reluctant to settle for affordable house. From the point of view of public, best house is constructed using conventional materials and more specious with plastering and painting and with some good flooring method such as Tiling etc.

In Colombo area, very few affordable houses are to be seen. Some of such rare housing schemes are Sooriyapura housing scheme, Samapura housing scheme, Sucharitha Mawatha housing scheme.

One of the examples is resettlement in "Sahaspura"- Colombo program which was intended to resettle the urban poor in high rise building, improving their quality of life and freeing up land for development. The program was also taken place to offer the poorer at different locations to select housing type options. The cost of a unit was around one and half million rupees.

Accordingly, 651 families were moved, 161 families declined the offer and 52 families were relocated elsewhere. Many poor families with good income/regular jobs preferred their new housing over the old, but dissatisfied with some of the features.
Some of the reasons are:

1. Designs were insensitive to their culture
2. Difficulty in expansions
3. Difficulties of using Paddy husk & firewood for cooking
4. Home base enterprise made difficult because of access and outdoor space
5. Higher utility costs being in urban areas and subjected to the same tariff structures as other occupants.

By 2010, 100-150 families had sold their newly acquired apartments and had either moved to suburbs or back to their original settlements (The State of Asian and Pacific Cities, 2015).

Middle level & low level income groups are not targeted by the private developers due to these reasons. But multi storey luxury apartments have become very popular having a good market due to high income generating local people, tourism and also due to seasonal vacations of locals who are resided in other countries. Therefore, private developers have more investments on luxury apartments

4.0 RESILIENCE IN AFFORDABLE HOUSES

Sri Lanka is subjected to landslides, floods, and droughts and high winds and also there is a risk of minor tremors. With improper planning of urban areas and infrastructure, rural and estate housing roads and highways, haphazard land clearances and irrigation and also due climate change these are going to increase in magnitude and frequency. Therefore, it is necessary to ensure the resilience to these vulnerabilities to avoid damage, injuries and deaths.

There are many manuals, guidelines for public use on resilient houses. These practices should be considered in all three stages of construction including design stage, orientation and planning stage. The structure should not fall down under gravity and the building must be prevented from being pushed sideways and lifted off upwards when subjected to cyclones, flooding and earthquakes throughout the life cycle.

5.0 RECOMMENDATIONS

Following activities are proposed in order to make these affordable houses popular among Sri Lankan community.

1. Introduction & promotion of low cost construction materials & technology to housing sector through contractors.
2. Regulations, tax concessions and incentives for affordable housing materials and owners.
3. Develop models, standards and specifications on affordable housing generating confidence among public on their use. Technology for resilience has to be introduced.
4. Awareness on saving of land as a resource as suitable lands for housing is rare.

Above recommendations are further elaborated below.

5.1 AWARENESS

Awareness on land and other resource shortage is highly required today. The facts and figures of resources such as for fresh water should be published and should be an indication of the scarcity of resources.

Unlike major projects that consultants are advising on materials and method statements, contractors recommend materials for domestic sector. Therefore, educating contractors on these materials is one of the methods available for promoting these materials. Some of the materials that can be promoted though contractors are mentioned below;

- **Cement stabilized soil blocks**
  It is shown that the cost saving of cement stabilized soil block walls compared to cement sand block walls will be around 11% to 38%. It depends on availability of soil at site and labour for preparation and construction of walls (A.A.D.A.J. Perera, Cement stabilized earth blocks)

- **Manufactured sand**
  Manufactured sand has been used for many years in all over the world in variety of construction applications. It is used from the crushed rock which has required properties to manufacture sand that is suitable for construction.

- **Off-shore sand**
  Off-shore sand is a good replacement for river sand which can reduce construction cost significantly. At present, it is available at Sri Lanka Land Reclamation and Development Co-operation yards at Colombo.

- **Construction and Demolition waste**
  Use of C & D waste in construction activities are not much popular in Sri Lanka. An awareness for Specifies are high priority important Awareness will improve to apply the technology know-how for separating fine aggregates etc. from C& D waste.

5.2 RAMMED EARTH CONSTRUCTION FOR WALLS

Building a rammed-earth wall involves compressing a damp mixture of earth that has suitable proportions of sand, gravel and clay into an externally supported frame or mould, creating either a solid wall of earth or individual blocks. Additives as lime, cement or asphalt emulsions also can be used to make the wall stronger.

- **Houses of monolithic concrete and plastic formwork**

  This is a new technology for Sri Lanka and constitutes the use of a removable, resuable, recyclable and lightweight plastic formwork mould which is filled with approved mortar to form the wall structure of a house. Each set of formwork panels can be reused 50 times making the technology cost effective due to its repertitive system produceing durable and permanet structures, which have been subjected to numerous tests and supported in independent reports. (www.Moladi.lk)

5.3 REGULATIONS, TAX CONCESSIONS AND INCENTIVES FOR AFFORDABLE HOUSING MATERIALS AND OWNERS

In India, use of a percentage of construction and demolition waste for a project is a must depending on the population of the area. Such contractors are allowed incentives and tax concessions by the Indian government. Sri Lanka also can consider implementation of such a regulation for identified construction materials such as concrete waste, tile pieces. Tax concessions also could be given for use of green materials such as solar panels, accessories and applications of rain water harvesting systems in order to reduce utility costs.

5.4 DEVELOP MODEL HOUSE FOR AN AFFORDABLE HOUSE USING AERNATIVES ETC

A model house can be designed by National Engineering, Research& Development center with necessary standards and specifications. The model house can be recommended for getting the approval from government regulating agencies and loans from financial institutions

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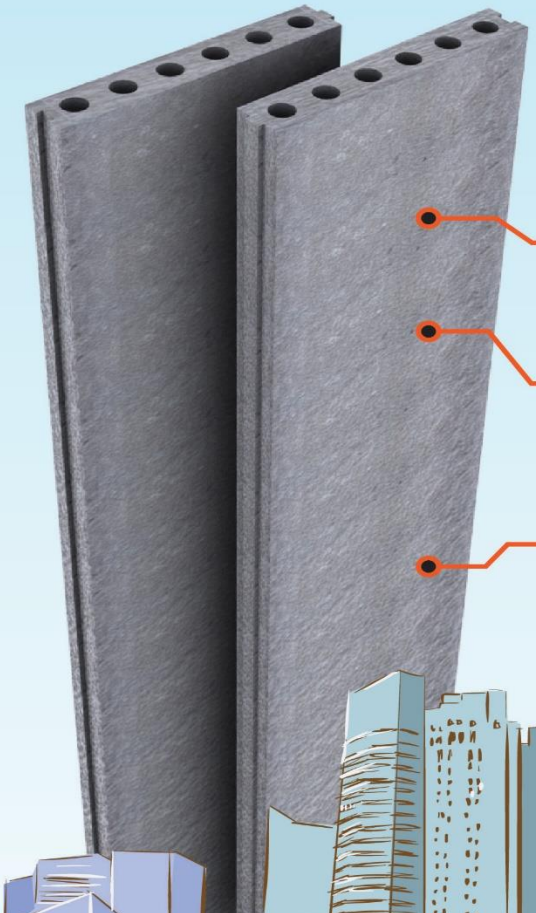

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CONSTRUCTION INDUSTRY POLICY- A TOOL FOR INNOVATION

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ABSTRACT

The paper defines a Construction Industry Policy, by defining construction as the creation of physical infrastructure necessary for socio-economic development of a country, followed by a definition of the construction industry as an organized process of utilizing the inputs of design, material, men, and machinery. Based on the above the vision, objectives and goals are stated, which result in a course of action or plan which is a policy.

The main areas of output that encompass a construction industry policy are to Promote national economic growth, ensure environmental sustainability, Promote education and training, Promote research and development, ensure health and safety in the construction industry, and promoting and safeguarding the local construction industry.

These outputs are achieved by formulating policies for each main area under the following inputs. Financial, design, labour, materials, construction machinery and equipment, standards and implementation.

The paper details the inputs where policy guide lines are required, and lists the essential inputs followed by the possible inputs, and the balance inputs.

In implementing the policy the paper suggests commencing with the essential, followed by the possible inputs and then the balance policy inputs. Implementation will have its barriers which will have to be overcome by innovation.

Overall therefore the paper tries to establish that policy formulation and implementation will become a tool for innovation, and gives examples related to Sri Lanka.

Finally the paper notes that the policy should be dynamic and not static, relating to the conditions of the industry at a point in time, which may indicate that policy changes may be required if innovation fails.

1. INTRODUCTION:

Construction is the creation of the physical infrastructure necessary for the socio-economic development of a country. This results in an industry which contributes between 5-10 percent of the GDP of a country. This industry will have a vision, objectives and goals, which are reflected in a construction industry policy, formulated by a government in consultation with its stakeholders.

In implementing a policy problems will be encountered which need innovation, or adjustment of the policy.

This paper therefore outlines a methodology for formulating and implementing a construction industry policy, which aims at creating an industry of Global standards, while outlining how innovation could be made use of ensure the policy objectives are achieved. It also indicates why policy changes may be necessary when innovation fails, concluding that the steadfast implementation of a construction industry policy is a tool for innovation, and vice-versa, that innovation may lead to changes in policy.

2. A CONSTRUCTION INDUSTRY POLICY:

In order to formulate a construction industry policy it is necessary to define what is meant by construction, the construction industry, and the vision, goals, and objectives which constitute the policy. This vision, the goals, and objectives are thus achieved by converting them into a clear course or principles of action adopted by the government of a country in the form of a "Construction Industry Policy".

2.1 What is construction:

"Construction" as commonly understood in relation to the construction industry, can be defined as the creation of the physical infrastructure necessary for the socio-economic development of a country.

2.2 What is the construction industry:

What then is the "Construction Industry". The construction industry can then be defined as an organized process for utilizing related professionals to design the socio-economic infrastructure, and implementing the designs through the organized inputs of materials, skilled craftsmen, and construction machinery and equipment usually by an organization commonly known as a contractor to convert the design into a physical reality.

The inputs will result in the creation of many sub-industries, i.e., Institutes for training professionals and skilled craftsmen, materials manufacturers, and the supply and hire of construction machinery and equipment, and last but not least all moveable for the smooth functioning of the socio-economic infrastructure.

2.3 What should be the vision, objectives and Goals of a construction industry Policy:

In order to formulate a policy all these inputs cannot be based on a haphazard system, there must be a clear vision for the industry with stated objectives and goals.

The vision, objectives and goals can be broadly described as follows;

2.3.1 Vision:

The vision is to achieve an efficient construction industry, serving the national socio-economic development needs through regulations and standardization to levels that are in par with global standards.

2.3.2 Objectives:

The objectives can be defined as; to provide strategic leadership to all stakeholders of the construction industry. To stimulate sustainable growth reforms and improvement. To promote energy efficient and environment friendly technology, building materials and systems. To promote appropriate research and dissemination and publication of research work. To formulate standards and codes of conduct and practices, and promotion of the export of construction services.

2.3.3 Goals:

The goals should target the following matters. Regulations and standardization of activities of the construction industry, registration of stakeholders, measures for improvement and the well being of the Industry related enterprises and workers, facilitating cheaper and faster settlement of disputes and ensuring public safety and health in construction work.

DEVELOPING AND IMPLEMENTING A CONSTRUCTION INDUSTRY POLICY

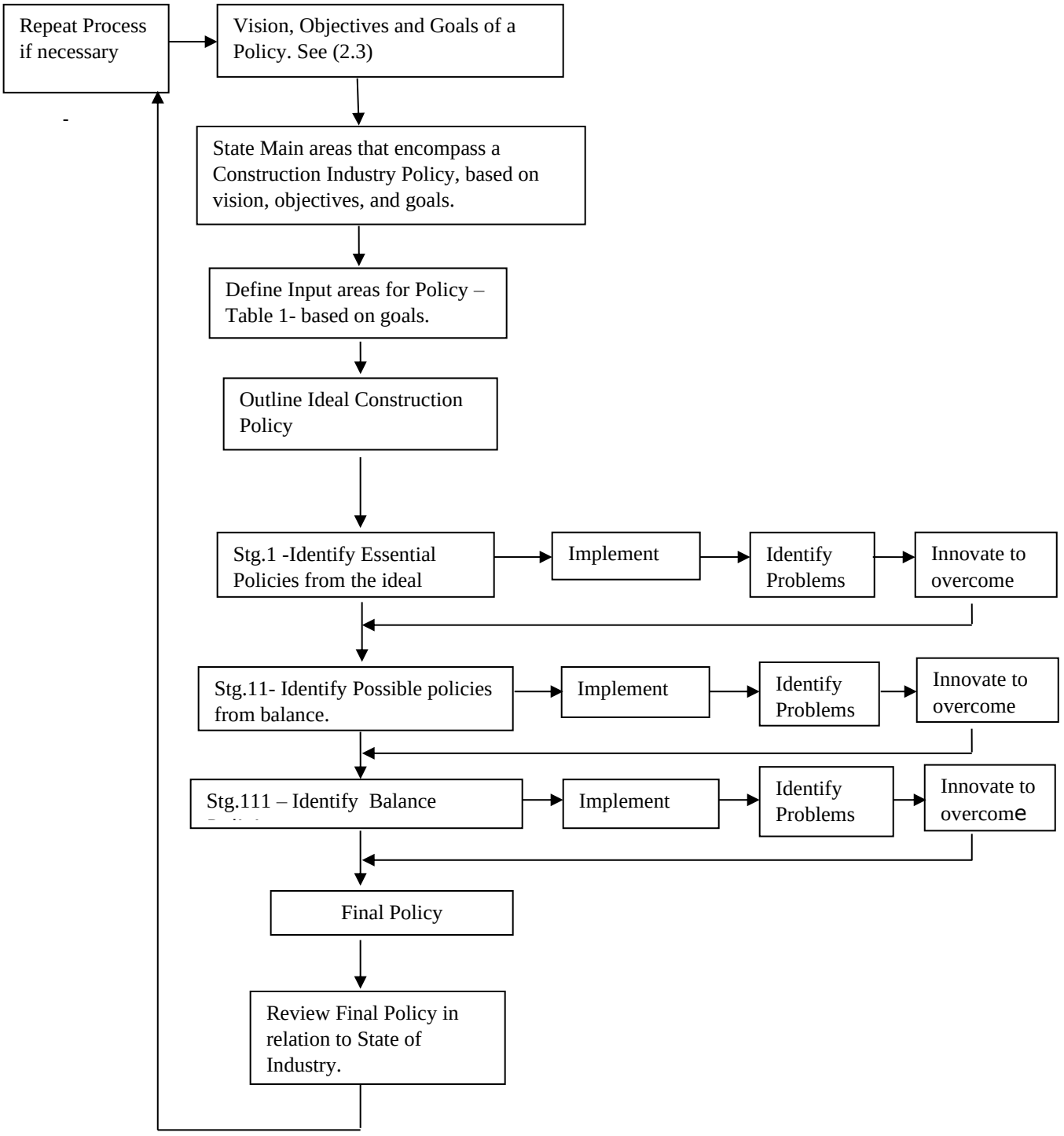


Figure 1: Developing and implementing a construction industry policy

2.4 What is a construction industry policy:

Finally we can therefore define a construction industry policy as a course of action or plan approved by the government which will ensure that the vision, objectives, and goals are achieved by the construction industry – Figure 1

3. FORMULATING AND IMPLEMENTING A CONSTRUCTION INDUSTRY POLICY

Once we have established a vision, objectives, and goals which should constitute a construction industry policy, it is necessary to define the input areas which are directly connected to the construction industry and formulate an ideal construction industry policy, which covers these areas. Implementing the policy is the critical activity. In implementing the policy many practical difficulties will be encountered. I therefore suggest this be done in stages i.e., essential and thereafter possible. Even then we will encounter difficulties which may require new ideas to achieve the policies without change which will lead to INNOVATION, resulting in our achieving our ideal vision, goals and objectives.

3.1 Main areas that encompass a construction industry policy:

Based on our vision statement, objectives, and goals, the main areas a construction industry policy, should encompass in my opinion would be the following;

Promote national economic growth, ensure environmental sustainability, Promote education and training, Promote research and development, and ensure health and safety in the construction industry, and promoting and safeguarding the local construction industry. These main areas would guide the input policies to obtain the outputs necessary for functioning of the industry as envisaged.

3.2 *Inputs governed by a construction industry policy:*

Table 1 gives the main areas of inputs which must be governed by policies formulated within the main areas of policy governing the construction industry.

I have considered the following inputs areas for which policy guidelines are necessary. Financial, design, labour, materials, construction machinery and equipment, standards and implementation.

Table 1 details the areas in which policy guide lines are required to govern the inputs for the construction industry.

3.3 The process of formulating a construction industry policy:

Figure 1 gives the process of formulating a construction industry policy in a flow chart. It will be noted that we begin by stating our vision, objectives and goals, as defined in section 2.3

Based on this we have stated the main areas that affect the formulation of a construction policy in section 3.1 and Table 1.

Further in Table 1 we have noted that inputs that should be governed by a policy (see sec. 3.2) to achieve the vision, objectives and goals of the construction industry.

When these policies are formulated and collated they will form an ideal construction industry policy - Table 1.

In Stage 1 - we must then sift through these policies and arrive at a set of essential policies i.e., those which are critical and need implementation under any circumstances. See Table 2 for essential policies.

3.4 The process of implementing a construction industry policy:

Once the policies have been framed, and published by government, the next step is to implement them. An Agency such as the “Construction Development Authority in Sri Lanka will take the responsibility of framing the regulations, obtaining government approvals, and finally implementing them. This authority will have the power by law to enforce these policies.

Creating policies is a relatively simple exercise, implementing them is very difficult. Hence, I suggest implementation be done in stages. The first Stage 1, is to implement the essential polices a listed in Table 2. This should be followed by implementing those which are possible in Stage 11, and finally the balance in Stage 111.

In implementing policies whether essential, possible or the balance we are bound to come up with blocks in trying to implement them. There are situations where policies may be outdated depending on the state of the industry. There are policies which need adjustment considering the state of the industry at a point in time.

We therefore see that a construction industry policy, being a plan for the industry cannot be static and constant, it is dynamic, and needs review. After all planning is a process of review.

Table 1 - Main Policy Areas and Inputs requiring Policy Directives for an Ideal Construction Industry Policy Frame work

	IDEAL POLICY FRAME WORK.						
Main Policy Areas	Inputs Requiring Policy Directives						
	Financial	***Design***	***Labour***	***Materials***	***Machinery & Equip.***	***Standards***	***Implementation.***
Promote National Economic Growth	*Public Investment * Private Investment * Public /Private Partnership *Procurement Procedure *Foreign funding *Foreign Aid *CESS on Construction. *Construction Statistics	*Minimize Project Cost *Control Engineers Estimates *Minimize F.E consumption.	*Construction labour wages for different categories *Pension fund from CESS * Productivity standards.	*Foster local industries for production of materials * Import restrictions	*Import Licenses *Preferential duty rates	*Performance standards	* Provide Strategic Leadership is all Stakeholders *Adherence to all standards.
Ensure Environmental sustainability	Meet costs from CESS fund	*Environment friendly designs * Ensure Green building standards.	Developing Attitudes	*Use of sustainable local materials. *use of re-cycled materials	* Emission Control * Effective Plant Management	*Environmental standards for Construction.	*Environmentally friendly methods of construction.* Disposal of Construction debris.
Promote Education and Training in Construction	Meet costs from CESS fund	*Universities *Technical collages	*Vocational training * Right skill at right operation		*Effective Maintenance * Skill development on right operational techniques and correct maintenance		Apprenticeship training with contractors.

Promote Research and Development in Construction	Meet costs from CESS fund	New Technologies	Methods of making labour more productive.	*Standards * Specifications * Innovation - new/alternate materials	*Choice of technology *Methodologies and Mechanisms for a productive output	*Functional standards * Specifications	Construction technologies.
Ensure Health and safety in Construction Industry	Insurance - * C A R * Workmen compensation.	Health and safety in Design	Safety standards for construction labour	Use of safe materials.	*Safe operation *Operator Licensing	Safety regulations.	*Ensure adherence to safety regulations. * Monitoring.
Promoting and safe guarding local construction organizations.	*Working capital *Bonds and Guarantees	Registration of Professionals.	Use of Registered Local Labour	Specified materials only.	Choice of technology	Performance standards	*Local contractors *Foreign contractors * Registration *Dispute resolutions.

Table 2 - Essential Policy Directives for a Construction Industry Policy Frame work

	IDEAL POLICY FRAME WORK.						
Main Policy Areas	Inputs Requiring Policy Directives						
	Financial	***Design***	***Labour***	***Materials***	***Machinery & Equip.***	***Standards***	***Implementation.***
Promote National Economic Growth	*Public Investment * Private Investment * Public /Private Partnership *Procurement Procedure *Foreign funding *Foreign Aid *CESS on Construction.		*Construction labour wages for different categories	*Foster local industries for production of materials	*Import Licenses *Preferential duty rates	*Performance standards	* Provide Strategic Leadership to all Stakeholders *Adherence to all standards.

	*Construction Statistics						
Ensure Environmental sustainability	Meet costs from CESS fund	*Environment friendly designs		*Use of sustainable local materials.	Regulations to control environment pollution	*Environmental standards for Construction.	*Environmentally friendly methods of construction.* Disposal of Construction debris.
Promote Education and Training in Construction	Meet costs from CESS fund	*Universities *Technical collages	*Vocational training *Right skill at right operation		Skill development on right operational techniques and correct maintenance		Apprenticeship training with contractors.
Promote Research and Development in Construction	Meet costs from CESS fund			*Standards * Specifications * Innovation - new/alternate materials	Methodologies and Mechanisms for a productive output	*Functional standards	Construction technologies.
Ensure Health and safety in Construction Industry	Insurance - * C A R * Workmen's compensation.	Health and safety in Design	Safety standards for construction labour	Use of safe materials.	*Safe operation *Operator Licensing	Safety regulations.	*Ensure adherence to safety regulations. * Monitoring.
Promoting and safe guarding local construction organizations.	*Bonds and Guarantees			Specified materials only.	Choice of technology	Performance standards	*Local contractors *Foreign contractors * Registration *Dispute resolutions.

3.5 Construction policy a "Tool for Innovation"

As we have noted there are many instances where policy implementation will come across barriers, and where policies need change from time to time depending on the state of the industry.

We still have to achieve the objectives and goals of the policy. How do we achieve this.

Keeping the vision, objectives, and goals in view we have to find ways and means of implementing the policy, in short we have to innovate with a view to achieving the prescribed vision, objective and goals.

Hence, we can conclude that innovation flows from polices that cannot be directly implemented, but need innovative ideas for implementation. Hence, construction policy becomes a tool for innovation.

4. INNOVATION IN THE CONSTRUCTION INDUSTRY

Innovation means, change, alteration, re-arrangement, transformation, re-organization, re-structuring, remodeling, new measures, new methods, modernization (Oxford Dictionary)

4.1 What is innovation in the Construction Industry:

Any of the meanings applied to the word innovation, will apply to the construction industry. A policy guide-line issued may be impossible to implement without innovation. Hence, once again we can conclude that construction industry policy is a tool for innovation, provided the policy is fixed, and not subject to arbitrary change. To cite a few examples;

i) In Sri Lanka we do not allow the free mining of river sand as a policy, We need sand for construction, therefore innovate – the solution is the large scale mining of sea sand, with washing plants, producing acceptable sea-sand in abundance as an alternative to river sand.

ii) In times of low investments, larger contractors tend to grab the small jobs meant for small contractors. This resulted in most small contractors going out of business. In order to avoid this the government of Sri Lanka, has announced a new policy where by small construction jobs can only be given to small contractors, thus ensuring the sustainability of small contractors, and that the industry can grow as a whole and not only develop a few large contractors.

iii) There is a shortage of skilled craftsmen for the industry in Sri Lanka. Foreign contractors are allowed to bring in their labour, but local contractors are facing a problem. Youth are not interested in doing construction jobs, import of labour is both economically and politically unsuitable and not allowed policy wise. What is the solution- an innovative idea is floating around i.e., Sri Lanka has a big civil defense force who are costly, but relatively unemployed after the war. Why not train them as skilled craftsmen and use them in the construction industry thus utilizing

their services, by providing the skilled craftsmen, and meeting the costs of maintaining these men by charging the contractors. This is still to be finalized.

Hence, it can be seen that policy will dictate innovation, if implemented steadfastly.

4.2 Promoting innovation through consultation, research and Government intervention with regard to the Industry.

If a policy is laid down, and we come across barriers in its implementation, we should not abandon the policy, but try to innovate and overcome the barriers.

Suggested approaches to innovation would be consultation with the stakeholders, researching the problem, and the government intervening where necessary. This I believe will be a function of the Construction Industry Authority of the country.

5. REFINING A CONSTRUCTION INDUSTRY POLICY THROUGH INNOVATION

We have established clearly that implementation of a policy can have many barriers that need innovative solutions to overcome the barriers, to ensure the policy is implemented.

Hence, construction policy becomes a tool for innovation, and vice-versa innovation can lead to change in Policy.

5.1 Refining a construction policy:

As we know a construction policy cannot be static, but should be dynamic, it must be changed to suit the needs of a country's construction industry at a given point in time. A Construction boom could demand a sudden expansion of the industry, which cannot be done overnight, and may need policy change to expand the industry without endangering the other aspects, resulting in changing the policy to suit the situation through innovation.

5.2 Assessing the state of the construction industry its strengths and weakness:

The state of a construction industry will be of highest concern to a government, in dictating policy. Can it handle the proposed work load, is there excess capacity. The answers to these questions may lead to proposed changes in policy to ensure sustainability. It is therefore of prime importance that the state of the construction industry should be monitored at all times. Hence, there is a need to establish a strong statistical data base, which is updated with accurate information on a regular basis. This information is absolutely necessary to pin-point areas requiring innovation – or to change policy if necessary, to ensure the sustainability and growth of the construction industry.

5.3 Identifying areas that need change in policy to rectify the situation, when innovation fails:

We are clear that if we establish a policy and insist on its implementation we are bound to face problems, which will demand innovative solutions for implementation.

There may however be problems that do not lend themselves to innovative solutions but must be overcome to ensure the functioning of the industry.

Rushing it to change the policy may not be ideal. In my opinion there should be a rigorous examination of the problem by all stakeholders, and if any only if an innovative solution cannot be found should we embark on changing the policy.

Further the implications of the proposed policy change should be studied in great depth, and the policy change be adjusted to minimize its detrimental effects.

6. CONCLUSION

The objective of this paper is to establish as to whether a construction industry policy can be a tool for innovation.

In order to achieve this I have tried to establish that construction is a necessary industry for the socio-economic development of a country, and forms a major part of the National Economy.

Hence, regulation of the Industry through a policy is vital to ensure that the Industry assists in economic growth and meets the needs it is meant for, to the highest standards possible.

Overall therefore the establishment of a construction industry policy is vital for a country.

Implementing the policy steadfastly with minor essential changes, will encounter problems which need solutions.

Solutions must be innovative. We can therefore conclude that a Construction Industry Policy is definitely a tool that generates innovation if and only if we adhere to the policy. There are however situations where innovation can lead to change in policy.

THE NEED FOR PRIVATE SECTOR INVESTMENT FOR INFRASTRUCTURE DEVELOPMENT IN SRI LANKA

Eng. Conrad H De Tissera

SYNOPSIS

There is an urgent need for a paradigm shift in thinking under the favorable current situation in the country for economic development. We have internal security, a stable democratic political system for political stability, a growing per capita income in excess of $ 3800 and a growing GDP over US $ 74 billion. This is a situation which can be marketed effectively for attracting foreign direct investment (FDI) for physical infrastructure development in the country

Sri Lanka has emerged from decades of internal conflicts that stunted its growth potential. It now desperately needs to commit substantial resources to critical areas of economic development. In the recent times Sri Lanka has experienced a high level of investment in infrastructure development. New highways, railroads and transport sector development projects, as well as port development projects have been the public sector contribution to such physical infrastructure investment.

In addition the active involvement of the private sector in recent times in this area of investment was also seen by increased securing of loans and advances from commercial banks for property development projects and other construction projects.

Sri Lanka's economic growth did show a decline in 2015 due to slowing of construction activity. Further the fiscal revenues have not been up to required levels over the last decade, which has restricted the space for public investment and countercyclical policy to combat this problem. With the country on course to join middle income countries, concessional borrowing sources are drying up and have been replaced by borrowings on commercial terms, which is not affordable.

With limited public and private national savings for investment compared to national needs, Sri Lanka has to attract Foreign Direct Investments (FDI) in order to maintain its high growth potential.

A PROPOSAL FOR GOVERNMENT INTERVENTION

In order to maintain the required level of much needed infrastructure investment in Sri Lanka, additional options for mobilizing supplementary investment capital to the infrastructure development sector have to be pursued?

Why invest in physical Infrastructure? A completed infrastructure Project which is functioning and in use, will stimulate intended development activities by forward linkages, creating many jobs, wealth and income to the economy. These returns go to pay back the investment in the medium to long term.

By backward linkages they stimulate demand for supply of materials & equipment and services needed for the construction activities. This creates additional demand on goods and services and thereby new production in these sectors and new jobs. The money that is put in people’s hands thereby creates more demand on goods and services stimulating more economic activities in the immediate to medium term

THE PRESENT SITUATION

The government sector has hitherto been contributing almost exclusively the total investment requirement for physical infrastructure development in Sri Lanka. A large part of public sector funding came from donor sources. Prospects in the future in this area are limited. With Sri Lanka being classified as a middle income country, we may no longer qualify for concessionary loans or grants from Multi Lateral Donors.

The Govt. at present has to commit a significant share of its revenue for

- maintaining several public services essential for the people
- targeted subsidies for health, education and other essential areas
- provide for the much needed social welfare to the low income population
- maintaining internal security

Govt. also has a sizable debt service commitment and a large import bill to service

In this background finding budgetary surpluses for investment in new infrastructure development is challenging. This is because the Government has to fund from its own budgetary resources

i. Modernizing or Expanding existing infrastructure to new and uneconomical but socially/politically important/needed areas
ii. Upkeep, repair and maintain existing infrastructure
iii. New infrastructure which has social, political and economic impacts but low financial returns
iv. Those which are in the funding pipeline with bilateral or official development assistance programmes

Thus the many additional new infrastructures with financial returns, that are possible and viable under the present favorable climate in the country, have to be financed from sources outside the present system. The option of funding by Government through bi-lateral sources on commercial terms as in the past is not a satisfactory option due to affordability reasons. Setting up public-private partnerships with private capital coming from outside the Government's balance sheet is a better option.

NATURE OF INFRASTRUCTURE INVESTMENT

Physical infrastructure projects are capital intensive and of long gestation. There has to be strong motivation for funding such projects by the private sector. The domestic capital market by itself will not be able to generate this level of funds. Private capital can come from both domestic and foreign sources.

Reasons for investor interest in the country are Sri Lanka's rich resource base, literate and trainable workforce, relatively lower costs of production, continuing liberal open economic policies followed by successive Governments, incentives and concessions offered under the BOI Law to foreign private investors and its geographical location

However investors have an abundance of alternative investment opportunities in several other countries which are offering equally attractive incentive packages to chose from.

Two critical issues confronting the Foreign Investor in Infrastructure Development are:

- Uncertainty regarding long term commitment
- Recovery of investment

The questions that have to be answered are-How does Sri Lanka therefore create a more hospitable investment climate? Are there any domestic uncertainties? How does Sri Lanka fare in the global investment scenario?

Global investment pulls are generally due to- Size of the market- eg India, China, Brazil; Per Cap Income – eg. Indonesia, Thailand, Malaysia, South Korea, Singapore; Predictable future outlook – South Africa, Vietnam, Myanmar and other emerging countries in East Asia and the Middle East

It is therefore difficult to imagine that Sri Lanka at present would be as attractive for receiving unsolicited investments offers in infrastructure development. Sri Lanka has to target solicited projects. There has to be an effective institutional mechanism to achieve this.

During Construction Industry Development Authority's consultations with partners of the industry, they say that when work opportunities start to reduce they have idle capacity and unproductive workforce. They also say that if there is assurance of continuous work opportunities they will be able to modernize and upgrade their systems to improve their efficiency for a more effective role.

Although the cyclical variation in work opportunities in construction is a universal phenomenon when the state of a country's economy changes or when most of the essential infrastructure has been put in place, in a developing economy like Sri Lanka whose physical infrastructure needs are still quite extensive, a facility for mobilizing investment for physical infrastructure development, particularly by attracting FDI, will be a worthwhile prospect to investigate. The establishment of a dedicated new Infrastructure Development Company, or a Venture Capital Company as a special purpose facility (SPF) to deal with this would be a feasible option.

The specific objective of such a company will be to facilitate funding of many new infrastructure projects, particularly those with financial returns that are required and viable under the present favorable climate in the country. These projects can be funded through public/private partnerships with private capital. They would necessarily be additional to the projects which are already in the official development pipeline of the line agencies of the Government and will not be in competition with them.

This proposal is therefore targeted to establishing a public-private partnership by way of an infrastructure development company to attract FDI for infrastructure development in Sri Lanka.

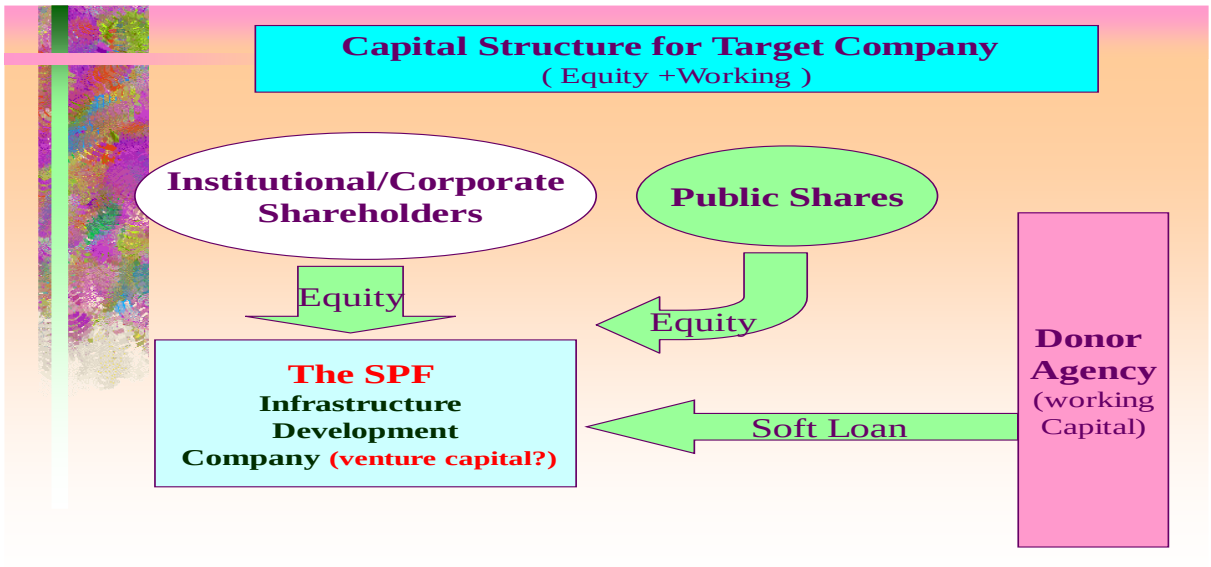
THE PROPOSED COMPANY (SPF)

The proposed infrastructure development company (SPF) will have the share capital contributed by a broad based, public and private investor group. The line agencies of government (SOEs)

responsible for infrastructure development in the country will be invited to contribute up to 25% of the share capital. They will represent the public sector's cost sharing and risk sharing contribution to the enterprise. Another 25% of the share capital will be offered to the corporate private sector that has investment interests in the construction industry. They will represent the private sector in this venture. Their participation in addition will bring in the private sector flair into the company's operations. A further 25% of the share capital will be offered to the development banking sector that sees lending opportunities in the company's activities. Their presence will also ensure that required financial discipline is brought into the company operations. The balance 25% will be offered to the investing public through the stock market. This important last part of the share capital, traded in the stock market, will require that the company conforms to the regulations of the Securities and Exchange Commission. The performance of these shares in the trading floor will be a barometer of the health of the company in the eyes of the private investor.

The share capital of the company as proposed above has to be supplemented by some substantial working capital support. This may be secured by way of a soft loan from a multilateral donor agency. This loan could be of the order of magnitude of around US$ 150- 200 million for the Company to have the stature, capacity and investor confidence to intervene effectively in mobilizing FDI for infrastructure development in Sri Lanka. This soft loan can be made available in say five tranches of US $ 30-40 million each, to be secured incrementally. The company may commence operations with the first tranche and draw on the balance working capital as the company expands operations. This way the company will be able to meet the investment demands as and when they arise and cope with the repayment commitments more easily, as it progressively mobilizes FDI for a series of infrastructure development projects that are performing as going concerns.

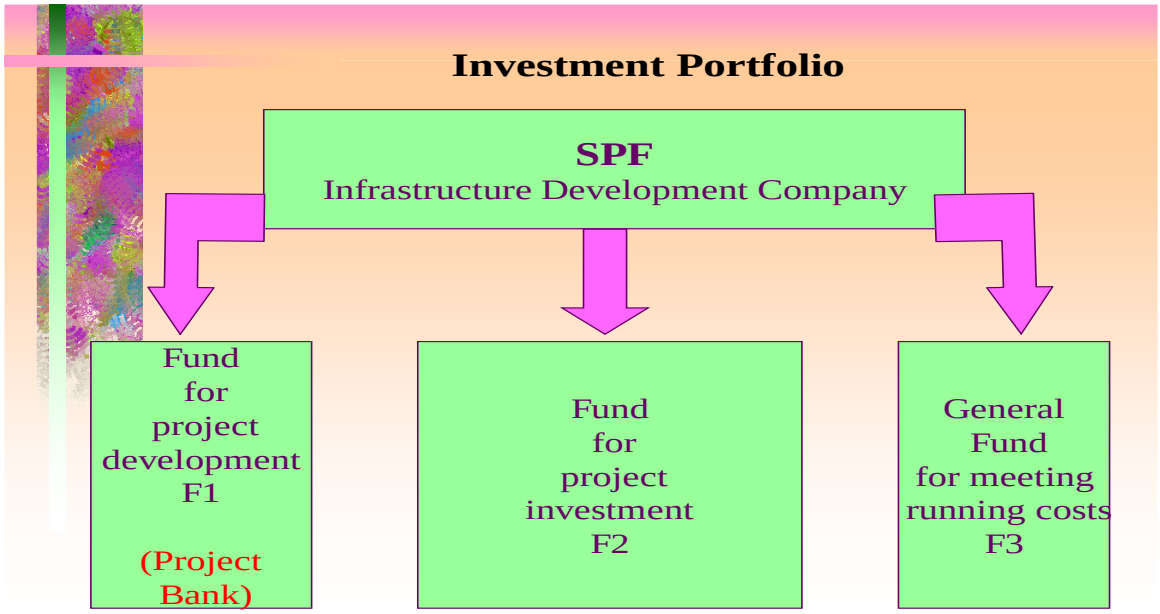
The schematic representation of this concept is given below.



The share capital and the working capital will be organized into three funds by the company. One fund (F1) will be dedicated for developing project proposals and creating a project bank of feasible proposals. The next fund (F2) will be used for providing share capital to start-up new project companies as subsidiaries, implementing infrastructure projects. These two funds will be created

from the working capital loan from a multi-lateral donor agency. The third fund (F3) made out of the share capital contributions from shareholders will be invested prudently so that the returns are available to meet the cost of running the company and paying dividends to shareholders.

An illustration of the concept is given below.



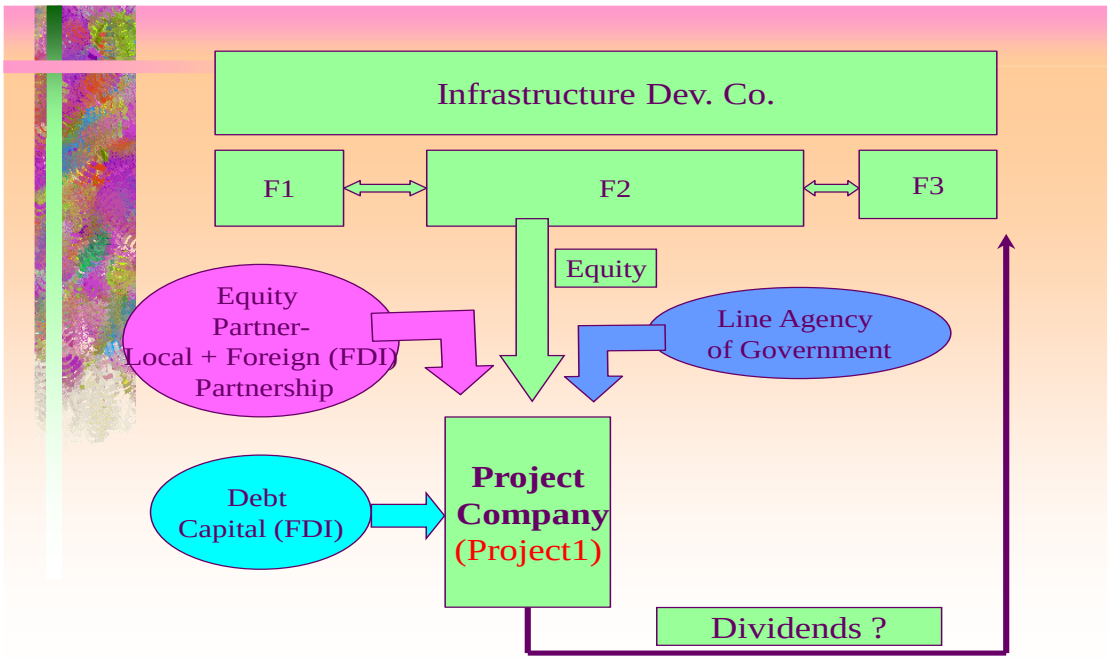
The issue of public shares will require the company to be supervised by the Securities and Exchange Commission of Sri Lanka giving it transparency and encourage the Private Sector to participate. Donor Agencies that promote private sector development will thus be motivated to contribute to the working capital

COMPANY OPERATIONS:

The Company Board will select a proposal from the project bank developed by its Fund F1, and agree on the share capital that can be committed from the Fund F2, to form a new subsidiary project company to implement the selected project. The Company will invite the corresponding line agency of the government to partner in providing the logistical support as permits, approvals and other inputs as land etc. for the selected infrastructure project.

The Company will then solicit expressions of interest from the local private sector with their foreign partners, through a public invitation, to form a public–private partnership to implement an infrastructure project. This subsidiary project company will mobilize FDI required to implement the infrastructure project.

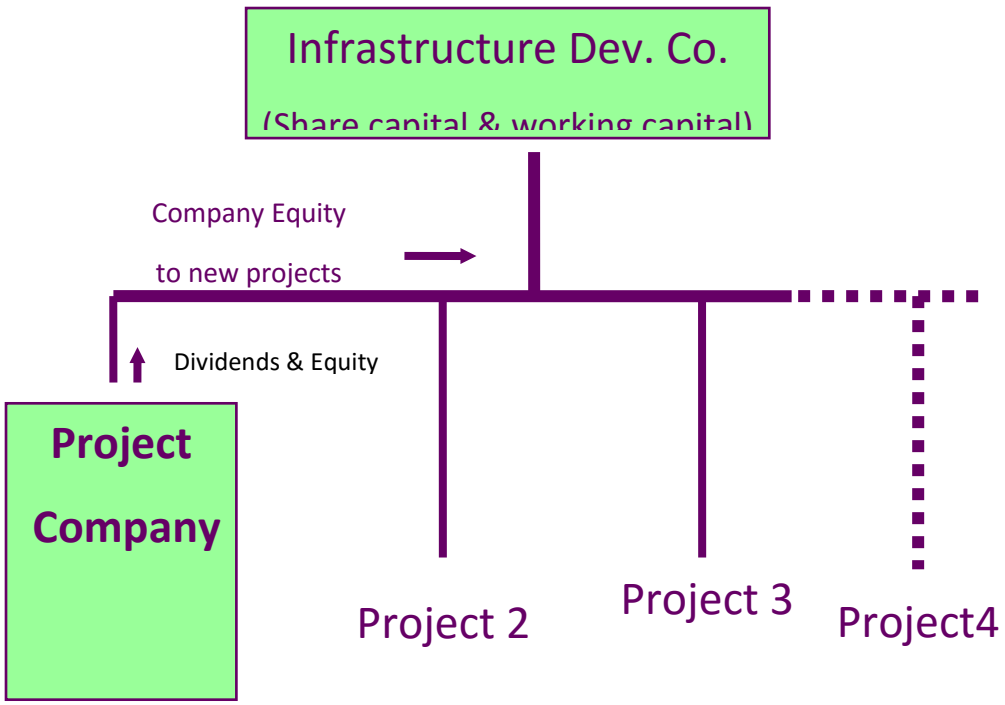
The schematic representation of this operation is given below in the following diagram.



THE COMPANY'S EXIT STRATEGY

Once the project is consolidated and up and running, the Company (SPF) will divest its share capital to the government partner and private partners or to the investing public and recover its investment and any share appreciation and engage in another project on a similar arrangement. This process will ensure that the Capital of the Company (SPF) is not fully used up in a few new projects initially thus depleting its capital early. Divesting equity among other partners or public will ensure recycling of capital over many projects. The Company will also not be tied down to many diverse projects all over the country at any given time

The schematic representation of this operation is given below.



CONCLUSION

Sri Lanka presently needs to commit substantial resources to physical infrastructure development. The government sector has to date been contributing this total investment. This public sector funding came from donor sources. Prospects in the future are not so bright. Critical issues needing Govt. attention are- Investment in infrastructure development is urgently needed; Infrastructure development is capital intensive and the domestic capital market alone cannot meet this high investment levels; To attract foreign investment Sri Lanka has to enter a highly competitive market ; An investment climate is needed to create investor confidence. A facility for mobilizing investment for physical infrastructure development, particularly by attracting FDI, will be necessary in this situation. The establishment of a dedicated new Infrastructure Development Company, as a special purpose facility (SPF) will be a feasible option in this regard.

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නිවාස හා ඉදිකිරීම් අමාත්‍යාංශය

ඉදිකිරීම් කර්මාන්ත සංවර්ධන අධිකාරිය

1982 වසරේ ලෝක බැංකු ආධාර මත ආරම්භ කරන ලද ගල්කුලම ඉදිකිරීම් යන්ත්‍රෝපකරණ මෙහෙයුම් ශිල්පී විදුහල මෙහෙයුම් ශිල්පීන් පුහුණු කිරීම සඳහා ශ්‍රී ලංකාවේ ඇති එකම රාජ්‍ය ආයතනයයි.

දේශීය සහ විදේශීය ඉහළ රැකියා ඉල්ලුමක් ඇති ඉදකිරීම් යන්ත්‍ර ක්‍රියාකරුවන් පුහුණු කිරීම සඳහා පාඨමාලා පවත්වයි.

මෙම ආයතනයේ පාඨමාලා හදාරා පුහුණුව අවසන් කරන ආධුනිකයින් සහ දැනට වෘත්තියේ යෙදී සිටින අය හට දක්ෂ ඉදිකිරීම් යන්ත්‍ර ක්‍රියාකරුවකු වී නිපුණතා ශිල්පී සහතිකය සහ හැඳුනුම්පතක් ද අවශ්‍ය න්‍යායික දැනුම හා ප්‍රායෝගික පුහුණුව කාර්යශූර ආචාර්යවරුන් හා නිලධාරීන් විසින් ලබාදේ.

රාජ්‍ය ආයතනයක් වශයෙන් කිසිම ලාභ පරමාර්ථයකින් තොරව රජය විසින් විශාල වියදමක් දරා නේවාසික පහසුකම් සමග මෙම පුහුණු කටයුතු සිදුකරන අතර, පුහුණු ලාභියාගෙන් අයකරනු ලබන්නේ පුහුණුව සඳහා වැයවන පිරිවැයෙන් ඉතා සුළු කොටසකි.

පාසල් හැරගිය රටේ දහසක් දුවා දරුවන්ට ගල්කුලම බරවාහන මෙහෙයුම් ශිල්පී පුහුණු මධ්‍යස්ථානය මෙම ක්ෂේත්‍රයේ ජාත්‍යන්තර පිළිගැනීමකින් යුතු නිපුණතා සඳහා මග විවර කර දී තිබේ.

ශ්‍රී ලංකාවේ ඉදිකිරීම් යන්ත්‍රෝපකරණ මෙහෙයුම් ශිල්පී පුහුණුවට ඇති එකම රාජ්‍ය ආයතනයෙන් ජාත්‍යන්තර සුදුස්සෙකු වන්න.

ඉදිකිරීම් යන්ත්‍රෝපකරණ මෙහෙයුම් ශිල්පී පාඨමාලා

- මූලික ඉදිකිරීම් යන්ත්‍ර නඩත්තු ශිල්පය
- සැහැල්ලු ඉදිකිරීම් යන්ත්‍ර මෙහෙයුම් ශිල්පය
- ට්‍රැක්ටර් පුහුණු පාඨමාලාව
- ගල් රෝලර් පුහුණු පාඨමාලාව
- ලෝඩර් බැකෝ
- වීල් ලෝඩරය
- ඒක්ස්කැවේටරය
- මෝටර් ග්‍රේඩරය
- ඩෝසරය
- ජංගම දොඹකරය
- ඩම්ප්ට්‍රක් රථය
- යන්ත්‍රෝපකරණ ප්‍රවාහකය
- ෆෝක්ලිෆ්ට් ට්‍රක්
- ස්කිඩ් ලෝඩරය
- බුම්ට්‍රක්/ක්‍රේන්ට්‍රක්
- ඉදිකිරීම් යන්ත්‍ර කළමනාකරණ පාඨමාලාව

ඉදිකිරීම් යන්ත්‍ර මෙහෙයුම් ශිල්පී විදුහල

ගල්කුලම, අනුරාධපුර.

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AWARD WINNERS FROM 1990 TO 2016

Construction Excellence Awards & Construction Merit Awards for Building Projects

Year	Type of Award	Project and Recipient
1990	Excellence	Petroleum Corporation Building - Pelawatta by Link Engineering Ltd.
1991	Excellence	Majestic City Complex - Bambalapitiya by Tudawe Brothers Ltd.
	Merit	Factory Complex – Biyagama by International Construction Consortium Ltd.
1992	Merit	Manning town Housing Scheme - Alvitigala Mawatha by State Engineering Corporation of Sri Lanka
	Merit	Army Commander's Secretariat - Galle Face by Maga Engineering (Pvt) Ltd.
1993	Excellence	Kandalama Hotel by Link Engineering Ltd.
	Excellence	Factory –Pannala by International Construction Consortium Ltd.
1994	Excellence	King's Court Apartment Complex - Bambalapitiya by Tudawe Brothers Ltd
	Merit	Office Building - Navam Mawatha by Maga Engineering (Pvt) Ltd
1995	Excellence	Maternity and office Complex of Co-operative Hospital - Matara. by Matara Construction Co Ltd.
1996	Excellence	Office Building for Hemas Ltd Colombo 02. (Category I) by Maga Engineering (Pvt) Ltd
	Merit	Queen's Court Apartment Complex -Kollupitiya. (Category I) by Tudawe Brothers Ltd.
1997	Excellence	Light House Hotel -Galle. (Category I) by Maga Engineering (Pvt) Ltd
	Merit	Head Office Building of Development Holdings (Pvt) Ltd . Colombo 02. - (Category I) by International Construction Consortium Ltd.
	Merit	Hotel Blue Waters -Wadduwa.- (Category I) by Maga Engineering (Pvt) Ltd.

Year	Type of Award	Project and Recipient

1998 - 1999	Merit	Bank of Ceylon Building at 1999' Kandy. (Category D) by Samuel Sons & Company Ltd.
	Merit	Post Graduate Institute of Science at the University of Peradeniya. (Category III) by J B Attanayake & Company (Pvt) Ltd.
2000	Merit	National College of Education at Ratnapura. (Category I) by Maga Engineering (Pvt) Ltd
	Merit	National College of Education at Polonnaruwa (Category I) by Link Engineering Ltd.
2001	Excellence	Premier Pacific International - Luxury Apartment Complex at Colombo 07. (Category I) by Tudawe Brothers Ltd.
	Merit	Lotus Tower - Luxury Apartment Complex at Colombo 07. (Category I) by Maga Engineering (Pvt) Ltd
	Merit	Class rooms, Library and Administration Building for the Advance Technical Institute at Mattakkuliya. (Category III) by Union Construction Engineering Ltd.
2002	Excellence	Information Technology Park at Malambe. by International Construction Consortium Ltd.
	Excellence	Speaker's Residence at Battaramulla by Link Engineering Limited.
	Excellence	Apollo Hospital at Narahenpita. (Category I) by Maga Engineering (Pvt) Ltd.
	Excellence	Hatton National Bank at Vavuniya by R R Group
2003	Excellence	Distribution Centre at Kelaniya. (Category I) by International Construction Consortium Ltd.
	Excellence	National College of Education, Jaffna. (Category (HI) by Euroville Engineers & Constructors (Pvt) Ltd.
	Merit	Luxury Apartments - Colombo 03. (Category II) by L H Piyasena & Co (Pvt) Ltd.
	Merit	Sports and Recreation Complex at Rattanapitiya. by Nawaloka Construction Company Ltd.

Year	Type of Award	Project and Recipient
	Merit	Vocational Training Centre at Narahenpita by Maga Engineering (Pvt) Ltd.
2004	Excellence	Home for the Aged at Colombo 10. by Tudawe Brothers Ltd
	Merit	Apartment Hotel for Global Towers at Wellawatta. by L H Piyasena & Company (Pvt) Ltd.
	Merit	Luxury Apartments at Colombo 03. by L H Piyasena & Company (Pvt) Ltd.
	Merit	Courts Complex at Trincomalee by Sierra Construction Ltd.
2005	Excellence	Cargo Building at the Katunayake Airport by Maga Engineering (Pte) Ltd.
	Merit	Sahanaya – Mental Health Care Centre at Gorakana by Nawaloka Construction Company Ltd.
	Merit	Commercial Centre at Bandarawela by Sierra Construction Ltd.
	Merit	Apartment Complex at Colombo 09 by Tudawe Brothers Ltd.
	Merit	Mixed Development at R A de Mel Mawatha –Colombo 7. by Maga Engineering Ltd.
2006	Excellence	St. Michaels Apartment Complex – Colombo 03 by Tudawe Brothers Ltd.
	Excellence	Factory Building to Orit Apparels (Pvt) Ltd. at Awissawella by R N Construction (Pvt) Ltd.
	Merit	Buildings and Structures for the Department of the Wild Life Conservation at Wasgamuwa. by Orient Construction Company (Pvt) Ltd
	Merit	Buildings and structures for the Department of Wild Life Conservation at Bundala. by Orient Construction Company (Pvt) Ltd
	Merit	Golden Residencies Apartment Complex at Kotahena by L H Piyasena & Co (Pvt) Ltd.

Year	Type of Award	Project and Recipient
2007	Excellence	Capital Residencies' Luxury Apartments at No. 65, Dharmapala Mawatha, Colombo 07. by Sanken Lanka (Pvt) Ltd.
	Excellence	'Golden Crescent' Luxury Apartments at Kollupitiya Road, Colombo 04. by L H Piyasena & Company (Pvt) Ltd.
	Excellence	Radiation Treatment Centre at Park Street, Colombo 02. by Maga Engineering (Pvt) Ltd.
	Merit	Skyline Residencies at Borella by Maga Engineering (Pvt) Ltd.
2008	Excellence	"Fairway Residencies" at Rajagiriya by Maga Engineering (Pvt) Ltd.
	Excellence	"Iceland Residencies", Colombo 03 by International Construction Consortium Ltd.
	Excellence	Building for National Institute of Nephrology, Colombo 10. by Tudawe Brothers Ltd.
	Merit	Model Green Factory at Thulhiriya by Maga Engineering (Pvt) Ltd
	Merit	6th Avenue Apartments, Colombo 05 by Tudawe Brothers Ltd.
	Performance	Improvement of Advanced Technological Institute, Jaffna by Euroville Engineers & Constructors (Pvt) Ltd.
2009	Excellence	Hospital for Hemas Hospitals (Pvt) at Wattala by International Construction Consortium Ltd.
	Excellence	Southern Zonal Officer Building for People's Bank at Anagarika Dharmapala Mawatha, Matara by Sathuta Builders (Pvt) Ltd.
	Merit	Apartment Complex for Sithma Development (Pvt) Ltd. at Havelock Road, Colombo 05 by Nawaloka Construction Co. (Pvt) Ltd.
	Performance Certificate	Upgrading of District Base Hospital at Elpitiya by V V Karunaratne & Company
2010	Excellence	"Fair Mount" – Luxury Apartment Complex by Maga Engineering (Pvt) Ltd.
	Excellence	Construction of a Boutique Hotel for Ulagalla Resort at Thirappane by International Construction Consortium (Pvt) Ltd.
	Excellence	OPD Building at Polonnaruwa General Hospital by Orient Construction Co. (Pvt) Ltd.

Year	Type of Award	Project and Recipient
2011	Excellence	Head Office for People's Leasing Co. Ltd. at Borella by Maga Engineering (Pvt) Ltd.
	Excellence	People's Bank Regional Head Office Building & Branch Office Building at Nugegoda by Sathuta Builders (Pvt) Ltd.
	Merit	Office Building for Greater Colombo Regional Support Centre (GCRSC) for NWS&DB Pelawatta. by Link Engineering (Pvt) Ltd.
	Merit	Extension to the Branch office for Commercial Bank of Ceylon Limited – Kotahena Branch by R N Constructions (Pvt) Ltd.
2012	Excellence	Head Quarters Building for Sri Lanka Customs at Fort by Maga Engineering (Pvt) Ltd.
	Excellence	House for Ambassador of Kuwait at Rosmead Place, Colombo 07 by Nawaloka Construction Company (Pvt) Ltd.
	Excellence	Jungle Beach Resort at Kuchchaveli, Trincomalee by International Construction Consortium (Pvt) Ltd.
	Excellence	"Trillium Residencies" Apartment Complex at Elvitigala Mawatha, Colombo 05 by Sanken Construction (Pvt) Ltd.
	Excellence	"Emperor Tower" at No. 75A, Galle Road, Colombo 03 by Sanken Construction (Pvt) Ltd.
	Merit	Shopping Complex for Crown Property Development (Pvt) Ltd. at Colombo 06 by Maga Engineering (Pvt) Ltd.
	Merit	Office Building for the Ministry of Environment & Natural Resources at 569, Pitakotte Rd, Pitakotte by Link Engineering (Pvt) Ltd.
	Merit	Bank of Ceylon Branch Office & Manager's Quarters at Kebithigollawa by A S B Constructions (Pvt) Ltd.
	Certificate of Appreciation	Building Complex for the Faculty of Technology under the South Eastern University of Sri Lanka Development Project – Phase 1A at Oluwil by Edward & Christie
	Certificate of Appreciation	Head Office Building for Valikamam South West Pradeshiya Sabha at Manipay, Jaffna by V V Ramanathan & Co. (Pvt) Ltd.

Year	Type of Award	Project and Recipient
2013	Excellence	Administrative Complex Building – Sethsiripaya Stage II at Sethsiripaya Premises, Battaramulla by Maga Engineering (Pvt) Ltd.
	Excellence	Hambantota Port Development Project Phase I - Administrative Complex by Maga Engineering (Pvt) Ltd.
	Excellence	Centara Passikudah Resort & Spa at Passikudah by Tudawe Brothers (Pvt) Limited
	Merit	Chaaya Bey Hotel Beruwala at Beruwala by International Construction Consortium (Pvt) Ltd.
	Merit	Dr. Neville Fernando Sri Lanka – Russia Friendship Teaching Hospital at Malabe by R N Constructions (Pvt) Ltd.
	Merit	Hikkaduwa Cultural Centre and Tsunami Research Centre (Tsunami Memorial Museum) Phase I at Peraliya, Hikkaduwa by Sripalie Contractors (Pvt) Ltd.
	Merit	Ceylinco Branch Office Building for Ceylinco Life at Gampaha by Sathuta Builders (Pvt) Ltd.
	Certificate of Appreciation	Mixed Development Apartment Complex at Dehiwala by L H Piyasena & Co. (Pvt) Ltd.
2014	Excellence	New Head of Mission Residence for Australian High Commission at Colombo 07 by Maga Engineering (Pvt) Ltd.
	Excellence	Mercedes Benz Centre" at Colombo 14 by Maga Engineering (Pvt) Ltd.
	Excellence	Commercial Development for Cargills (Ceylon) PLC at No. 420, Hospital Road, Jaffna by Nawaloka Construction Co. (Pvt) Ltd.
	Excellence	Club House & Swimming Pool for Havelock City Development at Colombo 06 by International Construction Consortium (Pvt) Ltd.
	Excellence	National Nanotechnology Park Phase 1 A at Mahenawatte, Pitipana, Homagama by Tudawe Brothers (Pvt) Limited
	Excellence	Prime Lands Head Office Building at No. 75, D S Senanayake Mawatha, Colombo 08 by Tudawe Brothers (Pvt) Limited

Year	Type of Award	Project and Recipient
2014	Merit	Hotel Complex for Airport Garden Leisure (Private) Limited at Seeduwa by Tudawe Brothers (Pvt) Limited
	Merit	Shinagawa Beach Hotel at No. 30, Old Guruniwasa Road, Balapitiya by N & A Engineering Services (Pvt) Ltd.
2015	Excellence	Housing for Relocation of Underserved Settlements in the City of Colombo at 194, Cyril C Perera Mawatha, Colombo 14 by International Construction Consortium (Pvt) Ltd.
	Excellence	Office Building for Citizen Development Business Finance PLC at Colombo 10 by Tudawe Brothers (Pvt) Limited
	Excellence	Warehouse Building for Nestle Lanka PLC Kurunegala Factory at Makandura, Gonavila by R N Construction (Pvt) Ltd.
2016	Excellence	Design and Construction of Secretariat for Personal Identification for Ministry of Defence & Urban Development at Battaramulla. by International Construction Consortium (Pvt) Ltd.
	Excellence	Luxury Residential Apartments at No. 320, Union Place, Colombo 02. by Sanken Construction (Pvt) Ltd.
	Excellence	Housing for Relocation of Underserved Settlements in the City of Colombo. by Access Engineering PLC
	Excellence	Design and Construction of Iceland Business Centre at Colombo 03. by International Construction Consortium (Pvt) Ltd.
	Excellence	Bottling Plant Complex at Munidasa Kumarathunga Mawatha, Seeduwa. by R N Constructions (Pvt) Ltd.
	Excellence	Commercial Building – Dialog Axiata PLC at 475 A, Union Place, Colombo 2. by Tudawe Brothers (Pvt) Ltd.
	Excellence	Supply and Installation of Aluminium Doors, Windows, Composite Panels, Entrance Foyer and Atrium Roof for Secretariat for Personnel Identification, Ministry of Defence and Urban Development at Battaramulla by AJAX Engineers (Pvt) Ltd.

Year	Type of Award	Project and Recipient
2016	Merit	Apartment Complex – The Fairway Sky Garden at 39, Perera Mawatha, Rajagiriya. by Maga Engineering (Pvt) Ltd.
	Merit	Highways Secretariat Building at Battaramulla by Nawaloka Construction Company (Pvt) Ltd.
	Merit	Six Storied Co-operative Hospital Building at Galle. by Sripalie Contractors (Pvt) Ltd.
	Merit	Branch Office for People's Bank at Hatharaliyadda, Kandy. by Kemyo (Pvt) Ltd.

Green Construction Award

Year	Type of Award	Project and Recipient
2012	Excellence	Design & Construction of Ulagalla Walawwa Resort (Boutique Hotel) by International Construction Consortium (Pvt) Ltd.
	Excellence	MAS Intimates Thuruli (Pvt) Ltd. by Maga Engineering (Pvt) Ltd.
2013	Excellence	Hatton National Bank, Nittambuwa by Tudawe Brothers (Pvt) Limited
	Excellence	CECB Head Office – Phase II by Central Engineering Consultancy Bureau
2014	Excellence	Factory Worker's Accommodation Building and Site Development Works for Variosystems (Pvt) Ltd at Badalgama by Nuwani Construction (Pvt) Ltd.
	Excellence	Hatton National Bank, Kalmunai by Niron Enterprises
2015	Excellence	National Nanotechnology Park, Phase I at Pitipana, Homagama by Tudawe Brothers (Pvt) Limited
	Excellence	Warehouse Building for Nestle Lanka PLC Kurunegala Factory at Makandura, Gonavila by R N Construction (Pvt) Ltd.

Electro Mechanical Construction Awards

Year	Type of Award	Project and Recipient
2014	Merit	Supply and Installation, Testing & Commissioning of Air Conditioning and Ventilation System – Colombo Gold Centre at Pettah by Frigi Engineering Services (Pvt) Ltd

Special Appreciation Awards for Government Institutions

Year	Type of Award	Project and Recipient
2014	National Award for Construction Performance	Auditorium at University of Wayamba by State Engineering Corporation of Sri Lanka
2014	Special ICTAD Award for Construction Performance	New Kallady Bridge at Batticaloa by State Development & Construction Corporation
2014	Special ICTAD Award for Construction Performance	Refurbishment of Water's Edge, Battaramulla by State Engineering Corporation of Sri Lanka
2014	Special ICTAD Award for Construction Performance	Paddy Storage Ware House at Marandagahamula by State Engineering Corporation of Sri Lanka

Construction Performance Awards for Building Projects
(assessed after completion)

Year	Type of Award	Project and Recipient
2012		**<u>Category I - value exceeding Rs: 150 million</u>**
	Construction Performance	Central Hospital Development Project by International Construction Consortium (Pvt) Ltd.
	Construction Performance	South Asian Institute of Technology & Management at Millagahawatte, Welivita, Malabe by International Construction Consortium (Pvt) Ltd.
	Construction Performance	Sri Sambuddha Jayanthi Mandiraya at 32, Havelock Road, Colombo 05 by Maga Engineering (Pvt) Ltd.
	Construction Performance	Vocational Training Centre at Matiyagane, Kurunegala by R H Steel Building Systems (Pvt) Ltd.
	Construction Performance	Courts Complex Tangalle by V V Karunaratne & Company
	Construction Performance	Empire Residential Development Project at 51, Braybrooke Place, Colombo 02 by Sanken Construction (Pvt) Ltd.
	Construction Performance	Office Building at No. 315, Vauxhall Street, Colombo 02 by Sanken Construction (Pvt) Ltd.
		<u>Category II - valued between Rs: 50 million & 150 million</u>
	Construction Performance	Extension to the Classroom Block Project – Stage I & II University of Moratuwa by State Engineering Corporation of Sri Lanka
	Certificate of Appreciation	New Life Housing Project at Madulkelle Estate, Kandy by Plantation Human Development Trust (PHDT)

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2006	Improvements to Dr. N M Perera Mawatha by Maga Engineering (Pvt) Ltd. Rehabilitation and Asphalt overlaying of Peliyagoda - Puttalam Road by International Construction Consortium Ltd. Piling Works for Empire Residential Development by Nawaloka Construction Company Limited. Vehicular Bridge at National College of Education Rathnapura by Maga Engineering (Pvt) Ltd. Extension to the Water Treatment Works at Ambatale by Sanken Lanka (Pvt) Ltd
2007	Piling work for Colombo Sewerage Rehabilitation Project by Nawaloka Construction Company Ltd. Improvements to a Section of Matara – Hakmana Road by Maga Engineering (Pvt) Ltd. Improvements to a Section of Akuressa Road, Matara. by Maga Engineering (Pvt) Ltd.
2008	Wellawaya Water Supply Scheme by Maga Engineering (Pvt) Ltd. Road Sector Development Project Phase II – LCV : UVB – 04 R Bridges by Maga Engineering (Pvt) Ltd. Improvements to Weeraketiya – Middeniya Road by Maga Engineering (Pvt) Ltd. Improvements to Palavi – Kalpitiya Road from 1.0 km to 5.0 km by Maga Engineering (Pvt) Ltd. Road Sector Development Project Phase 3 – LCB : NC – 10 R by Maga Engineering (Pvt) Ltd.
2009	Rehabilitation & Improvements of Nagoda - Agalawatta Road ADB Funded Road Network Improvement Project Contract No. RDA/ADB/RNIP/LCB/C4 by International Construction Consortium Ltd. Rehabilitation & Improvements to Panadura - Ingiriya Road ADB Funded Road Network Improvement Project Contract No.RDA/ADB/RNIP/ICB/C3A by International Construction Consortium Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2009	Rehabilitation & Improvements to Padeniya – Puttalam Road (A-010) (from 62.90km to 124.27km) by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements to Jayanthipura – Tirukkondaimadu Road (A-011) (from 59.90km to 128.76km) by Maga Engineering (Pvt) Ltd. Improvements to Welikada – Nawala Road (from 0+000m to 2+700km) by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvement to Bandarawela - Welimada Road (B044) Contract Package 04 (NCB) by Tudawe Brothers (Pvt) Ltd. Rehabilitation & Improvement to Bandarawela - Haliela Road (A016) Contract Package 03 (NCB) by Tudawe Brothers (Pvt) Ltd. Water Supply Galle District Phase II - Immediate Measures in Tsunami Affected Areas – Package 28 by Tudawe Brothers (Pvt) Ltd. Rehabilitation & Augmentation of Tangalle Water Supply Scheme by Sierra Construction (Pvt) Ltd. Construction of Bridge No. 5/2 on Kandy – Jaffna Road at Katugastota by State Development & Construction Corporation
2010	Balance Work & Re-construction of Bridge No. 36/3 (Warawala Bridge) on Kegalle - Bulathkohupitiya – Karawanella Road by Nawaloka Construction Company (Pvt) Ltd Implementation of Permanent Steel Bridge of Oddamavady under Batticaloa District by Progressive Builders & Resorts (Pvt) Ltd Construction of Suspension Bridge Across, Ma-Oya at Waddeniya by Sathuta Builders (Pvt) Ltd Construction of 1800 m^3 capacity Treatment Plant, Storage Tank Borehole Intake & Control Rooms for Radampola Water Supply Scheme by Valence Engineering (Pvt) Ltd Supplying & Laying of Water Distribution Mains in Bandaragama and Horana – Kaluganga Water Supply Project for Greater Colombo Contract No. KG/JBIC/KG-4 by Hovael Construction (Pvt) Ltd Thirukkovil Water Supply Scheme by Sierra Construction (Pvt) Ltd

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2010	Greater Kandy Water Supply Project Phase 1 Stage II Ampitiya Improvement & Construction of Engineer's Quarters by Maga Engineering (Pvt) Ltd Rehabilitation of Matara – Wellawaya (A-002) Road by Maga Engineering (Pvt) Ltd. Hambantota Harbour By-Pass Road by Maga Engineering (Pvt) Ltd. Widening & Improvements of Palavi – Kalpitiya Road (5.0 - 9.0 km) by Maga Engineering (Pvt) Ltd. Widening & Improvements of Palavi – Kalpitiya Road (9.0 – 14.0 km) by Maga Engineering (Pvt) Ltd. Rehabilitation of Navatkuli – Kerativu – Mannar (A-32) Road by Maga Engineering (Pvt) Ltd. Regional Bridge Project using British Government Finance Assistance – Construction of Kelaniya Railway Crossing Flyover by Access Engineering Ltd. Out side Plant Works (Fiber Routes / Civil Works, Cable Laying & Jointing) of the Optical Fiber Network Development Project Phase – 01 & 01B by Access Engineering Ltd. USAID – Sri Lanka Tsunami Reconstruction Program USAID Contract # 386-C-00-05-00166-00 SLTRP Contract # 1B-06. Construction including detail design of Major Works at Hikkaduwa, Mirissa and Puranawella Fish Harbours by Access Engineering Ltd. Raising of Unichchai Tank Bund and the Construction and Completion of its Appurtenant Structure in Batticalloa by Access Engineering Ltd. Secondary Towns and Rural Community Based Water Supply and Sanitation Project – Sri Lanka Polonnaruwa Water Supply Project. Supply & Laying of distribution pipes & construction of elevated water towers for Polonnaruwa Water Supply Project by International Construction Consortium (Pvt) Ltd. Rehabilitation of A014 Medawachchiya – Mannar – Talaimannar Road (from 33.00.km to 37.00 km) by International Construction Consortium (Pvt) Ltd. Rehabilitation of Navatkuli – Kerativu – Mannar (A 32) Road (from 91+370 km to 92+370 km) Contract No : RDA/MMC/MAINT/NKM/07R by International Construction Consortium (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2010	Design & Construction of a Bridge Across Ambanganga at 800m down stream of the proposed Moragahakanda Main Dam by State Development & Construction Corporation
2011	**Category I - value exceeding Rs: 1000 million** Rehabilitation of – Siyambalanduwa – Pottuvil – Akkaraipattu (A-04) Road Contract No. : RDA/TAARP/ADB-EU/ICB/C3 by Maga Engineering (Pvt) Ltd. Southern Transport Development Project (JBIC Section) Package II – Dodangoda to Kurundugahahetekma by K D A Weerasinghe & Co., (Pvt) Ltd. Supply & Laying of Distribution Pipes and Construction of Elevated Water Towers Hambantota Water Supply Project by Sierra Construction (Pvt) Ltd. Rehabilitation and Upgrading of A-006 Ambepussa-Kurunegala-Trincomalee Road from Habarana to Kanthale (43.8 km) by International Construction Consortium (Pvt) Ltd. **Category II - valued between Rs: 500 million & 1000 million** KfW Water Supply Galle District – Phase II Immediate and Medium Term Measures in Water Supply to Tsunami Affected Areas by K D A Weerasinghe & Co., (Pvt) Ltd. **Category III - valued between Rs: 100 million & 500 million** Regional Bridge Project using British Government Finance Assistance – Construction of Nugegoda Fly Over by Access Engineering Ltd. Regional Bridge Project using British Government Finance Assistance – Construction of Sangupiddy Fly Over by Access Engineering Ltd. Construction of a Bridge Across Maoya on Pannala – Maningamuwa – Mellawagedara Road Contract No. RDA/WD/NWP/SIRUP /2006/105 by Access Engineering Ltd. Construction of Elevated Tower, Sub Office Building, Caretaker Quarters and Laying of Distribution System for Kaluwanchikudi Water Supply Scheme Stage II by V V Karunaratne & Company Construction of Denawaka Ganga Mini Hydropower Project by V V Karunaratne & Company Negombo Water Supply and Optimisation Contract Civil Works Sub – Contract 816/003 by Sanken Lanka (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2011	Improvements to Udawalawa – Thanamalwila Road (24.5 km) by Maga Engineering (Pvt) Ltd. Rehabilitation & Augmentation of Kirindi Oya Water Supply Project by Maga Engineering (Pvt) Ltd. Construction of Fly over Bridge near Level Crossing at Gampaha by State Development & Construction Corporation Rehabilitation & Improvements of Valachchenai Fishery Harbour Package No. 02 – Marine Structure by Nawaloka Construction Company (Pvt) Ltd. **Category IV – valued up to Rs: 100 million** Construction of 1000 m^3 Water Tower at Ippalogama Ranawiru Gammanaya water Supply Scheme by Lohitha Construction Rehabilitation of Navatkuli – Kerativu – Mannar Road (A 32), (94 + 370 TO 93 + 370 KM), RDA/MMC/MAINT/NKM/05R by V V Karunaratne & Company
2012	**Category I - value exceeding Rs: 1000 million** Improvements to Sooriyawewa – Meegahajandura Road to 4 Lane Standard (0+000 km – 9+050 km) Contract No. RDA/WD/SP/GOSL/176 by Maga Engineering (Pvt) Ltd. Rehabilitation and Upgrading of Puttlam – Trincomalee Road (A-012) from Puttlam to Anuradhapura Contract No. RDA/NHSP/ICB-01 by Maga Engineering (Pvt) Ltd. Phase I Stage II of Grater Kandy Water Supply Project Contract No.RSC/GR.KANDY/CIVIL/2008/3A&4A by Maga Engineering (Pvt) Ltd. Construction of Ja-Ela, Ekala & Kandana Water Supply Schemes Contract No. WSDP/TNC/C1 by Sierra Construction (Pvt) Ltd. Supply & Laying of Treated Water Pumping Main Distribution Pipes and Construction of Elevated Towers, Muttur Contract No. PW&ET/UWS/PE3/MUT/ICB by Sierra Construction (Pvt) Ltd. Provision of Engineering Services for Optical Fiber Network and ITS Management System by Sierra Construction (Pvt) Ltd. **Category II - valued between Rs: 500 million & 1000 million** Improvements to Parliament Road (AA 000) from Devi Balika Roundabout to Polduwa Junction. Contract No. RDA/WD/WP/SIRUP/2006/01 by Maga Engineering (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2012	**Category III - valued between Rs: 100 million & 500 million** Rehabilitation of A014 Medawachchiya – Mannar – Talaimannar Road from 37.0 km to 42.0 km & an Additional 2 km from 45.0 km to 47.0 km Contract No. RDA/ADB/CAARP/NCB/NRC 5E by International Construction Consortium (Pvt) Ltd. Improvements to Wellawaya – Ella – Kumbalwela Road (0+000 to 14+000 km) Contract No. RDA/DW/UVA/PPRD/11 by Hovael Construction (Pvt) Ltd. Non-Revenue Water Prevention, Reduction and Treated Water Conservation of Water Supply Scheme of Harispattuwa, Akurana and Ampitiya Zones Contract No. RSC-C/GR.KANDY/CIVIL/2008/60 by Hovael Construction (Pvt) Ltd. Rehabilitation of Internal Roads of Galle Fort -Packages I, II, III & IV Contract No. RDA/DW/SP/GOSL/2011/11,12,13,14 by K D A Weerasinghe & Co. (Pvt) Ltd.
2013	**Category I - value exceeding Rs: 1000 million** Construction, Completion and Commissioning of Gated Salinity Barrier Across Walawe River at Hambantota Contract No. SB/UWS/PB2/HAM/ICB by Access Engineering PLC Towns North of Colombo Water Supply Project - Stage II Construction of Mahara and Biyagama Water Supply Schemes Contract No. WSDP/TNC/C2 by Sierra Construction (Pvt) Ltd. Northern Road Connectivity Project (NRCP) Rehabilitation / Improvement to B437 Road from Vallai to Araly (0+000 km – 27+400 km) by K D A Weerasinghe & Co. (Pvt) Ltd. Rehabilitation & Improvement of 63 Km of Kandy – Jaffna Road (A009) from 257 Km to 320 Km Contract No. RDA/NRRP/CGF/CIB by Maga Engineering (Pvt) Ltd. Sub-Contract works of 25+5 Km of Paranthan – Mullaitivu Road (A035) from 00.00 Km to 30.00 Km Contract No. RDA/NRIP/PRP1/C11 by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvement to A009 Road Section from Thonigala to Galkulama (98+000 Km – 122+170 Km) Contract No.RDA/NRCP/ICB/ADB/CP-02

	by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements to A032 Road Section from Navathkuli to Kerativu Jetty (00+000 Km – 17+400 Km) Contract No. RDA/NRCP/ICB/ADB/CP-04 by Maga Engineering (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2013	**<u>Category II - valued between Rs: 500 million & 1000 million</u>** Rehabilitation & Improvements to Ambepussa – Kurunegala – Trincomalee Road (A06) from 157+000 Km to 167+280 Km & Kantale to Ganthalawa (B196) Road by Access Engineering PLC Rehabilitation / Improvements to Section of Ambepussa – Kurunegala – Trincomalee Road (A06) from 167+280 Km to 178+000 Km Road Contract No. WB/RSAP II/KT/02 by Tudawe Brothers (Pvt) Ltd. World Bank Funded Provincial Road Project. Uva Province, Credit No 4630 LK Package "A" Contract No. Uva-04: Haggala – Ford – McDonald Road by Maga Engineering (Pvt) Ltd. Improvement & Rehabilitation of Hakmana – Beliatta – Tangalle Road Project, Section from 11+500 Km to 19+140 Km Contract No. RDA/RNIP/PRP1/CIA-1 by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements to A020 Road section from Anuradhapura to Rambewa (0+0000 Km – 14+500 Km) Contract No. RDA/NRCP/ICB/ADB/CP-03 by Maga Engineering (Pvt) Ltd Rehabilitation & Improvements to Road section from Manipay to Kaithady (0+000 Km – 14+020 Km) Contract No. RDA/NRCP/ICB/ADB/CP -05 by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements to Road section from Mankulam to Mullaitivu (0+000 Km – 13+000 Km) Contract No. RDA/NRCP/ICB/ADB/CP -07 by Maga Engineering (Pvt) Ltd. **<u>Category III - valued between Rs: 100 million & 500 million</u>** ADB Funded Eastern & North Central Provincial Roads Project – Phase I Contract No. ENCPRP/NCB/EPBP/02 by Access Engineering PLC Urgent Renovation at Unity Container Terminal (UCT), New North Pier in Port of Colombo

	by Access Engineering PLC Supply & laying of HDPE, DI pipes for water Transmission Main from Murunkan to Mannar with branch off to Vankalai Contract. No. P&D/C,N/ADB 5/2010/01 by K D A Weerasinghe & Co. (Pvt) Ltd. Widening of Bridge No. 1/1 on Security Access Road to Parliamentary Complex, Kotte by CML-MTD Construction Limited Asian Development Bank Funded Eastern and North Central Provincial Roads Project – Phase I Package EP-03 Contract No. ENCPRP/NCB/EP/03 by V V Karunaratne & Company

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2013	Civil Works of Point Pedro Water Supply Scheme under ADB Assisted Conflict Affected Region Emergency Project – Component-B (Water Sector) Contract No. P&D/C,N/ADB/CARE/PP/2010/01 by Maga Engineering (Pvt) Ltd. Improvement & Rehabilitation of Bopale Junction - Kiriibbanara – Udamauara Road Section from 0+000 Km to 8+500 Km Contract No. RDA/RNIP/PRP1/CIA-2 by Maga Engineering (Pvt) Ltd **Category IV – valued up to Rs: 100 million** Rehabilitation of Demalawadiya Ambana Opalgala Road Contract No ENDRP-07 by Gamini Construction
2014	**Category I - value exceeding Rs: 1000 million** Chinese Government Funded Rehabilitation of Road Works in North Project - Rehabilitation & Improvement of Kandy – Jaffna Road (A-009) between Galkulama & Jaffna – Sub Contract Works of 40 km of Kandy – Jaffna Road (A-009) from 120 km – 207 km by International Construction Consortium (Pvt) Ltd. Rehabilitation and Improvement to Ambepussa – Trincomalee Road (A006) from Dambulla to Habarana (91+420 km – 112+920 km) by International Construction Consortium (Pvt) Ltd Northern Road Connectivity Project (NRCP) - Rehabilitation / Improvement to A009 Road Section from Dambulla to Thonigala (74+650 km to 98+000 km) by International Construction Consortium (Pvt) Ltd Northern Road Connectivity Project (NRCP) - Rehabilitation / Improvement to Section of Mankulam – Mullaitivu Road A 034 from 38+500 km to 49+100 km by International Construction Consortium (Pvt) Ltd

	Rehabilitation and Upgrading of Narammala – Giriulla – Dankotuwa Road (from 0+000 – 16+030) by CML-MTD Construction Limited Rehabilitation and Upgrading of CRWB Road (A004) from Nugegoda to Homagama Contract No. RDA/NHSP/ICB-05 by K D Ebert and Sons Holdings (Pvt) Limited Dialog Optical Fiber Network Project – Phase 2 & 3 by Access Engineering PLC Construction of a Flyover Project at Siribopura Contract No. LK/CPRPA/MAGA/C1A-3 by Maga Engineering (Pvt) Ltd. Improvements to Palavi – Kalpitiya Road (B349) Section from (14.0 km to 40.6 km) Contract No. RDA/RNIP/PRP2/PACKAGE-C/ C13 by Maga Engineering (Pvt) Ltd. Construction of Kegalle Bypass Road Stage III by Maga Engineering (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2014	**<u>Category II - valued between Rs: 500 million & 1000 million</u>** Improvement & Rehabilitation of priority road project – Bibile – Uraniya - Mahiyangana Road (22+000 – 39+580 km) by K D A Weerasinghe & Co., (Pvt) Ltd. **<u>Category III - valued between Rs: 100 million & 500 million</u>** Construction of Kadurugaldola Mini Hydro Power Project (KMPH) by Access Engineering PLC Transmission & Distribution of Kanthale Ganthalawa Pipe Laying (KGPL) by Access Engineering PLC Supply & Laying of DI Pipes, Fittings and Valves for Rajapihilla Transmission Line (15 km long) for Medawala Water Supply Improvement - Kandy by Maga Engineering (Pvt) Ltd. Giritale Dam Rehabilitation Work by Gamini Construction Laying of DI Pipes & Fittings from Mahaveli Intake to Kantale Water Treatment Plant by Subasinghe Contractors and Earth Movers

2015	**Category IV – valued up to Rs: 100 million** Outer Circular Highway Project (Southern Section) Temporary Toll Plaza Kothalawala Interchange by State Engineering Corporation of Sri Lanka **Category I - value exceeding Rs: 1000 million** Thihagoda – Kamburupitiya – Mawarala – Kotapola Road (TKMK) (24+000 km – 67+000 km) by Maga Engineering (Pvt) Ltd Rehabilitation & Improvements of Polonnaruwa–Thambala–Sungawila– Somawathiya Road (from 0+000 to 33+000km) Contract No. RDA/DW/NCP/GOSL/2011/289) by Consulting Engineers & Contractors (Pvt) Ltd. Rehabilitation & Improvement of Priority Road Project -2 Mahiyangane- Dimbulagala – Dalukkane Road (24.10 km – 72.807 km) Manampitiya – Aralaganwila – Maduruoya Road (0-3.0 km) Contract No. RDA/RNIP/PRP2/PKGC/C15 by K D A Weerasinghe & Co., (Pvt) Ltd. **Category II - valued between Rs: 500 million & 1000 million** Design, Supply and Construction of the Veyangoda Flyover Project. Contract No. RDA/SB/F/10/G by Access Engineering PLC Design Construction and Completion (Turnkey Project) Ampara Water Supply Project by Sanken Construction (Pvt) Ltd.
Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2015	**Category III - valued between Rs: 100 million & 500 million** Walkability Improvement and Asphalt Overlaying – Package 3 Contract No. MCUDP/CMC/W/08 by State Development & Construction Corporation **Category IV - valued between Rs: 40 million & 100 million** Construction of Kokawita Upper mini Hydro Power Project at Kokawita, Kalawana. Contract No. Terr/Kokaw/Upper/N/08/2009 by Nimna Enterprises
2016	**Category I - value exceeding Rs: 1000 million** Improvements to Bodagama – Hambegamuwa – Kaltota Road (B528)

	(from 0+000 to 48+200 km) Contract No. RDA/DW/UVA/LBFP/2011/392 by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements of Bangadeniya – Andigama – Anamaduwa (B45) Road (from 0+000 to 38+000 km) Contract No. RDA/DW/NWP/GOSL/2011/347A by Access Engineering PLC Rehabilitation & Improvements of Kurunegala – Narammala – Madampe Road (from 40+870 to 64+770 km) Contract No. RDA/DW/NWP/LBFP/2011/753B by NEM Construction (Pvt) Ltd. Rehabilitation of national highways with concrete surfacing through domestic contractors Waskaduwa – Bandaragama Road (B-458) (from 0+000 to 12+070 km) & Kesbewa – Kidelpitiya – Bandaragama Road (B-216)(from 0+000 to 11+780 km) Contract No. RDA/DW/WP/GOSL/2011/453 by K D Ebert & Sons Holdings (Pvt) Ltd. Rehabilitation of Pannala – Kuliyapitiya Road (B356) (from 5.0 to 16.28km) & Kuliyapitiya – Hettipola Road (B243) (from 0.00 to 15.69 km) Contract No. RDA/DW/NWP/GOSL/2011/425 by NEM Construction (Pvt) Ltd. Widening and Re-construction of Matara – Hakmana Road Project (from 0+000 to 24+140 km) Contract No. RDA/DW/SP/GOSL/2012/10 by Maga Engineering (Pvt) Ltd. Rehabilitation and Improvements to B-157(west) Road Section from Aluthgama to Southern Expressway (from 42+600 to 53+670 km) Contract No. RDA/NHSP/ICB/ADB/CP-3 by K D A Weerasinghe & Co., (Pvt) Ltd.

Construction Performance Awards for Civil Engineering Projects (assessed after completion)	
2016	Rehabilitation & Improvements to A017 Galle - Deniyaya – Madampe Road Section from Rakwana to Madampe (from 130+000 to 143+930 km) Contract No. RDA/MFAP/ICB/OPID-1/01 by Maga Engineering (Pvt) Ltd. Rehabilitation & Improvements of Kurunegala – Narammala – Madampe Road (from 22+260 to 40+870 km) Contract No. RDA/DW/NWP/LBFP/2011/753A

	by Consulting Engineers & Contractors (Pvt) Ltd. Rehabilitation & Improvements of Galagedara – Rambukkana Road (from 0.00 to 18.50 km) Contract No. RDA/RNIP/PRP2/PACKAGE-C/ C7(iii) by Access Engineering PLC Rehabilitation & Improvements to A001 Colombo – Kandy Road Section from Peliyagoda to Kiribathgoda (from 5+860 to 13+100 km) Contract No. RDA/MEAP/ICB/SFD-2/07 by Maga Engineering (Pvt) Ltd. Metro Colombo Urban Development Project. Rehabilitation of Galle Road and R A De Mel Mawatha, from Liberty Roundabout to Dharmapala Road Junction. Contract Package C Contract No. MCUDP/CMC/W/12(C) by International Construction Consortium (Pvt) Ltd. Metro Colombo Urban Development Project. Rehabilitation of Galle Road from Bambalapitiya Junction to South City Limit - Contract Package B Contract No. MCUDP/CMC/W/12(B) by International Construction Consortium (Pvt) Ltd. **<u>Category II - valued between Rs: 500 million & 1000 million</u>** Rehabilitation / Improvements of A029 Vavunia – Horowpatana Road (from 24+000 to 34+950 km) Contract No. RDA/NRCP(AF)/ICB/ADB/CP-11 by International Construction Consortium (Pvt) Ltd. Metro Colombo Urban Development Project. Rehabilitation of Galle Road and R A De Mel Mawatha, from Galadari Roundabout to Kollupitiya Junction. Contract Package A Contract No. MCUDP/CMC/W/12(A) by International Construction Consortium (Pvt) Ltd. Design, Supply and Construction of Polduwa Bridge Contract No. RDA/UKSBP2/PLDW/006 by Access Engineering PLC Construction of Kandana Water Treatment Plant Extension Contract No. WSDP/KGWSP-P1 S2/ICB-01 by Access Engineering PLC

Construction Performance Awards for Civil Engineering Projects (assessed after completion)

2016	**<u>Category III - valued between Rs: 100 million & 500 million</u>** Construction of Elevated Water Tower, Office Building, Quarters, Stores and Supply and Laying of Transmission Main and Distribution Mains of Echchalampattu Water Supply Scheme. Contract No. P&D/SE/ADB/CARE/EP/2011/01 by K D A Weerasinghe & Co., (Pvt) Ltd. ADB funded Nothern Roads Connectivity Project – Additional financing (Provincial Component) – ADB Loan No.2890(SF) 2891(Sri) Contract No. NRCP/NP/NCB/KL02 by Maga Engineering (Pvt) Ltd. ADB funded Nothern Roads Connectivity Project – Additional financing (Provincial Component) – ADB Loan No.2890(SF) 2891(Sri) Contract No. NRCP/NP/NCB/MU01 by Maga Engineering (Pvt) Ltd. Reconstruction of Bridge No 3/2 (Karadana Bridge) on A-019 Polgahawela – Kegalle Road Contract No. RDA/MFAP/ICB/OFID-1/03 by V V Karunaratne & Company Remedial Works of New Laxapana Power Tunnel Contract No. DSWRPP-AF/WORKS/DC/151 by State Development & Construction Corporation

Other Awards

Awards for Effective Adaptation of Safety Measures in Construction	
2007	Skyline Residencies at Borella by Maga Engineering (Pvt) Ltd.
2008	Additions, Renovations & Refurbishment to the Ware House Complex at Orugodawatta by R N Construction Fairway Residencies at Rajagiriya by Maga Engineering (Pvt) Ltd.
2009	Arugambay Water Supply Project Package A - Construction of Pothuvil / Ulla Water Treatment Plant, Heda Oya Raw Water Intake and Raw Water Pipe Line by International Construction Consortium Ltd. Neuro Trauma Unit of the National Hospital, Colombo by Maga Engineering (Pvt) Ltd.

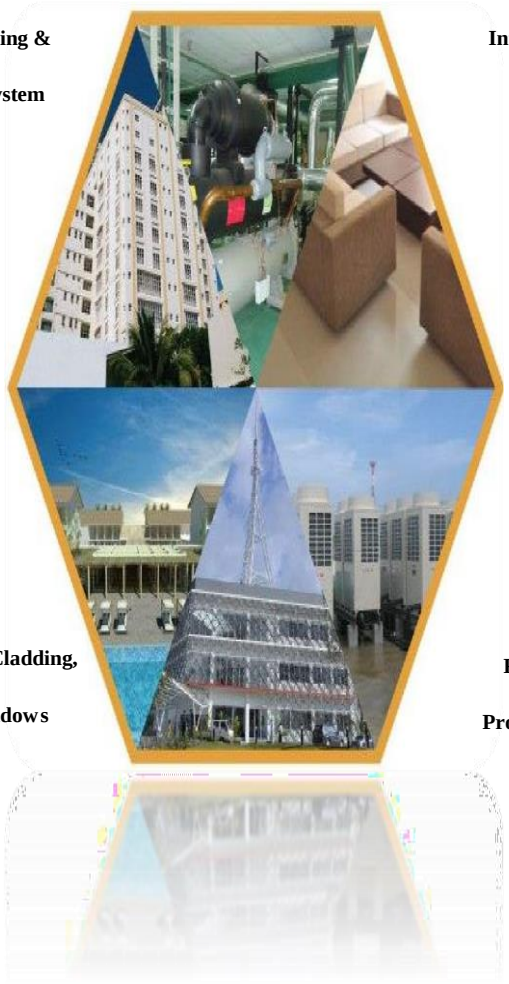
Awards for Human Resource Development	
2007	Maga Engineering (Pvt) Ltd (Head Office) by Maga Engineering (Pvt) Ltd.
2008	Maga Engineering (Pvt) Ltd (Head Office) by Maga Engineering (Pvt) Ltd.

Awards for Innovative Techniques in Construction	
2008	Gampola, Nuwara Eliya & Gampola Nawalapitiya Road Network Improvement Project by Soil Tech (Pvt) Ltd.
2010	Outside Plant Works (Fiber Routes/Civil Works, Cable Laying & Jointing) of the Optical Fiber Network Development Project Phase – 01 & 01B by Access Engineering Ltd.
2011	Arresting Ground Settlement at the South Asia Gateway Terminal at Colombo Harbour by Soil Tech (Pvt) Ltd. Production of manufactured sand as an alternative to River and Sea Sand for Concrete by International Construction Consortium (Pvt) Ltd. Introduction of micro panel system, to eliminate the use of Bricks and Block stones, and enhance the local construction industry to higher standards by Micro Construction (Pvt) Ltd.
2013	Urgent Renovation at Unity Container Terminal (UCT), New North Pier in Port of Colombo by Access Engineering PLC Proposal for Hybrid Fracture Grouting with cast-in-situ pile Foundation for Proposed 5 Storey Supermarket Complex by Soil Tech (Pvt) Ltd.
2016	Construction of Trough Across Kon Oya Contract No. ID/HO/DORP/01,02,03/2010 by State Development & Construction Corporation

We do…

Air Conditioning & Ventilation System

Interior Fit out & Contracting



Electrical Installations (HT & LT)

Total M & E Solutions

Aluminium Cladding, Doors & Windows

Fire Detection & Protection Systems

Our Pride…..

SUNTAN BEACH RESORTS (PVT) @ PASSIKUDAH

NATIONAL NANO TECHNOLOGY PARK @ HOMAGAMA

THE GATEWAY HOTEL (AIRPORT GARDEN) @ SEEDUWA

TUDAWE Engineering Services

Tudawe Engineering Services (Pvt.) Ltd.

505/2, Elvitigala Mawatha, Colombo 05, Sri Lanka

Tel: +94 11 2368494, 4356200

E mail: tesinfo@tudawe.com

Web: www.tudawe.com

Tudawe Engineering Services (Pvt.) Ltd is Sri Lanka's premier engineering firm with ICTAD ***EM 1*** *Classification for M & E works &* ***SP 1*** *for Aluminium works. Our specialities are timely delivery, quality products, services & completion within the budget.*

NATIONAL AWARDS FOR CONSTRUCTION EXCELLENCE & CONSTRUCTION MERIT – 2016

(FOR BUILDING PROJECTS)

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Design and Construction of Secretariat for Personal Identification for Ministry of Defence & Urban Development at Battaramulla.

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Luxury Residential Apartments at No. 320, Union Place, Colombo 02.

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Housing for Relocation of Underserved Settlements in the City of Colombo.

Contractor : Access Engineering PLC

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Design and Construction of Iceland Business Centre at Colombo 03

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Bottling Plant Complex at Munidasa Kumarathunga Mawatha, Seeduwa

Contractor : R N Constructions (Pvt) Ltd

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category I - value exceeding **Rs: 600 million**

Commercial Building – Dialog Axiata PLC at 475 A, Union Place, Colombo 2.

NATIONAL AWARD FOR CONSTRUCTION EXCELLENCE – 2016

Category II - value in between **Rs: 300 million & 600 million**

Supply and Installation of Aluminium Doors, Windows, Composite Panels, Entrance Foyer and Atrium Roof for Secretariat for Personnel Identification, Ministry of Defence and Urban Development at Battaramulla

NATIONAL AWARD FOR CONSTRUCTION MERIT– 2016

Category I - value exceeding **Rs: 600 million**

Apartment Complex – The Fairway Sky Garden at 39, Perera Mawatha, Rajagiriya

Contractor : Maga Engineering (Pvt) Ltd

NATIONAL AWARD FOR CONSTRUCTION MERIT– 2016

Category I - value exceeding **Rs: 600 million**

Highways Secretariat Building at Battaramulla

Contractor : Nawaloka Construction Company (Pvt) Ltd

NATIONAL AWARD FOR CONSTRUCTION MERIT– 2016

Category III - value in between **Rs: 100 million & 300 million**

Six Storied Co-operative Hospital Building at Galle

Contractor : Sripalie Contractors (Pvt) Ltd.

NATIONAL AWARD FOR CONSTRUCTION MERIT– 2016

Category IV - value in between **Rs: 40 million & 100 million**

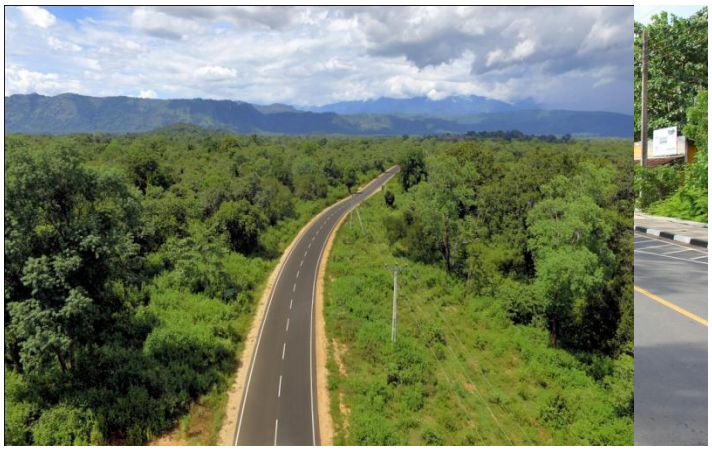
Branch Office for People's Bank at Hatharaliyadda, Kandy

Contractor : Kemyo (Pvt) Ltd

NATIONAL AWARDS CONSTRUCTION PERFORMANCE - 2016

(FOR CIVIL ENGINEERING PROJECTS)

(Assessed after completion)



National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Improvements to Bodagama – Hambegamuwa – Kaltota Road (B528)

(from 0+000 to 48+200 km)

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation & Improvements of Bangadeniya – Andigama – Anamaduwa (B45) Road

(from 0+000 to 38+000 km)

Contract No. RDA/DW/NWP/GOSL/2011/347A

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation & Improvements of Kurunegala – Narammala – Madampe Road

(from 40+870 to 64+770 km)

Contract No. RDA/DW/NWP/LBFP/2011/753B

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation of national highways with concrete surfacing through domestic contractors Waskaduwa – Bandaragama Road (B-458) (from 0+000 to 12+070 km) & Kesbewa – Kidelpitiya – Bandaragama Road

(B-216) (from 0+000 to 11+780 km)

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation of Pannala – Kuliyapitiya Road (B356) (5.0 to 16.28km) & Kuliyapitiya – Hettipola Road (B243) (from 0.00 to 15.69 km)

Contract No. RDA/DW/NWP/GOSL/2011/425

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Widening and Re-construction of Matara – Hakmana Road Project

(from 0+000 to 24+140 km)

Contract No. RDA/DW/SP/GOSL/2012/10

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation and Improvements to B-157(west) Road Section from Aluthgama to Southern Expressway

(from 42+600 to 53+670 km)

Contract No. RDA/NHSP/ICB/ADB/CP-3

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation & Improvements to A017

Galle - Deniyaya – Madampe Road

section from Rakwana to Madampe

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation & Improvements of

Kurunegala – Narammala – Madampe Road

(from 22+260 to 40+870 km)

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Rehabilitation & Improvements of

Galagedara – Rambukkana Road

(from 0.00 to 18.50 km)

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Metro Colombo Urban Development Project.
ehabilitation of Galle Road and R A De Mel Mawatha,
from Liberty Roundabout to Dharmapala Road
Junction. Contract Package C

Contract No

National Award for Construction Performance 2016

Category I - value exceeding Rs: 1000 million

Metro Colombo Urban Development Project.
Rehabilitation of Galle Road from Bambalapitiya Junction to South City Limit - Package B

Contract No. MCUDP/CMC/W/12(B)

National Award for Construction Performance 2016

Category II - valued between Rs: 500 million & 1000 million

Rehabilitation / Improvements of A029

Vavunia – Horowpatana Road

(from 24+000 to 34+950 km)

National Award for Construction Performance 2016

Category II - valued between Rs: 500 million & 1000 million

Metro Colombo Urban Development Project.
Rehabilitation of Galle Road and R A De Mel Mawatha, from Galadari Roundabout to Kollupitiya Junction.
Contract Package A

Contract No. MCUDP/CMC/W/12(A)

National Award for Construction Performance 2016

Category II - valued between Rs: 500 million & 1000 million

Design, Supply and Construction of Polduwa Bridge

Contract No. RDA/UKSBP2/PLDW/006

by Access Engineering PLC

National Award for Construction Performance 2016

Category II - valued between Rs: 500 million & 1000 million

Construction of Kandana Water Treatment Plant Extension

Contract No. WSDP/KGWSP-P1 S2/ICB-01

National Award for Construction Performance 2016

Category III - valued between Rs: 100 million & 500 million

Construction of Elevated Water Tower, Office Building, Quarters, Stores and Supply and Laying of Transmission Main and Distribution Mains of Echchalampattu Water Supply Scheme.

Contract No. P8 D/SF/ADB/CARE/ED/2011/01

National Award for Construction Performance 2016

Category III - valued between Rs: 100 million & 500 million

ADB funded Northern Roads Connectivity Project – Additional financing (Provincial Component)

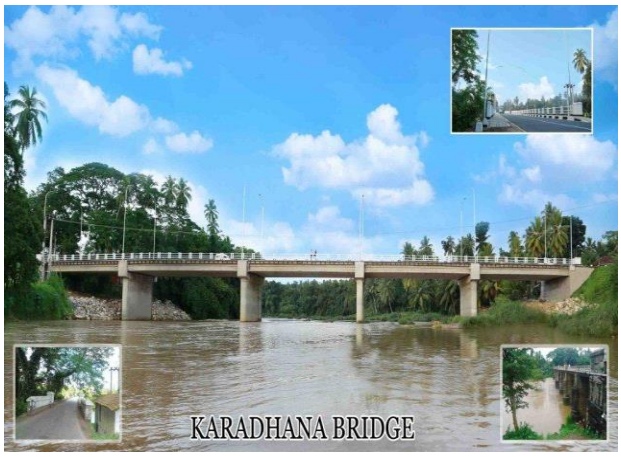
ADB Loan No.2890(SF) 2891(Sri)

National Award for Construction Performance 2016

Category III - valued between Rs: 100 million & 500 million

ADB funded Northern Roads Connectivity Project – Additional financing (Provincial Component)

ADB Loan No.2890(SF) 2891(Sri)



National Award for Construction Performance 2016

Category III - valued between Rs: 100 million & 500 million

Reconstruction of Bridge No 3/2 (Karadana Bridge) on A-019 Polgahawela – Kegalle Road

Contract No. RDA/MFAP/ICB/OFID-1/03

by V V Karunaratne & Company

National Award for Construction Performance 2016

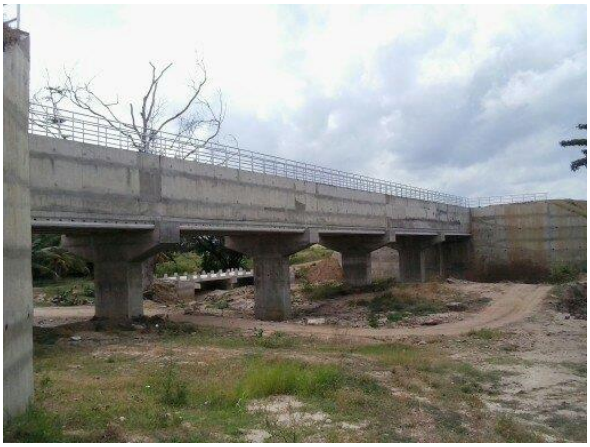
Category III - valued between Rs: 100 million & 500 million

Remedial Works of New Laxapana Power Tunnel

Contract No. DSWRPP-AF/WORKS/DC/151

by State Development & Construction Corporation

NATIONAL AWARD FOR INNOVATIVE TECHNIQUES IN CONSTRUCTION -2016



National Award for Innovative Techniques in Construction -2016

Construction of Trough Across Kon Oya

Contract No. ID/HO/DORP/01,02,03/2010

CIDA AWARD OF EMINENCE

- ***CIDA Award of Eminence - 2016***

Chartered Architect

Prof. Chitra Weddikkara

for her life time contribution

to the upliftment of the

Construction Industry &

the profession of Architecture

Professional experience encompasses fields of Architecture, Quantity Surveying, International Construction Management Dispute resolution, Arbitration, Value management and Project Management.

Work experience also encompasses working as the Professor of Building Economics, Head of Department of Building Economics, Dean, Faculty of Architecture, University of Moratuwa Sri-Lanka and Senior lecturer in University of Western Sydney in New South Wales Australia, President of the Institute of Quantity Surveyors, President Sri Lanka Institute of Architects /Chairman/ Member of many technical and advisory committees of the Sri Lanka Institute of Architects and the Government of Sri-Lanka

ACADEMIC QUALIFICATIONS

- Ph.D. in Dispute resolution College Law, Murdoch University Perth Western Australia
- Master of Science Building Studies, Curtin University of Technology, WA
- Bachelor of Applied Science in Quantity Surveying, Curtain University of Technology, Perth, Western Australia
- Associate Diploma in Quantity Surveying Western Australian Institute of Technology, Perth, Western Australia.
- Associate ship in Architecture , Western Australian Institute of technology, WA
- Bachelor of Science in Built Environment University of Colombo Sri Lanka
- Part I Royal Institute of British Architects, University of Colombo, Sri Lanka
- Certificate in International Construction Management, Sweden

PROFESSIONAL MEMBERSHIPS

- Fellow of the Institute of Architects Sri- Lanka (FIA) SL Sri Lanka
- Assoc member of Royal Australian Institute of Architects (ARAIA)
- Fellow member of the Australian Institute of Quantity Surveyors (FAIQS)
- Fellow of Royal Institute of Chartered Surveyors (FRICS) 199

- Fellow of the Institute of Quantity Surveyors (FIQS) SL Sri Lanka 1998
- Mediator- LEADR' Centre for Commercial Mediation, Australia
- Fellow Member of Institute of Project Mangers (SL)

OTHER COMMITMENTS

- Member of the National Procurement Commission
- Member of the CIDA Advisory Board
- Vice President of Chamber of Construction Industry

- ***CIDA Award of Eminence - 2016***

Eng. C H De Tissera

for his life time professional contribution

to the upliftment of the

Construction Industry

- B Sc. (Engineering) – University of Sri Lanka - 1965
- Post Graduate Diploma in Housing Planning & Building – Bowcentrum (IHS) Rotterdam, Holland - 1969
- M Sc. (Soil Mechanics & Foundation Engineering) - University of New Castle upon Tyne, U.K - 1979
- Post Graduate Certificate course in Construction Management for from University of California, Berkeley, USA - 1982
- Member, Institution of Engineers, Sri Lanka
- Director General – ICTAD – 1986 to 1989
- Additional Secretary (Technical), Ministry of Urban Development, Housing & Construction - Dec. 1989 to Aug.
- Additional Secretary (Development), Ministry of Science & Technology - Aug. 1999 to May 2001
- Project Management Consultant - JBIC and UNDP - May 2001 to Feb. 2005
- Habitat Programme Manager, UN-Habitat Sri Lanka - March 2005 to December 2008
- National Consultant to UN-Habitat Sri Lanka - January 2009 to Sept 2009
- Free- lance Consultant - UN-HABITAT Projects - Oct.2009 to date

- Chairman - Sri Lanka Land Reclamation and Development Corporation
- Director General - National Building Research Organisation (NBRO)
- Chairman – CIDA - Feb. 2015 to April.2016

- ***CIDA Award of Eminence - 2016***

Eng. K L S Sahabandu

for his life time contribution to the upliftment of the Construction Industry & the profession of Engineering

- **B.Sc. Eng. Hons**, University of Peradeniya, Sri Lanka, 1980
- **Pg. Dip. (Hydraulic Engineering)**, University of Moratuwa, Sri Lanka, 1985
- **M.Sc. (Structural Engineering)**, University of Newcastle upon Tyne, UK, 1988
- **Chartered Engineer,** UK, 1985
- **Chartered Engineer,** Sri Lanka, 1985
- **M.I.C.E. (UK)**, 1985
- **M.I.E. (S.L.)**, 1985
- **M.S.S.E (S.L.)**, 1993
- **M.Cons.E (S.L.)**, 2004
- **F.S.S.E. (S.L.)**, 2015
- **Visiting Lecturer**-City School of Architecture, Colombo, 2005 to date
- **President**, Society of Structural Engineers, Sri Lanka, 2016
- **Vice President**, Sri Lankan Geotechnical Society, 2015 to date
- **Vice President**, National Committee of Large Dams, Sri Lanka, 2006 to date
- **Chairman**, Subcommittee for preparing Design Guidelines at Disaster Management Centre, 2011-2014
- **General Manager**, Central Engineering Consultancy Bureau (CECB), 2013 to date

- **Director**, Central Engineering Services (Pvt) Ltd. (CESL), 2011 to date
- **Director**, Mahaweli Consultancy Bureau, 2015 to date
- **'Award for the Best Paper'** at the "**7th International Conference on Inspection, Appraisal, Repairs & Maintenance of Structures**" organized by the University of Nottingham and the Institution of Structural Engineers, UK in September 2001 for the paper on "**Damage Assessment and Repair Techniques used in Bomb and Fire Damaged Central Bank Building in Sri Lanka** ".
- **'Patrick Parson's Prize – 1987/88' – For the best all-round academic record in the M.Sc. course in Structural Engineering –** University of Newcastle upon Tyne - UK.
- **'NECTTA/TRADA Structural Timber Award Competition – 1988' - UK - Second Place.**

- ***ICTAD Award of Eminence - 2014***

Eng. S A Karunaratne

for his life time contribution to the upliftment of the Construction Industry & the

- BSc Eng. (University of Peradeniya) 1967
- MICE (UK) 1970
- Chartered Engineer
- MIE (SL) 1971
- MIStructE (UK) 1974
- FIStructE (UK) 1990
- FIE (SL) 1990
- HF (SSE-SL) 2009
- HLF (SL) 2014
- President SSE (SL) 2004, 2005, 2006, 2007, 2008
- Visiting Lecturer (MSc Structural – University of Moratuwa) 2006 to 2015
- Chairman - EuroCodes National Annexes (SLSI)
- Managing Director – STEMS Consultants (Pte) Ltd

- ***ICTAD Award of Eminence – 2014***

Archt. Jayantha Kithsiri Perera

for his life time contribution

to the upliftment of the

- FIA(SL) 1992
- M.Sc.(Arch.), B.Sc (BE)
- SLIA First Membership 1981
- President SLIA 2007/2009
- Chairman SAARCH 2009/2012
- Deputy Chairman ARCASIA Zone A 2010/2011
- Chair Communication CAA 2014/2017
- Director UIA Work Programme on Responsible Architecture 2014/2017

- ***ICTAD Award of Eminence – 2014***

Dr. (Eng.) Ananda Ranasinghe

for his life time contribution

to the upliftment of the

Construction Industry in General

- PhD, MEng, MTech, LLM, BScEng,
- CEng, FIStructE, FICE, FIESL,MSSE,
- Attorney-at-Law
- President IESL 2011/2012

- ***ICTAD Award of Eminence – 2013***

Eng. W J R De Mel

for his life time contribution

to the upliftment of the

  - BSc Eng, C Eng
- M.Sc.(Construction Management)
- MICE, MIE

- ***ICTAD Award of Eminence – 2011***

Dr. E M G de Zylva

for his life time professional contribution

to the upliftment of the

Construction Industry

- MBA (Const. Mgt.) USA
- Doctoral Fellow – Institute of Professional Financial Managers (UK)
- Professional Member – Dispute Board Federation (Geneva)
- Fellow – Institute of Dispute Management Professionals (SL)
- Hon. Fellow – Institute of Quantity Surveyors (SL)
- Fellow – Institute of Project Managers (SL)
- Member Board of Governors of the National Arbitration Center (SL)
- Lecturer/ Examiner (Arbitration Diploma Courses) of the Institute of Commercial Law & Practice (SL)

- ***ICTAD Award of Eminence – 2011***

Vidyajyothi Prof. Lakshman Alwis

for his life time contribution

to the upliftment of the

Construction Industry & the

profession of Architecture

- B. Arch. (Melbourne) 1967
- ARAIA 1967
- RIBA (UK) 1968
- FIA (SL) – 1980
- Chartered Architect
- D. Sc (Honaris Causa) University of Moratuwa
- PG Diploma Architectural Conservation of Monuments & Sites, ICCROM Rome 1983
- President SLIA 1987/1988, 1988/1989
- Dean Faculty of Architecture, University of Moratuwa 1991 to 1999
- Professor of Architecture, University of Moratuwa 1991 to 2004
- Chairman, Board of Education, ARCASIA 94/95, 95/96
- President of ICOMAS 1995
- Director Conservation of Cultural Triangle Project, Dambulla 1995
- President, Rotary Club of Colombo 1996/1997
- Deputy Chairman ARCASIA 2001 – 2002
- Chairman, ICTAD 2004 to 2007
- Honorary Fellow, SLIA 2005
- Vidyajyothi (National Award) by the President of Sri Lanka 2005
- ICTAD Award of Eminence 2011
- SLIA Gold Medalist 2013
- Principal Architect / Chairman – Design Consortium Ltd

- ***ICTAD Award of Eminence – 2011***

Mr. H D Chandrasena

for his life time contribution

to the upliftment of the

Construction Industry &

the profession of Quantity Surveying

- Fellow of the Institute of Quantity Surveyors Sri Lanka (F.I.Q.S. SL)
- Fellow of the Australian Institute of Quantity Surveyors (F.A.I.Q.S.)
- Fellow of the Royal Institution of Chartered Surveyors (F.R.I.C.S.)
- Fellow of the Institute of Dispute management Professionals (F.I.D.M. P)
- Associate of the Institute of Arbitrators Australia A.I.Arb (Aus) 1979
- Present Position – Chairman, Cost Consultancy Services (Pvt.) Ltd. Rajagiriya.
- Previous Position Asst. General Manager Consultancy Services and Chief Quantity Surveyor – State Engineering Corporation. Sri Lanka.
- Representative for Sri Lanka of the Australian Institute of Quantity Surveyors.
- Member, Board of Governors Sri Lanka National Arbitration Centre.
- Executive Committee Member Chamber of Construction Industry Sri Lanka.
- Past President Institute of Quantity Surveyors Sri Lanka
- Visiting Lecturer and Lesson Writer Open University Sri Lanka
- Member of the Dispute Adjudicators Panel – Institute for Construction Training and Development – Ministry of Housing Construction and Common Amenities.
- Member of the Executive Committee of the Institute of Dispute Management Professionals- Sri Lanka
- External Examiner Royal Institution of Chartered Surveyor Accreditation Panel 1998-2003 & 2008– to date (Department of Building Economic University of Moratuwa)
- Member of the main Planning Committee of the Urban Development Authority representing the Chamber of Construction Industry Sri Lanka.
- Visiting Lecture of Board Member of the Faculty of Architecture University of Moratuwa. (1974 to 1998)
- Member of the Consultative Committee and Steering Committee Member (Technical Publications) - Institute for Construction Training and Development (ICTAD)
- Member of the Construction Cluster of the National Council for Economic Development.
- Member of the Committee for Drafting Procedure for Contract Adjudication and Setting up of National Adjudication Centre- Sri Lanka.

CONSTRUCTION INDUSTRY DEVELOPMENT AUTHORITY

CETRAC
TO GO BEYOND

නිවාස හා ඉදිකිරීම් අමාත්‍යාංශය

ඉදිකිරීම් කර්මාන්ත සංවර්ධන අධිකාරිය



පාසැල් හැර යන සිසුන් සඳහා තුන් අවුරුදු පූර්ණ කාලීන පාඨමාලාවක් නොමිලේ

ඉදිකිරීම් යන්ත්‍රෝපකරණ නඩත්තුව පිළිබඳ පැවැත්වෙන වාර්ෂික පුහුණු පාඨමාලා

- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ කළමනාකරණය
- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ නඩත්තු අධීක්ෂණය (ද්‍රාවබල සහ සම්ප්‍රේෂණ පද්ධතිය)
- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ නඩත්තු අධීක්ෂණය (එන්ජිම සහ මෙකාට්‍රොනික් පද්ධතිය)
- ➔ ද්‍රාවබල සහ මෙකාට්‍රොනික් පද්ධති නඩත්තුව
- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ විද්‍යුත් පද්ධති නඩත්තුව
- ➔ ඩීසල් එන්ජින් නඩත්තුව
- ➔ ද්‍රාවබල පද්ධති නඩත්තුව
- ➔ ඩීසල් ජෙනරේටර් නඩත්තුව
- ➔ ස්ටියරින් බ්‍රේක් සහ ක්ලච් පද්ධති නඩත්තුව
- ➔ ටෝක් කන්වර්ටර් සහ සම්පීඩන පද්ධති නඩත්තුව
- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ මූලික ඉලෙක්ට්‍රොනික් සහ මෙකාට්‍රොනික් පද්ධතිය
- ➔ ජල පොම්පය සහ වායු සම්පීඩන පද්ධති නඩත්තුව
- ➔ ඉදිකිරීම් යන්ත්‍රෝපකරණ සේවා කිරීම
- ➔ මූලික ඉදිකිරීම් යන්ත්‍රෝපකරණ කාර්මික පාඨමාලාව (තුන් අවුරුදු පූර්ණකාලීන)

ශ්‍රී ලංකාවේ ඉදිකිරීම් යන්ත්‍රෝපකරණ තාක්ෂණික ශිල්පි පුහුණුවට ඇති එකම රාජ්‍ය ආයතනයෙන් ජාත්‍යන්තර සුදුස්සෙකු වන්න.

ඉදිකිරීම් යන්ත්‍රෝපකරණ පුහුණු මධ්‍යස්ථානය

අංක. 17, ඩී.පී. විජේසිංහ මාවත, පැලවත්ත, බත්තරමුල්ල.
ටෙලි. 011 2784413 / 2786829
ෆැක්ස් : 011 2784411
ඊ-මේල් : cetrac@sltnet.lk වෙබ් : www.cida.lk

Best Compliments

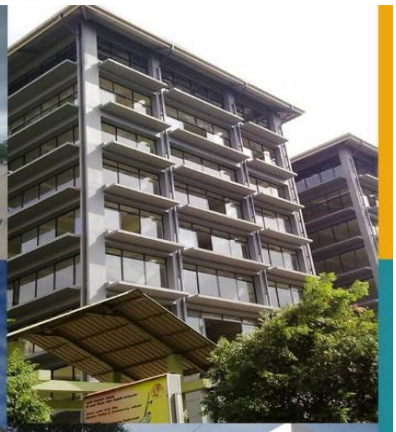
Nawaloka Construction Company is a major player in the Sri Lankan building industry which has been in existence for over 70 years.

We could offer multi-disciplinary services to suit the client's requirements.

Present Chairman Jayantha Dharmadasa son of the founder and former Chairman with the intention of diversifying the business further formed Nawaloka Holdings (Pvt) Limited, of which Nawaloka Construction Company (Private) Limited is a key member.

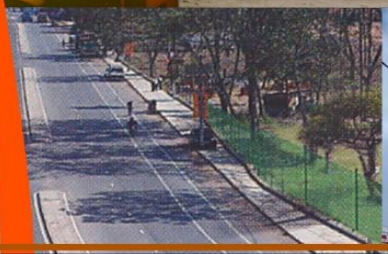
Our strength lies in our ability to fulfill the expectations of our clients with our extensively experienced engineering skills and management techniques.

With the CS2 Grading of CIDA for Buildings, Highways and Heavy Construction, ISO-9001:2008 Certification for Quality Management System for Construction & Manufacture of Ready Mix Concrete, OHSAS 18001:2007 for Health and Safety Management and EN ISO 14001:2004 for environment system of Civil Engineering Construction Works, we are committed to client satisfaction with timely delivered high standard finished products faithfully uncompromising the quality.








NAWALOKA

Construction Company (Private) Ltd

Member of Nawaloka Holdings

TÜV AUSTRIA

ISO 9001: 2008 Certified Company,
ISO 14001: 2004 Certified Company
&
OHSAS 18001: 2007 Certified Company

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Email : construction@nawaloka.net Web : www.nawaloka.net