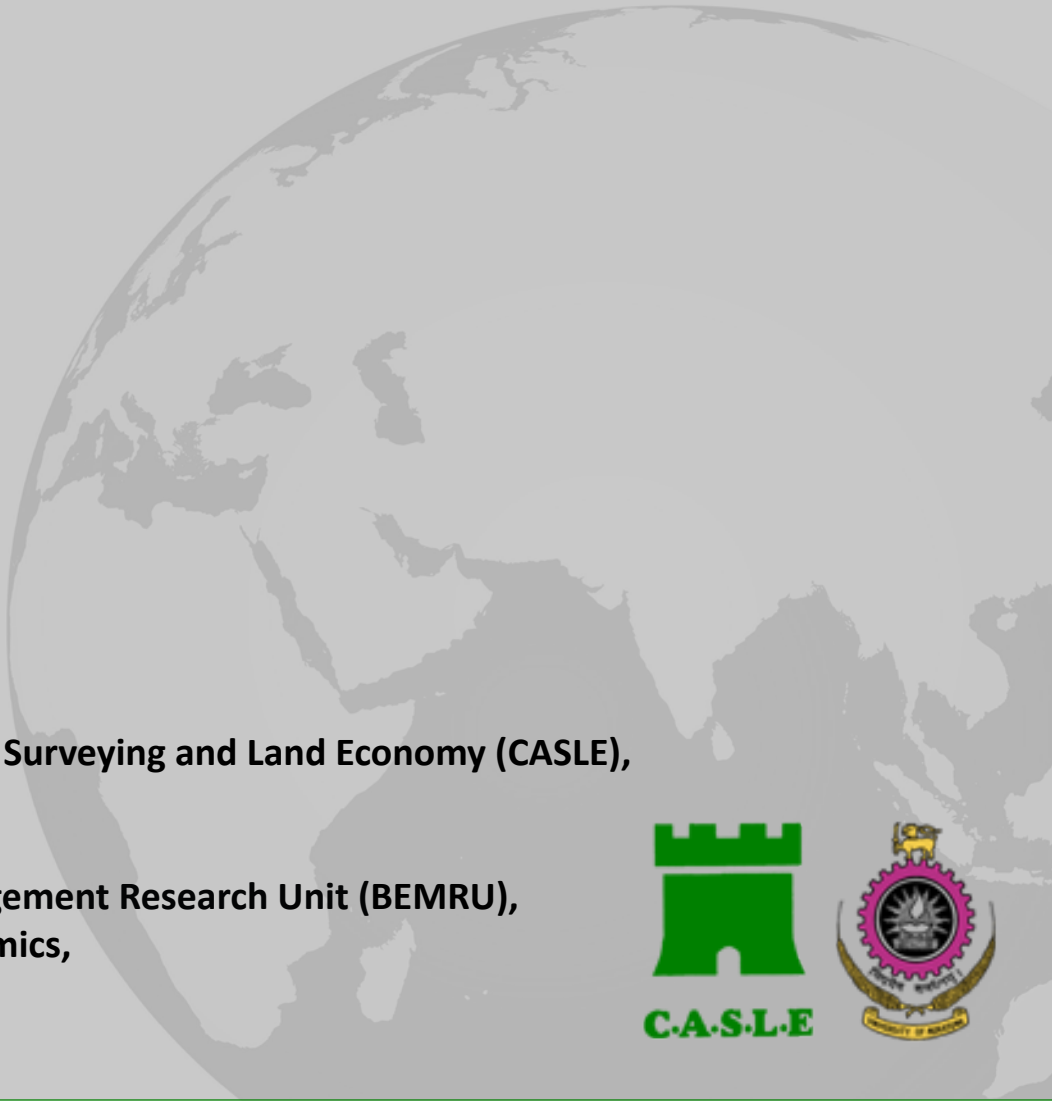


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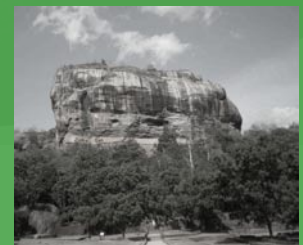
June - 2010



Commonwealth Association of Surveying and Land Economy (CASLE),
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Conference Proceedings

International Research Conference
on
Sustainability in Built Environment

18th - 19th June 2010

Colombo, Sri Lanka

Edited by

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Edited by Prof. R. Rameezdeen, Dr. S. Senaratne and Dr. Y.G. Sandanayake
International Research Conference on Sustainability in Built Environment

ISBN 978-955-9027-33-1

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ACKNOWLEDGEMENT

We would like to express our appreciation towards the Commonwealth Association of Surveying and Land Economy (CASLE), United Kingdom and Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics, University of Moratuwa, Sri Lanka for their support without which it would not have been possible to bring out this event. This is an outcome of the devoted interests shown by many authors from the academia and the industry. Their support makes this event successful in many forms.

Our thanks go to the International and Local Scientific Committee members for reviewing articles, making suggestions for modifications to make the articles meaningful and contextual. We would like to extend our gratitude towards keynote speaker, chief guest, guest of honours, guest speakers, session chairs and other invitees for their commitment and contribution to the conference.

We are also thankful for the organizations that have provided sponsorships. All of our colleagues on the organizing committee are especially thanked for devoting their time and effort on this event to make it a success. Last but not least, we express our sincere gratitude to all presenters and participants who have immensely contributed towards the success of this conference.

Conference Committee

June 2010

PREFACE

The International Research Conference on Sustainability in Built Environment, organized by the Commonwealth Association of Surveying and Land Economy (CASLE), United Kingdom and Building Economics and Management Research Unit (BEMRU) of the Department of Building Economics, University of Moratuwa, Sri Lanka, provides a forum for exchange of ideas between construction researchers in the areas of sustainability with a view to fostering a better link between industry and academia.

The main theme of the conference is Sustainability in Built Environment and the sub themes covered a wide spectrum of areas related with sustainability such as, sustainable design and architecture, sustainable urbanization, energy management, environmental economics and management, sustainable procurement and risk management, green buildings, green rating and green certification, green labelling of materials, facilities management in construction, innovative technologies in construction, construction safety and welfare, construction quality and continuous improvements, legal aspects in sustainability, disaster management and research and education.

We received number of abstracts and full papers for the conference, which were reviewed by a well qualified panel of international and local reviewers with respect to the originality, significance, reliability, quality of presentation and relevance, prior to selection. Priority was given for the quality and standard of papers rather than the number of papers presented at the conference. It is our firm belief that the publication that emerged from this conference is the result of the tireless effort of all authors, reviewers and conference organising committee members and it would pave way for advancement of knowledge in the field of sustainability in the built environment.

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Legal Aspects Concerning Sustainable Buildings and Cities Relating to the Urban Development in Sri Lanka

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ABSTRACT

Sustainable buildings are energy and environmentally efficient, providing economic, environmental and social benefits over the whole built environment, while protecting and improving the needs of future generation. Sustainable construction also should be environmentally efficient and economically viable. "Green Buildings" are an evolving term in Sri Lanka that encompasses both the general concept of environmentally conscious development and construction, as well as multiple formal rating systems for measuring the environmental impact of projects. A Sustainable City is a city where achievements in social, economic, and physical development are made to last. It is now widely recognized that cities make an important contribution to social and economic development at national and local levels. Cities are important engines of economic growth. Cities absorb two-thirds of the population growth in developing countries as well as it offer significant economies of scale in the provision of jobs, housing and services. Also cities are important centre of productivity and social advancement.

Laws governing protection of environment in Sri Lanka are largely based on legislative enactments. The objectives of this legislation are to promote planning of economic, social and physical development aspects and its implementation in the urban areas. This paper presents existing and new environmental and planning law and legal aspects to be considered in sustainable buildings, cities and urban development in Sri Lankan construction industry.

Key Words: *Legislation, Green Building, Cities, Urban development, Sustainable development*

1. INTRODUCTION

Sustainable building is energy and environmentally efficient, providing economic, environmental and social benefits over the whole building environment, while protecting and improving the needs of future generation. Sustainable construction also should be environmentally efficient and economically, therefore the Sri Lanka's legislation implements most law about these areas. "Green Buildings" are an evolving term that encompasses both the general concept of environmentally conscious development and construction, as well as multiple formal rating systems for measuring the environmental impact of individual projects.

The Sri Lankan legislation has given the responsibility to the local government bodies and Urban Development authority, thereby when making the building and construction in there are areas all urban councils are considering and controlling that. Otherwise, the people will make, as they want. After the "Tsunami", the Sri Lankan legislation created more laws about the building and construction, because more non-government organizations came to the Sri Lanka. In that time Sri Lankan government, emphasize the green building projects.

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2. SUSTAINABLE CITY

Is a city where achievements in social, economic, and physical development are made to last. A Sustainable City has a lasting supply of the natural resources on which its development depends (using them only at a level of sustainable yield). A Sustainable City maintains a lasting security from environmental hazards, which may threaten development achievements (allowing only for acceptable risk). It is now widely recognized that cities make an important contribution to social and economic development at national and local levels. Cities are important engines of economic growth and Cities are important centre of productivity and social advancement. Full realization of cities' potential contribution to development is often obstructed by severe environmental degradation in and around rapidly growing urban cities. Environmental and physical Planning Law always control and regulate sustainable cities and buildings through legislation provisions and case law.

3. BASIC LEGAL PROVISIONS RELATING TO BUILDINGS AND CITIES

Sri Lanka's Constitution adopted in 1978 specially refers (Article 27) to the preservation of the environment. The laws governing the protection of environment and conservation in Sri Lanka are largely based on legislative enactments. Sri Lanka Parliament enacted National Environmental Act No. 47 of 1980 to the establishment of the Central Environmental Authority (CEA) in 1981 as the state agency responsible for the formulation and implementation of policies and strategies for the protection and management of environment. Also our Parliament enacted various legislation for protection of environment such as Fauna & Flora Protection Ordinance - No. 02 of 1931, Forest Ordinance – No 16 of 1901, Soil conservation Act –No 02 of 1951, National Heritage Act No 03 of 1988, Coast Conservation Act – No 51 of 1981 etc. for controlling environmental matters. These laws are directly applicable to the construction matters.

3.1. PHYSICAL PLANNING LAW IN SRI LANKA FOR SUSTAINABLE BUILDINGS

There are number of physical planning legislation in Sri Lanka such as Housing and Town Improvement Ordinance No. 19 of 1915, Urban Development Authority (UDA) Law No 41 of 1978, Town and Country Planning Ordinance No. 16 of 1946, Municipal Council Ordinance and Urban Council Ordinance, Pradeshiya Sabahas Act etc. One such early legislation is Housing and Town Improvement Ordinance No. 19 of 1915 for control of physical planning matters to protection of environment. The objective of this Ordinance is to deal with the problem of in sanitary conditions of urban overcrowding as well as to prevent such situation. Towards this end, this Ordinance has introduced sanitary and environmental standards in urban areas and to improve the quality of the housing stock. Accordingly a set of building regulations are set out inn the Schedule to the Ordinance. These regulations relate to controlling height, light, ventilation and accessibility. In addition, the Ordinance provides for the introduction of town improvement schemes, slum clearance schemes and street line schemes. This is a basic law relating to sustainable buildings. However this law is not properly implementing by relevant regulatory bodies.

3.2. PHYSICAL PANNING LEGISLATION AND ITS PRACTICE

Housing and Town Improvement Ordinance No. 19 of 1915 is to deal with the problem of in sanitary conditions of urban overcrowding as well as to prevent such situation. Towards this end, this Ordinance has introduced sanitary and environmental standards in urban areas and to improve the quality of the housing stock. Accordingly a set of building regulations are set out in the Schedule to the Ordinance. These regulations relate to controlling height, light, ventilation and accessibility. In addition, the Ordinance provides for the introduction of town improvement schemes, slum clearance schemes and street line schemes. The development control powers are vested with the Mayor or chairman of the local authority under the Ordinance. Until the introduction of the Urban Development

Authority Law (UDA) Law in 1978, this Ordinance together with Town and Country Planning Ordinance of 1946 were the main legal instruments with regulated the physical planning and development of urban areas in Sri Lanka. Today these two Ordinances are operation in areas which have not been declared under the UDA Law.

Urban Development Authority Law No. 41 of 1978 (UDA Law) marks a new era in the physical planning exercise in Sri Lanka. This law was in acted in 1978 due to inadequacies found in both Housing and Town Improvement Ordinance No. 19 of 1915 and Town and Country Planning Ordinance No. 16 of 1946 to deal with physical planning problems of the urban areas of Sri Lanka. According to the preamble to the UDA law, the objective of the law is to promote planning of economic, social and physical development and its implementation in the urban areas declared under this law and control of environment. In order to realize these objectives, clearance of slums and shanties, coordination and control of development projects carried out by other governmental agencies, exercising of development controls to ensure conformity to development plans and planning regulations. UDA has introduced a new set of development regulations in areas under replacing the provisions of housing and Town Improvement Ordinance. Also Jayasinghe vs. Stheethawaka Urban Council held that UDA has wide powers for controlling building matters than local government authorities in their region.

3.3. URBAN DEVELOPMENT AUTHORITY (UDA) REGULATIONS

Regulations may be made by the Minister of Construction and Urban Development for the purpose of carrying out or giving effect to the principles and provisions of the UDA Law No. 41 of 1978 as amended by Act No. 4 of 1982 for regulate any physical planning projects or schemes prepared by any Government Agency or other persons in such areas (Section 8 (r) of UDA Law), regulating the use of land and buildings in different zones, and imposition of conditions and restrictions in regard to several factors of building development. In addition, regulations may also be made on several matters on which they are required to be prescribed. One of the latter is on “the levy of fees and service charges in respect of different categories of developments”. However, all of the above matters should relate to a Development Plan prepared and sanctioned for the development of the corresponding UDA declared area. On the other hand, since there were no Development plans prepared for the UDA declared areas in the immediate period after the establishment of the principal enactment (No. 41 of 1978), and of its amendment (No. 4 of 1982) The Minister at that time, acting under the generality of the powers conferred by Section 21, has published the, “UDA Planning and Building Regulations 1986” in Gazette NO.392/9 of 1986.03.10. It specifically stated that the provisions of these regulations shall be applicable to every area for the time being declared by the Minister as a UDA Area. These regulations were approved by Parliament as required by Section 21 (3) of the law.

4. DISASTER MANAGEMENT LAW AND SUSTAINABLE CITIES

On the other hand Sri Lanka is one of the countries that were hardest hit by the tsunami tidal waves that ravaged severed countries in the Indian Ocean rim on December26, 2004. The tsunami caused extensive damage and disruption to human life, livelihood, public and private property, economic infrastructure, buildings in Sri Lanka. The main objectives of the new planning laws in the tsunami affected areas are to provide immediate to communities and local government authorities to speedy restart functions and construct buildings through protection of environment. The Sri Lanka Parliament has enacted special two Acts namely Tsunami (Special Provisions) Act No.16 of 2005 and Disaster Management Act No. 13 of 2005 for path of rehabilitation. These two Acts specially mentioned planning and recovery techniques of disaster management of Sri Lanka. In the post tsunami reconstruction work, the government has given high priority to rebuild human settlement and shelters.

The main objectives of the new planning laws in the tsunami affected areas are to provide immediate to communities and local government authorities to speedy restart functions Laws and regulations

relating to the Tsunami Reconstruction are re-construction of infrastructure facilities in cities in Sri Lanka under the new planning law and re-settlement of displaced families outside buffer zone with property law rights.

5. ENVIRONMENTAL PROTECTION AND LEGAL PROCEDURE FOR SUSTAINABILITY

The functions of the CEA as provided for in part II of the Act as to administer the provisions the Act and its regulations, to conduct, promote and coordinate research relating to aspects of environmental degradation or prevention, to specify standards norms and criteria for the protection of the environment, to regulate, maintain and control activities relating to aspects of environment and to undertake investigations to ensure compliance with the Act. Recognizing that the CEA lacked regulatory powers to act on environmental pollution, the National Environmental Act was amended in 1988. The amendment requires all project approving agencies to obtain an Environmental Impact Assessment (EIA) from the developer proposing a development activity. The EIA process is a useful tool in assessing the impact of development projects and activities.

Environmental Impact Assessment (EIA) as a term used to define a document which assesses the environmental effects for proposed development projects or policies and evaluates alternatives to that project/ policy that might be environmentally better. The procedure established provides for the submission of EIA's in respect of projects that are generally determined by the Minister of Environment. Once an EIA is submitted, the Act provides for a public inspection period with mandatory 30 days period for the receipt of public comments. A public hearing may be held where the public interest so demands and a decision to proceed with a project with or without conditions have to be arrived at thereafter. Therefore EIA process is a useful tool in assessing the impact of development projects and activities. However project approving agencies ignore this procedure. It was held by Colombo – Katunayake Express way case.

Further Antiquities Ordinance has been amended by Act No. 24 of 1998 to obtain an approval from the Department of Archeology before any major project is launched by any developer. This process is known as *Archaeological Impact Assessment (AIA) Survey for maintain sustainability of cultural matters*. Coast Conservation Act No. 57 of 1981 and the Board of Investment (BOI) No. 04 of 1978 are another two statutes with provisions for physical planning matters for development of economic infrastructure facilities in coastal belt and free trade zones.

6. NUISANCE LAW AND SUSTAINABILITY

Nuisance action is a common law action which is based on the premise. This action was one to use for the purposes of environmental protection. There are three types of nuisance actions, namely private nuisance, public nuisance and statutory nuisance. A person is said to commit the tort private nuisance when he is held to be responsible for an act causing physical damage to land or substantially interfering with the use or enjoyment of land or of an interest in land. Thus nuisance which is unreasonable covers interference with use and enjoyment of land by water, fire, smoke, smell, fumes, gas, noise, heat, disease or any other like thing which may cause such an inconvenience. Public nuisance is a crime rather than a tort and an action for public nuisance will be instituted by the state. It is therefore, an act or omission which affects the reasonable comfort or convenience of members of the public. It is not necessary to prove that every member of the public has been so affected. A representative group is sufficient. In that matter, nuisance law can protect sustainability.

As far as environmental related actions in nuisance are concerned, the most common actions would relate to noise, pollution of the air and water ways, disposal of garbage, etc. As regards statutory nuisance, the *Nuisance Ordinance No. 15 of 1862* provides that whatsoever shall commit any of the offences specified in that Ordinance, shall be guilty of an offence. Apart from this Ordinance,

Municipal Councils, Urban Council Ordinance and Pradeshiya Sabhas Act also provide for the prevention of nuisance and protect sustainability concept.

7. CASE LAW RELATING TO SUSTAINABLE CONCEPT

In the *Keangnam Enterprises Ltd vs. Abeyinghe and Others* case, Sri Lanka Supreme Courts developed the Environmental Law and sustainability. In this case the Petitioner-Company had established a metal quarry, a metal crusher and a premix plant at a site taken on lease for developing and rehabilitating the Ambepussa - Dambulla - Anuradhapura road: The Respondents complained of a public nuisance created by the Petitioner-Company. The Magistrate Courts granted an injunction restraining the operation of the quarry under section 104(1) of the Code and also entered a conditional order under Section 98(1) of the Code for the removal of the public nuisance caused by the quarry. In this case Supreme Courts observed any one can enter in to courts for protection of environment and sustainability.

The Supreme Court of Sri Lanka clearly emphasized in the *Eppawala phosphate case*. This case can be mentioned as *Bulankulama Vs Secretary, Ministry of Industries* and Supreme Courts stated that environmental protection and environmental sustainability should constitute an integral part of the economic development process in order to achieve sustainable development and courts further explained that as a member of the United Nations could hardly ignore the environmental requirements, norms and standards laid down in the Stockholm and Rio Declarations.

In the *De Silva vs. Minister of Forestry and Environment* case is on Pollution Control and - Air Quality Regulation case. Petitioner complained that the Air Quality standards were not being maintained in some parts of Colombo Metropolitan area. And the petitioner sought a direction of Court to the Minister to make and gazette regulations specifying: Mobile Air Emission Standards, Fuel Standards and Vehicle Specification Standards. Court decided that the respondent, the minister will make and gazette regulations specifying those three standards. As a result of this case the National Environmental (Air Emission, Fuel and Vehicle Importation Standards) Regulation No.1 of 2000 was gazette intended to come into effect on 1st Jan 2003 for protection of sustainability concept in cities.

In *M.M. Khalid and Three Others vs. Chairman, Sri Jayawardenepura-Kotte Municipal Council* case is on Public Nuisance, plaintiffs who were residents of Senanayake Avenue, which is a residential area and causing a public nuisance to the residents in that it was attracting crows and other animals, was causing diseases. Court decided that the respondent, the municipal Council, garbage must be disposed of in a manner which does not cause a nuisance.

In the *Environmental Foundation Ltd vs. Geological Survey and Mines Bureau & Seven Others* case is on conservation of Biological Diversity matter. The petitioners claimed to prevent unsustainable sand mining in river beds in Maha-Oya. Operations under licenses are not monitored and causing severe environmental damage. As a result of unchecked mining, more sand is being removed from river beds. The petitioner pointed out that adverse environmental impacts of these activities include costal erosion, erosion of river banks, salt water intrusion, lowering of the water table, ecological imbalance and habitat loss. The petitioner requested court to carryout EIAs, to monitor the mining activities and to prevent the over exploitation of the resources. This case was developed new legal concepts than provisions of legislation.

In the *S.C. Amarasinghe and Three Others vs. the Attorney General and Three Others* (The case is on Land Acquisition and Environmental Case) Lands belonging to the petitioners were to be acquired under the Urban Development Project Act No. 2 of 1980 for the Colombo Katunayake Expressway. The petitioners filed action challenging the order. The petitioners claimed that in forming an opinion that the expressway would meet the just requirements of the general welfare of the people. The petitioners also claimed that approval for the project must be obtained under the National

Environmental Act and can not be in respect of the expressway before an EIA has been prepared. The court states, it is not for this court to determine whether, upon a consideration of all these factors, the disadvantages outweigh the advantages of the expressway or whether in its view the expressway meets the just requirements in the general welfare of the people. The court was therefore unwilling to consider environmental issues at this stage and in relation to the issue of land acquisition.

In *Jayasinghe vs. Seethawakapura Urban Council and Others* case is on unauthorized constructions matter and Courts developed new concepts. Petitioner was asked to remove the unauthorized structure within seven days by the 1st respondent. The area has been declared as a Development Area in terms of the Urban Development Authority Law. The petitioner seeks an injunction of the UDA notice as that notice was illegal and void. The court states, once an area has been declared as a "development area" no person could carry out or engage in any development activity in any such part without a permit issued by the UDA. And if any development activity is commenced, continued, resumed or completed without a permit issued by the UDA, in a development area, action has to be taken only by the UDA. Towards the protection of environment, aspects of physical planning and built environment in the country have a considerable role to play for sustainability. In this regard an account of some important statutes seeking to regulate physical planning matters in the country is useful.

8. NEW NATIONAL POLICY ON SAND AS A RESOURCE FOR THE CONSTRUCTION INDUSTRY

Sand is a mineral as defined in the Mines and Minerals Act No. 33 of (1992), and is the property of the State. The estimated annual national demand for sand for the construction industry is approximately 7 million cubic metres. Almost all of this is manually or mechanically harvested from river beds, carved from river sides, or mined from sand deposits on previous riverbeds. Unrestricted harvesting of sand is resulting in heavy rates of soil erosion, land degradation, increased river-water turbidity, lowered water tables and salinity intrusion in the lower reaches of rivers. Mechanised sand mining has caused irreparable damage to the ecology of the affected areas. It is recognized that the sound management of sand, e.g. so as to minimize flooding, is also necessary for sustainable cities situated in river basins. Because much of the human population too, lives close to and depends on major rivers, this has in turn led to severe water stress, especially for the poor in the western and south-western coastal areas, necessitating costly salt water extrusion schemes. Many rivers in the densely-populated western part of the island are already experiencing the risk of suffering serious habitat alteration and water quality loss and immediate remedial measures are therefore needed. Article 28(f) of the Constitution makes it the duty of every person in Sri Lanka to protect nature and conserve its riches. Sri Lanka has also committed to the principle of sustainable development and to the sustainable use of its natural resources by subscribing to United Nations Conference on Environment and Development and its Agendas. This sand policy statement should reflect Sri Lanka's constitutional, international and national obligations, including the Mines and Minerals Act No. 33 of 1992, the National Environmental Act of 1980, the Coast Conservation Act of 1981 and other relevant legislation, regulations and policy statements. It should be viewed within the evolving policy framework for sustainable development of country including cities and urban development. It defines the commitment of Government, in partnership with the people, to effectively manage the construction-sand resource for the benefit of present and future generations and establish sustainability for environment.

9. HOUSING AND THE ENVIRONMENT POLICIES AND GREEN BUILDINGS

Housing is a crucial factor in the changing form of town. The planning system including the land legislation are closely connected with the provision and availability of land for housing development, and there is an interaction between the planning system and housing policy, which influences the amount of new land required. Many strands of policy come together in the consideration of the future of inner urban areas. Urban areas are not alone in having bad housing condition but the some urban

areas are often associated with other severe social problems, especially poverty and unemployment. There has been wholesale demolition of order housing, accompanied by the disruption of existing communities and loss of jobs. An effective housing policy can play a central part in regenerating sustainable areas. Housing policies, which too often change direction, are harmful to the efficiency of the construction industry and its supplier's. It is important to secure for new and improved green housing so that the industry does not suffer from periodic damaging under utilization of its resources.

10. CONCLUSIONS

The Sri Lankan legal system has sufficient provisions to protect the environment as well as good system procedure for physical planning. The enforcement of National Environmental Act No. 47 of 1980 and Urban Development Authority Law No. 41 of 1978, mark a new era of Environmental and Planning areas of the country. The court of first instance has the powers to act in the environmental planning matters. The Court of Appeal and the Supreme Court has the appellate authority of environmental and planning law matters for develop the sustainable buildings and cities.

It can be concluded that the legal system of Sri Lanka is structured with legislation for environmental protection and planning issues. And also the regulatory powers are well granted for relevant authorities and a structured court system is available to go through environmental matters. However still the environmental and planning issues continuing to exist despite the legal detailed legal system. Every professional should observe loopholes lies in the resource capacity of the relevant authorities to effectively enforce law in environmental and planning law issues and the effectiveness of jurisdiction for certain acts of wrong doing.

Also Locus Standi and Public Interest Litigation has recognized by several cases that held by the court regarding the environmental issues. This Public Interest Litigation has given authority on interested parties to file cases on environmental issues behalf of aggrieved parties. Bulankulama and Others vs. Secretary, Ministry of Industrial Development and Others (Eppawela Phosphate Case) was one famous case that held in Supreme Court under Public Interest Litigation rule.

Hence different branches and divisions of law for green buildings and sustainability in Sri Lanka are categorized as follows. It is stated in Figure 1.

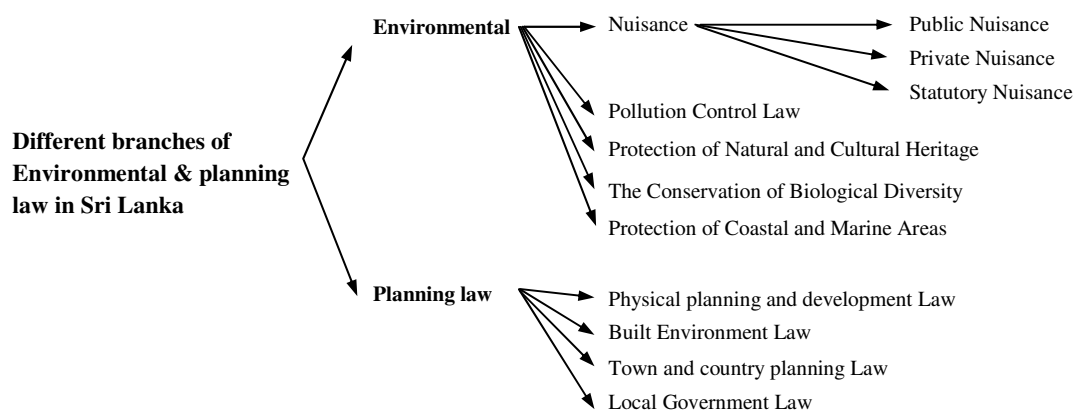


Figure 1 -Different branches of Environmental & Planning Law in Sri Lanka related to sustainability

11. RECOMMENDATIONS

The growth of the construction industry is considered as an indicator of the level of development. Being a developing country Sri Lanka also having a higher growth in construction industry. Environmental and planning law is a tool introduced to regulate natural resources in the ambition of

the protection and improvement of the environment. The understanding of environmental and planning law together with the functions and powers vested to court system in Sri Lanka would be beneficial in the future carrier as professional quantity surveyors ,architects, town planners and engineers.

It should be noted however as lawful citizens of a country and professionals should be aware of these laws and regulations to ensure. Every professional in the construction industry including the quantity surveyors, architects, town planners, engineers should be well aware of the environmental and planning law and abide by them in order to better protect the environment by the impact of construction project as well as create a country with better living conditions in future.

Therefore, the government of Sri Lanka and other developing counties in Asia should introduce new sustainability policies relating to housing and introduce new provisions of the green building law especially to the urban sector. Also Environmental law related to construction matters should amended by Parliament for protect rights of future generations. Ministry of justice should establish new Environment courts for the industrial I sector for proper administration of justice in the country.

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Special Features of Labour Law Relating to the Health, Welfare and Safety Standards of the Construction Industry in Sri Lanka

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ABSTRACT

This research will analyse Employment/Labour Law relating to the human resource management in Sri Lanka. It analyses health, safety and welfare legislation and regulations concerning construction industry in Sri Lanka. Employment or Labour Law regulates the rights and obligations between employers and their employees and protects employees from unjust exploitation and wrongful treatment by their employers. Much of these laws are now governed by legislation relating to industrial disputes, collective agreements, wages boards, employees' provident and trust funds, holiday and annual leave, workmen's compensation, employment of women and young persons, maternity leave etc. This area of law is governed in Sri Lanka both by legislation and common law. Contract of employment although is supposed to be a free contract between employer and Employee, like any other contract. In the context of present day industrial democracy, the relationship between the employer and the employee is to a large extent governed by various legislative enactments. The minimum standards in respect of terms and conditions of employment and sometimes welfare are laid down by employment law. There are nearly forty enactments enacted by the Parliament and under each of these enactments which govern the relationship between the employer and the employee in Sri Lanka. Specially Factories Ordinance, Workmen Compensation Ordinance, Industrial Disputes Act are directly related to construction industry deal with the sanitary, meal arrangements, washing facilities, welfare facilities, security of employees, Workmen's Compensation Ordinance makes provisions to pay compensation in the event of loss of earning capacity due to accidental injuries caused during the course of employment and arising out of employment. Industrial Disputes Act provides for the machinery for the settlement of industrial disputes. Employment relationship in the construction industry may arise when independent contractors are engaged for one particular job.

This paper presents special features of labour law relating to Health, Welfare and Safety standards of construction industry in Sri Lanka.

Key Words: *Legislation, Health, Welfare and Safety, Regulations, Enactments*

1. INTRODUCTION

Industrial and Labour Law regulates the rights and liabilities between employers and their employees and it protect employees from unjust exploitation and wrongful treatment by their employers. Much of these laws are now governed by legislation relating to industrial disputes, collective agreements, wages boards, employees' provident and trust funds, holiday and annual leave, workmen's compensation, employment of women and young persons, maternity leave etc. This area of law is governed in Sri Lanka both by legislation (Industrial Dispute Act No. 43 of 1950, Factories Ordinance-1942, Workmen Compensation Ordinance) and common law principals.

1.1. THE RESEARCH

Although there are labour legislation in Sri Lanka regarding the human resource development and Health and Safety (H&S) issues, still the conditions at sites are not favourable enough to safeguard the

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workers. Therefore, this research is focused to identify level of awareness of H&S practices, different H&S risks, problems being facing, and explore challengers to enhance H&S performance. Aiming to this, an industry wide field survey was conducted to identify H&S performance at the construction sites. During the survey, a total of thirty sites that handle large projects (more than 7-storey height building projects) were studied. Two sets of structured questionnaires were used for data collection for two population frames comprising management level consisted with Human Resources Managers, safety officers, site engineers, site mangers, project managers and site workers. These site workers are masons, carpenters, electricians, painters, and plumbers. Majority of them terminated their formal education after ordinary level (O/L), 17% after advanced level (A/L) and the rest of the workers had only primary education.

The questionnaire was designed into four sections including (1) general profile, (2) knowledge and practices of safety performance (3) health and welfare performance and (4) challengers for H&S performance. In the forth section, respondents were asked to identify the extent to which the different statements would challenge to enhance the H&S performance at sites, on a 7-point scale where 1 represented 'not important at all', 4 indicated 'neutral', and 7 stated for 'extremely important'. Statistical-tests of the mean were carried out. Further, factor analysis is used to identify if there is any further relationship to establish challengers for H&S, using the statistical package of social science (SPSS).

There are nearly 40 legislation are enacted under each area and these enactments govern the relationship between the employer and the employee. Out of these there are few very important and significant laws that all employees and employers should be familiar with.

2. IMPORTANT H&S PROVISIONS IN THE LEGISLATION

Shop and Office Employees Act, deals with terms and conditions applicable to office and shop employees. According to this Act, "Office" covers all construction offices of companies. It covers (i) Hours of work (ii) Weekly holidays (iii) Casual leave (iv) Annual holidays (v) Statutory holidays (vi) Meal and rest hours (vii) Authorized deductions from the salary (viii) Maternity leave (ix) Establishment of Remuneration Tribunals etc. Wages Boards Ordinance covers the terms and conditions of employment of the employees in various trades and vocations including construction trades with regard to hours of work, weekly holidays annual holidays, minimum wages etc. Employment of Women, Children and Young Persons Act deals with special terms and conditions applicable to said categories of employees in the construction cities and other industries also. Termination of Employment Act restricts the termination of workmen (Retrenchment and lay-off) on non-disciplinary grounds.

Employees Provident Fund Act (EPF) deals all employers are compelled to see that all employees under them contribute to the Fund. This is a contributory Pension Fund where the employers required contributing a minimum of 12% of the gross earnings of the employee to the Fund and the employee to contribute a minimum of 8%. While the Labour Department administers the fund the fund is under the custody of the Central Bank. These deposits with accrued interests can be withdrawn.

Employees Trust Fund Act (1980) is a non-contributory fund, only the employer is required to contribution this fund. Contribution is 3% of the employees' gross earnings. There is a special Board called Trust Fund Board established to administer this fund. Employees can withdraw this fund on termination of employment with any employer irrespective of the age, once in a period of five years.

However, most employees of construction sites are not contribute to fund and they ignore casual or daily paid or temporary employees intentionally.

Payment of Gratuity Act (1983) Establishments in the private and corporation sectors including statutory bodies, construction companies and corporations are covered by this Act. Every employer who employees 15 or more employees (average for the previous 12 months) is required to pay a

gratuity computed at the rate of 2 weeks (in the case of daily paid employees 14 days salary) for each years of completed employment. Only those workmen who have completed at least 5 years continuous employment under the same employer are eligible for this payment. Some times minor construction companies infringe those provisions and they always look of not raised 15 employees.

Factories Ordinance also deals with the sanitary, recreational, meal arrangements, washing facilities, welfare facilities, security of employees in the construction industry. Workmen's Compensation Ordinance makes provisions to pay compensation in the event of loss of earning capacity due to accidental injuries caused during the cause of employment and arising out of employment, Accident is defined in this act to include even occupational deceases. However they ignore this ordinance due to lack of labour laws of employees.

The workmen compensation Ordinance No: 19 of 1934 and its amendments have been enacted by the parliament to give compensation to those employees who're killed or injured while on duty. According to this law, compensation is payable only if the injury or affect is caused while the duty. However employer is not bound to give compensation to the employee. If the employee has violated or ignored the instructions of the employer at the time of the accident and t he time of the security measures available in the company.

2.1. APPLICABILITY OF LABOUR LAW LEGISLATION

There are many statutes, which cover construction industry. The chief among them are the Wages Boards Ordinance, Shop & Office Employees Act, Factories Ordinance, Workmen's Compensation Ordinance, Employees Provident Fund Act, the Employees Trust Fund Act, the Payment of Gratuity Act and the Maternity Benefits Ordinance. The less important statutes include the Medical Wants Ordinance, Diseases (Labourers) Ordinance, Women, Young Persons & Children Act, Employees Councils Act, Mines, Quarries and Minerals Ordinance etc.

Wages Board Ordinance comprises three parts. Part I is applicable to all trades including construction trades. It specifies the dates within which wages should be paid and restricts the maximum amount which could be deducted from the wages. It also specifies the authorized deductions from wages. There is provision for imposition of fines but approval should be obtained from Commissioner of Labour in advance. Part II deals with establishment of Wages Board for any trade and the powers and functions of the Wages Board. Part III deals with the general provisions relating to powers of the Commissioner of Labour, offences and penalties.

In Sri Lanka the Wages Boards do not have any specific guidelines or recipe for fixing of minimum wages. It has been alleged that haphazard changes in wage structure have been made in certain instances despite objections. It has to be conceded by any reasonable human being that productivity should play prominent and pivotal role in fixation of minimum wages. There is no vestige of doubt that in the present context of cost of living spiraling sky-high the rate of wages fixed by Wages Boards cannot be reckoned as living wage and they are far too low. The current behavior pattern in the private sector is that wages paid are higher or more than the minimum wages prescribed by Wages Board.

This Ordinance is applicable to any industry including construction industry, business undertaking, occupation, profession or calling carried out, performed or exercised by an employer or worker and any branch of or any function or process in any trade. It does not include any industry, business, undertaking which is carried or mainly for the purpose of giving an industrial training to juvenile offenders or orphans or to persons who are destitute dumb deaf or blind. It also does not apply to the State. In this Ordinance "worker" means any person employed to perform any work in any trade.

Therefore, this provision discriminates employees in the government and mercantile sector. However there is a legal concept that all are equal before the law.

Under the Shop & Office Employees Act employers have to provide sufficient ventilation and lighting at workplaces, facilities for the taking of meals, and sanitary and washing facilities. In the Factories Ordinance dangerous machinery and equipment must have protective covers and ancillary devices to ensure the safety of workers from the dangers of injury, accidents, occupational diseases or death while at work. Workers have also to be provided with meal, rest and changing rooms, cloth cupboards, first aid equipment, protective clothing, spectacles, head, body and foot wear. Further dangerous gas, smoke, and steam likely to emanate from machinery and equipment have all to be let out of the factory premises and dangerous electrical appliances and floor areas must be covered to prevent mishaps likely to take place. In addition sanitary and washing facilities have to be provided for men and women separately. Also good drinking water must be provided within the factory. In the case of the Workmen's Compensation Ordinance employers are liable to pay compensation at various rates scheduled under the Ordinance in respect of injuries, accidents, occupational diseases and deaths if any worker becomes subject to such mishaps while at work. However employees in the construction industry always ignored those provisions of legislation.

Under the Factories Ordinance the Chief Factory Inspecting Engineer is also now designated as the Commissioner of Labour (Industrial Safety). The others who have power under the Factories Ordinance are the Deputy Chief Factory Inspecting Engineer, District Factory Inspecting Engineer, Special Factory Inspecting Engineer, Factory Inspecting Engineer, Special Inspecting Medical Officer and Inspecting Medical officer. According to the law, they can inspect all factories including construction sites. However practically there are no implementation laws for construction site. However Under the English common law there are lot of legal provisions under the Health and Safety at Work Act of 1974. In this legislation some offences at work place are considered as crime.

Workplaces must be sufficiently ventilated to make working a pleasant exercise, and not injurious to the health of workers. Suitable facilities have also to be provided within the workplace for employees to take their meals. Also suitable sanitary and washing facilities should be provided separately, wherever possible for men and women. Female employees engaged in the serving of customers at counters should be provided seats for them to be seated when they are not serving customers.

A very long and wide description is found in the Factories Ordinance as to what constitutes a factory. However in essence a 'factory' means and includes construction, extension, alteration, renovation and even cleaning of any premises or building or even a building structure, where one or more workers are employed for any of the under mentioned purposes.

The Workmen's Compensation Ordinance, which was administered by the department of Labour up to 1945, is now under the Ministry of Social Services. The Commissioner of Workmen's Compensation, his Deputies and Assistants appointed in terms of Section 27 of this Ordinance carry out the powers, functions and duties assigned to them and they can order to pay compensation for injured employees of construction industry.

Employment of Women, Young Persons and Children Act deals exclusively with women, young persons and children and is the most confusing statute to understand when considered with provisions contained in other statutes as various requirements and strictures applied to different undertakings, industries and services have to be observed. These conditions, requirements and strictures will be discussed separately in regard to women, then to young persons and thence to children. In industrial undertakings like factories, mines, quarries, mineral extraction works, ship building, electricity generation, building and civil engineering works, irrespective of whether they are publicly owned or privately owned, women can be employed throughout the night hours from 7.00 p.m. to 5.00 a.m. subject to the under mentioned conditions:-

1. No woman can be compelled to work during the night hours against her will.
2. If women workers are to be employed after 10.00 p.m. permission of the Commissioner General of Labour has to be obtained.

Trade Unions Ordinance covers regulatory provisions relating to Trade Unions of Workers and employers. Government, local government, corporation and private sector employers as well as employees in construction industry are entitled to register trade unions under this ordinance. However there are no trade unions in the construction industry business organizations.

Under the provisions of secondary labour law such as the Medical Wants Ordinance, Diseases (Labourers) Ordinance, Women Young Persons and Children Act, Employees Councils Act, Mines Quarries and Minerals Ordinance and the Minerals and Mines Law certain sections in these statutes apply to the welfare facilities that have to be provided and the limits to the amount of over time and night-work for construction industry employees.

3. HEALTH AND SAFETY ISSUES AT WORK PLACES IN SRI LANKA

Workplace health and safety (H&S) is one of the core affairs considered by all organizations that are responsible for protecting and optimizing their human resources. However, there are evidences for occurring serious accidents, injuries and health issues at a high level in the construction industry than in other industries, due to its nature of labour orientation. An industry-wide survey was carried out to explore the above issues from the various personals at the construction sites, including project managers, site managers, site engineers, and workers were got involved in this survey. Results indicate that the H&S performance at many construction sites are at a lower level. Further, four challenges were identified as barriers to enhance the H&S performance.

The construction industry is highlighted as one of the most dangerous industries upon the number of accidents and the injuries (Perttulla, 2003; Baradan and Usmen, 2006). Further, Pathirage (2003) showed the ratio between the fatal and non-fatal accidents is 1:13 in the local construction industry. In this study, the non fatal accidents are grouped into three categories including minor (medical leave up to 3 days), serious (medical leave up to 15 days) and very serious (medical leave above 15 days) and found the respective percentages as 78%, 14% and 8%. Among them, 81% injuries were treated within the site and the remaining 19% cases were hospitalized. The main reasons have been highlighted for the accidents in the construction industry due to the negligence of safety measures recommended by the relevant authorities, poor knowledge, attention and the attitudes over the safety measures.

Further, health issues at the sites become a complex issue and require long term strategies due to lack of knowledge, attention or even negligence. Aspiratory diseases caused by dusts are some times not avoided. Recently, it was reported a complaint regarding noise nuisance. The heavy machines used for pile driving were created awful noise and was reported to the Department of Public Health, CMC and Central Environmental Authority. Similarly, Ceylon Electricity Board (CEB) of Sri Lanka was guilty according to case - Deshan Harindra and others vs. Ceylon Electricity Board.

A noise nuisance in 1997 for construction and operation of emergency power plant in Kotte, was a large private power plant that had commenced operation to supply emergency power crisis in 1997 in Sri Lanka.

Therefore, the construction industry has to play a vital role in improving the H&S performance. Owing to this, the practices, attention and attitude towards the H&S are required to enhance, though the legislation have been established. Having said that, there should be effective ways and means to enhance the level of awareness and knowledge of H&S and also should have strategies to overcome existing H&S barriers.

3.1. H&S LEGISLATION IN SRI LANKA FOR DEVELOPMENT OF HUMAN RESOURCES IN THE CONSTRUCTION INDUSTRY

During the last few decades various Act and Ordinances were passed relevant to the employees in the construction industry for health and safety. For instance, there are 40 labour statutes in operation, of which some are more or less obsolete, rules and regulations (Kariyawasam, 2003). The chief among them are the, Factories Ordinance, Workmen's Compensation Ordinance and the Maternity Benefits Ordinance, Medical Warrants Ordinance, Diseases (Labourers) Ordinance, Employment of Women, Young Persons and Children Act, Mines, Quarries and Minerals Ordinance, Shop and Office Employees Act and the Minerals and Mines Act etc. According to these legislations, relevant employment safety and health provisions regulate the rights and liabilities of H&S matters between employers and their employees. There are a lot of provisions in this legislation for health and safety of employees in the construction and building industry. For example, Factories Ordinance and its regulations state that the employer should display relevant safety notice boards, and supply of safety helmets and belts to the employees in their industries/ construction sites. On the other hand Employment of Women, Young Persons and Children Act mentioned that the employers are obliged to protection of safety and health conditions of children, young person and women employees. Under this legislation employer should also supply safety helmets and belts, hand protections, safety shoes, and dust masks to the employees and were stated as the commonly provided personal protective equipments in the relevant industry. Practically there are no implementation of laws and no special independent office for inquiries.

3.2. LIABILITIES OF EMPLOYERS IN THE CONSTRUCTION INDUSTRY

According to the Workmen's Compensation Ordinance (1934), employers are liable to pay compensation at various rates scheduled under the Ordinance in respect of injuries, accidents, occupational diseases and deaths if any worker becomes subject to such mishaps while at work. Therefore, compensation is payable if the injury or affect is caused while at the duty. Further, if a worker dies within seven days of the occurrence of an injury then the heirs of the deceased employee are entitled to claim compensation arising from the death of the worker. However, if the employee has violated the safety or health instructions of the employer at the time of the accident, the employee is not entitled to compensation under this Ordinance.

In addition, there are many industrial diseases enumerated in the third schedule of the Workmen's Compensation Ordinance. Further, following legislation provisions and directives are also used to govern the H&S at construction sites as criminal offences in Sri Lanka and these provisions are enacted for the protection of citizens', employee's health and safety condition in impliedly.

- Chapter XIV in the Penal code captioned "offences affecting the public health, safety, convenience, decency and morale"
- Presidential Directive captioned "safety precautions to be taken in the construction of building".

However, there is a provision in the Ordinance for an employer to insure worker against risks of accidents of mishaps after obtaining approval from the Commissioner of Workmen's Compensation. In fact there are employers, who have insured workers for payment of workmen's compensation. There are also some business contracts where Workmen's Compensation Insurance scheme has been made compulsory for health and safety aspects. However implementation mechanism is very weak in Sri Lanka.

4. DISCUSSION OF RESEARCH FOR DEVELOPMENT OF HR IN THE CONSTRUCTION INDUSTRY

4.1. LEVEL OF AWARENESS ON SITE SAFETY

The survey identified that the awareness level of personnel even at the management level (i.e. HR managers, site engineers, site mangers and project managers) over H&S legislation and practices is low (Table 1). This implies that they have received very little safety training and education. Existing literature also emphasizes that the level of training and education are insufficient. However, awareness of the H&S practices/measures has been shown much better response.

Table 1: Awareness Level of Respondents

No	Description	Awareness of personal level %
1	Awareness about legislation, (H&S regulations and standards)	27.62
2	H&S governing Authorities	34.29
3	H&S practices/measures	69.88
Overall score		43.92

4.2. SAFETY RISKS AT SITES

4.2.1. Statutory Test for Plant and Equipment

Unhealthy functioning of the plant and equipment may cause severe accidents. Hence, it is crucial to examine the operating process of the plant and equipment by a competent person regularly. According to the Factories (Amendment) Ordinance, No 12 of 1976, construction sites health and safety condition should be inspected by a competent person eg: Asst. Commissioner of Labour or Factories Engineer or Labour officer periodically. However during this survey period of one month, no inspections were carried out. Further, it was reveled that, the poor interest was given on statutory test for the plant and equipment. This was observed as 34.29%. The main reasons for poor interest can be highlighted as (1) lack of financial resources to hire a competent person and (2) non availability of the necessary equipments to carry out the statutory tests.

4.2.2. Providing Safety Equipments

Safety helmets, safety belts, hand protections, safety shoes, and dust masks were identified as the commonly provided personal protective equipments (PPE) used in most of the building sites. Factories Ordinance, and Employment of Young Persons, Women & children Act are also mentioned those health and safety conditions in these provisions. However, employers always violated those safety and health legislation. Table 2, illustrates the levels of availability of these personal protective equipments and the levels of usage by the workers. In general, providing of safety helmets, glows and belts are at a good level, but the workers' acceptance level is shown very poor.

Table 2: PPE and Their Usage of Workers

PPE	Availability (%)	Usage (%)
Safety helmets	77	53
Safety shoes	57	39
Safety belts	71	33
Hand protection	91	37
Protective clothing	26	15
Dust mask	66	31

4.2.3. Safety Training Programmes

Safety training programmes are one of the effective sources of transferring knowledge on H&S. However, this research revealed the efforts taken to initiate or conduct such programmes are not at an impressive level (54.29%). Further, it revealed that only 17% of respondents were provided safety training for their workers on weekly basis, and 11% on monthly basis. Rests of the respondents have given only an introduction at the beginning of the construction project.

4.2.4. Health Risks at Sites

It was noticed that the cement dust, paint particles, dust from carpentry work and tile/granite dust are commonly available types of dusts in the construction sites. Among them cement is shown the highest profile (Table 3). However, the figures shown in the Table 3 are generous figures drawn based on their frequencies. In the sites, there are many efforts taken to reduce the impact of these dusts. Some of these efforts to control the dust generation are (1) water is used, when cutting and drilling asbestos, granite and tiles, (2) tyres of vehicles are washed when leaving the site. This helps to avoid, spreading of dusts from the site.

Table 3: Different Dusts Levels (Based on the Frequency) at Sites

Type of the dust	Dust level (%)
Quarry dust	06
Asbestos dust	03
Cement dust	91
Tile/granite dust	40
Particles from painting work	60
Lead particles from welding process	20
Dust from carpentry work	57

4.2.5. First-Aid Facilities

Factory Ordinance emphasizes that the first aid facilities should be maintained in sites. But the results reveal that only 63% of sites have first aid kits and few of them have a trained person and emergency equipment such as a stretcher at sites (Table 4).

Table 4: First Aid Facilities Available at Sites

Type of facility	Availability (%)
Trained person	29
First aid kit	63
Emergency equipments	11

5. CONCLUSIONS

This research was carried out to elaborate current human resource development and protection practices of H&S performance at sites. It is basically focused on statutory test for plant and equipment, providing personal protective equipment, noise controlling, pest controlling, dust controlling, sanitary facilities available at sites etc. Survey results illustrates that the performance of H&S need to be improved.

Further, significant constraints of having efficient human resource development and H&S practices or programmes are exploded. They were further grouped them to establish the challenging factors. With these findings, they can be taken as a momentum to address the H&S issues and enhance the image of the H&S performance, establishing systematic industry wide programmes.

The inherent characteristic of the construction industry as well as other industries such as high mobility and dispersion etc., has bought many advantages and disadvantages. It is clearly seen that the H&S issues are becoming more and more increasing in the present context. The larger projects, which normally existing high risks and in general need higher priority for H&S than in the smaller projects.

Therefore, the government of Sri Lanka and other developing counties in Asia should introduce health and safety law policies and introduce new provisions of the labour and industrial law especially to the private sector. Also Labor law related to health and safety should amended by Parliament for protect labour rights. Ministry of justice should establish new employment courts for the industrial sector for proper administration of justice in the country.

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The Challenges in the Application of Sustainable Construction Concept in the Malaysian Housing Industry

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ABSTRACT

With the target to achieve a developed country in 2020, Malaysia has seen a rapid development in all sectors with construction industry acts as a catalyst to spark its growth. However, the lack of attention on environmental issues in previous development has taken its toll as deterioration of natural resources and environment is reaching critical level. The government has urged construction practitioners to be sustainable in their practices as a way forward in producing a development that is responsive to its environmental and social needs. So far, the concept of sustainable construction is slow in penetrating the industry. To understand why, two field studies have been conducted to investigate the problems and challenges in applying sustainable concept in Malaysia based on the perceptions of the project developers. Several challenges have been identified and classified under two categories: internal and external challenges. To improve the momentum of sustainable practice in the industry, many facets of actions are necessary to overcome the identified challenges.

Keywords: Sustainable Challenges, Sustainable Construction, Developers, Malaysia Construction Industry, Environmental Issues

1. INTRODUCTION

The construction industry is an important sector in the economy not just because it directly provides growth to the gross domestic product (GDP) but, more importantly, helps other sectors contribute to the GDP. In Malaysia, the nationwide push for development growth and wealth generation since 30 decades ago has led to extensive development of building and infrastructure with little regard to the environment. Greater urbanization has put more pressures on land with developers turning their interest on hill land (Ngai, 1998). This excessive construction had led to many environmental problems such as deforestation, decimation of water catchments, destruction of endangered fauna and flora, soil erosion, landslides and many more (Zainul Abidin, 2010; Ithnin, 2006). The indifferent attitude of the Malaysian policy makers towards a long-term development in preference to short-term fast economic gains has contributed immensely to the environmental woes of the country (Maidin, 2005).

Sustainable construction has been hailed as a way forward to eradicate further adverse impacts on environment. It is a significant milestone on the road to a more socially and environmentally responsible. It creates a framework within which the industry can look beyond the delivery of buildings and infrastructure and contributes towards opportunities that can reduce the usage of resources and energy, minimise pollution, enhances economic efficiency and social cohesiveness (Hussein, 2009).

Sustainability in built environment has been the choice of most architects, developers as well as authority of all across the world in order to tackle the environmental impact. Nonetheless, the development and implementation of sustainable or green building in Malaysia is still lagging behind. There are some buildings which claimed to be green but they are actually not classified as green

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building because they do not meet certain requirements (Mastor, 2008) Housing industry is booming in Malaysia and more investment is being pumped into this industry to cope with the rising demand. As such, transforming the way houses are being built would have a significant impact on the overall environmental condition. Various aspects of housing construction, design and use have the potential for sustainable improvement (Tosics, 2004; Huby, 1998).

To tackle the problem in the industry, it is important to identify what the weaknesses are. Only then the weaknesses can be addressed and rectified (CIDB, 2007). This paper focuses on identifying the challenges in implementing sustainable construction from the view of housing developers. Developers are selected because they are the ones initiating the project and have prevailing influence over the overall project direction. It was argued that there are two types of challenges that restricting the developers in pursuing sustainable projects. Some of the challenges are within the developers control while the others would require collaboration from other construction players.

2. HOUSING INDUSTRY IN MALAYSIA

Housing sector contributes to the domestic wealth through assets generations and property investment. Good quality housing provides the foundation for stable communities and social inclusion. In Malaysia, the demand for housing started to grow in 1960s (Yusof, 2007) and expanded rapidly in the late 1980s as a result of rapid urbanization (Ithnin, 2006). Activities in the residential segment remained strong, underpinned by firm demand for residential property which was encouraged by the low interest rates, attractive housing loan packages, as well as incentives provided by the government. Malaysian government also committed into providing adequate, affordable and quality houses for all income groups, particularly on lower income group (Economic Planning Unit (EPU), 2001). Supported by favourable demand conditions, construction of new houses continue to expand by 5.5% and 1% respectively in the first 9 months of 2004. In the 9th Malaysian development Plan (2006–2010), the government has set to invest RM220 billion (including RM20 billion in Private Funding Initiatives) in construction in the next 5 years (EPU, 2006). For medium to high income group, most of the housing is being constructed by the private sectors i.e. private developers and cooperative societies. Under 9th Malaysia Plan (EPU, 2006), the number of medium and high cost houses constructed by private sectors far exceed its target reflecting a continuous demand for houses in these categories. The government is also set about branding the nation as a top property investment destination in order to encourage more foreign investment and boost asset values under the Malaysia My Second Home (MM2H) programme. The political stability and sound fiscal policy of the government in Malaysia makes this country an attractive place to invest which in turn booming further the economy.

3. BEING SUSTAINABLE IN THE HOUSING INDUSTRY

A house is sustainable if it is accessible, promotes social cohesiveness, self dependence (Edwards and Turrent, 2000). It linked with the concept of quality of life, well-being and livability. It encourage community participation and accommodate the needs of current and future generations in ways that reproduce and balance local social, economic, and ecological systems and link local action to global concern (Berke and Conroy, 2000). Being sustainable in housing is as much about efficient profit-oriented practice and value for money as it is about helping the environment (BRE Report, 2002).

The concept of sustainable housing is still new in Malaysia. According to Jasan (2004) and Mustaffa and Ahmad Baharum (2009), the houses being built in the past decades did not meet the essential criteria of sustainability and contributing to energy inefficiency. The design, orientation of the houses and the materials used does not help in terms of cooling the indoor environment which shoved the occupier to use air-conditioner, thus contributing to more greenhouse emission (Zainul Abidin, 2010). About 40% of total world energy consumption is from built environment and property industry contributes about 20% of CO₂ emissions mainly via energy use and also waste and water production

(Mustaffa and Ahmad Baharum, 2009). Hillside housing is also popular due to its impressive view and the 'feel' of exclusiveness. Although many regulation and guideline has been imposed on hillside development, landslides disasters did happened and in many cases lives are lost (The Star, 2008). Most of the developing cities in Malaysia are located near to coastal regions. Environmental stress increases as coastal development intensifies such as water pollution, resource degradation and depletion, coastal erosion, wetland degradation, ecosystem disruption, fisheries problem etc. (Abdullah, 1993). The awareness of the society on the importance of building sustainable houses is still low and demand for it is almost negligible.

Many guidelines and research are introduced by the government and corporate body such as CIDB to mitigate measures for environmental protection (Zainul Abidin, 2007). The government was also called to review and upgrade present law and regulation to cater for environmental needs (Chong, 2005). There are some positive outlooks on green application in the housing industry. The Board of Architects Malaysia in collaboration with the Association of Consulting Engineers Malaysia has launched a rating system known as Green Building Index (GBI) Malaysia which has two assessment systems to cater for residential and non-residential buildings to lead the Malaysian property industry towards becoming more environment-friendly. A renewable energy programme called "SURIA 1000 for Developer" has been introduced to the Malaysian property developers to be involved in sustainable housing development via the use of Building Integrated Photovoltaic (BIPV) to generate clean electricity from solar energy (Suria 1000, 2007). Some private developers have also taken initiative towards green movement by incorporating environmental criteria in their housing development, although most of it is at pioneer stage (Zainul Abidin, 2009).

The actions for sustainable housing are present but still the participation from the industry is limited which hampers the rate of acceptance for wider application. Why is the housing industry slow in accepting this concept? What are the factors that hindering the participation of developers for sustainable housing?

4. RESEARCH METHODOLOGY

4.1. THE STUDIES

Two types of studies have been conducted to investigate the application of sustainable concept within construction industry from the experience of Malaysian developers. As qualitative research, the questionnaires designed for both studies are mostly open-ended typed to allow for deeper discussion on the research subject. Nevertheless, it was discovered that many developers did not discuss their opinion in depth which makes it necessary to gather more information via interview. The two studies are interconnected, with the first being a reconnaissance study and the second to amplify the findings. It was done sequentially. For the purpose of this paper, only aspects related to challenges of sustainable concept application will be focused and discussed.

The first field study is a survey focused on developers of building construction such as property and commercial building located in the area of Kuala Lumpur (capital city of Malaysia) and Selangor. These two areas were selected because many construction developers, which have projects throughout Malaysia, have their main offices located there. The list of the construction developers was obtained from the Real Estate and Housing Developers' Association (REHDA). A total of 271 respondents were approached via post and 35 questionnaires were returned for analysis. The second field study is a series of interviews conducted with 12 well-established developers who have been in the industry for more than 15 years and currently responsible for multi-million worth of projects. Data gathered from the survey and interviews were analysed qualitatively using contextualising technique as the information was in the form of opinion, comments and statements with exceptions on a few closed-type questions in the survey which were analysed quantitatively using averaging statistical analysis.

4.2. THE FINDINGS

4.2.1 CURRENT APPLICATION

In Malaysia, the government, professional bodies and private companies are beginning to take heed in the necessity to incorporate the concept of sustainable in the construction industry and to promote 'greener' development for future projects. With the growing concern over our mother earth, the actions towards sustainable path should be wide spread. However, from the studies, the effort has not penetrated deep into the micro level. From the survey (see Figure 1), most of the respondents (43%) stated that the implementation of sustainable practices is low while another 34% respondents stated moderate. None believed that the implementation is excellent. The respondents were requested to give their opinion on the prospect of sustainable construction application in Malaysia in the next 5 years. A total of 77% of the respondents believed that not much will change and the level is still low-moderate. This is further supported by the interview session. The respondents generally agreed that the implementation of sustainable practices is between moderate to low. The factors that limiting the wider spread of application presently and may continue to be a hindrance if not addressed quickly are discussed under the challenges below.

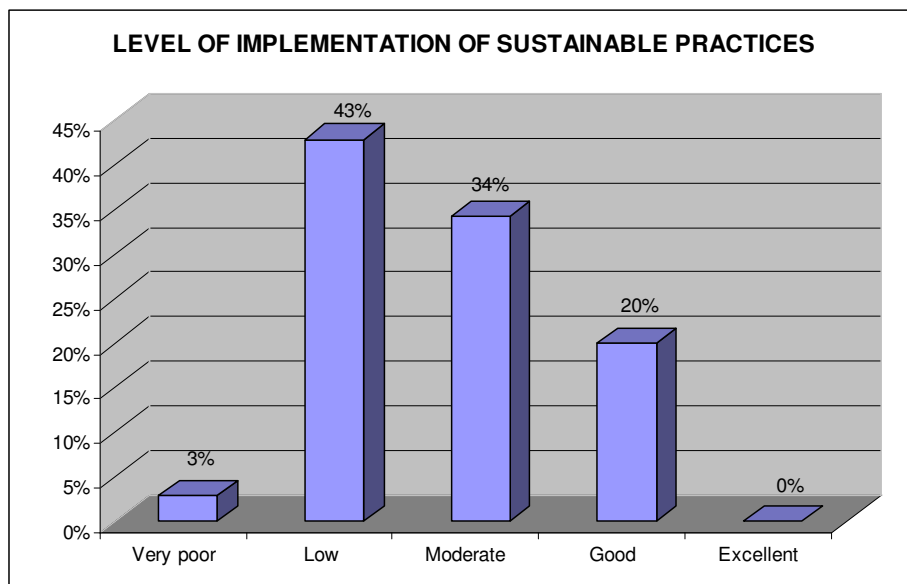


Figure 1: Level of Implementation of Sustainable Practices

4.2.2 THE CHALLENGES

Based on the findings, the challenges of applying and implementing sustainable practices can be divided into two major categories: internal and external challenges. Internal challenges refer to challenges within the organisation that would affect its involvement with sustainable practices. It involves factors that would influence the readiness and commitment of the developers' organisation to venture into sustainable practices and projects. External challenges refer to challenges beyond the direct control of the developers' organisation that impose certain restrictions or limitations towards the development of sustainable implementation for the industry. It involves other parties within the construction industry.

4.2.2.1 Internal Challenges

Internal factors relate to the strength within the organisation which indicates its readiness and capability for pursuing sustainable projects accompanied with the commitment from the top

management. The challenges within organisation that have been identified are the lack of awareness and knowledge of developers, size of developers' organisation, interest, direction and commitment of top management, associating sustainable concept with luxury living, cost vs. economic viability, target buyers and passive culture.

a) *Awareness and Knowledge of Developers*

The term sustainable has been freely used in local news and it relates to many aspects of development. This term however, is not popular in construction context. It was discovered that many respondents did not understand the full concept of sustainability for construction projects. It was found that the concept of sustainability is largely being dubbed as environmental protection only, whilst the attention for social and economic aspect, which encompass the pillars of sustainable construction, are not regarded as part of sustainable concept. Only a handful of respondents stated that sustainability is about balancing the aspects of environment, economic and social.

A total of 80% respondents stated that the lack of knowledge among developers is the major hindrance in applying sustainable construction. Generally, developers are aware about the need to become 'green'. But their knowledge is limited to theoretical only. The majority of respondents rely on written materials (journals, proceedings, newspapers and websites) to improve their knowledge about sustainable construction. Other sources of knowledge are through education and higher learning; seminars and conferences. In-house learning was given a relatively low percentage indicating that most of the developers' companies do not promote this concept within their organizations and project, thus giving small window of opportunity for the employees to learn about this concept internally. The respondents stated that their knowledge on sustainable practices is vastly improved from hands-on experience with sustainable projects.

From the survey, the majority of respondents (80%) perceived that overall developers' knowledge on sustainable concept is between low and moderate level (mean of 2.80). From the interview, a total of 83% respondents agreed with the survey findings. The respondents are in consensus on the ways that can be adopted to improve sustainable construction knowledge. 'Emphasis at education level' and 'highlight success of other sustainable projects' received equal percentage of 62.9%. Followed closely by 'encourage seminar, talk and conference' with 60% and then in-house learning (54.3%).

b) *Size of Developers' Organisation*

Developers ranged from big and well-established company to new and small company. From the survey, respondents from the first category rated their implementation of sustainable practices as high or excellent, whilst the latter category between moderate and low. The respondents were asked whether different size of company (small, medium or large) would affect the capability to execute sustainable practices in the construction projects. A total of 75% respondents agreed that it would. This is because of the belief that sustainable practices require a higher upfront cost which can be afforded by big companies. The respondents stated that large companies can focus on sustainable practice because of their strong capital, wide-range experience, full commitment from the top management, expertise and because of their target users (high income earners and foreigners). Small companies tend to minimise their cost and sustainable practices would affect their profit margin. However, 25% respondents believed that size would not affect the capability to execute sustainable practices. If the developers plan to expand their business and compete, they can learn to execute sustainable practices. One developer stated that they are small but they have managed to execute sustainable practices in their project. From the interview, some of the medium size developers are beginning to take heed in sustainable construction and stated that the size of the firm does not affect their interest and commitment to build sustainably. As the direction of the industry

is towards that path, these developers believed that following the same path is a wise thing to do. They do not build in a grander scale like the big developers, but the essence of 'green' is incorporated in their projects through design and orientation of the building, providing more green spaces, improving social needs such as upgraded facilities, accessibility for disabled and senior citizen etc.

Although many believed that the size of the firm would affect the capability of the firm, with the right planning, it should not be one of the hindering factors. However, in general, the respondents rated that only 10% of developers are really interested on environmental-friendly projects and mostly is dominated by the big companies. The perception that company size affect the capability for sustainable projects has put off interest of many developers before making any attempt towards it.

c) *Interest, Direction and Commitment of Top Management*

In the interview, the majority of the respondents (75%) rated the level of interest among developers for sustainable concept is between low-moderate. Apart from their level of knowledge on this issue, the interest is affected by the direction and commitment of the top management. The rising attention on environmental issues opens avenue for well-established developers to pioneer new projects to showcase their capability in the industry and to conquer new market opportunities. The respondents stated that it is about rebranding their products and enhancing their image and reputation. They believed that by responding to the need to protect the environment and addressing social need, they can generate more profit. It is a good move as it adds value to the project and projected a good image of the developer. This direction pushes top management to commit to sustainability.

The big and medium size developers whose taking heed on sustainability agenda, are still relatively small number as compared to the greater population of developers. From the survey, only 26% of the respondents that admitted to have included environmental aspects as part of their business agenda and organisation policy. The majority of developers still regard environmental and social aspects as not a major priority. There is no urgency factor that compelled them to incorporate sustainability elements in their present and upcoming projects. For many developers, they can generate profit by targeting for medium and low cost houses, which still dominate the housing industry. The direction and commitment of these developers is to ensure that each unit constructed is sellable without adding features that could add to their project cost which may affect housing prices and thus, their marketability. They are comfortable with their business and reluctant to commit to something new. Changing the mindset of this group is a major challenge to the greater implementation of sustainable practices.

d) *Associating Sustainable Concept with Luxury Living*

The respondents were asked whether different category of projects (high end, medium or low cost) would have different level of sustainability consideration. A total of 67% respondents agreed to this statement. The reasons are budget and cost, complexity and target buyers or market. High end product is expected to be of high quality. Green design has been seen as luxury or quality living. High end project usually cost more and the target buyers are those from a higher social status, who can afford expensive homes. Most of eco-friendly products are expensive which cannot be applied to low cost projects. However, 4 respondents disagreed with this statement. These companies have applied Environmental Management System (EMS) in their projects and have produced various range of housing scheme. For them, sustainability consideration can be applied to all categories of project. For low cost for example, instead of incorporating expensive product, the focus could be on maximising natural resources when design.

e) *Cost vs. Economic Viability*

A total of 65.7% respondents from the survey stated that the presumption that project cost will escalate is another major factor that affecting the interest of many developers on sustainable projects. From one perspective, this presumption is not baseless. From the interview, the respondents stated that sustainable practices do need a higher capital upfront due to the need for appointing environmental consultants, allocations for green rating assessment, importing new technology and materials and many others. An Environmental Impact Assessment (EIA) report is quite costly (RM30K+) which is why many developers are not willing or try to avoid it. Many developers are interested to pursue green certification such as Green Mark but the cost is at least 10% more of the project cost. One developer stated that environmental buildings are normally more expensive to construct. Based on their experience, it will cost around 40% higher than normal. The payback period is long. That is why their green building projects is usually high-end and expensive to ensure they still gain profit. The number of unit built is not massive to ensure that every unit built will completely sold.

For many developers though, increasing project cost to build low and medium class residential unit is seemed as economically non-viable. Furthermore, the price of low cost housing is controlled by the government. In cases where the building is constructed for the developer's or individual client's usage such as offices and business centre, respondents from the interview stated that the developers are willing to invest on the higher capital associated with sustainable building because they are aware of the benefits they can reap in the long term such as low maintenance and energy cost. This, however, is applied to large developers who have reputation to uphold.

f) *Target Buyers*

Each project is planned and designed to comply with its target buyers' affordability, interest, expectation and needs. For those developers who targeted for high income earners and foreigners, either resided or interested to invest in Malaysian property under Malaysia My Second Home (MM2H) Programme, the branding of sustainable homes or green homes is a major selling point as it portrays a higher quality or style of living. As such, the property constructed is sellable at premium prices, which well surpassed the amount of upfront capital.

However, many local developers are dealing with local buyers from low, medium-low, medium-high income earners. The priority is to provide affordable houses that complies the minimum standard of government regulation. Additional features that enhance home comfort and quality will increase the house price range. Some element of sustainability such as more green spaces, solar panels etc. is being embedded in the design for medium-high housing projects. The larger population of Malaysia however, fall under medium to low income earners, who are content with the modest style of living.

g) *Passive Culture*

Many developers tend to wait for others do instigate changes in the industry. Even if they have knowledge, not many want to implement it unless specified by their client, or required by government. The action for sustainable concept is business driven for some of large developers but for those who are not striving for it, the market is still lucrative. The respondents stated that sustainable concept lacks 'urgency' in this industry as it was not demanded by most buyers and it was not regulated by law. Some of the respondents believed that the role of 'promoting' and 'encouraging' sustainable practices lies on everyone shoulders. For example, if consultants can come up with a good design within the project budget that can sustain the environment and give good business return, then the developers will be inclined to accept the proposal. If government impose regulation on environmental aspects in for planning approval, for example, then the developers have to comply. The wait-

and-see and pointing fingers among construction players would tardy the progress of sustainable application.

4.2.2.2 External Challenges

External challenges refer to challenges beyond the direct control of the developers' organisation that impose certain restrictions or limitations towards the development of sustainable implementation for the industry. The challenges are local authority and government involvement, public interest and buyers' demand, availability of green materials, status quo in rules and regulation and learning and time factor.

a) *Local Authority and Government Involvement*

A total of 50% respondents believed that local authorities and government have the highest influence over reducing environmental impact from construction project. The government is the regulator, controller or the monitor of overall project performance because they are the ones imposing the law and requirement that must be followed by all construction practitioners. A strict enforcement will ensure that the developers and contractors will not take things for granted. The system of environmental protection in Malaysia is in the form of Environmental Impact Assessment and it monitoring. The system is rigorous and if abide, would reduce the environmental impact from construction activities. However, the enforcement and monitoring is weak allowing some developers to circumvent the law. Generally, the respondents agreed that the lack of enforcement and monitoring of law and legislation is one of the problems of sustainable construction and believed that the government can play bigger role in promoting sustainable construction.

Presently, the government is slow in promoting sustainable concept in their projects. As the biggest client of the industry, the government actions on sustainable concept will trigger other parties such as private developers, consultants and contractors to follow this footstep especially for those who are interested on tendering for the government project. Competition is created and market trend is shifted. Slowly, everyone will accept the new standard raised by the government. The government can encourage developers to involve in sustainable practices by providing incentives, tax deduction or rebates for developers who have performed more than the minimum standard set by the regulation, especially when it come to the issues of environmental and social improvement. For example, for every development, the developers have to pay for service improvement fund. It is normally 1% of revenue of the development. This money is for future improvement of services. Perhaps the local authority can reduce this fee if the developers provide something which is more than the required level (20% green space instead of 10% etc.) or can waive it if the developers has done a good job in the environmental issue (such as obtain green certification from Green Mark or LEED). If the developers don't do it, then they have to pay the fund. Performing more than the requirement means more money, thus, by proving the incentive or waiver of charges, the developers would be more interest to grab this opportunity as it will no longer seen as a burden but an opportunity. Presently, there is incentive provided by the government for the use of specific materials such as BIPV (Building Integrated Photovoltaic) but not for any other sustainable initiatives.

b) *Public Interest and Buyers Demand*

According to the respondents, the issue of sustainability is not in their priority list as it lacks publicity and interest of the potential buyers. Thus, they do not feel the 'urgency' for it. The interest on sustainability is also affected by market trend. Many developers are not willing to push the boundary especially when it means they have to shift the conventional way of construction and venture into a new realm of technology which may incur more upfront cost. However, to stay in the business, they would have to follow the market trend. If more buyers

are demanding green houses or if the market is lucrative where every unit built is sellable, then, more developers will join in by producing more and better houses.

c) *Availability of Green Materials*

One of the elements that make sustainable buildings expensive is the products or materials used for it. Presently, developers have to import green products. Cost will significantly reduce if the products can be obtained locally. The respondents believed that until such products are made available locally and at cheaper price, the progress of sustainable practice will be slow. According to the respondents, the Ministry of Works has imposed ISO 9000, which is for product's quality assurance, but they have not imposed environmental certification such as ISO 14000. Local manufacturers need to be pushed into producing green products to cater for local demand and with the government enforcement on environmental certification more green products can be produced.

d) *Status Quo in Rules and Regulations*

For most developers, they would comply with the existing standard as required by law and only small number of firms has the interest and capability to go beyond the minimum standard. Without new or upgraded regulations, the situation would likely remain the same. It depends on how fast the government can change and improve their regulation and enforcement. If the government raise the current standard, the developers for example, will have to raise their standard to meet the requirement to avoid facing legal actions or fines. For most developers, they will abide by the minimum standard of requirement set by the government to ensure their unit can be bought and occupied.

e) *Learning Period*

A decade ago, environmental issue was not pertinent and was not given a priority in education. The respondents stated that developers are still trying to balance the three pillars within their means. It is hard to break from their norm in practice. The younger generation, however, have been exposed about sustainable construction in their higher education level but, due to their lack of experience in the real world, they have problem disseminating their theoretical understanding of sustainability knowledge into practice. There are a few companies that have started to apply some of the sustainable principles in their projects or planning for green rating system. They would have to wait for 2 to 3 years to assess the benefits they gain from this practice. Once they are satisfied with it, then more projects will follow. Learning from experience usually takes time.

4.2.3 MOVING FORWARD IN SUSTAINABLE HOUSING

Time is needed to overcome these challenges. Most of the respondents (80%) believed the changes for sustainable housing will slow to take place. Planting effort to push sustainable housing now is crucial but the benefit can only be reaped after several years. Seminars and conferences are being organized to improve the knowledge of construction players on sustainable construction. Media is also participating in improving the public awareness on environmental protection and social participation. Various construction-related courses offered by local universities and college are playing their part by including sustainable aspects as part of the subjects, so that future generation of builders would have the basic knowledge on sustainability. Learning from experience will also takes time because usually, the duration fro completion of one construction project is between 2 to 3 years. Time is also needed to revise any rules and regulations and then, to enforce the new upgraded regulations. Public interest on environmental impact is growing and sooner or later, this interest will become an expectation and demand. Greater demand for sustainable projects will encourage more developers to pursue it. Local manufacturers' interests on green products will emerge as there is market for it. The respondents

believed that when green products are made available locally, sustainable houses can be built at lower price as compared to present price.

5. CONCLUSION AND RECOMMENDATION

The construction sector is not only to deliver buildings and infrastructures, but to look beyond on opportunities that can reduce the usage of resources and energy, minimise pollution and waste, and enhance economic efficiency and social objectives. It is time for industry players to think in different dimensions, rather than just on construction costs and immediate profit. The initiatives by the government and many others for more sustainable practices are bearing fruits as several large developers are beginning to implement this concept in their construction projects. Nevertheless, the acceptance of sustainability concept is not industry-wide as many developers are still reserving themselves. Several challenges that are impeding a faster progress in sustainability agenda have been identified. The internal challenges are: awareness and knowledge of developers; size of developers' organisation; interest, direction and commitment of top management; associating sustainable concept with luxury living; cost and economic viability; target buyers; and passive culture. The external challenges are: local authority and government involvement; public interest and buyers demand; availability of green materials; status quo in rules and regulations; and learning period.

Several recommendations, forwarded to speed up the acceptance level, are discussed below:

- a) The seminars, conferences, workshops that have been organized previously managed to attract some of local developers to produce sustainable buildings. This effort should continue and perhaps, redoubled to have a wider impact.
- b) Research is recommended to assist developers and consultants in incorporating sustainable issues at project conceptual stage and planning stage. Researchers from local universities should collaborate with the industry players to introduce sustainable or environmental guidelines, tools or technique that is workable in the industry.
- c) Present standard, rules and regulations enforced by the government and local authorities should be revisited and revised accordingly to incorporate sustainable needs.
- d) Developers viewed sustainable construction as a way for environmental protection and not many relate this concept with social wellbeing and even less relate this with economic factor. This could be the major problem in pushing this concept and practices among developers as developers are profit driven. To bring this concept to the forefront of the project initiation, sustainable construction must be projected as good business case which has many tangible and intangibles benefits. A research that highlights the economic benefits arising from being responsible to environment and society would provide evidence to persuade developers to accept this way of construction.

Last but not least, developers' actions are influenced by the market situation and demand. Raising buyers demand for sustainable houses will push the housing developers to improve the specification of their houses which include certain sustainable elements to attract buyers.

6. ACKNOWLEDGEMENT

The author acknowledges the financial support provided by the Science University of Malaysia (USM) in Penang, Malaysia for this research.

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Advancement of Built Environment Higher Education through Lifelong Learning

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ABSTRACT

The mismatch between graduate skills and labour market requirements has been identified as one of the main factors behind graduate unemployment and employer dissatisfaction, particularly in the Built Environment sector, as reported by EU labour force survey 2008. This paper presents the initial conceptual ideas of a research project titled Built Environment Lifelong Learning Challenging University Responses to Vocational Education. This research projects aims to modernise the Higher Education Institutions to be more responsive to construction labour market skills needs. To achieve this aim, lifelong learning concept will be incorporated within the Higher Education system where focus will be given on Built Environment programmes. The overall research methodology and the research techniques adopted are outlined in this paper. It also shares an initial literature review in the area of skills and employability and discusses the role of HEIs in lifelong learning.

Keywords: Built Environment, Higher Education reform, Labour market skills, Lifelong Learning

1. BACKGROUND TO THE RESEARCH

Construction is a vital sector for any economy as it contributes to economic growth and employment. The UK construction industry has changed significantly over the past decade with new forms of procurement, partnering arrangements, increased use of design and build with more integration between design and production, more specialisation and a new culture of health and safety (Gurjao, 2008). If this situation continues, the industry can expect a collaborative environment in construction, reducing the fragmented nature in the long run. Increased need for labour and the dynamic nature of the construction industry demand a workforce which meets the industry's requirements both in terms of numbers and skills. However, the industry is suffering from severe skills shortages, resulting in a threat to the healthy production of construction output, and in turn, its business performance. The current economic condition makes the situation even worse in terms of recruiting more skilled workers to meet the increased demand. The shortage of people, with the technical and managerial skills, to fully utilise the new technologies has been a problem for many years in the construction industry (Egan, 1998; Whittock, 2002; Construction Skills, 2007). The results of a new skills survey conducted by the Chartered Institute of Building (CIOB, 2008) show that skilled trades and crafts people, and those with senior and middle management experience are in great demand within the construction industry. The trade level skill shortages have been identified in bricklaying, carpentry

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and joinery, electrical installation, plumbing, pipe fitting and roofing (Dainty *et. al.*, 2005). The CIOB (2008) survey found that the demand for middle and senior managers is an on-going and increasing problem within the industry. This skill and labour shortage can be a threat to the long-term growth of the industry and it may also challenge the industry's capability to deliver the projects on time, within the budget and of the desired quality.

The industry also faces recruitment problems with its traditional source of labour – young men aged 16-19 (Gurjao, 2008). Construction employers recruit and rely increasingly on workers from overseas, either inside or outside the European Economic Area, giving rise to immigration issues with an increasingly diverse force (Gurjao, 2006). However, a survey by CIOB (2008) revealed that migrant workers are not very common as senior and middle managers in UK construction. Even if migrant workers hold managerial skills they are often not recruited due to their poor English language competence (CIOB, 2008). This leaves the industry to focus more on skills enhancement for the people who are already in the industry.

In this context, the Higher Education Institutions (HEIs) as one of the major suppliers of the professionals to the construction labour market could contribute to enhance the existing skills levels in the industry through training and re-training initiatives, while also ensuring that the level of employability of the fresh graduates from their institutions is high. This way, they could play a major role in meeting the skills requirements of the construction labour market.

However, in reality, there is a mismatch between graduate skills and labour market requirement. European Union (EU) labour force survey (OECD, 2008) reported that the mismatch between graduate skills and labour market requirements has been identified as one of the main factors behind graduate unemployment and employer dissatisfaction, particularly in the Built Environment sector. Most universities tend to offer the same courses to the same group of academically best-qualified young students and fail to open up to other types of learning and learners, e.g. retraining courses for graduates or gap courses for students. This has hindered the provision of training/retraining opportunities to increase skills and competency levels in the workforce and led to persistent mismatches between graduate qualifications and labour market skill needs. In order to overcome this persistent problem, university programmes should be structured to enhance directly the employability of graduates and training/retraining programmes which include broader employment-related skills along with more discipline specific skills.

In addressing this issue, this research considers 'student engagement' as a continuous through-life process rather than a temporary traditional engagement limited by the course duration. This through-life studentship defines the essence of the new innovative "Lifelong University" concept, whereby providing an opportunity for learners to acquire and develop skills and knowledge and enabling response to changing construction labour market needs on a continuous basis. In doing so, the role HEIs play in continuous improvement of the skills and knowledge among the construction professional is investigated.

This paper presents the conceptual ideas of the research undertaken followed by the overall research methodology adopted to carry out this project. It also analyses some initial literature on skills and employability, and discusses how the HEIs could play a role in advancement of the Built Environment education through Lifelong Learning.

2. THE CONCEPTUAL MODEL

A conceptual framework explains, either graphically or in narrative form, the main things to be studied – the key factors, constructs or variables – and the presumed relationships among them (Miles and Huberman, 1994: 18). Based on this definition, this section illustrates the initial conceptual framework as shown in Figure 1.

As shown in Figure 1, there are 2 major components identified within the labour market skills requirements. They are skills demand and skills supply. The demand is generally created by the labour market to which the HEIs are expected to respond as they are one of the major suppliers of skills and knowledge. But, the problem was identified within the process of capturing the skills requirements of the EU construction labour market and the process of appropriately responding to such requirements by HEIs. In order to address this problem, it is important to create a link between the capture and response by the HEIs. The HEIs have basically 3 components to deal with; they are Governance (G), Funding (F), and Curriculum (C) as identified in Figure 1. Nevertheless, the major focus of the research will be on governance reform where it aims to minimise the mismatch identified between the skills demand and the skills supply. In this regard, three major elements such as Capturing skills needs (Demand), Responding to the skills needs (Supply), and HEI Governance reform have been identified and included within the initial framework as shown in Figure 1. All the issues associated with these 3 elements will be analysed in order to address or minimise or resolve the identified problem.

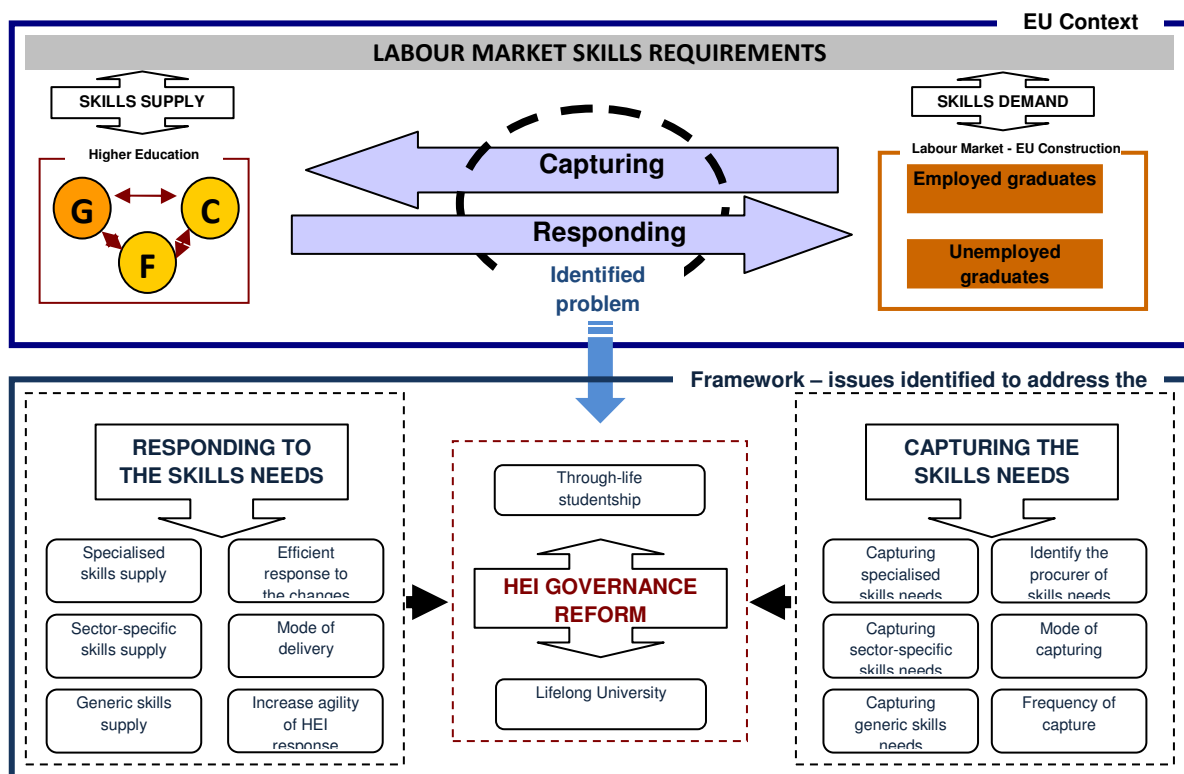


Figure 1: Conceptual Framework of the Research Project (BELLCURVE)

The next section explains briefly the overall research methodology, the research techniques in particular, adapted to this research.

3. RESEARCH METHODOLOGY

Research methodology refers to the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data (Collis and Hussey, 2003; Remenyi *et al.*, 2003).

The Lifelong University is a concept of capturing the labour market needs from the field of built environment and conveying the necessary knowledge and the skills to respond to the captured needs. This is basically a two way process. In one hand, 'lifelong university' encourages graduates who are

either employed or unemployed to inform their university on labour market skill requirements. On the other hand this will provide the opportunity for HEIs to be appropriately responsive to provide the right mix of skills for the labour market through training and retraining programmes.

In order to make the HEIs as lifelong universities, they need to be modernised as the current system of HEIs in terms of its governance, funding and curriculum are not flexible enough to respond quickly and effectively to the dynamic nature of the labour market. Thus the focus was given on Higher Education reform.

This will be achieved through developing a framework, as identified in Figure 1, to capture and respond to the skills requirement, giving particular attention to governance, funding and Built Environment curriculum. This process involves 3 phases as detailed below.

3.1. PHASE 1 – FRAMEWORK DEVELOPMENT

In order to provide the initial input for the framework, a thorough literature analysis will be conducted. This will help to identify the issues associated with the framework development. Further structured questionnaire and semi-structured interviews will also be used as part of primary data collection for the framework development. These research techniques including the literature analysis are used in order to understand the current state of art in labour market requirements in the field of Built Environment and to understand the system of Higher Education Institutions in terms of its governance, funding and curriculum. Further, the barriers and challenges faced by the HEIs in efficiently capturing from and responding to the labour market needs will also be analysed. The target audience for data collection will mainly include the Built Environment undergraduates and graduates from HEIs; employers of construction labour market; recruitment agencies; members from top management team of HEIs.

3.2. PHASE 2 – FRAMEWORK REFINEMENT

The developed framework will then be refined based on expert interviews and focus group. The purpose of this phase is to ensure that the developed framework captures all the important components associated with the identified research problem. The framework will be given to experts who are part of top management structure of HEIs; company CEOs; and policy makers who influence the decisions related to HEIs. The data analysis of expert interviews and focus group will help to refine the initial framework. This will in turn identify the ways to reform the governance structure of HEIs in order to make them more responsive to labour market needs.

3.3. PHASE 3 – FRAMEWORK VALIDATION

Once the framework is developed and refined, then it needs to be validated for its practicality. A case study strategy has been chosen to achieve this purpose. At least 3 case studies will be conducted from 3 different EU countries. UK, Lithuania and Estonia, who are the official countries involved in this research project, have been identified to carryout the case studies. Existing Built Environment programmes provided by the HEIs from each of the above countries will be included in the case studies. Any specific labour market needs will also be identified in order to validate the refined framework. Further, views of the policy makers and University authorities of all the countries involved will be obtained for the validation process.

As a contribution of the research carried out in all 3 phases, recommendations will be provided on governance reform for HEIs to become continuing education centres for graduates while responding to labour market skills needs. These will be in the form of best practice guidelines and policy documents which will finally be disseminated to the stakeholders of the EU HEIs and construction labour market. This will ultimately lead the HEIs to provide lifelong learning to the graduates and in turn to become lifelong universities.

The next section provides an initial literature review on skills and employability, where the changing nature of the skills requirement and the methods available to improve the existing level of skills are discussed.

4. SKILLS AND EMPLOYABILITY

The term 'Employability' has been defined in various ways. A review of the literature suggests that employability is about work and the ability to be employed (Hillage & Pollard, 1998). This includes the ability to gain initial employment; the ability to maintain employment and made 'transitions' between jobs and roles within the same organisation to meet new job requirements; and the ability to obtain new employment if required. According to Centre for Employability, University of Central Lancashire, it has been defined as "A set of skills, knowledge and personal attributes that make an individual more likely to secure and be successful in their chosen occupation(s) to the benefit of themselves, the workforce, the community and the economy" (Dacre Pool and Sewell, 2007).

The employers seek individuals with specific and generic skills for employment. The specific skills are the skills specific to the job performed. To give few, for example, are structural engineering, carpentry, estimating, etc. The generic skills are not specific to any particular job, but they are essential to perform effectively and efficiently any kind of job. To give few, as example, are team working, communication, customer focus, leadership, problem solving, reflection, report writing, etc. Therefore it is important to increase the supply of employable individuals to the labour market by ensuring that the HEIs place greater emphasis on the respective employability skills that employees are expected to have in the respective sectors.

Employability skills are those basic skills and capabilities required for getting, keeping and doing well on a job (Robinson, 2000). They complement the technical skills required for a specific job. UK commission for Employment and Skills (UKCES, 2008) has identified the employability skills under two categories as 'Personal skills' and 'Function skills'. The personal skills consist of self-management; thinking and solving problems; working together and communicating; and understanding the business, whereas the functional skills consist of using effectively the numbers, IT and language. The employers, when recruiting graduates, mainly look for a good degree; specific skills; generic or transferable skills; experience; and personal attribute (Gilleard, 2010). This shows that in addition to the academic achievement, one should be able to demonstrate a good level of skills and competencies to succeed in the employment in today's competitive world. Curtis & McKenzie (2001) have identified communication; problem solving; personal skills; numeracy; information technology and competence in a modern (foreign) language as core skills required for an employee in the United Kingdom. Further, USEM model developed by Knight and Yorke (2004) have identified four broad and inter-related components that influence employability. They are Understanding which is more than knowledge; Skilful practice which includes the deployment of skills, Efficacy beliefs including students' views of themselves and personal qualities; and Meta-cognition including student's self awareness regarding, and capacity to reflect on their learning.

Based on the aforementioned facts, it is evident that there is a strong connection between the skills and employability. The more skills and knowledge one will demonstrate the more chances available for him getting employed. Therefore it is important to focus on matching the skills requirements with the level of skills one possesses. As discussed within the background of the research, reducing or minimising the gap identified between the skills requirements and skills supply will help to increase the level of employability.

The next section focuses on the construction labour market and its skills needs.

4.1. THE CHANGING NATURE OF THE SKILLS REQUIREMENTS IN CONSTRUCTION

Construction labour market, due to its labour-intensive, multi-disciplinary and highly fragmented nature, relies highly on the skills and competencies of its workforce. As it involves workers with various disciplinary backgrounds, the industry uses a wide range of technical and managerial skills. For construction project leaders, decision-making, leadership, motivation and communication have been identified as most important skills, in addition to their technical skills (Odusami, 2002). The labour market requirements of the construction industry are of dynamic nature, changing from time to time, due to various factors. Some of the factors contributing to the construction labour market skills crisis and thus affecting the skills shortfalls have been identified (Dainty *et. al.*, 2005). They are demographic decline in the number of people entering the labour market; the changing and fluctuating nature of the market and the related decline in the operative skills; the introduction of the new technologies; the growth in self employment and the use of specialist and labour only sub contractors; the fragmentation of the industry; the decline in the training and related resources; the changes in the industrial structure, wastage rates and industrial competition; and considerable market expansion. In addition to above factors, the recent developments in the economic recession have made a reduction in the labour demand and vacancy levels for construction workers. The employers are thus trying to achieve the maximum utilisation with the minimum numbers of workers. This has resulted in the existing construction workers to concentrate more on acquiring or developing new skills in order to retain in the industry and to meet various skills demand. In relating to this, Dainty *et. al.*, (2005) has identified that the employers need the employees to be able to work in more than one trade area and this has created a need for multi skilled workers. It is, therefore, of utmost important to gain insight into the problems companies face with the level of skills of their own staff and how do they want such skills to be improved. Hence, possessing up-to-date skills and competencies has become a vital role in the construction sector.

The next section briefly presents the existing methods available to improve the skills levels of construction labour market. It further discusses what could HEIs do in meeting the skills requirements.

4.2. EXISTING METHODS TO IMPROVE THE SKILLS LEVELS OF CONSTRUCTION LABOUR MARKET

This section describes in brief few mechanisms such as new recruitment; skills improvement; skills utilisation; and lifelong learning, which currently exist to meet the skills requirements of the industry.

All the construction related jobs are included within the list of shortage of occupancy which is frequently researched and published by the UK Boarder Agency. This clearly shows the pertaining demand for the construction jobs and the difficulties of requirement within the domicile of UK workers. The construction industry increasingly relies on migrant workers. However, it faces difficulties as the recruitment of new staff in England has been severely affected by the economic downturn (CITB Construction Skills, 2009).

The present conditions challenge the employees to possess and be able to demonstrate a range of skills in order for them to retain in their jobs. It demands the employees to improve their skills and acquire new skills. Further, the changing nature of the labour market and introduction of new technologies have also led the employees with no option but to enhance their skills. This can be achieved through training and development activities. There are basically two types of training such as on-the-job training and off-the-job training. The former helps employees to develop and improve their work skills whilst doing the job. This type of training includes demonstrations, instructions on how to perform the job effectively, learning by doing, etc. Employees are also encouraged to develop their skills through off-the-job training courses. These could include training from external professional or educational centres; undertake short courses, distance leaning or sandwich courses that are useful for their job; and self-learning. In this regard, Personal Development Planning (PDP) contributes to increase the level of employability. PDP is directly relevant to employability and it helps students to

translate their learning experiences into the language of employability. It also develops skills which could help students to sustain their employability (Ward, 2010).

Skills utilisation has been identified as another important factor which will contribute to meet the labour market requirements. One of the key gaps in the existing sources of labour market information is on the issue of how employers make use of the skills their employees possess (UKCES, 2010). Policy makers from across all four UK nations are now increasingly turning their attention to the issue of skill utilisation in the workplace and this is a development that is likely to exacerbate as there is a widening realisation that 'there is little value to an organisation having a skilled workforce if the skills are not used well' (UKCES, 2009: 11).

Further, the lifelong learning is an emerging concept of acquiring new skills throughout the life of an employee. The CITB Construction Skills (2009) has identified that more employers are supporting the lifelong learning and have begun to use associated products and toolkits. Little has been realised by the HEIs to adopt lifelong learning within their education system, despite the fact that lifelong learning is a core concept in modern education.

In this context, it is vital to explore the role of HEIs in the lifelong learning and how could they continuously support the construction workers, throughout their life time, through training and re-training programmes. This research will help HEIs to increase the duration of their student-engagement, which is presently limited to the course duration.

The next section explains the role of HEIs in lifelong learning.

5. THE ROLE OF HIGHER EDUCATION INSTITUTIONS IN LIFELONG LEARNING

Higher education around the world is growing faster. The universities are under pressure to change as they are expected to produce new knowledge which is to respond to student needs and to satisfy the practitioners (OECD, 2003). The Higher Education Funding Council for England (HEFCE) funded the Enhancing Student Employability Co-ordination Team (ESECT), which comprises key researchers; practitioners in the field; and representatives of stakeholder organisations, to help the sector engaging with the issue of the employability of graduates. As a body for knowledge creation and sharing, the HEIs are also responsible in enhancing the student employability. Developing employability skills entails experiential action-learning; work experience and opportunities for reflection and integration (Smith, 2010). Lack of such skills is one of the critics of the new graduates from HEIs. Re-engineering was also proposed as another method for the change in Higher Education based on a research conducted in Mexico (Mungaray-Lagarda, 2002). The author further argues that achieving substantial improvement in university affairs is impossible if change is limited to academic quality.

Educational institutions are improving their system to incorporate the concept of lifelong learning as they recognise that lifelong learning is a common importance for many countries both at national and international levels (Xiaozhou, 2001). A research carried out in China, identified few measures to make their universities function in lifelong learning. They include establishment of a lifelong learning mission in the running of a university; the regulation of profession and course system; practice of proper teaching methods for lifelong learning; development of recurrent education at various levels; taking full advantage of educational technology; establishment of lifelong learning regulation and system; internationalisation of promoting lifelong learning (Xiaozhou, 2001).

It is therefore vital to research how the HEIs can be modernised to incorporate the lifelong learning aspect within the system of education and how would this lead to uninterrupted supply of skills and knowledge to the construction labour market in an efficient and effective manner. Taking this aspect into consideration this research aims to reform higher education, giving particular focus on Built Environment programmes.

6. CONCLUSIONS AND WAY FORWARD

This paper is part of a research project which aims to promote the concept of ‘lifelong university’ in modernising Higher Education Institutions to be more responsive to labour market skills needs. The conceptual ideas of this research have been shared in this paper and accordingly this research intends to address the mismatch between the supply of skills by the HEIs and the demand created in the construction labour market. A framework to effectively capture and efficiently respond to the labour market skills will be developed through 3 phases called framework development, refinement and validation. Throughout these 3 phases various research techniques such as questionnaire, semi-structured interviews, expert interviews, and focus groups will be used. An initial analysis of the literature has been presented where it is evident that the skills one possesses have a direct link with the employability. It has also been realised that the HEIs has a vital role to play to increase the employability of their graduates and to continuously support them by providing training and re-training programme throughout the life-time of the students. This way, the student-engagement with the HEIs will be strengthened. As this research mainly focus on construction labour market, the programmes offered by the HEIs where the changes are required, will mainly fall under the broader discipline of Built Environment. Further, particular attention will be given to the governance system in the HEIs as the authors believe that the reform should take place in governance to make the HEIs more agile. As a way forward of this research, the existing system of HEIs across the EU will be studied to understand the system in terms of its governance, funding and curriculum. The barriers associated with the quick respond will also be identified and action will be taken to minimise or eliminate such barriers. Finally this research project will provide recommendations to reform higher education to advance the built environment both in terms of educational and practical perspectives.

7. ACKNOWLEDGEMENT

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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Sustainable Benefits in Application of Lean in Prefabrication Production Process

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ABSTRACT

Prefabrication is recognised as an appropriate solution to overcome several problems in construction such as low productivity, high waste production, inferior working conditions and insufficient quality. Even though prefabrication offers many benefits, significant number of inefficiencies could be identified from its production process. Lean Production Principles are recognised as a paramount concept, which enables to address such production process related inefficiencies. This study aims to investigate how application of Lean principles help to mitigate inefficiencies in Prefabrication Production Process (PrefabPP) and thereby learn how such an application leads to sustainability. Observations and semi-structured interviews were conducted to collect data within selected three case studies in Sri Lanka (prefabrication production yards) targeting executive level professionals who engaged in 'prefabrication bridge beam production process.' The collected data were analysed using code-based content analysis and mapped using tables and matrices. Findings revealed several inefficiency issues in PrefabPP which were highly severe, moderately severe and less severe. The study revealed that by adopting lean principles into PrefabPP that it will offer several key benefits to PrefabPP and its customers. Moreover, the results indicated that the application of Lean Production Principles to PrefabPP offers long-term benefits to construction by contributing towards sustainability. Thereby study offers some useful implications to prefabrication companies, construction professionals, researches and those who deal with sustainability issues.

Keywords: *Prefabrication Production Process, Lean Production Principles, Sustainability, Sri Lanka*

1. INTRODUCTION

The construction industry is generally labour - incentive with several wet-trade activities. Hence, it suffers from several drawbacks such as lengthier construction duration, cost overruns, low quality, poor safety records (Chan and Ma, 1998) and environmental impacts. Further, clients' expectations have grown up on aspects leading to 'maximum value and minimum waste' (Luo *et al.*, 2005). Prefabrication has been viewed for a long time as one direction of progress to meet this challenge by providing solutions for above-mentioned problems in construction (Koskela, 1993).

Prefabrication offers several benefits such as reduce waste generation; improve site safety; enhancing quality under factory production; encourage recycling construction waste; leading to environmental protection; process standardization; shorten lead time; and, sustainability (Hendricks and Pietersen, 2000; Luo *et al.*, 2005; Tam *et al.*, 2007). Despite the benefits of off-site construction, as any factory production, prefabrication relies on extensive use of mechanisation and automation in the manufacturing settings (Pheng and Chuan, 2000), which could lead to other type of wastes such as; overproduction, waiting time, transportation, too much machines (over processing), inventories, moving, making defective parts and products (Imai, 1997; Shingo, 1984; Walton, 1999). Further,

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Prefabrication Production Process comprises of demerits, such as high initial cost; lack of variety in design; usage of advanced technology; requirement of well- trained people; need of comprehensive quality control techniques; and, need of more efficient testing (Pheng and Chuan, 2000). Thus, adoption of appropriate techniques or mechanisms to overcome the persistent problems in Prefabrication Production Process becomes vital.

Lean Production is regarded as an approach that avoid waste of time, money and equipment (Shingo, 1992). Hence, it should formulate conversion activities (which adds value to outputs) more efficient and reduce or eliminate non-value adding flow activities such as inspection, waiting and moving (Koskela, 1993). Previous research confirm that the adaptation of lean principles facilitate manufacturing through increasing productivity, reduction of manufacturing space, improving quality and safety, reducing the lead time, reduce human effort, reduce investments in tools, reduce engineering hours to develop a new product and ultimately increasing of sustainability values (Koskela, 1992). Thus, it is argued that many problems persistent with Prefabrication Production Process can be solved or reduced by adopting lean principles. Hence, adoption of Lean Production Principles to address the issues in Prefabrication Production Process in the construction industry needs a thorough investigation in order to gain advantages/ improvements achieved by the manufacturing industry to the construction industry and ultimately towards sustainability. The next section explains the research issues related to this aspect through a literature review.

2. KEY LITERATURE FINDINGS

2.1. RESEARCH ISSUES ON PREFABRICATION

Prefabrication in construction is defined in different ways by different authors. However, some of the definitions are narrowed in explanations, yet in line with general definitions. For instance, Tatum (1986) defines prefabrication as “the transferring stage of construction activities from field to an off-site production facility.” A more detailed definition given by Bjornfot and Sarden (2008, p.266), is, “prefabrication is making of construction components at a place different from the point of final assembly, may lead to better control of the inherent complexity within the construction process.” On the other hand, Chiang *et al.* (2006) define prefabrication as “manufacturing and pre-assembly process, generally taking place at a specialized facility, in which various materials are joined to form a component part of the final installation.” Thus, a working definition can be put forward incorporating key attributes of aforementioned definitions as, “Prefabrication is a manufacturing and pre-assembly process, whereby, construction components are made at a location different from the place of final assembly, under specialized facilities joining various materials, may lead to better control of the inherent complexity within the construction process.”

Unique features of prefabrication include centralization of production, mass production, standardization, specialization, effective organization, integration, repetition, lightweight components, factory production (Pheng and Chuan, 2000; Tam *et al.*, 2007). These unique features facilitate effective construction techniques in terms of quality, time, cost, function, productivity, safety, waste minimization and sustainability. Further, it offers benefits such as saving site space; on-site less labour-intensive operations; and, opportunities for good architecture. Features of prefabrication on sustainable construction includes: increase potential of improved supply chain integration of green materials; safer working conditions; easier recycle of materials in an off-site environment; enhance flexibility and adoptability; reduced overall life cycle cost; reduced environment impact; and, reduced economic impact (Bae and Kim, 2007).

While these merits of prefabrication confirm its appropriateness, identification of the associated demerits demand possible improvements to enhance the soundness of the prefabrication technique for building construction. A number of studies (Luo *et al.*, 2005; Tam *et al.*, 2006; Tam *et al.*, 2007; Waskett, 2001; Wong, 2000) identify key issues in prefabrication as; higher initial construction cost;

time consuming for design, construction planning, procurements and approval procedures; use of extensive mechanisation and automation leads to significant waste; overproduction, waiting time, transportation, over processing, inventories, moving, making defective parts or products; lack of variety in design; high technology usage; required well trained people; issues related to site; high quality control techniques; more efficient testing. Further, Waskett (2001) identified barriers to apply prefabrication in construction industry such as general image; perceived performance; customer expectations; perceived value; industry culture; and product awareness. These demerits and barriers should be reduced or eliminated to reap the optimal benefits from prefabrication. Thus, this study argues that 'Lean Production' - an application in manufacturing settings can be applied as a potential way to improve and overcome the above-mentioned issues in PrefabPP.

2.2. RESEARCH ISSUES ON LEAN PRODUCTION

Both the flow and conversion activities are considered in 'Lean Production.' Koskela (1992) mentioned that, production is a flow of material and/or information, which transfers raw material to an end product. In this flow, the material is processed (converted), inspected or kept waiting or moving. Conversion aspect of production is represented by 'processing' and flow aspect is represented by 'inspecting', 'moving' and 'waiting'. The inefficiency of conversion activities creates rework and scrap. The key attributes of the flow processes of production can be identified as time, cost and value. Here, value refers to the fulfilment of customer requirements. While all activities expend cost and consume time, only conversion activities add value to the material or piece of information being transformed to a product. Thus, the lean concept urges, making conversion activities more efficient, while reducing or eliminating non-value adding activities as its primary focus (Koskela, 1993). Hence, for the overall efficiency of a production process while delivering a project, there should be an ongoing effort, which maximizes the value and minimizes waste.

Lean Production brings significant benefits to an organisation. For example, Schmenner (1988) reports that all possible techniques for improving productivity are only those related to the new production philosophy and demonstrated as effective in manufacturing industry. Similarly, according to the study of Womack *et al.* (1990), Lean car production can be characterized as a production which uses lesser of everything compared to mass production: half the human effort in the factory, half the manufacturing space, half the investments in tools, half the engineering hours to develop a new product in half the time. Moreover Stalk and Hout (1989) discovered that Japanese companies have doubled their typical factory productivity rates over a five year period, as a result of implementing the new principles. According to Harmon and Peterson (1990) Lean Production typically targets a reduction of manufacturing space by 50 %. Hence, the application of Lean Production Principles in any production process offer benefits such as improved productivity, reduced wastage, reduced working space requirements, reduced human effort, lesser production time, increased quality and safety, shorter lead time and more sustainability.

In particular, lean can contribute to sustainability, but only if and when the customer values sustainability (Bae and Kim, 2007). According to Huovila and Koskela (1998), there are two major contributions of lean construction to sustainable development: eliminating waste and adding value to the customer, mainly related to materials. Sustainability not only aims of adding value while minimising waste; but it also means 'triple bottom lines' economic, social and environment sustainability. Hence, some researches focused on corporative benefits in economic, social and environment perspective of Lean Philosophy (Hawken *et al.*, 1999). According to the research finding of Bae and Kim (2007), Lean Philosophy provides a concrete basis for economic, social and environmental perspectives in sustainable construction by adopting project delivery process of green facilities. Ballard (2000) identifies prefabrication as a better option, which facilitates 'Lean Assembly' as one of the best procurement methods for sustainable construction. Hence, it is argued that adoption of lean principles in PrefabPP leads to sustainable benefits, through addressing inefficiency issues

prevailing in the prefabrication process in the construction industry. The next section explains the research method adopted in this study.

3. RESEARCH METHOD

Case study method was selected for the empirical study, since this research needed to be conducted by studying real-life production processes. Prefabrication companies and their yards were selected as unit of analysis and three (3) PCBBPPs in Sri Lanka were selected for data collection, based on the popularity, demand and wide coverage of the activities in PrefabPP.

The brief description of case study samples as in Table 1.

Table 1: Brief description about the selected cases

Precast Concrete	Yard A					Yard B					Yard C					
Company type	<i>Private</i>					<i>Semi government</i>					<i>Semi government</i>					
Experience	20 years					47 years					59 years					
Details of interviews conducted	Interviewees	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
	Profession	Quantity Surveyor	Store keeper	Batching plant supervisor	Civil Engineer	Manager	Accounts clerk	Store keeper	Civil Engineer	Civil Engineer	Manager	Quantity Surveyor	Store keeper	Civil Engineer	Civil Engineer	Manager
	Experience (Yrs)	18	3	8	4	12	7	16	3	3	12	5	30	3	4	10
	Process Section	Estimating	Store keeping	Concrete batching	Casting	Overall process	Estimating	Store keeping	Concrete batching	Casting	Overall process	Estimating	Store keeping	Concrete batching	Casting	Overall process
	Duration hrs	1 1/2	1 1/2	2	1 1/2	2 1/2	1 1/2	1 1/2	2	1 1/2	2 1/2	1 1/2	1 1/2	2	1 1/2	2 1/2
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Observations and semi-structured interviews were undertaken to collect data using triangulation logic as data collection tools targeting executive level professionals who engaged in PCBBPP. Accordingly, executive staff of prefabrication production yards in the capacities of Production Engineers, Civil Engineers, Quantity Surveyors, Batching Plant Operators and Store Keepers, who are supposed to be well experienced with the PrefabPP, formed the 15-member Interviewee panel (i.e. 5 members from each case).

Data were collected to identify the production process; evaluate production processes related issues; identify effect of lean application and its sustainable benefits. In addition, interviews identified the perception of interviewees regarding application of lean principles as mean of mitigating issues prevailing with the PrefabPP. Code based content analysis was used to analyse data. Since, content analysis support to capture important concepts from the transcripts and for effective interpretation of

those. The NVivo computer software was used in this study to simplify the clerical works relating to content analysis. The next section presents the key findings of this study.

4. RESEARCH FINDINGS

4.1. CURRENT ISSUES IN PREFABPP

The case studies identified several key issues in PrefabPP. These key issues were categorised into three sets as highly severe, moderately severe and less severe based on case study findings. See Table 2 for a summary of key findings related to PrefabPP issues.

Most of the identified issues are controllable and can be mitigated by adoption of proper strategies. This is necessary in order to reap the maximum benefits from prefabrication and its production process. Thus, the next attempt was made to identify the benefits of application of ‘Lean Production Principles’ in PrefabPP as a potential way to overcome the above-mentioned issues.

Table 2: Current issues in PrefabPP

<i>Issues</i>	<i>Severity</i>	<i>Case study findings</i>
<i>Waiting time</i>	<i>High</i>	<i>Poor planning and programming of work, inefficient management controlling, breakdown of machineries, delay issuing of materials, weather conditions, delay approvals, late material purchasing</i>
<i>Quality controlling</i>	<i>High</i>	<i>Huge costly component quality check must, minimise errors, quality of shutter work highly affect, concrete grade, stressing of reinforcement, curing, strength of component</i>
<i>Testing</i>	<i>High</i>	<i>Concrete, material testing, testing of final product, to assure the quality of product</i>
<i>Store keeping</i>	<i>High</i>	<i>Timely issuing of materials and equipments, maintaining competitiveness</i>
<i>Inventories</i>	<i>High</i>	<i>Future references, audits</i>
<i>Standardization, mass production</i>	<i>High</i>	<i>Standardize production, but mass scale not involve</i>
<i>Variety in design</i>	<i>High</i>	<i>Cross sectional shape generally flat or I shape, only vary from span</i>
<i>Usage technology</i>	<i>High</i>	<i>New materials (ex: admixtures), plant and machineries, production techniques and management techniques</i>
<i>Well trained people</i>	<i>High</i>	<i>Highly skill labours required</i>
<i>Labour, plant and machinery</i>	<i>High</i>	<i>High plant and machineries involvement and labour incentive</i>
<i>Production time</i>	<i>Medium</i>	<i>Curing time, effectiveness and efficiency of labour force, limited number of shutters, limited numbers of beds, large heavy component</i>
<i>Production cost</i>	<i>Medium</i>	<i>Depend on length of beam, concrete grade, labour involvement, material usage</i>
<i>Moving</i>	<i>Medium</i>	<i>Materials, components, plant , machineries and labour moving, long distance between stores, casting yard</i>
<i>Transportation</i>	<i>Medium</i>	<i>Transportation of materials</i>

<i>Issues</i>	<i>Severity</i>	<i>Case study findings</i>
<i>Initial cost</i>	<i>Low</i>	<i>Fabricate moulds, construct precast beds, buy machineries, batching plant, get approval from authorities, land, buildings</i>
<i>Defective products</i>	<i>Low</i>	<i>Improper compaction, less quality of concrete, errors in shutters</i>
<i>Sound and dust</i>	<i>Low</i>	<i>Sound of machineries, cement dust, dust due to movement of machines, dust while cleaning shutters and beds</i>
<i>Productivity, efficiency</i>	<i>Low</i>	<i>Sufficient productivity, can cater the demand</i>
<i>Safety</i>	<i>Low</i>	<i>Maintain safety at site well</i>
<i>Environmental effects</i>	<i>Low</i>	<i>Very less</i>
<i>Over processing</i>	<i>N/A</i>	<i>Huge cost, only produce ordered quantity</i>
<i>Over production</i>	<i>N/A</i>	<i>Huge cost, unless sales huge loss</i>

4.2. KEY BENEFITS

Study identified that by applying Lean Production Principles to PrefabPP several key benefits such as; increase productivity, increase quality, increase sustainable values, provide better value to the customer, reduce lead time, reduce manufacturing space, reduce wastage, reduce production cost, reduce production time and reduce the human effort. Table 3 explain the benefits of applying lean in PrefabPP with the reasons. Study found that lean application can offer these benefits, since it was basically focused on increasing the efficiency of value adding activities, elimination/minimisation of waste in unnecessary flow activities and ultimately focused to enhance customer value.

In addition to the above findings, interviewees mentioned that Lean Production Principles as a better option to achieve their company targets, provide better value to the customer with a reasonable cost at target time in a competitive market. While identifying its benefits, some interviewees mentioned some barriers to implement this application such as difficulties in changing attitudes of people’s and unawareness of workers about this concept. Hence, interviewees highlighted the need of an effort to develop and change people’s attitudes, management control and planning prior to applying this concept to reap benefits successfully. However, the significant findings was the belief of the interviewees that by ‘minimizing wasteful flow activities and maximizing the efficiency of conversion activities (i.e. application of Lean Production Principles) most of the current issues in the PPP could be overcome.

Table 3: Benefits of applying lean in PrefabPP

Benefit	Reasons
Increase productivity	Eliminating unnecessary flow activities and increasing the efficiency of value adding activities, directly affect to productivity
Increase quality	Enhancing key activities lead to increase the quality of product. Proper planning and management controlling important which reduces defects and errors
Increase safety	Reduction of unnecessary activities enhance safety

Benefit	Reasons
Increase sustainable values	Highly affect the sustainability, since lean directly focused to reduce unnecessary wastages
Provide better value to customer	Provide better value to the customer at less cost and shorter time
Reduce lead time	Reduce waste in flow activities such as waiting, moving, inspection etc. Proper planning techniques minimised idle time
Reduce manufacturing space	Reduction of unnecessary storage and unnecessary activities save site space
Reduce production cost	Production cost can be automatically reduced by eliminating non value adding wasteful activities
Reduce production time	Eliminating non value adding unnecessary activities from the total process, the process itself became shorter, thus it save production time
Reduce the human effort	Elimination of unnecessary activities is shortening the process. Hence, directly influences to reduce human effort
Reduce wastage	Lean directly contributes to reduce unnecessary wastages

4.3. SUSTAINABLE EFFECTS

Prefabrication itself comprises with sustainable features. When adopting lean principles in PrefabPP, it must be more towards sustainability, since the lean concept focuses to reduce unnecessary wastages and urges several benefits. These sustainable effects are presented under the triple bottom lines; economic, environment and social sustainability.

First, in terms of economic sustainability, features such as reduce production cost, provide better value to customer, reduce production time, increase productivity, reduce lead time and increase quality of product and productivity can be identified as economic sustainable features which facilitates through application of Lean in PrefabPP. Interestingly, application of Lean Production Principles to PrefabPP provides better value for money spent which is a clear economic sustainability feature.

Second, in terms of environmental sustainability, features such as reduce wastages and reduce manufacturing space, are directly connected with the environment sustainability. Since lean application eliminates unnecessary wasteful activities from the production process it reduces material, time and labour wastages. Utilize resource only at the required level.

Third, in terms of social sustainability, features such as increase safety, reduce human effort, reduce working hours and increase skills of labour can be identified as social sustainability features.

Having identified the sustainable benefits of applying lean principles in prefabrication, the sustainability effects of application of lean in PrefabPP was modelled as given in Figure 1.

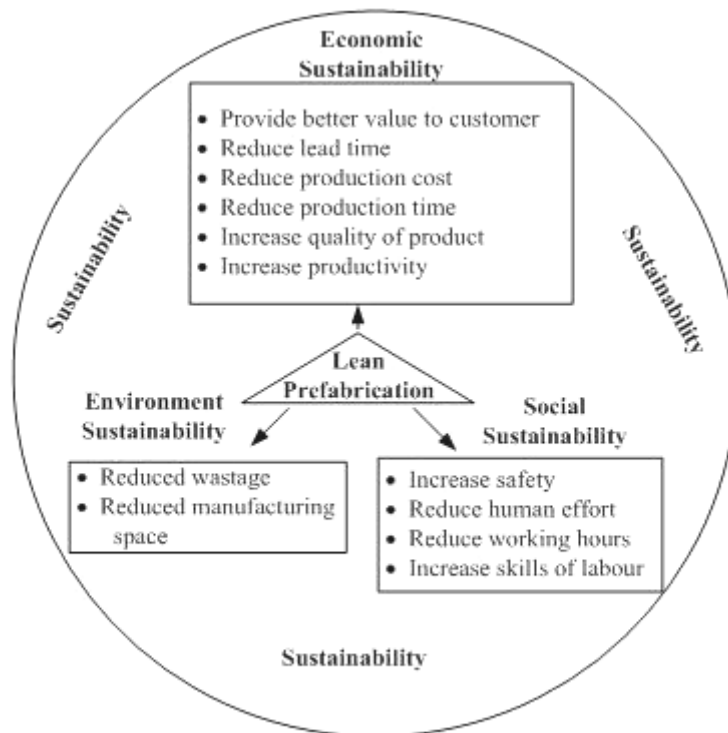


Figure 1: Sustainability effects of application of lean in PrefabPP

The conclusions of the study are offered in the next section.

5. CONCLUSIONS

The research has investigated PrefabPP related inefficiencies; issues and how lean concept can mitigate these issues while enhancing the efficiency of PrefabPP. The study identified many key issues related to PrefabPP, which need to be minimised in order to reap successful benefits from prefabrication. The case study participants agreed that the application of Lean Production Principles offer several key benefits to PrefabPP such as increase productivity, increase quality, increase sustainable values, provide better value to the customer, reduce lead time, reduce manufacturing space, reduce wastage, reduce production cost, reduce production time and reduce the human effort. Hence, case study findings were in line with the existing literature and confirmed that most of the PrefabPP related inefficiencies could be minimised through application of lean principles.

Furthermore, the study identified that application of Lean principles in Prefabrication contributes more towards sustainability by facilitating economics, environment and social sustainability goals. This ensures that it is a sustainable approach for construction industry.

Finally, the study found that the people attached to the production process are willing to adopt lean application in PrefabPP yards. Yet, production yards need several changes in terms of the proper implementation of lean principles such as top management commitment to the implementation, sufficient technical experts regarding the Lean Production; a quest for a culture of continuous improvement the company as well as at prefabrication yards, fullest dedication of workers towards the implementation; awareness of employees regarding lean principles, change people's attitudes and sufficient management expertise to induce the changes in the production flow process.

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Multidimensional Model for Contractor Selection in Private Sector Construction Projects

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ABSTRACT

One of the most difficult decisions taken by the client in this era of construction industry is selecting a most suitable contractor. Since the construction industry is characterized by cost and time overruns, serious quality issues, and an increased number of claims, performance of the selected contractor is highly influential on sustainable construction project. During this oscillating economic circumstance, the construction organizations need to evaluate business performance across a wider range of business success criteria. The aim of this study is therefore to introduce a multidimensional model for contractor selection in private sector construction projects.

Comprehensive literature survey was conducted to develop a conceptual Balanced Scorecard (BSC) model and preliminary survey with industry experts was used to refine the model. Questionnaire survey was then conducted among 30 qualified client/consultant Quantity Surveyors to find the relative importance of BSC criteria to Sri Lankan private sector construction projects. Data were analyzed and prioritized using Analytic Hierarchy Process (AHP) tool. The study revealed the importance of the modern perspectives such as innovation, learning and growth, rather than traditional organizational management and business relationship and reputation perspectives for the contractor selection. Moreover, perspectives like quality level of past projects and level of innovative construction concepts were also given high priority. The bid amount, which is a traditional financial measure, was given a moderate importance levels. This research therefore proposed a sustainable and multidimensional performance measurement criterion for contractor selection in Sri Lankan private sector construction projects.

Keywords: Contractor Selection, Multi-dimensional Model, Balanced Scorecard (BSC), Analytic Hierarchy Process (AHP)

1. CONTRACTOR SELECTION MODELS

Many researchers have proposed different criteria and models using multi-criteria utility theory (Hatush and Skitmore, 1998), analytic hierarchy process (Fong and Choi, 2000), fuzzy decision framework (Singh and Tiong, 2005), multiple criteria evaluation (Topcu, 2004 and Zavadskas and Vilutiene, 2006) for contractor selection. However, these frameworks are generally based on basic decision criteria such as cost, time and quality to evaluate the capability of the contractor and also based on the assumption that the decision is made by a single person rather than multiple decision makers. Alupotha (2007) has presented a conceptual model using multi-criteria approach for contractor selection in public sector construction projects. Moreover, Mahdi *et al.* (2002) proposed a model using analytic hierarchy process tool that considers multi-criteria decision making for contractor selection. However, aforementioned models analyzed and prioritized tangible assets of the

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contractor rather than intangible performance aspects such as capability of carrying out the work successfully, relationship with stakeholders and managerial capacity. The aim of this study is therefore to introduce a multidimensional model for contractor selection in private sector construction projects.

The balanced scorecard (BSC) is a framework which provides set of measures that gives top managers a fast but comprehensive view of the business (Kaplan and Norton, 1996). It translates an organisations' mission and strategy into a comprehensive set of performance measures and provides the framework for strategic measurement and management (Kaplan and Norton, 1996). According to Sanger (1998) BSC is used to measure performance and develop strategies by analysing results across a range of activities.

According to the past literature, it is obvious that both BSC and Analytic Hierarchy Process (AHP) tools have been used in manufacturing industry for performance evaluation. Further, both tools have been adapted individually in the construction industry. However, there is a lack of a multi-dimensional approach to evaluate suitability of contractors in construction industry. Therefore, there is a need to develop a multi-dimensional model for contractor selection in construction industry.

2. STRATEGIC PERFORMANCE MEASUREMENT SYSTEM FOR CONTRACTOR SELECTION

The performance measurement revolution has spread over many industries, including the construction industry (Bassioni *et al.*, 2004). Significant number of construction firms has implemented different performance measurement frameworks during last few decades. Assessing a contracting organization's performance has become vital for number of reasons. This includes both internal and external factors such as necessity to attract future investments, to retain and to achieve benefits and to remain competitive and innovative in order to increase profits (Robinson *et al.*, 2005).

However the construction industry is criticized for lack of effective methods to evaluate contractor's strengths and weaknesses and to measure their performances (Luu *et al.*, 2008). When assessing the success or failure of a construction project, the common approach is to evaluate performance of contractor on the extent to which client objectives like cost, time and quality were achieved (Love and Holt, 2000; Ward *et al.*, 1991). These measures have always been criticized by many researchers due to their over dependency on financial aspects (Kagioglou *et al.*, 2001), retrospective nature (Love and Holt, 2000) and non accurate reflection of the interests of stakeholders (Kaplan and Norton, 1996).

Selecting the best contractor for a project is one of the critical tasks in construction industry. The client or consultant looks for the most appropriate contractor with a good organizational performance and a reputation in the industry. Therefore, use of appropriate techniques to analyze client objectives, contractor capabilities and performance as well as bid price, objectively and transparently become very crucial task (Hatush and Skitmore, 1998). Various researchers and practitioners have emphasized that the ultimate aim for contractor selection should be to identify the "best bidder", but not the "lowest bidder" (Topcu, 2004).

3. CONTRACTOR SELECTION IN SRI LANKAN PRIVATE SECTOR CONSTRUCTION PROJECTS

Selective competition is the most common contractor selection technique used in private sector construction projects in Sri Lanka. Further, methods such as open competition and negotiation also used for contractor selection in private sector projects. Private sector clients and consultants prefer to conduct prequalification of contractors and then invite eligible contractors to submit their bids. But it is obvious that these methods may vary from project to project according to clients' preferences. Prequalification of contractors in Sri Lankan construction industry is based on the prequalification guidelines issued by the Institute for Construction Training and Development (ICTAD) based on five basic criteria, i.e. financial stability, work in hand, technical ability, work experience, and organization capability.

4. BALANCED SCORECARD APPROACH FOR CONTRACTOR SELECTION

Traditionally, businesses have tended to judge their performances on financial measures such as return on capital employed and profitability that can create long-term problems if insufficient attention is given to the main enabling factors such as resources, processes and people (Somerville and Robertson, 2000; Love and Holt, 2000; Kagioglou *et al.*, 2001; Robinson *et al.*, 2005). There is also a growing interest on non-financial measures such as customer satisfaction, employee satisfaction or innovation as useful indicators of a firm's future performance (Sim and Koh, 2001).

The Balanced Scorecard (BSC) is a performance measurement system developed in early 1990s' by Professor Robert S. Kaplan and David P. Norton. The BSC has been described as a set of measures that gives top managers a fast but comprehensive view of the business (Kaplan and Norton, 1996). Traditional BSC consists with four perspectives. It includes financial measures that emphasis the results of actions already taken and it complements with operational measures on customer satisfaction, internal business processes and the organisations' innovation and improvement activities. Kaplan and Norton (1993) emphasised that BSC is not a template that can be applied to businesses in general or even industry wide. Researchers further added the view that different market situations, product strategies, and competitive environments require different scorecards while business units devise customized scorecards to fit their mission, strategy, technology and culture. Hepworth (1998) and Ahn (2005) suggested that additional perspectives should be included if applicable and necessary. Lee *et al.* (2008) also observed "depending on the sector in which a business operates and on the strategy chosen, the number of perspectives can be enlarged or new perspectives can be replaced by the other".

The use of BSC tool can be found in large number of studies. According to Stewart and Mohamed (2001), BSC has been used extensively in the manufacturing, government, banking, retail, insurance and financial services sectors. Implementation of BSC for project management in construction sector can be identified from early 1990s. Kaplan and Norton (1993) described the implementation of BSC tool thorough three case studies. Stewart and Mohamed (2001) developed the BSC framework allowing for the measurement of IT/IS performance in construction. Mohamed (2003) adopted the BSC tool to benchmark organisational safety culture in construction. Kagiouglou *et al.* (2001) developed a project management process conceptual framework based on the BSC with the addition of 'project' and 'supplier' perspectives, which can be tailored to construction industry needs.

The initial implementation of BSC framework can be identified to measure performance of organizations internally. Hence an attempt was made in this research to make use of that approach to assess performance of contracting organizations externally.

5. APPLICATION OF ANALYTIC HIERARCHY PROCESS TOOL FOR MULTI-CRITERIA DECISION MAKING

The Analytic Hierarchy Process (AHP) tool was developed by Thomas Saaty for elucidating and resolving unstructured problems in the economic, social and management sciences. AHP tool particularly caters multi-criteria decision making. Decisions today are more complicated and difficult to make due to the greater number of impacts on them. AHP tool has been extensively applied in different areas due to the ease of its use. This method decompose a complex problem into a set of elements, organized the variables in a multilevel hierarchical form and pair wise comparison process by comparing two objects at a time to formulate a judgement as to their relative weights. According to Saaty (1980), to be a realistic model, it must include and measure all important tangible and intangible, quantitatively measurable, and qualitative factors. AHP has been known as an essential tool for both practicing managers and academic researchers to conduct research for making business decisions. It helps to rank elements in order to identify the key elements (Cheng *et al.*, 2002). AHP provides a powerful and flexible tool that may be used to make decisions in situations when multiple and conflicting objectives/criteria are presented.

Wu *et al.* (2007) employed the AHP tool to prioritize the accessibility criteria in a building. Teo and Yng Ling (2006) proposed a method to develop and test the tools that auditors may use to assess the effectiveness of a construction firm's safety management system. The study applied AHP and factor analysis to identify the most crucial factors and attributes affecting safety. Palaneeswaran *et al.* (2006) introduced an AHP based supplier selection framework to enable the choice of the best supplier.

6. RESEARCH METHODOLOGY

A three step approach was adopted to develop multidimensional model for contractor selection. Three steps are;

1. Identification of BSC perspectives and contractor selection criteria
2. Development of conceptual BSC model for contractor selection
3. Prioritization of BSC perspectives and contractor selection criteria

Data collection and analysis techniques used during the implementation of three step approach is shown in Figure 1.

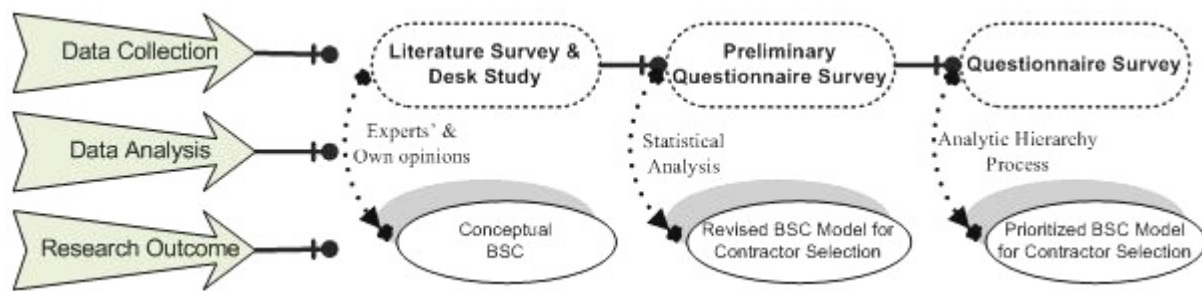


Figure 1: Research Framework for Development of Multidimensional Approach for Contractor Selection

6.1. IDENTIFICATION OF BSC PERSPECTIVES AND CONTRACTOR SELECTION CRITERIA

Determination of BSC perspectives and contractor selection criteria is one of the prime objectives of this study. A comprehensive literature review including ICTAD guidelines for prequalification and brainstorming session with industry experts were carried out to identify BSC perspectives and contractor selection criteria. Success or failure of construction projects are generally influenced by the efficiency of construction processes implemented by the contractors and their organizational management ability. Thus, the original BSC would need to be expanded to incorporate other perspectives such as “construction processes” and “organizational management”. Further, the customer perspective in original BSC amended as the ‘Business Relationship and Reputation Perspective’ to comply with the given context. Therefore, five BSC perspectives identified from the desk study are ‘Financial’, ‘Construction Processes’, ‘Organizational Management’, ‘Innovation, Learning and Growth’ and ‘Business Relationship and Reputation’.

6.2. DEVELOPMENT OF CONCEPTUAL BSC MODEL FOR CONTRACTOR SELECTION

Preliminary questionnaire survey was conducted with ten qualified quantity surveyors who have experience with large private sector construction projects representing both consultant and client organizations, in order to validate the BSC perspectives and contractor selection criteria. The study

analyzed the degree of current usage of the criteria or the probability of implementing the criteria in future. Study expanded to evaluate the level of importance of each contractor selection criteria and results were analyzed using statistical tools. ‘Profitability ratio’, ‘efficiency of cost analyzing and controlling systems’, ‘level of technical training and development’, ‘credit rating’ and ‘total amount of unapproved claims for each projects’ obtained low mean values for level of current usage or probability of implementing in future and level of importance and therefore, removed from the conceptual model. Figure 2 presents the revised conceptual multidimensional BSC model for contractor selection in private sector construction projects in Sri Lanka.



Figure 2: The Conceptual Multidimensional BSC Model for Contractor Selection

6.3. PRIORITIZATION OF BSC PERSPECTIVES AND CONTRACTOR SELECTION CRITERIA

The next step in the contractor selection model development process is data analysis using AHP tool. A series of structured interviews were carried out with 30 construction professionals, representing consultant and client quantity surveyors. The respondents were asked to give their individual opinion and indicate the magnitude of the importance placed on contractor selection criteria for each BSC perspective. For all decision alternatives, geometric mean was calculated from the allocated weights from the participants; the mean for each alternative was considered in the analysis. The AHP is consisting with set of mathematical calculations mainly focusing three steps (Saaty,1994), i.e. “Pair-wise Comparisons”, “Normalise the Comparison” and “Consistency Calculations” and analysis is presented in Table 1, 2 and 3 respectively.

Table 1: Pair-Wise Comparisons of BSC Perspectives

STEP 01 : Pair-Wise Comparisons of BSC Perspectives					
Perspective	Financial	Construction Process	Organizational Management	Innovation, Learning & Growth	Business Relationship & Reputation
Financial	1.000	1.757	2.432	1.440	1.826
Construction Process	0.569	1.000	3.075	2.235	3.156
Organizational Management	0.411	0.325	1.000	2.115	1.819
Innovation, Learning & Growth	0.694	0.447	0.473	1.000	3.431
Business Relationship & Reputation	0.548	0.317	0.550	0.291	1.000
SUM	3.222	3.847	7.530	7.082	11.232

Table 2: Pair-wise Normalized Comparisons of BSC Perspectives

STEP 02 : Normalize the Comparisons of BSC Perspectives							
Perspective	Financial	Construction Process	Organizational Management	Innovation, Learning & Growth	Business Relationship & Reputation	SUM	Performance Score
Financial	0.310	0.457	0.323	0.203	0.163	1.456	0.291
Construction Process	0.177	0.260	0.408	0.316	0.281	1.442	0.288
Organizational Management	0.128	0.085	0.133	0.299	0.162	0.806	0.161
Innovation, Learning & Growth	0.216	0.116	0.063	0.141	0.305	0.841	0.168
Business Relationship & Reputation	0.170	0.082	0.073	0.041	0.089	0.456	0.091

Table 3: Consistency Calculations for BSC Perspectives

STEP 03 : Consistency Calculations of BSC Perspectives							
Perspective	Financial	Construction Process	Organizational Management	Innovation, Learning & Growth	Business Relationship & Reputation	SUM	SUM ÷ Performance Score
Financial	0.291	0.507	0.392	0.242	0.166	1.598	5.489
Construction Process	0.166	0.288	0.495	0.376	0.288	1.613	5.595
Organizational Management	0.120	0.094	0.161	0.356	0.166	0.896	5.563
Innovation, Learning & Growth	0.202	0.129	0.076	0.168	0.313	0.888	5.279
Business Relationship & Reputation	0.159	0.091	0.089	0.049	0.091	0.480	5.264

$$\begin{aligned}
 CR &= \{(\lambda_{\max} - n) / (n - 1)\} \times (1/ RI) \\
 &= \{(5.438 - 5) / (5 - 1)\} \times (1/ 1.11) \\
 &= \mathbf{0.0986}
 \end{aligned}$$

Where, CR is Consistency Ratio, n is size of matrix (i.e. Number of BSC perspectives) and RI is Random Index for n number of matrices.

In this analysis, CR is 0.0986, thus lower than the acceptable limit of 0.10 and hence data are considered as acceptable and consistent.

The next step of AHP analysis is the pair-wise comparison of contractor selection criteria with respect to BSC perspectives. The same procedure is followed and results are given in Table 4. Results are discussed and prioritized BSC model for contractor selection is presented in the following section.

7. PRIORITIZED MULTIDIMENSIONAL BSC MODEL FOR CONTRACTOR SELECTION

The ultimate objective of this study is to develop a ‘**Multidimensional model for contractor selection in private sector construction projects**’ with prioritized BSC perspectives and contractor selection criteria. Table 4 presents the prioritized multidimensional BSC model for contractor selection. Relative performance scores of each BSC perspective and contractor selection criteria provide the importance level of each perspective and criterion in contractor selection in private sector construction projects in Sri Lanka.

Table 4: Prioritized Multidimensional BSC Model for Contractor Selection

Balanced Scorecard Perspectives and Contractor Selection Criteria	Performance Score (In respect to individual perspectives)	Overall Importance (In respect to overall BSC)
Financial Perspective	0.291	29%
• Working capital (asset and liabilities)	0.293	8.5%
• Bank overdraft limits	0.234	6.8%
• Bid amount	0.229	6.7%
• Value of projects in hand	0.120	3.5%
• Turnover in past few years	0.076	2.2%
• Liquidity ratio	0.050	1.4%
Construction Process Perspective	0.288	29%
• Quality level of past projects	0.296	8.5%
• Capability to on time completion	0.185	5.3%
• Number of required/special plant and equipment	0.181	5.2%
• Responsiveness for tendering	0.156	4.5%
• Value of completed projects	0.141	4.1%
• Importance of company safety and the OSHA incidence rate	0.041	1.2%
Innovation, Learning and Growth Perspective	0.168	17%
• Level of innovative construction concepts	0.486	8.2%
• Knowledge management capacity	0.382	6.4%
• Investments on research and developments	0.132	2.2%
Organizational Management Perspective	0.161	16%
• Availability of required/ specialized professional and supervisory staff	0.455	7.3%
• Availability of skilled craftsmen	0.225	3.6%
• Level of risk minimization	0.187	3.0%
• Degree of waste management in past projects	0.133	2.1%
Business Relationship and Reputation Perspective	0.091	9%
• Clients satisfaction on past projects	0.374	3.4%
• Relationship with subcontractors and suppliers	0.227	2.1%
• Number of years of experience in relevant field	0.171	1.6%
• Number of landmark projects handled	0.115	1.0%
• Amount of financial penalties previously levied	0.114	1.0%
Total		100%

According to findings both ‘Financial’ and ‘Construction process’ perspectives have been top ranked equally with 0.291 and 0.288 performance scores respectively, while ‘Innovation, learning and growth’ (0.168) and ‘Organizational management’ (0.161) perspectives were given moderately

important levels. The 'Business relationship and reputation' perspective has obtained the least important level with 0.091 score. Though the "Innovation, learning and growth" was considered to be less important in literature, findings revealed it as a prominent parameter. Further 'Financial' and 'Construction process' perspectives are preferred more than three times of 'Business relationship and reputation'.

According to Table 4, 'Working Capital' is the most important criterion in 'financial perspective' with 0.291 performance score. 'Quality level of past projects' (0.296) is the most important criterion from 'construction process perspective'. 'Level of innovative construction concepts' (0.486), 'Availability of required/ specialized professional and supervisory staff' (0.455) and 'Clients satisfaction on past projects' (0.374) have become the most important performance criteria in 'innovation, learning and growth', 'organizational management' and 'business relationship and reputation' perspectives respectively.

In financial perspective 'Working capital' (0.293) criterion has been preferred six times more important than the 'Liquidity ratio' (0.050) criterion. Findings revealed that criteria related to the contractors' strength of finances such as 'working capital' and 'bank overdraft limits' have become more prominent than others. In construction process perspective 'Quality level of past projects' (0.296) criterion has almost twice more important than the 'Responsiveness for tendering' (0.156) and 'Value of completed projects' (0.141) criteria. As the innovation, learning and growth perspective is newly introduced to the contractor selection criteria, the data analysis of particular perspective became much more paramount. It revealed that the 'Level of innovative construction concepts' (0.486) of a particular construction company is a better evaluation criterion with comparatively 3.5 times more important than 'Investment on research and developments' (0.132). Moreover, though the 'Knowledge management capacity' criterion is not practiced in current contractor selection procedures, it has also been recognized as an important aspect for the success of a construction project. In organizational management perspective 'Availability of required/ specialized professional and supervisory staff' (0.455) criterion was given relatively two times more importance than 'Availability of skilled craftsmen' (0.225) criterion. Hence, findings indicated that there is no considerable difference between priority levels of the last three criteria in similar perspective. 'Number of landmark projects handled' (0.115) and 'Amount of financial penalties previously levied' (0.114) in business relationship and reputation perspective have been given low preferences with almost equal importance.

According to the overall comparison, 'Working capital' (8.5%) in 'financial perspective' and 'Quality level of past projects' (8.5%) in 'construction process perspective' became the most important contractor selection criteria with equal important levels.

Interestingly, findings exposed that 'Working capital' (8.5%), 'Quality level of past projects' (8.5%), 'Level of innovative construction concepts' (8.2%), 'Availability of required/ specialized professional and supervisory staff' (7.3%) and 'Bank overdraft limits' (6.8%) should be given high priority at the contractor selection in private sector than 'Bid amount' (6.7%).

'Number of years of experience in relevant field' (1.6%), 'Liquidity ratio' (1.4%), 'Importance of company safety and the Occupational Safety and Housing Administration (OSHA) incidence rate' (1.2%), 'Nr. of landmark projects handled' (1.0%) and 'Amount of financial penalties previously levied' (1.0%) have obtained a low priority level in the contractor selection model.

8. CONCLUSIONS

The ever increasing need on selecting the most competent contractor have led to the use of alternative forms of contractor evaluation procedures. The contractor evaluation is a prominent task in the construction industry, where the project owner or consultant has to make a decision based on complex alternatives. Selection of inappropriate contractor may lead to substandard work, delays, disputes, or

even bankruptcy. Therefore, in order to select suitable contractor, it is necessary to apply appropriate contractor selection methodology.

This research intended developing a contractor selection model for private sector construction projects in Sri Lanka, which integrates the BSC concept with AHP tool and establish an overall procedure as a universal application. The BSC that is used extensively in worldwide to monitor organization performance against its' strategic goals, was further extended to align the contractor selection to project owners' needs in the construction industry. The AHP tool was applied to quantify relative priorities for a recommended set of BSC perspectives and contractor selection criteria based on the intuitive judgments of the industry experts.

The survey results revealed that some of the proposed novel criteria have been obtained higher preference than the criteria, which are used in current practice. "Innovation, learning and growth perspective", which is an extremely novel aspect to the industry was given a moderate priority than existing "Organizational management" and "Business relationship and reputation" perspectives. Criteria such as 'Quality level of past projects' and 'Level of innovative construction concepts' were ranked on the top levels in the ranking order with remarkable relative important levels. The 'Bid amount' criterion, which gives a higher priority as a traditional financial measure was ranked to the sixth place among 24 criteria. It witnesses that the industry practitioners have prioritized modern criteria than traditional financial measures in the contractor selection model.

The proposed BSC model for contractor selection contributed to the knowledge a sustainable and multidimensional contractor evaluation process related to the Sri Lankan private sector construction industry through modern performance perspectives. This research presents a robust and specific contractor selection procedure for the construction industry in order to confront the clients' objectives successfully.

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Construction Quality: Sri Lankan Contractors Perspective

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ABSTRACT

In today' changing environment, quality is the key to an organisation's success and survival. Many construction organisations have turn to adopt quality as a reliable management tool. With this perspective, the research problem is articulated for this study as follows: "How does the Sri Lankan construction contractors identify and utilize quality in their organisations". The research methodology adopted for this study was qualitative, within which case studies were used to investigate the research question. The primary data collection technique used in the case studies was semi structured interviews. Content analysis and cognitive mapping techniques were used to analyze primary data. The study identified several causes for poor construction quality and current practice of quality planning. The ISO 9000 quality management system is the most widely practicing or almost only system practicing in construction organisations, as it is a mandatory requirement acted by the ICTAD (Institute for Construction Training and Development). It was also identified that Sri Lankan construction industry is less exposed to new quality approaches such as total quality management, six sigma and benchmarking and etc. Several prerequisites for successful implementation of strategic quality planning in Sri Lankan context are also proposed including a strategic quality framework for construction organisations.

Keywords: *Quality, Construction Industry, Sri Lanka, Contractors, Case studies*

1. INTRODUCTION

The construction industry is now a highly dynamic sector, and its operating environment, industry structures and product characteristics are changing at an ever increasing pace (Dansoh, 2005). With the changing economic environment, management of construction companies and projects are looking for emerging new management philosophies to construction. Many organisations in various industries have turn to adopt quality as a reliable management tool in the competitive market environment and they have achieved numerous benefits such as saving money and time through fewer defects, achieving required level of performance of the production, less reworks and wastage, more committed work force and management team and ultimately outstanding company image (Kumara, 1997). The current trend in the construction industry is also now moving towards higher quality and contractors are forced to upgrade the quality of their service (Pheng and Hong, 2005). According to Barrett (2000), quality in construction can be considered as the satisfaction of a whole range of performance criteria owned by an interacting host of stakeholders and mediated by a range of mechanisms running from regulation to market forces. The aim of this research was to study how Sri Lankan construction contractors identify and utilize quality in their organizations.

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2. KEY LITERATURE FINDINGS

Numerous expressions have been adopted to define quality in both the manufacturing and the construction industry. Quality is a much more complicated term than it appears. Dictionary definitions are usually inadequate to help a quality professional understand the concept. It seems that quality expert like Deming, Juran, Garvin and Ishikawa defines quality in different ways. There are a variety of perspectives that can be taken in defining quality (e.g. customer's perspective, specification-based perspective). One of the modern definitions of quality derives from Juran's "fitness for intended use" (Juran and Gryna, 1993); this definition basically says that quality is "meeting or exceeding customer expectations." Based on Garvin's definitions Omachonu and Ross (2004) summarized quality into five ways as transcendent, product-based, user-based, manufacturing-based and value-based quality. Transcendent quality is universally recognisable and it is related to comparison of features of products. Product-based quality is a precise and measurable variable attributed to the product. User-based quality is fitness for intended use. Manufacturing-based quality is conformance to specifications while value-based quality defined in terms of cost and prices. To ISO 9000:2000 quality is degree to which inherent characteristics fulfil requirements. The definition of quality is developing in different approaches, from the time it emerged.

In construction industry, Battikha (2003) states that the participants in the construction industry have become notably aware of the role of quality as an essential means to achieve client satisfaction and gain a competitive advantage (Wah *et al.*, 1994). However, unlike other economic sectors (especially in manufacturing), the construction industry is characterized by activities, which are discontinuous, dispersed, diverse and distinct in nature. Quality management in the construction setting is, therefore, more difficult not only at the national level but also at the project level for a wide spectrum of reasons (Pheng and Tan, 1996) such as insignificant technical growth, lack of co-operation among professional groups, outmoded QA/QC programmes, outmoded safety programmes, and transference of professional liability (Yasamis *et al.*, 2002).

Acceptable quality levels in construction have long been a problem to attain on time and within budget in a highly dynamic, complex, and competitive environment. Therefore, quality management is a critical component to the successful management of construction (Battikha, 2003). A study by Rahman (1997) showed that construction industry lacks exposure to the tools and methods, which have been applied successfully in the manufacturing industry to promote the management of quality. Battikha (2003) showed that with inefficient or non-existent quality management procedures, significant expenditures of time, money, and resources are wasted on construction projects. This lack of quality due to deficient construction quality management is detected through non-conformance to established requirements. The quality has entered to the context of construction in different approaches such as Total Quality Management (TQM), six sigma, benchmarking and ISO 9000. Despite the perceived importance of the topic and the widely publicized value of the quality, little is known on how Sri Lankan Construction contractors perceive quality and approach quality in their organisations. This research gap led to particular study and the next section set forth the research method adopted for the empirical investigation.

3. RESEARCH METHOD

As the research problem in this study was "how Sri Lankan construction contractors identify and utilize the quality in their organisations", it prompted for a qualitative research study. Accordingly, the case study method was chosen. First, a pilot study was conducted to fully develop the research problem and questions; and, second, detailed case studies were carried out.

In the pilot study, data was collected by unstructured interviews with five key knowledgeable people on construction quality management. They were a project manager, a quality assurance manager, a manager on human resource and skills development and two general managers from two private quality consultant organisations. The pilot study was focused to identify the environment related to

the research problem in order to develop the interview guidelines and to select cases to study. Accordingly, three large-scale contracting organisations were selected for the detailed case studies. See Table 1 for a brief description of cases.

Table 3: Brief description about the selected cases

Project	Organisation A	Organisation B	Organisation C
Nr of years in the field	Sixty six years	Twenty four years	Twenty eight years
Annual turnover	One billion	Seven billion	Five billion
Specialisation areas	Buildings and civil construction.	Buildings and all civil construction.	Buildings and civil construction.
Nr of employees	400 staff and labourers are on sub contract basis	500 staff and labourers are on sub contract basis	400 staff and 300 direct labourers and others are on sub contract basis.
Nr of on going projects	7 projects	20-35 projects	8 projects

In case studies, semi-structured interviews were used as the main method of collecting data targeting key personnel from each construction organisations such as Quality assurance Managers, Chief Executive Officers, General Managers and etc. See Table 2 for interview sample.

Table 2: Interview sample

Organisation	Interviewees	Abbreviated to
A	A1 – Senior manager – Technical services	Senior manager
	A2 – Senior Engineer – procurement and contract monitoring	Senior engineer
	A3 – Quality assurance officer	QAO
B	B1 – Deputy general manager construction	DGM
	B2 – Quality assurance manager	QAM
	B3 – Deputy manager estimating	DME
C	C1 – Chief executive officer	CEO
	C2 – Quality assurance manager	QAM
	C3 – divisional head internal and local building projects	Divisional head

In the data analysis process, two techniques were used to analyse data; content analysis and cognitive mapping. Nvivo software was used for coding while manual cognitive maps were developed to get a holistic view of the data. The next section presents the key research findings.

4. RESEARCH FINDINGS

4.1. NATURE OF THE CONSTRUCTION QUALITY

Nature of construction quality as revealed through the case studies is discussed in this section using the cognitive map (see Figure 1).

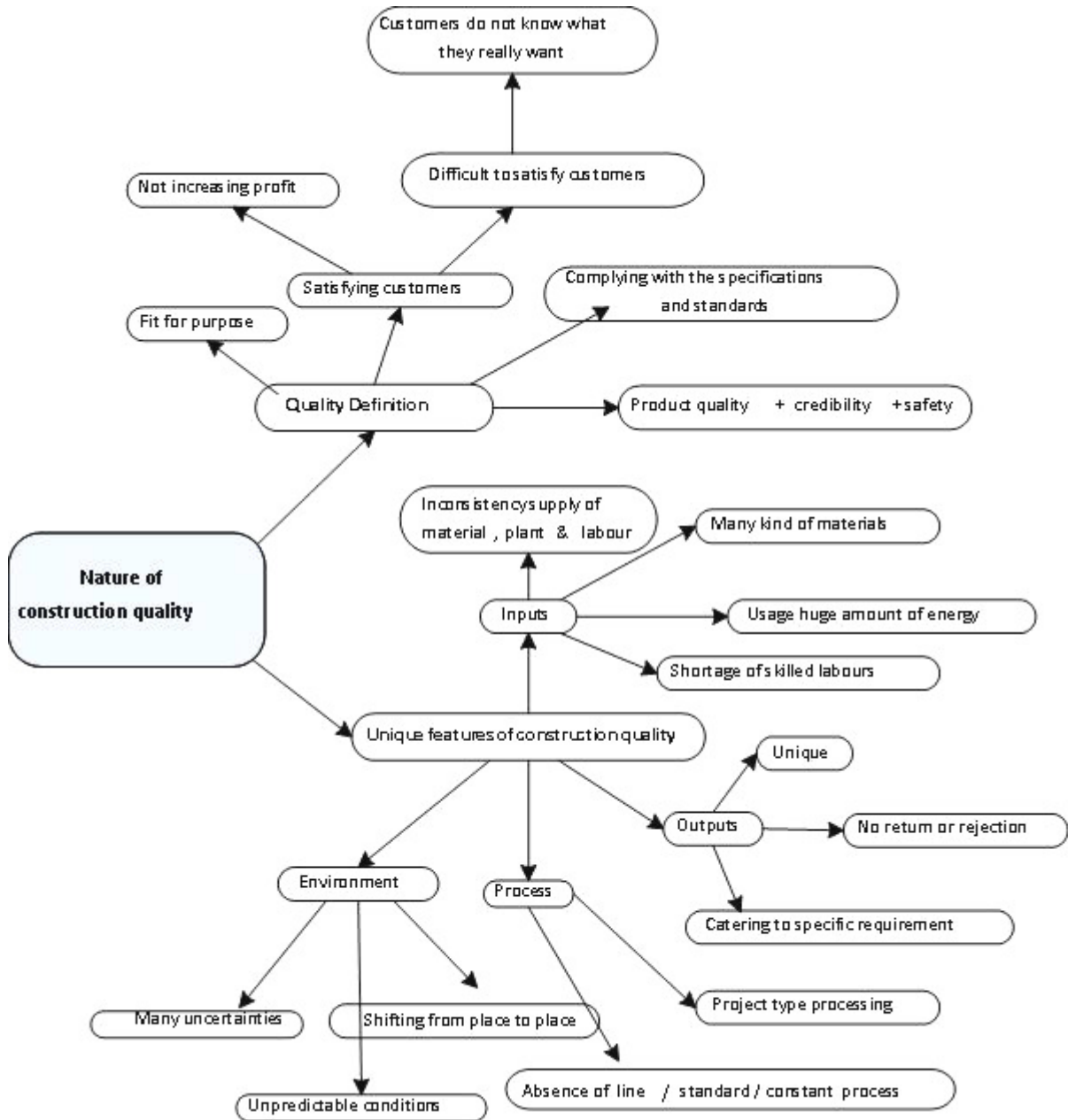


Figure 1: Cognitive Map for Nature of Construction Quality

How contractors define Construction Quality?

According to the empirical study the majority of the professionals in construction industry identify and defined the construction quality as “complying with specifications and standards.” In other words quality means doing the construction according to the contract documents and standards. For example, senior engineer of organisation A said “if we are able work according to the given standards and specifications, we believe that we have done a good quality product.” To some this is fit for purpose that is specifications and standards.

The case study data showed that construction quality is not really meeting or exceeding customer expectations. All organisations meticulously say it is very much difficult to satisfy the customer or meet the customer’s expectations. For example, the senior manager of organisation A indicated “it is very difficult to satisfy the customers or client in construction. Because most of the customers don’t know what they really want. They don’t give the correct details to the designers and designers designed the structure according to what he has assumed as the requirement of the client. So from the very first day of construction the design changes and also contractors have to do what clients want whether it produce required quality or not.” Therefore the explanation of construction quality by satisfying customer is incompatible with construction industry due to the nature and conduct of the parties of construction.

Apart from that, the divisional head of organisation C identified construction quality as a combination of product quality, credibility and safety. He further elaborated that not only the product but also the process should be a quality assured one. In summary, the case studies data showed that most appropriate definition for construction quality is conformance to specifications and standards.

How constructors’ identify unique features of construction quality?

The empirical study identified the unique features of the construction industry in terms of inputs, outputs, process and environment. This is illustrated in the cognitive map (see Figure 1).

The research findings reveal that inputs of the construction industry always change from project to project or even within the project. As the quality assurance manger of organisation A described “as the production of construction is shifting from place to place, it is difficult to keep a constant supply of inputs.” Therefore, in construction, it is difficult to make a constant supply of inputs, specially the skilled labour force. The quality assurance manger of organisation B stated that “construction industry is the industry which uses many types of material and a substantial amount of energy.” Industries like manufacturing use the same material, equipments and same labour force for their production for a long period of time.

The process of construction quality also reveals unique features. Chief executive officer of organisation C explained, “Manufacturing industry have a line, standard and constant production process but construction have a project type production process.” Most of the interviews disclosed that in construction, they cannot have a line, standard process due to its changing nature of environment and inputs. Further, they agreed that it is difficult to maintain a single quality planning and controlling system, as the process of construction is constantly changing.

The environment is another element discussed. The environment of the construction is full with uncertainties and unpredictable conditions. As the QAM of organisation B stated “the environment of the construction is not as comfortable as manufacturing industry.” Most of the interviews also agreed to this and they further explained that it is difficult to have the same quality procedure over different types of projects, which are placed under different environment conditions.

Finally, the unique features in output stage of construction quality were discussed. Majority of the interviews explained that output of the construction is unique and it is catering to specific requirements. As senior manager- technical services of organisation C emphasised “there is no return and rejection in construction”. He further explained that in construction the product is sold before it is produced and the production have a specific time period to finish.

In summary, all of the interviewees agreed that it is unfair to compare the quality of construction with other industries, since the inputs, process, environment and output are changing in an extraordinarily manner. The CEO of organisation C emphasized “quality procedures can be easily applied in the manufacturing and, therefore, they can have a better quality control over construction, but cannot underestimate the quality of the construction, since it conducts in extremely different environment.” As a summary most of the interviews agreed that quality in construction has unique features, and it is not easy to maintain a good quality management while facing to various conditions and uncertainties.

4.2. FACTORS AFFECTING THE CONSTRUCTION QUALITY

The reasons for quality failures in construction are discussed in this section. The cognitive map (see Figure 2) shows causes for construction quality in a more graphical manner.

The majority of interviewees, except three, expressed that the construction industry is not having poor quality as highlighted in the literature and many construction firms have developed their quality systems better than many companies in different industries.

This is indicated by the statement of senior engineer of organisation A, “According to my view quality in construction is better than quality in some other sectors. In construction, we check the quality of the product at one stage and if there are defects we rectify them and go to the next stage. Not like other productions we can identify and rectify the defects throughout the construction period and even in the defect liability period. So when we handover the project to the customer less number of defects is there, and any time in construction the customer can show any work which is not up to the quality. Such things cannot be done in a manufacturing industry. For example, we only get to know whether the colour is washing out or not only after buying a dress and washing it once. There is no opportunity for the client to recover defects and reproduce it. So I think construction industry cannot be considered as an industry with poor quality.” Even though all interviewees were satisfied with their quality of work, there were some circumstances, which ended up with poor quality of construction due to several reasons. They emphasised that these problems exist, especially with the small contractors who have lack of quality management.

The most common reason revealed through the study is the absence of a quality-oriented vision. The DGM of organisation B indicated that most of the small contractors do not have a quality-centred vision. For example, he explained that, “When the vision becomes maximizing profit, quality will fail without a doubt. Sometimes some contractors bid very low prices for a project, just to get the project. So then to get profit they cut the quality of the work.” This absence of quality vision in effect generates lack of support from employees and management, which lead to create inefficient quality system in the organisation. As per the opinion of the QAM of organisation C, the absence of quality vision is a barrier to cultivate corporate quality culture within the organisation.

Another important factor, which affects construction quality, is the shortage of skilled labourers. According to QAM of origination A, “There is a huge shortage of skilled labourers in the industry. Because the construction industry largely depends on informal labourers who come from different other industries, they are not trained up to the required level.” Another reason disclosed through the case studies for shortage of skilled labourers was inefficient wages, welfare facilities and lack of assurance on the employment.

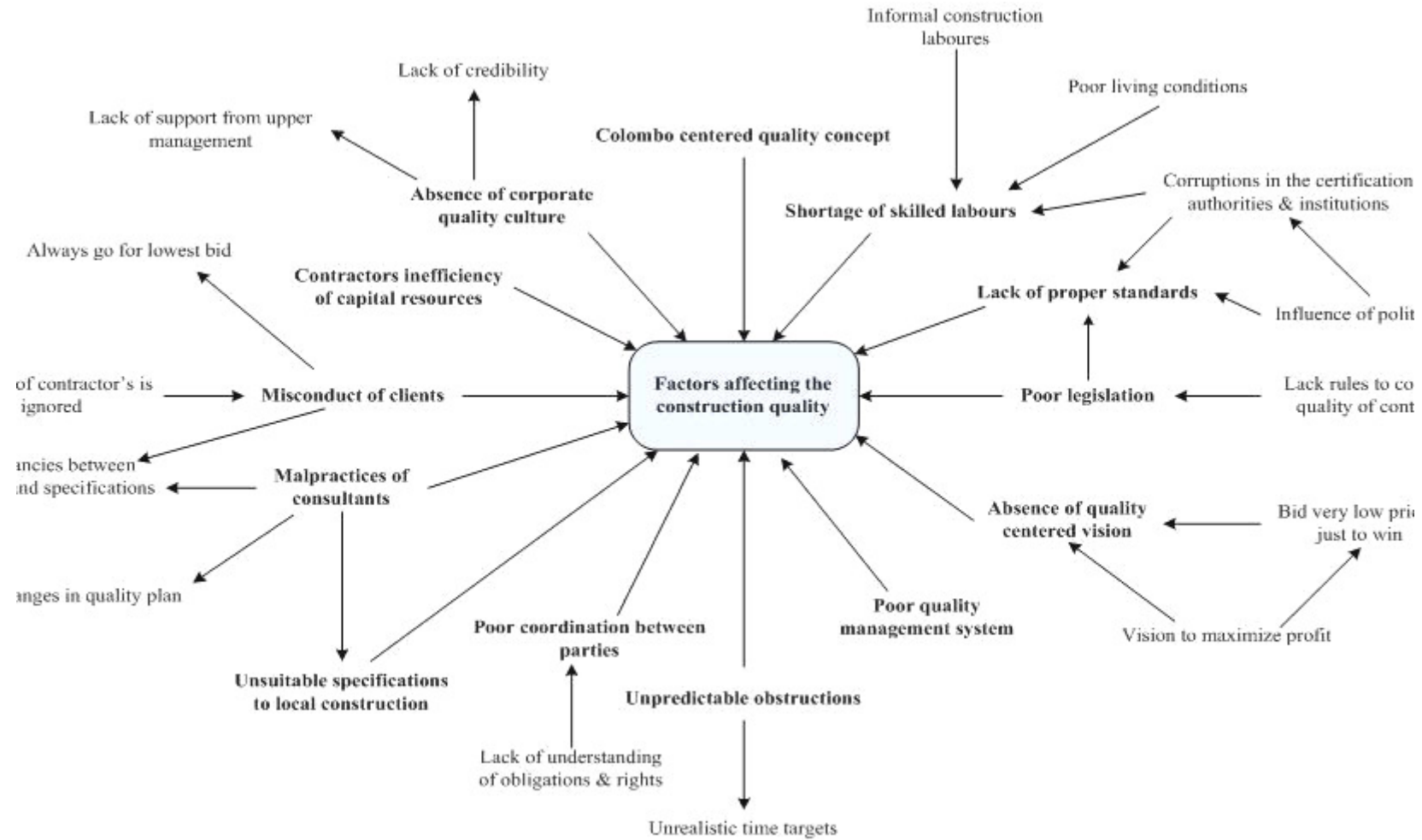


Figure 2: Cognitive Map for Factors affecting Construction Quality

Most of the interviewees agreed that they do not have a proper system to maintain the standards of material, labour, plant and equipments in Sri Lanka. This is indicated through the explanation of senior manager of organisation A, "The major reason is there are no standards in the country for material, labour and plant. Any material can be sold in the market. The authorities or institutions are corrupted that they certify any sort of material, even though they are not complied with the standards to be fulfilled. Then the workers who come with certain certifications from different institutions in the country do not have the required skills up to the standard. If we only give the quality inputs, the output is going to be a quality one. So when the inputs of the construction are not in good quality, the final outputs will end up with poor quality." This factor was strongly emphasized by most of the interviewees and they suggested all these certification bodies have to be more effective and trustworthy on their duties.

The empirical study disclosed some other causes for poor quality in construction such as insignificant technical growth, lack of co-operation among professional groups, out mode QA/QC programmes, lack of supervision and unrealistic time targets. Other causes recognised through the case studies are poor co-ordination between contractors and subcontractors, disregarding the buildability by the designers, standards and specifications which are unsuitable and unavailable in Sri Lanka and poor legislation. This is mainly due to the malpractices of consultants, since most of specifications are copied from foreign documents and they are not fitting with the Sri Lankan context.

Most of the interviewees did not accept 'discrepancies between drawings and specifications' and 'attention on cost and time rather than quality' as causes for poor quality in construction. The divisional head of organisation C explained that these obstacles can be overcome and cannot be excused for any quality failures occurred due to these reasons. This was further enhanced by the senior manager of organisation A, "if there are discrepancies between drawings and specifications, the contractor can discuss with the consultant and resolve the problems." The senior engineer of organisation A explained, "The more attention on cost and time rather than quality cannot be a reason for failure of quality in construction. Since quality cannot be sacrificed due to time or cost. But sometimes to achieve quality, time delays and cost increases can happen." There were some other causes, which were very specific to construction industry in Sri Lanka. One of these is that client generally selects lowest tender without considering the quality. So contractors tend to do the work at the lowest quality to get more profit. Another is, in Sri Lanka all these quality considerations are Colombo-centered. Constructions that are in areas away from Colombo, quality is not taken as an important factor. Therefore after considering all these reasons, it is evident that although contractors satisfy with their construction work, there are still several causes, which make it difficult for contractors to achieve good quality construction.

4.3. APPLICATION OF DIFFERENT QUALITY APPROACHES IN CONSTRUCTION

Different Quality Approaches used by Sri Lankan construction contractors are discussed in this section. Majority of the case study participants agreed that the construction industry is aware on new quality management (QM) concepts. This is ensured by the explanation of deputy manager estimating of organisation C "we are aware on the new QM concepts and some are suitable and some are not" and DGM of organisation B also agreed that "construction industry is aware on new approaches of quality up to some extent." Senior engineer of organisation A stated that "construction industry is aware on these concepts and we hardly use any of them." Therefore according to majority of the interviewees, there are limitations or barriers to the application of new QM concepts in construction industry.

According to the case studies, none of the organisations were able to reach up to total quality management. As per the opinion of the senior manager of the organisation A, "Most of the people do not understand why TQM cannot be directly applied to the construction industry. When we take construction there are so many unpredictable issues. From project to project, parties who involves such as client, consultant, suppliers, subcontractors, labourers, materials, method of construction and

climate differ. Also from project to project, the local authorities, rules and regulations are varying. Therefore the environment behind the construction is not constant, it is changing every moment. So it is very difficult to achieve total quality management when an organisation is depending on so many parties and conditions which are varying continuously.” Therefore the concept of total quality management is still a new approach to Sri Lankan construction sector.

Most of the interviewees believed that quality concept six sigma is not applicable to the construction industry. This was indicated by the statement of DGM of organisation B, “According to my view, six sigma is not applicable to the construction industry, since it is very hard to achieve zero defects in construction industry due to its changing environment. I think it is good for production or manufacturing industry which has a large number of products and a fairly constant environment.”

The organisation A has implemented the concept of Kaizen in their organisation. But unfortunately due to various reasons they fail to maintain it. All of the organisations have implemented concept of 5S. According empirical study, a significant factor which was expressed by most of the interviewees is, that these new quality approaches need to be changed according to the nature of the construction, as most of these concepts are developed to improve the quality of the manufacturing industry. For example the QAM of the organisation C indicated that “These new quality approaches are developed based on the manufacturing industry which has totally different characteristics compared to construction. Therefore, before we are going to apply those new concepts we have to adopt them according to the environment of the construction sector.” He further indicated that these quality approaches are still new to the Sri Lankan construction industry. This was approved by the DME of organisation B. According to him, “We believe sticking to the basic is the main thing. These new approaches can be applied in construction, but before that we have to develop the background for it. When you know basics only, you can reach high techniques. But in construction, we are still learning the basics in quality management.” Therefore, as a summary, most of the interviewees agreed that although construction organisations are aware on these new concepts, they have still not developed their knowledge and resources to implement such concepts in their organisations.

The case studies data showed that all organisations are following ISO 9000 quality management system. Some reasons for this popularity of ISO 9000 quality management in construction sector were identified through case study data. For example, main reason for following ISO 9000 is the regulation made by ICTAD (Institute for Construction Training and Development). Having an ISO 9000 certification is a mandatory requirement for grade M1 contractors as categorised by ICTAD. As the senior engineer of organisation A explained “A major advantage is we can easily adopt ISO 9000 quality management system according to our requirements. It is more flexible than other quality management systems. In ISO 9000 the main principal is, we write what we do and we do what is written. Therefore it is easy to control the system from top to bottom.” This is further enhanced by the statement of CEO of organisation C, “it gives a broader picture. When we take six sigma, it is focused on productivity improvement. But in ISO it does not look at the quality of output, it improves the process of the quality management. When you improve the process it automatically improves the quality of the output.” Apart from these reasons the majority of interviewees agreed that there is a good reputation built around the ISO 9000 certification among the society. Therefore, most of the clients are now willing to award the contract to the contractors who have the ISO 9000 certification. In general, the above factors are the reasons for the high popularity of ISO 9000 quality management system among most of the contractors in Sri Lanka. The next section offers conclusions of this study.

5. CONCLUSIONS

The prime aim of this study was to explore how the Sri Lankan construction contractors identify and utilize the quality in their organisations. The study was carried out using three case studies of main contractors in Sri Lanka.

The results indicated unique nature of the construction quality. The construction industry is characterized by activities, which are discontinuous, dispersed, diverse and distinct in nature, which make it difficult to achieve good quality in construction. Hence, most appropriate construction quality definition revealed from the findings is 'complying with specifications and standards'. Findings also indicate that quality cannot be defined as 'satisfying customers' as it is not fitting with the environment of the construction.

Case study findings disclosed several causes for poor quality in construction. Major reason of this is the absence of quality-centred vision and the absence of corporate quality culture. This issue can hinder the development of Sri Lankan construction industry. Therefore, it is advisable to develop quality culture within the organisation, and the commitment of the top management is essential to such implementations. Besides, top managers need to ensure that quality initiatives are understood at all key levels of the organisation. The shortage of skilled labourers is another reason for poor quality as revealed through the findings. Thus, it is recommended to establish new training institutions and improve the conduct of these institutions and organisations. It is advisable to assist to improve the living conditions of labourers, in order to minimise the skilled labour turn over in the construction industry. Similarly, in order to improve the quality of materials use in construction, the standards and regulations that govern the process of material certification need to be stronger and more effective. The policy makers like Sri Lanka Standards, ICTAD should provide more proactive roles to mitigate malpractices in the industry to achieve better quality construction. According to the disclosed results, the quality of the construction is also influenced by the misconduct of clients and mal practices of consultants. Therefore, it is advisable for the clients to have a clear picture about their requirements before starting a project to minimise the conflicts, which occur due to the changes in the scope of the work. It is also recommended to consultants, to be more observant in drawings and specifications.

It was also revealed that Sri Lankan construction industry is less exposed to the new quality approaches such as TQM, six sigma, benchmarking and etc. The ISO 9000 quality management system is the most widely practicing or almost only system that is practicing in construction organisations as it is a mandatory requirement acted by the ICTAD.

Followings can be recommended as implications for the construction industry from this study. Since, this study focused on quality related issues, all these implications were highlighted on construction quality improvements. The research findings revealed that Sri Lankan contractors were less exposure to the new quality approaches such as TQM, six sigma, benchmarking and etc. In addition, the quality improvements were only restricted to fulfil the ISO standards. Due to this, Sri Lankan industry fails to compete with foreign construction organisations, which have accomplished with new theories, knowledge and practices. Thus, innovation of new quality approaches is a necessity in the context of Sri Lankan construction industry. Therefore it is important to conduct training programmes, workshops to improve the knowledge of the employees. The training and development institutes such as ICTAD have an important role in promoting such approaches.

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Construction Procurement Selection: Comparative Study of Public Sector vs. Private Sector

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ABSTRACT

Construction procurement selection has been a major research area in recent past. Lots of researches have considered procurement selection by considering the overall construction industry as a one unit. Almost all the previous studies have identified the factors affecting procurement selection but a client wise consideration has not been carried out (Public sector vs. Private sector). Eg: Love et al., (1996), Masterman, (1992), NEDO et al., (1985), Luu et al., (2003), Chan et al., (2001). Since public sector and private sector play equally important roles in the construction industry, factors affecting procurement selection should be separately identified for each sector. Major reason for that is, although there are lots of procurement selection parameters have been identified, the importance level of those factors to the public sector selection may differ from private sector selection. That importance level can be very vital in selecting different types of procurement. Three rounds of Delphi surveys were conducted, to extract a set of exclusive factors and their levels of influence on public sector and private sector and to identify the suitability of available construction procurement options for each sector, with participation of a panel of experts who are engaged in procurement selection in the construction industry.

Keywords: Construction procurement, Factors affecting, Selection criteria, Public sector, Private sector

1. INTRODUCTION

Procurement system is a key means through which objectives of the project are achieved. It is claimed that the correct choice of a building delivery method will lead to the success of a building project (Chan, 2001). Hence selecting an appropriate procurement system is an essential step in any construction project process. If a client makes a wrong choice, the penalty may be time and cost overrun and general dissatisfaction.

Basically clients in construction industry can be divided into two types. There are the public clients and private clients. The public clients consist of government-funded development agencies and local authorities. The private clients consist of property developers, owner-occupiers and investors (Hashim et al., 2006). In Sri Lanka also, public sector and private sector plays equally major roles in construction industry.

Masterman (1992) pointed out that; the selection of a procurement system for a project is largely depends on the objectives of the client and according to Hashim et al. (2006), both public and private clients have some common project objectives, but the prioritization of them is different from a public client to a private client. Therefore there is a necessity of separate investigation on public sector procurement selection and private sector procurement selection. Thus this paper presents procurement selection criteria of both public and private sectors and the different between two sectors.

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2. CONSTRUCTION PROCUREMENT SELECTION

Selection of procurement system is influenced by Client requirements and characteristics (Moshini, 1993; Masterman and Gameson; 1994, Molenaar, 1999), Project requirements (Gordon, 1994; Ambrose and Tucker, 1999; Rowlinson, 1999) and External environment (Walker, 1989; Hughes, 1989; Sheath et al, 1994, Alhazmi and McCaffer, 2000; Kumaraswamy and Dissanayake, 2001) (Luu *et al.*, 2003).

A list of predominant procurement selection parameters have been identified by the Luu et al. (2003, p.211) under the categories of client characteristics and objectives, Project characteristics and external environment. Through evaluation of large number of researches following factors were identified as most discussed construction procurement selection parameters.

Cost Certainty	Degree of Complexity
Price Competition	Time Constraints
Financial Risk	Payment method of the Project
Tendering Cost	Integration of Design and Construction
The Early Start of Project	Project Funding Method
Tendering and Evaluation Time	Site Risk Factors
Planning and Designing Time	Construction Method
Construction Time	Market Condition
Speed of Construction	Technology Feasibility
Functionality of the Product	Regulatory Feasibility
Aesthetic Appearance of the Building	Material Availability
Complexity	Availability of Experienced Contractor
Degree of Flexibility	Weather Conditions / Natural Disasters
Familiarity (Client awareness)	Objection from neighbour / Public
Accountability and Transparency	Political Constraints
Allocation of Responsibilities	Cultural Differences
Disputes and Arbitration	Education of Builders
Type of the Project	Finance for the project
Size of the Project	Information Technology
Project Cost	Institutional Bodies
Degree of Flexibility	Industrial Actions

3. PUBLIC SECTOR AND PRIVATE SECTOR AS MAJOR CLIENTS IN SRI LANKA

Basically clients in construction industry can be divided into two types. There are the public clients (Government) and private clients. The public clients consist of government-funded development agencies and local authorities. The private clients consist of property developers, owner-occupiers and investors (Hashim *et al.*, 2006).

The Government is an important participant in the construction industry of every country playing the role of a major client (Ofori, 1996). Alhazmi and McCaffer, (2000) and many other researchers (Mustapha *et al.*, 1994; Mcdermott, 1999; Ofori, 1996) have stated that changes in state regulations and policies have made an impact on the procurement trend. Further, some governments directly influence the project procurement through their policies. Government being a major client creates an impact on the construction market, thus indirectly regulating the project procurement practice in a country. In Sri Lanka also, public sector and private sector plays equally major roles in construction industry.

4. PUBLIC SECTOR AND PRIVATE SECTOR PROCUREMENT SELECTION

The study of Love *et al.* (1998) identified nine Client's priority variables (Client's requirements) which highly impacts to the construction procurement selection. Hashim *et al.* (2006) has conducted a research to identify how some of these factors (excluding Flexibility and Disputes) influence in construction procurement selection in public and private projects separately, according to the context of Malaysia. This research has taken into account only the Client's requirements and also limited number of client's requirements have been discussed. Findings of that research as follows,

4.1. TIME

To the public clients, time is not the most important factor for them. This is because their main objective is towards public accountability. As for the private clients, their most important criteria are completion on time. This means that need a procurement method that involves a comprehensive planning at the beginning of the construction period in order to achieve the specified completion time (Hashim *et al.*, 2006).

4.2. ALLOCATION OF RESPONSIBILITIES

For public clients, the responsibility criterion is less important in the selection of procurement method. The main reason could be that the public clients will have to conform to the needs of the publicly funded bodies to choose the lowest price for the project, as well a satisfying public accountability. As for the private sector, responsibility criterion is important as they focus more on criteria such as time frame and price certainty (Hashim *et al.*, 2006).

4.3. PRICE CERTAINTY

Public clients consider price certainty as less importance as they focus more on the functionality of the work done. Private clients rated it as important since they can control their financial budget by getting the certainty in price (Hashim *et al.*, 2006).

4.4. QUALITY LEVEL

Comparing between the public and private client, the public client emphasize on the quality factor more than the private clients in selecting procurement methods. This is mainly because the projects are funded by the government and the functionality of the completed projects is more important to the client (Hashim *et al.*, 2006).

4.5. COMPLEXITY

In complex projects, there will be higher levels of nomination because of the need to harness the design skills of specialist trade contractors. Therefore, the more complex a project, the more favourable it is to the private clients rather than to the public clients. It is because public clients will emphasize the functionality of the project rather than the prestigious project. Private clients will demand for higher complexity of project because their priority is mainly on the prestige value of the project (Hashim *et al.*, 2006).

4.6. RISK ALLOCATION / AVOIDANCE

Public clients consider risk avoidance as mediocre and the least important requirement for them. This may be due to public clients involving central and local government whereby construction expenditures represent a small proportion of their annual turnover. Meanwhile, private clients consider risk avoidance as an importance factor towards their project success (Hashim *et al.*, 2006).

4.7. PRICE COMPETITION

Competition is important to the public clients because of public accountability, often require them to obtain competitive tenders and also mainly due to their focus on obtaining the lowest price for a project. Meanwhile, private clients mostly require competition for obvious commercial reasons (Hashim *et al.*, 2006).

5. METHODOLOGY: THE DELPHI TECHNIQUE

The Delphi technique is being increasingly used in many complex areas in which a consensus is to be reached. Moreover, the Delphi method is a highly formalized method of communication that is designed to extract the maximum amount of unbiased information from a panel of experts (Chan *et al.*, 2001).

This is done by giving individuals in the group a series of questionnaires (or interviews) that reiterate the same questions while providing group feedback from previous rounds. Delphi experiments tend to produce convergence of opinion – not just toward the mean but toward the true value (Helmer, 1983 cited Gamage, 2005). In a Delphi study, the participants do not interact with one another, their responses are anonymous, the group results are given in terms of means, medians, or standard deviations, and participants are given the opportunity to reconsider their response after receiving the group feedback.

5.1. SELECTION OF THE EXPERT PANEL

The success of Delphi method depends principally on the careful selection of the panel. A group of experts has been selected to provide opinions on the suitability of a certain procurement path for a given criterion. Since the information solicited requires in-depth knowledge and sound experience about the various procurement options, a purposive approach is adopted to select this focused group of experts (Chan *et al.*, 2001). Following criteria is used to correctly identify eligible participants for the Delphi surveys.

1. Experts to have extensive working experience in the construction industry.
2. Experts to be currently or recently directly involved in the construction management
3. Experts to have a detailed knowledge of all the procurement options.

The panel size of seventeen fits within the guidelines recommended for Delphi studies. Helmer and Dalkey used a panel of seven experts in their original Delphi experiment in 1953 (Helmer, 1983 cited Gamage, 2005). Chan *et al.* (2001) suggests a panel size of anywhere from 10 to 50 participants.

6. DELPHI ROUND ONE - IDENTIFICATION OF PROCUREMENT SELECTION PARAMETERS

6.1. FORMAT

This first round comprises of questionnaire including identified some of the selection criteria from the previous research studies and literature. The panel is asked to provide the major criteria in the selection of a procurement system for a construction project in Sri Lankan construction industry separately for public and private projects and to assess the suitability of given factors for each sector separately. First round of questionnaires were issued with the findings of the factors, which influences the selection of the procurement system, from the literature. This was done to eliminate the time constraints.

6.2. RESULTS AND ANALYSIS

According to the result of the Delphi round one **Familiarity of the client on the procurement system and Market competitiveness/Economic condition**, were considered as important only in private sector procurement selection by more than 50% of the respondents, and **Project Funding Method** was considered as important only in public sector procurement selection by more than 50% of the respondents.

All the other factors were identified as important in both public and private sector procurement selection. These analyzed factors were used for the second round of Delphi, which is conducted to further refine the importance of identified factors affecting procurement selection.

7. DELPHI ROUND TWO - REFINING THE IDENTIFIED FACTORS

7.1. FORMAT

In this Questionnaire the experts are asked to reconsider the factors which had been identified and analyzed from the round one Delphi survey. Same time experts have been asked to indicate the relative importance of those factors using a simple 3 – level scale: very important, important and not important. Weights for the scale as follows,

Very important	-	3
Important	-	2 (Neutral point)
Not important	-	1

7.2. RESULTS AND ANALYSIS

All together there were 30 respondents. Factors which obtained a *Percentage* value of less than 50% were disregarded and the factors which obtained a *Percentage* value of more than 50% were considered for the analysis of the round two.

Therefore for the factors **Industrial Actions, Objection from neighbour/Public, Weather Conditions/Natural Disasters** were disregarded for both sectors while **Integration of Design and Construction** was excluded from public sector procurement selection and **Payment method of the Project** was excluded from private sector procurement selection.

7.3. METHOD OF ANALYSIS OF DELPHI ROUND TWO

- A mean weighted rating is computed to deliver an indication of the importance of the factor.
- The severity index computation is used to rank the factors according to their significance in affecting procurement system selection
- Coefficient of Variation (COV) expresses the standard deviation as a percentage of the mean and it is useful to compare relative variability of different responses.

7.4. ANALYSIS OF PUBLIC SECTOR PROCUREMENT SELECTION PARAMETERS

All together 28 factors were considered for the analysis in public sector procurement selection. Out of those 16 factors are assigned mean ratings of higher than the neutral point 2, and each of them maintained a Severity Index more than 65%. Remaining 12 factors have gain mean rating less than 2. Among those factors 8 of them recorded Severity Index 60% to 65% and remaining factors scored


50% to 60% of severity index (Table 1). This indicates that among the identified factors 16 factors are seen by panel of experts as highly important in public sector procurement selection.

Statistical result obtained through coefficients of variations is a good indication of the agreement between responses of the experts. Low Coefficient of variations indicates higher level of agreement between respondents.

Among the above identified 16 factors 5 factors have coefficient of variations below 20% and remaining 11 factors ranging between 20%-35%. These are comparatively lower coefficient of variations; hence indicate higher agreement between experts. Other 12 factors have obtained coefficient of variations ranging between 35%-45%, relatively higher coefficients of variations, but still represent satisfied level of agreement between respondents (Table 1).

Table 1: Significance of Factors Influencing Public Sector Procurement Selection

Criteria	Public Sector				
	Mean Weight	Severity Index	S.D	C.O.V%	Rank
Cost Certainty	2.57	85.67	0.496	19.28	6
Price Competition	2.77	92.33	0.423	15.27	3
Financial Risk	2.30	76.67	0.586	25.48	9
Tendering Cost	1.63	54.33	0.605	37.09	27
The Early Start of Project	1.60	53.33	0.611	38.19	28
Construction Time (Speed of Construction)	1.93	64.33	0.814	42.16	18
Quality of the Product/Functionality	2.80	93.33	0.400	14.29	2
Degree of Flexibility	1.87	62.33	0.701	37.47	20
Accountability and Transparency	2.90	96.67	0.300	10.34	1
Allocation of Responsibilities	2.23	74.33	0.616	27.60	10
Disputes and Arbitration	1.80	60.00	0.748	41.57	22
Type of the Project	2.13	71.00	0.725	34.04	12
Complexity of Project	1.67	55.67	0.691	41.38	26
Payment method of the Project	2.60	86.67	0.611	23.50	5
Project Cost	1.97	65.67	0.684	34.71	17
Degree of Flexibility of the Project	2.00	66.67	0.775	38.73	16
Construction Method	1.77	59.00	0.761	42.99	23
Time Constraints	2.03	67.67	0.513	25.29	15
Availability of IT Knowledge	1.70	56.67	0.651	38.27	25
Technology Feasibility	1.73	57.67	0.748	43.27	24
Regulatory Feasibility	2.47	82.33	0.664	26.88	7
Material Availability	1.83	61.00	0.618	33.79	21
Availability of Experienced Contractor	1.90	63.33	0.764	40.20	19
Cultural Differences	2.10	70.00	0.671	31.94	13
Education of Builders	2.07	69.00	0.606	29.26	14
Institutional Bodies	2.20	73.33	0.653	29.69	11
Political Constraints	2.33	77.67	0.517	22.20	8
Finance for the Project	2.63	87.67	0.482	18.32	4

 Less Significance of Factors Influencing Public Sector Procurement Selection

7.5. ANALYSIS OF PRIVATE SECTOR PROCUREMENT SELECTION PARAMETERS

In the private sector procurement selection there were 29 factors were considered. Among those 25 factors are assigned mean ratings of higher than the neutral point 2, and each of them maintained a Severity Index more than 65%. Other 5 factors have gain mean rating less than 2 and Severity Index of 60% to 65% (Table 2). According to the results there are 25 factors which are highly important in selecting a procurement system for a private project.

Coefficient of variations of 10 factors among above mentioned 25 factors are below 20 % and other 15 factors are between 20%-30%, which are comparatively very low. Rest of them are having a Coefficient of variations between 30%-45%, relatively higher coefficients of variations, but still represents satisfied level of agreement (Table 2).


Table 2: Significance of Factors Influencing Private Sector Procurement Selection

Criteria	Private Sector				
	M.W.	S.I.	S.D	C.O.V%	Rank
Cost Certainty	2.93	97.67	0.249	8.51	1
Price Competition	2.63	87.67	0.482	18.32	7
Financial Risk	2.77	92.33	0.423	15.27	3
Tendering Cost	2.00	66.67	0.707	35.36	25
The Early Start of Project	2.57	85.67	0.496	19.28	9
Construction Time (Speed of Construction)	2.50	83.33	0.563	22.51	11
Quality of the Product/Functionality	2.37	79.00	0.454	19.16	14
Integration of Design and Construction	2.33	77.67	0.650	27.89	16
Degree of Flexibility	2.40	80.00	0.663	27.64	13
Accountability and Transparency	2.10	70.00	0.681	32.41	23
Allocation of Responsibilities	2.70	90.00	0.458	16.97	5
Disputes and Arbitration	2.27	75.67	0.717	31.57	18
Type of the Project	2.53	84.33	0.562	22.20	10
Complexity of Project	2.60	86.67	0.490	18.84	8
Project Cost	2.67	89.00	0.471	17.66	6
Degree of Flexibility of the Project	2.33	77.67	0.707	30.36	15
Construction Method	1.97	65.67	0.793	40.23	26
Time Constraints	2.73	91.00	0.442	16.20	4
Availability of IT Knowledge	1.90	63.33	0.781	41.11	27
Technology Feasibility	2.17	72.33	0.637	29.35	21
Regulatory Feasibility	2.07	69.00	0.651	31.47	24
Material Availability	2.20	73.33	0.600	27.27	20
Availability of Experienced Contractor	2.30	76.67	0.700	30.43	17
Cultural Differences	2.13	71.00	0.670	31.46	22
Education of Builders	2.73	91.00	0.771	28.25	19
Institutional Bodies	1.87	62.33	0.618	33.06	28
Political Constraints	1.80	60.00	0.748	41.57	29
Market Competitiveness	2.80	93.33	0.400	14.29	2
Familiarity of Client	2.47	82.33	0.618	25.03	12

7.6. COMPARISON OF RANKINGS OF PROCUREMENT SELECTION PARAMETERS

Table 3: Difference in Public Sector and Private Sector Procurement Selection

Criteria	Rank		Difference in Ranking
	Private Sector	Public Sector	
Cost Certainty / Completion within the Budget	1	6	5
Price Competition	7	3	4
Financial Risk	3	9	6
Tendering Cost	25	27	2
The Early Start of Project	9	28	19
Construction Time (Speed of Construction)	11	18	7
Quality of the Product/Functionality	14	2	12
Integration of Design and Construction	16	29	13
Degree of Flexibility	13	20	7
Accountability and Transparency	23	1	22
Allocation of Responsibilities	5	10	5
Disputes and Arbitration	18	22	4
Type of the Project	10	12	2
Complexity of Project	8	26	18
Payment method of the Project	30	5	25
Project Cost	6	17	11
Degree of Flexibility of the Project	15	16	1
Construction Method	26	23	3
Time Constraints	4	15	11
Availability of IT Knowledge	27	25	2
Technology Feasibility	21	24	3
Regulatory Feasibility	24	7	17
Material Availability	20	21	1
Availability of Experienced Contractor	17	19	2
Cultural Differences	22	13	9
Education of Builders	19	14	5
Institutional Bodies	28	11	17
Political Constraints	29	8	21
Finance for the Project	31	4	27
Market Competitiveness	2	31	28
Familiarity of Client	12	30	18

 Factors which are having highest difference in rankings

7.7. TEST STATISTICS TO TEST RANK CORRELATION COEFFICIENT

$$r_s = 1 - \frac{6 \sum_{i=1}^n d_i^2}{n(n^2 - 1)}$$

r_s	-	Rank correlation coefficient
d	-	Difference between rankings
n	-	Number of factors
ρ	-	Standard symbol of correlation coefficient

$$t_{cal} = r_s \frac{\sqrt{n-2}}{\sqrt{1-r_s^2}}$$

Distributed "t" with "n-2" degree of freedom

Null Hypothesis H_0 : $\rho = 0$ (There is no correlation between rankings)

Alternative Hypothesis H_1 : $\rho \neq 0$ (There is a correlation between rankings)

"t" value was calculated using the SPSS computer package and the result of the test hypothesis as follows,

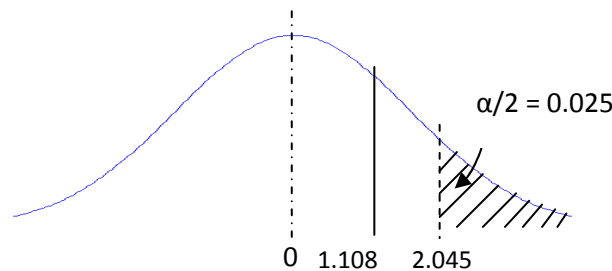


Figure 1: "T" Distribution of the Test Statistics

Decision Rule	:	Reject H_0 if $T_{cal} > 2.045$ or $T_{cal} < -2.045$
Decision	:	There is no enough evidence to reject H_0
Conclusion	:	The null hypothesis is accepted. According to that there is no relationship between the rankings.
Therefore to a 95% confidence interval it can be stated that the ranking of the significance factors affecting construction procurement selection in public sector vs. private sector is different. So, Procurement selection criteria of public sector are different from private sector.		

8. DELPHI ROUND THREE - SUITABILITY OF PROCUREMENT SYSTEMS FOR PUBLIC SECTOR AND PRIVATE SECTOR

8.1. FORMAT

In the third round of Delphi technique, experts were asked to enter a utility factor for 10 major factors which are affecting procurement selection in each sector against each procurement system, by considering the suitability of each criterion for each procurement system. Purpose of this round was to find the most suitable procurement system to achieve the major requirements of procurement

selection. Coefficient of Concordance (W) was calculated to obtain a measure of consistency for the data set.

8.2. RESULTS AND ANALYSIS

In the Delphi round three, consistency among the respondents is at a higher level, due to the fact that for almost all the factors coefficient of concordance is around 0.5 or above 0.5. Experts have had some difficulties only in assessing Allocation of responsibilities, project cost and financial risk and it is reflected by the “W” value of 0.4. But for all the factors level of significance is far below than 0.05 and coefficient of concordance is higher than 0.33, therefore it can be stated that data are reasonably consistent. Summarized results of round three are shown in table 4 and table 5.

Table 4: Utility Factors for Procurement systems in Public Sector Procurement Selection

Rank	Selection Factors Public Sector	Separated			Integrated			Management Oriented		Concordance Coefficient (W)	Significance (α)
		M.P	L.S	P.C	D.B	P.D	T.K	C.M	M.C		
1	Accountability & Transparency	94.13	79.30	89.57	61.17	60.52	54.09	76.98	74.13	0.5661	0.0000
2	Functionality of the product	85.61	76.17	69.00	69.78	66.57	59.70	88.35	88.35	0.4024	0.0000
3	Price Competition	93.26	82.83	69.57	64.57	62.35	51.74	64.13	59.57	0.5931	0.0000
4	Finance for the Project	79.80	74.35	76.00	70.52	66.45	48.30	66.55	67.25	0.3225	0.0000
5	Payment method of the Project	78.50	77.22	78.00	72.22	69.43	51.30	69.83	69.57	0.2978	0.0000
6	Cost Certainty	66.41	95.43	43.70	82.83	76.71	86.96	60.43	58.57	0.6229	0.0000
7	Regulatory Feasibility	69.60	55.60	53.08	61.20	61.40	63.60	69.00	66.00	0.4879	0.0000
8	Political Feasibility	68.60	55.60	63.08	61.20	61.40	63.60	66.00	66.00	0.4879	0.0000
9	Financial Risk	66.83	82.74	59.06	77.83	69.57	81.43	61.09	63.48	0.3855	0.0008
10	Allocation of Responsibilities	67.87	70.13	60.43	72.09	67.39	74.35	70.57	69.74	0.3368	0.0009

MP - Measure and Pay, **LS** - Lump Sum, **PC** - Prime Cost, **D&B** - Design and Build, **TK** - Turn Key, **MC** - Management Contracting, **CM** - Construction Management

Table 5: Utility Factors for Procurement systems in Private Sector Procurement Selection

Rank	Selection Factors Private Sector	Separated			Integrated			Management Oriented		Concordance Coefficient (W)	Significance (α)
		M.P	L.S	P.C	D.B	P.D	T.K	C.M	M.C		
1	Cost Certainty	66.41	95.43	43.70	82.83	76.71	86.96	60.43	58.57	0.6229	0.0000
2	Market Competitiveness	87.61	77.17	69.00	67.78	64.57	59.70	88.35	88.35	0.5024	0.0000
3	Financial Risk	66.83	82.74	59.06	77.83	69.57	81.43	61.09	63.48	0.3855	0.0008
4	Time Constraints	58.83	60.00	65.00	86.17	84.30	88.13	63.09	63.50	0.4548	0.0000
5	Allocation of Responsibilities	67.87	70.13	60.43	72.09	67.39	74.35	70.57	69.74	0.3368	0.0009
6	Project Cost	63.04	90.13	59.57	78.04	71.76	82.78	63.26	59.78	0.3827	0.0006
7	Price Competition	93.26	82.83	69.57	64.57	62.35	51.74	64.13	59.57	0.5931	0.0000
8	Complexity of Project	66.47	55.87	61.83	67.00	63.04	50.60	81.35	78.04	0.3992	0.0004
9	Familiarity of Client	97.83	90.00	73.17	72.61	57.61	59.13	43.04	42.09	0.7397	0.0000
10	Type of the Project	75.90	66.30	65.65	72.83	63.91	58.70	76.26	75.39	0.4961	0.0000

MP - Measure and Pay, **LS** - Lump Sum, **PC** - Prime Cost, **D&B** - Design and Build, **TK** - Turn Key, **MC** - Management Contracting, **CM** - Construction Management

According to the results of the round four, for the public sector, measure and pay procurement system is the most suitable one to achieve its major requirements and for the private sector there are several procurement systems which can be used in achieving its major requirements.

9. CONCLUSION

Construction procurement selection has been one of the major research areas in current practice. The reason is that, in almost all the countries construction industry is a major industry which seriously affects to the countries' economy and wrong selection of construction procurement approach usually leads to a project failure. Basically clients in construction industry can be divided into two types. There are the public clients and private clients. For both clients it is very important to select the most suitable procurement system for their projects.

This study attempts to address the problem of construction procurement selection in both public sector and private sector. The attempts were made to identify and analyze the factors which are highly influencing in the selection of a procurement system in public sector projects as well as in private sector projects and to identify the difference in procurement selection criteria of public sector vs. private sector from perspectives of clients' requirements, project characteristics and external environment factors.

Rankings of the factors were done through the mean waited ratings of each factor. Considering the public sector procurement selection, **accountability and transparency** has been the most important procurement selection parameter. Apart from that **price competition, functionality of the product, financing source** are also considered as much significant.

For the private sector **cost certainty/completion within the budget** has been the most dominant procurement selection parameter while **market competitiveness, financial risk** and **time constraints** also have given major importance in the procurement selection process.

Through the rankings of the significant factors affecting procurement selection in each sector, ranking correlation coefficient was calculated. Result of the test hypothesis proved that there is no correlation among the rankings of factors for each sector. Therefore there it can be concluded that the procurement selection criteria of the public sector is different from the private sector procurement selection criteria.

When consider the difference in selection criteria, it was identified that factors such as *Market Competitiveness, Early Start of Project, Complexity of Project, Familiarity of Client, Project Cost, Time Constraints and Integration of Design and Construction* have significant importance in private sector construction procurement selection than public sector procurement selection.

Factors such as, *Accountability and Transparency, Quality of the Product/Functionality, Payment method of the Project, Political Constraints, Institutional Bodies, Regulatory Feasibility and Finance for the Project* have significant importance in public sector construction procurement selection than private sector procurement selection.

According to the assessment of suitability of alternative procurement systems for both sectors, it is clear that although private sector now moving into new procurement paths still public sector heavily preferred with the traditional measure and pay system. The reluctance of the public sector to use other non-traditional procurement methods is due to the bureaucratic barrier created by financial and administrative regulations of the country. Among others, transparency and public accountability are very important requirements in public work projects. Measure and Pay procurement method ensures both transparency and accountability compared to any other method. These findings explain, why in Sri Lanka, majority of public works are procured using Measure and Pay system.

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Capacity Building towards Sustainability: Context of Post Disaster Waste Management

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ABSTRACT

Concept of Capacity Building is an essential component in development theory and practice. In developing countries, it is identified as a key concept in achieving sustainability. In particular, in post disaster scenarios, focus has been placed upon local capacity building as a means of increasing resilience to natural hazards. In this context, this paper focuses on concept of capacity building and its role on achieving sustainable post disaster waste management. A literature review and pilot study have been conducted to gather information on post disaster waste management in Sri Lanka. Semi-structured interviews were held as the main data collection method and content analysis was used to analyse collected data. Unavailability of a centralized body, poor implementation of rules and regulations; lack of skills and confidence, inadequate funds, lack of communication and coordination were identified as prevailing capacity gaps in post disaster waste management. Thus, finally paper proposes a framework for capacity building for sustainable post disaster waste management.

Keywords: Capacity building, framework, Disaster waste management, Sustainability,

1. INTRODUCTION

Concept of capacity building became an essential component in development theory and practice in recent years. Specifically in developing countries it has been identified as a key concept in achieving sustainability (Hartwig *et al.*, 2008). Though there is no agreement as to what is meant by sustainability it has been interpreted as ensuring adoption and maintenance of communities and local organizations to cope future challenges while achieving set objectives (Bracht *et al.*, 1994). Boyd and Juhola, (2009) indicate that capacity building provides an opportunity to understand strengths, weaknesses, threats and opportunities towards a resilient future through identification of broader issues around sustainable development of a particular program, project or process, including their unique cultural, social, and ecological characteristics.

Webb and Rogers (2003) indicates that capacity building becomes dominant in disaster management, policy and practice, specifically in developing communities more vulnerable to disasters in developing countries. Many argue that developing countries are particularly vulnerable to advance impact of climate change due to poverty, weak governance and ecosystem degradation. Blakely (2007), highlighted that by focusing long-term debris planning and setting measure for ecological and economic sustainability, can improve the region's resilience to future disasters. Furthermore, Deutz and Gibbs (2004) indicates, the expansion of recycling capabilities and eco-industrial planning results in more job creation and promote partnerships. However, building capacity is becoming a challenge

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with rapidly changing social, economic and technological drivers, polices and various players involved in disaster management.

This is equally applicable to Sri Lanka where United Nations Environment Protection report (2005) highlighted that debris created by the tsunami of 2004 was not properly disposed, reused or managed. Further, National Symposium on Disaster Risk Reduction and Climate Change Adaptation held in 2009 highlighted undermining sustainable development as a one of the key issues prevailing in Sri Lanka (Munasinghe, 2009). The said speaker further emphasized on adverse impacts of climate change and the role of stakeholders towards sustainable development through research on building local capacities on human skills, technology, data models, methodology etc. In this context, this paper focuses on identification of capacity gaps exists in post disaster waste management and how to enhance capacities towards sustainability.

2. LITERATURE REVIEW

2.1. CAPACITY BUILDING AS A SUSTAINABLE APPROACH

LaFord *et al.* (2002) stated capacity building can be defined as either as a process or outcome activity that improves the ability. He further argued that capacity building can be seen in two extremes where in one extreme resides the increase of knowledge and development of skills of individuals through training programs and the other, in a much broader context which integrates wide range of systems such as policy making, management and finance.

Capacity building has been identified as a key concept in achieving sustainability in developing countries whereas absence of knowledge and practice on sustainable concepts is a major challenge visible in various fields. The report of World Commission on Environment and Development (1987) defined sustainable development as, “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Furthermore, many have identified that it does not mean self sufficiency whereas communities need to exchange best practices and there are no environmental impacts, where population growth and economic decentralization may get impacted in absence of any adaptation. In addition, sustainability does not imply change of human spirit, whereas it motivates humans towards actions which will sustain a community (Braden and Van Ierland, 1999). Serageldin (1994) stated that most important element of sustainability is to get institutions right in the sense of engaging all people to overcome consequences of short and long term impacts of social, economic and environmental aspects (Hayles, 2003). However, Hassan (2001) predicted that increasing trends of population growth, consumption of materials and energy, environment degradation and human needs will direct towards non sustainability. This is equally applicable to the context of disaster management with rapidly changing social, economic and technological drivers, polices and various players involved. Next section of the paper discusses capacity building with relation to disaster waste management.

2.2. CAPACITY BUILDING IN POST DISASTER WASTE MANAGEMENT

Kennedy *et al.* (2008) highlighted the importance of integrating relief and development together by introducing capacity building and capacity development of local and national partners in post-disaster programmes for future resilience. It becomes dominant in disaster management, policy and practice, specifically in developing communities more vulnerable to disasters in developing countries (Webb and Rogers, 2003). Hyogo Framework for Action 2005-2015 (UNISDR, 2005) also highlighted the importance of institutional capacity building to prevent, prepare and respond to disasters to enhance resilience of disaster-affected communities (World Disaster Report, 2004). This means building on existing resilience, which essentially makes an emphasis on enhancing capacity of affected communities to recover with little or no assistance following a disaster (UNISDR, 2005; Tadele and Siambabala, 2009; Haigh and Amaratunga, 2010). Accordingly, in any event, above stand evidence

for importance of addressing all phases of disaster management cycle: Emergency Response and Relief; Recovery and Reconstruction; Mitigation and Preparedness, rather than responding solely to immediate needs of emergency, particularly, making grants to build capacities to enable local communities to develop internally to face future emergency.

In a disaster, generation of waste is unavoidable. Generally, waste is defined as any losses produced by activities that generate direct or indirect costs but do not add any value to the product from the point of view of the client (Formoso *et al.*, 1999) or any substance or object which the holder intends or is required to discard. Peterson (2004) indicated that disaster waste become critical as it differs from the normal situation which generates waste in a more or less stable quantities and composition whereas in a post disaster, it radically changes in type and quantity. Specifically, disaster waste may contain or be contaminated with certain toxic or hazardous constituents. Srinivas and Nakagawa (2007) indicated that disaster debris as the most critical environmental problem faced by countries affected by the Asian Tsunami 2004. Further, General Accounting Office report on *Hurricane Katrina: Continuing debris removal and disposal issues* also highlighted that how failures in disaster debris management continue to impact on environmental health of citizens at the end three years (GAO 2008). Thus, importance of focusing on long term ecological and economic sustainable debris management strategies for resilience to future disasters is emphasized by Blakely in year 2007. Further, Lauritzen, (1998); Baycan and Petersen, (2002) highlighted the need of designing early stage strategies to be managed debris in the most environmentally sound manner through maximizing source reduction and recycling options while minimizing land disposal. Specifically, it is essential for long term peace, stability and security in disaster prone countries, particularly, in developing countries where affected communities rely heavily on natural resources for survival. Thus, it is important to maximize environment sustainable values while minimizing disaster waste generation and impact.

In this context, UNDP (2005, p2) collaboration with external assistance launched “The Tsunami Recovery Waste Management Programme (TRWMP) aiming to build capacity and Poulsen (2007) introduced four streams for capacity building specifically for post disaster waste management in national level institutions. Furthermore, Van der Wel and Post (2007) discussed evaluation measures on capacity building on disaster waste management and Ardani *et al.* (2007) discussed measures to overcome barriers with respect to deconstruction, segregation and sorting, establishment of permanent recycling infrastructure and enhancement of eco-industrial networks. Accordingly, the importance of long-term efforts on capacity building in disaster waste management are vital in order to identify risks, responds appropriately and take measures for sustainable recovery for future resilience.

In Sri Lanka, risk assessments conducted in recent past indicated that most disaster waste management programs conducted at local levels with collaboration of NGOs do not consistently meet current best practices due to lack of readily available guidance, practical procedures and resources (UNDP, 2005; UNEP 2005). In 2007, National Disaster Management Committee of Sri Lanka also indicated that capacities of Sri Lankan institutions are inadequate for successful disaster management (DMC, 2009). Thus, there is a significant necessity to evaluate existing capacities of disaster waste management in Sri Lanka. In this context, forthcoming section of the paper explains research methodology adopted for identification of existing capacities of disaster waste management.

3. RESEARCH METHODOLOGY

Literature review and documentary survey was conducted on capacity building in various disciplines with special emphasise to post disaster waste management to identify capacity building principles, strategies, evaluation measures and challenges. A framework as developed based on these secondary data, which was strengthened by a pilot study using exploratory case studies.

Primary data were collected through several exploratory case studies using interviews. These case studies include both government and non government organisations that involve in disaster waste management at national level in Sri Lanka. A detail of profile of pilot study is illustrated in table 1.

Table 1: Profile of pilot study

Organisation	Type	Designation
Disaster Management Centre	Gov.	Director
Central Environment Authority	Gov.	Director
Cost Conservation Authority	Gov.	Senior Engineer
Solid Waste Management Authority	Gov.	Deputy Director
Sarvodaya Shramadana Movement	Non-Gov.	Manager
International Union for Conservation	Non-Gov.	Coordinator
Sri Lanka RedCross	Humanitarian	DM, Coordinator

Four number of government institutes covering Ministries, Departments, Authorities and three number of non government organisations covering INGOs, NGOs, Humanitarian were selected for data collection. One interviewee from each case was selected from top or middle management involved in post disaster management processes having experience in waste management. Semi-structured interviews were conducted to gather data as it facilitated in depth analysis and gather different views and opinions of respondents within the scope of study.

Content analysis was used in order to analyze collected data. Nvivo software was used for easier and speedy content analysis. Relevant coding structures were prepared using software and analysed in order to determine existing capacities of national organisations. Coding structure prepared mainly focuses on two sections, existing status and issues as illustrated in figure 1.

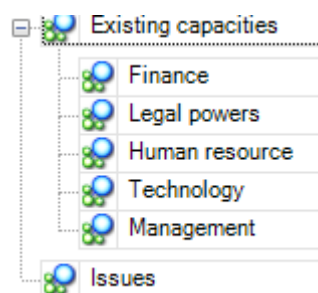


Figure 1: Coding structure

Next section explains the findings of the study.

4. FINDINGS

4.1. EXISTING STATUS

In the case of post disaster waste management, except projects implemented at Amapara and Hambantota districts, there were hardly any others worthy of mention except for the COWAM (Construction Waste Management) training and consulting centre project. It functions as a centre for training and consulting for region as well as to local authorities in the country on sustainable C&D

(Construction and Demolition) waste management which was initiated as a product of the Asian Tsunami of 2004 (Raufdeen, 2009). The main purpose of the project includes collection, sorting and recycling or reuse of construction waste as road construction material. Amapara and Hambanthaota districts' waste projects are targeted at recycling of plastic items and composting of degradable components (Van der Wel and Post, 2007).

Further, in-depth review on national level policies for disaster management (Refer Disaster Management Act no 13 of 2005) and waste management (Refer National Environmental Act 1981) revealed that there are no provisions for disaster waste management. Disaster Management Act only states that disaster management council shall provide protection for environment and maintain and develop affected areas (Disaster Management Act, 2005) whereas National Environmental Act addresses general solid waste management (Raufdeen, 2009). In Sri Lanka, C&D waste is still classified as solid waste as there are no regulations specifically dealing with C&D waste. Further, National Disaster Management Plan and National Emergency Operation plan in progress which would be enforceable in near future also have less provisions for disaster waste management.

Further, findings revealed that in large scale disasters C&D debris have been managed with the collaboration of national level organizations. Role and functions of an organization in disaster waste management varied based on type of disaster. As a result, organizations do not owe any responsibility over disaster waste made contributions at massive disasters in their own specialized areas. For example, while one organization cleaned roads, another cleared debris from the sea shore. Moreover, some organizations provided equipment and technical knowledge whereas some other organizations gave financial assistance.

4.2. ISSUES

Lack of knowledge and expertise about waste management was one striking factor behind implementation of projects to a wider audience facilitating knowledge sharing and dissemination. In most of the cases, international assistance is sought to recover from such situations whereas local participation, involvement and capacities are either not adequate or not given attention. This is further affected by inadequacy of a regulatory framework and institutional capacity to deal with problems of the country in the past, specially after the tsunami. Further, this was affected by political impacts, civil war and unavailability of pre-defined objectives. In addition, capacity constraints of both government and non - government agencies involved in post disaster management. Line of authority, delegation and devolution, training, communication and information management systems, power imbalances, lack of clarity in policy directives, community consultation, use of indigenous knowledge and people's participation, attention on legal and judicial aspects and awareness raising as key capacity issues noted to be affecting the government sector. Mismatch between large inflow of funds and relatively lesser absorptive and processing capacities, donor deadline requirements within an unusual implementation environment, accountability to donor public of money raised, necessity to spend money quickly, lack of decentralization in decision making, rapid expansion of INGOs and competition between international and local NGOs are some key capacity related issues identified in the non government sector. DMC itself indicated difficulties in executing its tasks due to lack of statutory power vested with it. Additionally, incapacities of transport and communication services, difficulties in recruiting staff, office accommodation and infrastructure development are identified as significant factors having an adverse effect.

Lack of coordination among different level organizations, including government agencies, NGOs, International NGOs and donors appeared to be a common issue. In spite of local contribution, it was observed that external interventions played a significant role in recovery process. However, unavailability of guidance for international donors' (INGOs) affected funding for local NGOs and CBOs which otherwise would have got complemented with capacity building, enhance their abilities to respond and support community development efforts in the long-term.

Accordingly, with reference to findings the status of capacity of post disaster waste management established the necessity of capacity building for sustainable post disaster waste management in Sri Lankan context. Further findings established most capacity requirements identified relate with the functions of national level agencies involved with the disaster waste management, such as planning, coordinating and implementation of statutory enforceable legislations, resources allocation, budget allocation etc. Thus, next explains proposed framework for capacity building for post disaster waste management at national level agencies developed based on secondary data and refined with pilot study findings.

5. PROPOSED FRAMEWORK FOR CAPACITY BUILDING

Proposed framework for capacity building for disaster waste management is illustrated at figure 2. In developing the framework various assumptions were extracted from other sectors such as health and public administration identified through secondary data. Further, proposed framework is refined with accordance to pilot study findings. Capacity building is considered with following characterises for the proposed framework:

- Dynamic and a continuous process.
- Two levels - human resource and organisational, contributing institutional and legal development.
- Shall lead to improvement of performance.
- Shall be influenced by the external environment.
- Contribute towards sustainability.

Accordingly, proposed framework consist with two capacity building levels and seven principles for capacity building towards effective and efficient disaster waste management as illustrated in detail below. This proposed framework will be further enhanced and validated through detailed case studies and expert opinions which are intended to conduct in future. Hence, proposed identical capacity building levels and principles will be established through these findings.

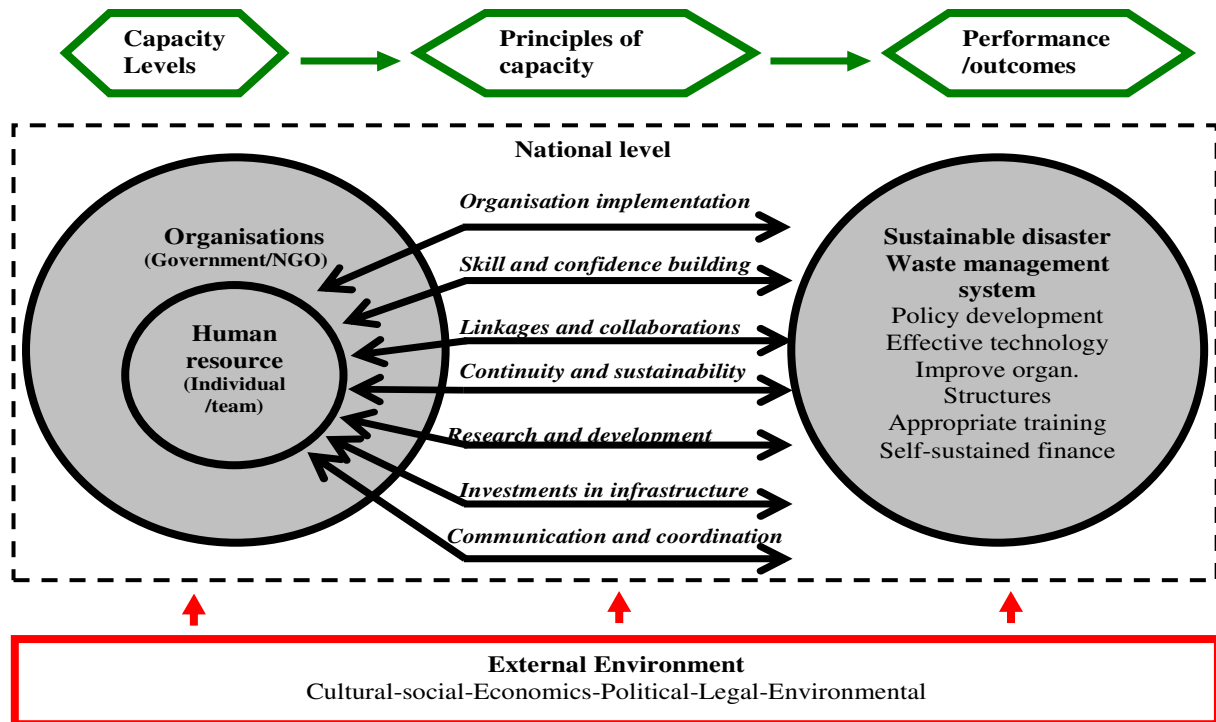


Figure 2: Framework for capacity building for post disaster waste management

5.1. TWO LEVELS OF CAPACITY DEVELOPMENT

Two levels of capacity development known as human resource and organisational levels are identified for capacity building for sustainable disaster waste management. Human resource development (individual & teams) addresses issues pertaining to skills and access to information, knowledge and training that enables to perform functions effectively at national level agencies. Organisational level development focuses on issues pertaining to structures, processes and procedures within organizations and maintaining relationships with other organizations and sectors. Development of these two levels of capacity will eventually lead to establishing statutorily enforceable rules and regulations for sustainable disaster waste management (institutional and legal development) which is not available in Sri Lanka. Though the two levels target different interventions to measure effectiveness it should not be considered in isolation. One level may impact on capacity development and the other can cause a synergistic or detrimental effect on the other.

5.2. PROPOSED PRINCIPLES OF CAPACITY BUILDING

There are seven proposed principles represented by arrows within the diagram which indicates activities and processes that contribute towards capacity building. The arrows cut across structural levels indicating that activities and interventions may occur within, and across, structural levels. The arrow heads point to both directions suggesting that proposed principles applied to each structural level can impact on other levels. Brief description of each proposed principle is explained in table 2.

Table 2: Proposed principles of capacity building

Principles	Description
Skills and confidence building	Focuses on human resources education and training to improve ability to perform functions. Further this involve with developing policies and position statements supporting concepts of career progression, retain employees etc.
Organizational implementation	Focuses on improving organization structures and processes related with disaster waste management. This involves establishing goals, institutional hierarchy for disaster waste management and formal and informal communication
Linkages and collaborations	Focuses on building partnerships and collaborations as a means of building capacities by mechanisms which exchange skills and practice knowledge. The linkages that exist for disaster waste management includes universities, researchers, professional groups, policy makers, UN agencies, government and non government organizations, community groups and different countries.
Continuity and sustainability	Focuses on continuously maintaining acquired skills and knowledge. This can be enabled by providing opportunities to extend skills and experience which may be linked with a concept of career development.
Investments in infrastructure	Focuses on investing in infrastructure to enable smooth and effective management of post disaster waste. Hence, information on calls for funding, fellowships and conferences is important for long term survival.
Research and development	Focuses on developing research capacity in disaster waste management that is useful for practice. This will add new knowledge and inventions close to practice enhancing effectiveness and efficiency of post disaster waste management. This involves creating opportunities for research such as scholarships, funds etc.
Communication and coordination	Focuses on avenues of enhancing communication and coordination capacities of post disaster waste management. This will address issues encountered among non government organizations and volunteer groups related to communication and coordination such as non existence of practical guides, transparency and accountability.

As discussed, the proposed framework sets out a tentative structure by which capacity building can be enhanced for disaster waste management.

6. CONCLUSION

Literature and pilot study established the necessity of sustainable post disaster waste management system in Sri Lanka. Among a wide range of approaches, capacity building was identified as the ultimate aim of improved practices which are sustainable. This paper identified values gained by capacity building in general, disaster management and specifically in post disaster waste management. Pilot study revealed unavailability of enforceable legislation, non-availability of institutional framework, lack of coordination and communication, non-availability of district and divisional contingency plans, less political will and inadequate resources including finance, equipments and labour as key capacity gaps prevailing in post disaster waste management. These established the importance of capacity building of post disaster waste management processes through enhancing capacities of individual, organizational, institutional and community levels with skills development, information management and resource acquisition for a sustainable system. Accordingly, paper presents a proposed framework with probable approaches to enhance capacities of national level agencies for effective disaster waste management in Sri Lanka. This framework together with the proposed principles will be further established through detailed case studies in the next phase of this research.

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Disability Access in Public Buildings

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ABSTRACT

Rapid ageing, rise of road accidents, manmade and natural disasters, debilitating medical conditions and often invisible ailments cause more and more people with lowered ability to move freely. This is equally applicable to Sri Lanka which is adversely impacted by 30 years civil war and there are an estimated 900,000 disable people which mean around 5% disabilities from the population.

In this context it is vital to provide them with basic facilities to live independent lives on an equal basis with others and acquire their contribution to national economic development through employing them in effective manner for sustainability. Sustainability in built environment involves promoting efficient buildings and minimizing their burden on environment, involving them on contribution of economic development, while protecting and restoring green systems, and enhancing the well-being of all people in general. Therefore it should focus on barrier free environment when designing buildings.

Whilst discussing for the creation of barrier free environment, it has been created some drawbacks focus on most people neglect the disability access when planning and designing. Within this context this paper presents existing facilities available for disability access in public buildings in Sri Lankan context including critical review on available policies for building design for disability access. Comprehensive literature review, pilot survey and industrial survey was carried out to assess the disability access in public buildings such as banks, educational, hospital, office and administration, railway and bus stations and results revealed that the attention paid on disability access in public buildings were not up to the satisfactory level.

Keywords: Disability, Disability Access, Public buildings

1. INTRODUCTION

A person with disability means any person who as a result of any deficiency in his physical or mental capacities, whether congenital or not, is unable by him self to ensure for himself, wholly or partly, the necessities of life (Ministry of Social Services, 2005). Disables were increased day by day due to the civil war and road accident and large segment of disabled persons in Sri Lanka are young, between the ages of 20 and 30. A study revealed that are 43% for intellectual disability and 45% for mobility disability, 72% for psychiatric disability, 81% for hearing disabilities are 88% for those with speech disability (Asia Pacific Regional Seminar, 2006).

According to the Act No 28 of 1996, for the protection of rights of the persons with disabilities, implement “National council for persons with disabilities”. According to this council there are rules to protect the rights of the persons with disabilities. In addition to ministry of social services published

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the guidelines “Promotion of accessibility to built environment for protection with disabilities” this also said requirements of disability access. The new legislation titled ‘Disability rights act’ Act No 1 of 2006 was made to amend the above regulation after seeking observations and recommendations from professionals including Sri Lanka, the institute of Architects and the Colombo municipal Council (Jegarasingham, 2009). Furthermore when designing building there should be followed Urban Development Authority rules and regulations; it is including rules and regulations correlated with disability access. According to above rules and regulations there should be appropriate accessibility facilities for disable peoples.

Sustainability in built environment involves promoting efficient buildings and minimizing their burden on environment, involving them on contribution of economic development, while protecting and restoring green systems, and enhancing the well-being of all people in general. Therefore it should focus on barrier free environment when designing buildings. Whilst discussing for the creation of barrier free environment, it has been created some draw backs focus on most people neglect the disability access when planning and designing. Within this context this research aimed to explore existing facilities available for disability access in public buildings in Sri Lankan context including critical review on available policies for building design for disability access. The objectives can be identified as to identify various types of disability groups, identify the problems faced by disability people during the access, identify building rules and regulations for disability access and evaluate existing facilities available for disability access in public buildings.

2. LITERATURE REVIEW

2.1. DISABILITY ACCESS IN BUILDINGS

A person with a disability means any person who as a result of any deficiency in his physical or mental capacities, whether congenital or not, is unable by himself to ensure for himself, wholly or partly, the necessities of life (Ministry of Social Services, 1998). The World Health Organization has adopted international classifications on "impairment", "disability" and "handicap". There is a clear distinction between these three terms. Previous terminology to define these terms reflected a medical or diagnostic approach. The new definitions represent a more precise approach. People with visual, hearing and speech impairments and those with restricted mobility or with so-called "medical disabilities" encounter a variety of barriers. From the perspective of diversity in unity, it is useful to clarify distinctions among three commonly used terms.

Number of disabilities are increasing day by day with several reasons such as the on going civil war, road accidents, increasing proportion of elders, etc. although be consider that all people are different, some are made “disabled” by ‘barriers’ in the society; ignorance, lack of access to resources, discrimination etc. it is acknowledged that rights of disabled people, including right to appropriate rehabilitation, medical treatment, aids and equipment if needed, are not properly addressed they also can work and participate at increasing our national productivity. But they have special requirements than a normal person. Presumption that people who have disabled are ‘abnormal’ or sick is wrong. By providing necessary environment disabled people can be “able” in different terms.

“As well it should, the subject of disability appears now to be an increasing matter of interest in the mass media and among the mass media and among the general public. There is certainly a greater concern in our society about the situation of their social and economic deprivation is slowly surfacing to become a topic which must at least be discussed” (Daily News, 2006).

Discussing about rights and requirements of disabled people is essential, because in local context, (according to ministry of social services of Sri Lanka) about 12% of the Sri Lankan population are either disabled or aged citizens. Therefore it is necessary to be concerned about a barrier free built

environment. According to the Ministry of Social Services there are four major groups of disabled people as;

- Persons with impaired hearing
- Persons with intellectual impairment
- Persons with impaired vision
- Persons with physical disabilities

The number of people being with some disabilities, it can be smaller than other people. But people who disabilities are an important group, because they need special facilities for access than other people. That's why designers must pay special attention to provide such facilities to ensure barrier free access. Problems arise on design considerations can be summarized as follows.

1. Unexpected vertical changes of levels (kerbs, steps, ruts, gutters etc.) are avoiding continuous accessible path of travel.
2. Excessive slope (camber) across direction of travel on a footpath which makes control of the wheelchair difficult.
3. Inadequate provision of space into doorways and within rooms to allow for wheelchair dimensions and turning circles.
4. Not provide Specific attention to steps and handrail design to ensure adequate support and a feeling of confidence and ease when negotiating steps.
5. Seating is not consisting of waiting areas, at counters and along lengthy walkways to reduce tiredness.
6. Access vulnerability associated with doors, including the need to manipulate a handle while using a walking aid and difficulty in moving quickly through swinging doors.
7. Visual signs are not very clear and accurate. A flashing light unaccompanied by a message can be confusing (e.g., a flashing fire exit sign would be preferable to a flashing red light; it gets the message across much more quickly).
8. Lack of providing loud speakers with supplementary messages of public premises, e.g. railway stations, bus stations and air ports with visual messages.
9. Edges of walls, furniture and other items are not rounded to prevent physical injury if people walk into them
10. Unguarded projections are accessible barriers. Such a height that someone who can not see them would be in danger of walking into them.
11. Due to obstructions along corridors or hallways such as cupboards and etc are disturbed to continuous accessible path.

2.2. RULES AND REGULATIONS REGARDING DISABILITY ACCESS

Ministry of Social Services published rules and regulations for promotion of accessibility to built environment. Table 1 represent identified requirements of people who have physical impairments.

Table 1: Basic design requirements for disable people (Source: Ministry of Social Services, 1998)

Item	Basic design requirements
Entrance	Even and slip resistance surface.
	1300 mm or wider.
Doors and openings	Doors can be easily open by Disabled people.
	900 mm or wider.
	Space to manoeuvre wheelchair while opening.
	Height of thresholds 15 mm or less than 15 mm.
Stairs, steps and hand rail	Same tread and rise throughout the staircase.
	Nosing not protruding.
	Tread at least 300 mm.
	Rise 150 mm or less.
	1300 mm minimum wider.
	If more than 12 steps, there is a landing 1300 mm long.
	Handrails provided at a height of 900 mm for both end.
	Width is 1300 mm (1000 if short).
Ramp	preferred gradient 1:20, but requested 1:12
	If steeper than 1:12, is there an alternative, stepped approach.
	Length of landing 1300 mm. not sloping more than 1:50
	Kerbs at edges 75 mm.
	Double hand rails provided at height of 700 and 900 mm.
	Continuing 300 mm at both ends of ramp.
Lift	The internal lift space must be at least 1100mm wide x 1400mm clear depth internally and preferably 2000mm wide and 1400mm deep.
	Within the car and at each landing there must be audible announcements and a clear visual display of the level reached.
	The lift controls should be clearly distinguishable and easy to operate, giving clear visual and tactile indications of the floor buttons pressed.
	Within the car the controls should be located on a side wall.
	An alarm button should be provided, with a repeater light to show that the alarm bell has sounded.
	The emergency telephone in the lift must incorporate inductive couplers for hearing aid users.
	There should be clear space of at least 1500 x 1500mm in front of the lift.
	Width 1800 mm or more.
Verandas/ corridors	Located on ground floor
Toilets	Continuous accessible path from entrance to toilets.
	Door open outwards
	Door opening width at least 900 mm
	Floor area at least 1700X1700 mm
	Grab rails provide at a height of about 700 mm
	Seat available to those who cannot squat or commode available.

According to "Protection of the Right of Persons with Disabilities Act, No.28 of 1996" it is required that all new constructions are to be designed that they can be entered in such way used by people with disabilities. To achieve functional access and meet legislative requirements, it is recommended that disability access issues be planned for at documentation and construction stages of a development project. To ensure compliance and quality control, it is recommended that access requirements be specifically considered at following six stages of the construction process.

2.2.1. ACT, NO.28 OF 1996 : PROTECTION OF THE RIGHT OF PERSONS WITH DISABILITIES

The Act for the Protection of the Rights of Persons with Disabilities came into effect on 24th October 1996 by proclamation in the Gazette of the Democratic Socialist Republic of Sri Lanka (The Gazette, 1996). A Bill for its enactment had been presented to the Parliament on 09th August 1996 by the Minister of Health, Highways and Social Services (Official Report (Hansard) of Parliamentary Debates, 1996). This Bill was passed unanimously on 17th September. It is not often that members of both the Government and Opposition concur in the Parliament (Parliament of the Democratic Socialist Republic of Sri Lanka, 1996), and this unanimity is a significant indication of national support for the Bill and the subsequent Act, and for what it sets out to do. The Act principally provides for the establishment of a "National Council for Persons with Disabilities" which will be concerned with all matters concerning the promotion, advancement and protection of the rights of persons with disabilities in Sri Lanka.

There had been in existence from 1989 a "National Council for Coordinating the Work of Disability Organizations" appointed by the Minister of Social Services. With stimulation being provided by the Sri Lanka Office of the Swedish Handicapped Organization International Aid Foundation (SHIA), discussions started within this Coordinating Council about the necessity for legal provision to safeguard the Rights of People who have Disabilities. Accordingly, a Technical Sub-Committee was set up five years ago with the membership consisting largely of people who have disabilities. The Organisations represented included the Sri Lanka Federation of the Visually Impaired, National Council for the Blind, Central Council for the Deaf, Sri Lanka Association of Physically Handicapped Technicians, Sri Lanka Association for the Mentally Retarded (which has a large representation of parents in its membership), other non-governmental organizations working in the disability field, and the various line Ministries.

The task of the Technical Sub-Committee was to prepare the draft legislation. This was submitted to the Ministry in 1994. The draft legislation submitted by the Technical Sub-Committee was finalized by the parent body and the Ministry, and presented to the Cabinet of Ministers, and following their approval, to the Parliament. The UN World Programme of Action Concerning Disabled Persons, the UN Rules for the Equalization of Opportunities, and the Constitution of Sri Lanka provided both the basis and the background documentation for the formulation of the Act. Ratification by Sri Lanka of the ESCAP (Economic and Social Commission for Asia and the Pacific Region) Resolution No 48/3 declaring the period 1993-2002 as the Decade of Persons with Disabilities in the Asia-Pacific Region and identification of the formulation of legislation as one of the regional priorities for the decade gave a considerable momentum to the process described above leading to the enactment of this much needed legislation in the form of the Act.

The Act provides the necessary legislation to implement the national policy on rehabilitation. The Act established a "National Council for Persons with Disabilities" and gave it a legal status to take action regarding all matters concerning "the Promotion, Advancement and Protection of the Rights of Persons with Disabilities". The Act is, therefore, at the same time a comprehensive statement of the national policy on rehabilitation. It should also be mentioned that in the Act a person with disability is defined as any person who, as a result of a deficiency in physical or mental capability, is not able to ensure for himself or herself the necessities of daily life. It is thus a reasonably broad definition, encompassing the conventional socio-economic basis and definition of "handicap". The Act has five major provisions as follows.

1. Establishment of a National Council for Persons with Disabilities

The purpose of the Council is to take any and all necessary actions to promote and safeguard the interests of people who have disabilities, which include initiating, implementing and sponsoring programmes to meet their needs, monitoring and evaluating State and NGO activities, recommending policy and research, information collection and dissemination. The Act empowers the Council to work autonomously in all these activities.

2. Establishment of a "National Secretariat for Persons with Disabilities"

This is the implementing arm of the Council. Its proposed organizational structure describes the manner in which it aims at fulfilling its role of carrying out the Council policy and strategy.

3. Establishment of a "National Fund for Persons with Disabilities"

The National Fund deals with all the financial transactions of the Council, both receiving funds voted by the Parliament for the use of the Council donations, aid and grants, and paying out all such finances required for expenditure by the Council.

4. Registration of Non-Governmental Organizations (NGOs)

All NGOs working in the disability field are required, under the Act, to be registered with the Council. Fears that this is a repressive measure are unfounded. This provision has been made to give the Council the necessary powers to prevent the exploitation of individuals who have disabilities and disabilities itself. It will also no doubt be valuable in enabling the Council to facilitate coordination between the State and NGO sectors.

5. Protection of Individual Rights

The fifth major provision deals with individual rights, making particular mention of discrimination in employment and educational aspects and access to public places. It also describes legal measures that may be taken in instances where individuals have been discriminated against, empowering Provincial level Judicial Institutions to deal with such matters, and gives the Council powers to act on behalf of individuals when necessary.

3. RESEARCH METHODOLOGY

Initially a comprehensive literature survey was carried out to investigate the rules and regulations which made for the protection of disability access rights. To analyze critical problems about disability access, an industrial survey was conducted. Consequently arranged to do a pilot survey contained by disability organizations for decide on significant disability group and important types of buildings. After that quantitative research was carried out to collect prevailing facilities available for Disability Access. Main objectives of the pilot survey were to identify the main disability types to be considered, and also the types of buildings important to disability people. For the selection of better scope to the research a pilot survey was carried out by selecting 15 Non-Governmental organizations (NGO) over 20 number of identified main Disability organizations which registered by Ministry of Social Services.

According to the pilot survey this research mainly considered on “people who have physical impairment” affecting movement. Research was carried out for Public Buildings and the scope was limited to buildings which are situated in Colombo metropolitan area. As general access points identified Entrance and exit, Doors and opening, Staircase, Lift, Ramp and also as a special access requirement identified toilet and sanitary access for the Questionnaire Survey. UDA regulations were followed for the above selection but it is only indicating important items. For the additional details, “Planning and Design Guideline” was referred which was published by Ministry of Social Services.

According to pilot survey 5 types of buildings were selected. Used limitations to selected sample of the each type of buildings such as,

- Banks

According to research scope it was difficult to assess all banks within Colombo metropolitan area. In that case head offices were selected of the pioneer banks.

- Educational Buildings

As educational buildings selected major Government and semi government colleges within Colombo metropolitan area.

- Hospitals and nursing homes

Government and main private hospitals were selected for hospital buildings.

- Office and administration Buildings

Colombo metropolitan area consist of large number of offices and buildings, which were randomly selected which are mainly people use for there general activities

- Railway and Bus stations

Mainly considered Bus stations and railway stations are within Colombo metropolitan area.

Ten buildings were elected for the questionnaire survey from each building types and through observations collected necessary data from selected buildings.

4. SURVEY FINDINGS AND SUMMARY

Followings Table presents the survey findings of selected five types of buildings, in accordance with necessary requirements.

Table 2: Survey findings of selected five types of buildings, in accordance with necessary requirements

Item	Design requirements	Total percentage Achieved "Yes"				
		Banks	Educational	Office and Administration	Hospital	Railway and Bus station
Entrance / Exit	Even and slip resistance surface	90%	70%	100%	100%	80%
	900 mm or wider	100%	100%	100%	100%	90%
Doors and opening	Doors can be easily open by Disabled people	70%	60%	80%	100%	60%
	900 mm or wider	100%	90%	100%	100%	50%
	space to manoeuvre wheelchair while opening	90%	50%	100%	100%	30%
	Height of thresholds 15mm or less	60%	40%	60%	90%	30%
stairs	Uniform Risers and Goings	100%	90%	100%	100%	80%
	Tread at least 300 mm	100%	80%	100%	100%	80%
	Rise 150 mm or less	90%	90%	100%	100%	80%
	900 mm minimum wider	100%	100%	100%	100%	70%
	If more than 12 steps, there is a landing 1300 mm long	30%	100%	90%	100%	10%
	Handrails provided at a height of 1000 mm for both end	60%	70%	70%	70%	50%
ramps	Ramp and landing surfaces should be slip-resistant	40%	0%	20%	100%	0%
	Width is 1200 mm (1000 if short)	40%	0%	20%	100%	0%
	Landing every 10 m	10%	0%	0%	0%	0%
	Kerbs at edges 75 mm	10%	0%	0%	10%	0%
	Double hand rails provided at height of 700 and 900 mm	20%	0%	10%	20%	0%
Lifts	Lift Door should wide enough for wheelchair users	90%	0%	80%	100%	0%
	There should be clear space of at least 1500 x 1500mm in front of the lift.	70%	0%	80%	100%	0%
	The internal lift space must be at least 1400mm x 1400mm	20%	0%	80%	100%	0%
	Control panel can be operate by wheelchair user	60%	0%	50%	80%	0%
Toilets	Located on ground floor	100%	60%	100%	100%	70%
	continuous accessible path from entrance to toilets	60%	20%	70%	100%	20%
	Door open outwards	0%	0%	20%	30%	0%
	Door opening width at least 900 mm	60%	50%	90%	90%	20%
	Floor area at least 1700X1700 mm	80%	40%	50%	90%	20%
	Grab rails at a height of about 700 mm	0%	0%	0%	60%	0%
	seat available those who cannot squat or commode available	90%	50%	90%	100%	0%

5. DISCUSSION OF SUMMARY

5.1. HOSPITAL BUILDINGS

While considering Hospitals most of the people are accessing these types of buildings for their medical and health reasons, not only people who have disabilities but also normal. Hospitals are often using wheelchairs and trolleys for the purpose for the patient. Hospitals use two types of disabled people, such as permanently disabled people who use wheelchairs and other type is temporary disabled people. Ramps are the other critical need for people who have disabilities. According to research findings, ramp and landing surfaces are provide as slip resistance. But it is rarely seen landings, because it wasn't found ramps length more than 10 m.

Some buildings can be identified which only hand rails are used to single side it is not provided to wall end. Other thing is not designed to handrail at a 700 and 900 mm both level.

According to field survey all hospital buildings have sufficient lift facilities and those are also fulfilling design requirements. When considering about toilet facilities of the hospital buildings it is accomplished in satisfactory level. But some buildings are not provide grab rails for the use of persons who can not squat and it is rarely seen toilets which can open the doors at outwards. Subsequently it will affect to wheelchair users, because it is difficult to close the door when wheelchair is in.

5.2. EDUCATIONAL BUILDINGS

During the research mainly considered about government school buildings as educational buildings. Government and Non Governmental Organizations are established some schools for the use of students who have disabilities. But within this research mainly focus on how to provide equal opportunity and preparing environment for working with other people. Educational buildings provide sufficient facilities for the entrance and exit to the people who have disabilities.

When considering doors and opening facilities those are not providing satisfied level for the use of people who have disability. Sometimes doors can not be opened by people who use wheelchairs. Other thing is most of buildings are designed with thresholds which is higher than 15 mm. In these school buildings could not provide ramps and lifts. While designing school buildings disability problems are not considered as very critical matter. Any of government buildings could not find lift facilities. Reason is the school buildings are not higher than four stories. Therefore it is not worthy to provide lifts, and other thing is government regulations not request lift as important item for buildings which have less than four storeys. Regarding toilets facilities can not satisfied because those are not designed for the use of people who have disabilities.

5.3. OFFICE AND ADMINISTRATION BUILDINGS

Office and administration buildings mainly include government offices and private offices. Those buildings are used by lots of people who have disabilities. It is recommended to provide accessible facilities for people who have disabilities. Within entrance of Office and Administration buildings should provide more than 900 mm wider even and slip resistance surface. Within this research have been found, all buildings provide sufficient requirements of entrance and exit. Doors and openings also should be provided acceptable level, however most of buildings use thresholds which the height more than 15 mm. When considering staircases of the buildings those are consist of higher level of standards. Because of that these buildings are used by public. Main weak points of these types buildings are not included ramps for the wheelchair access.

Office and Administration buildings are used by large number of people. Therefore it has provided toilet facilities according to requirements. During the research identified that those toilets are not

comply with needs of wheelchair users. Because of that there are not providing grab rails for the convenience of the people who have disability.

5.4. BANK BUILDINGS

Banks are mainly focus on customers. Therefore those buildings are providing more facilities for customers. Banks are provided enough facilities for entrance and exit. When considering doors and openings of the bank buildings, some doors can not open by people who have disability. But most of bank buildings have security persons for open door while enter customers. Other weak point is those buildings design with thresholds more than 15 mm height. It is difficult to enter wheelchair users. Staircases are designed with including more requirements. But most of banks do not provide landings, because most of buildings are using escalators or lifts for rise up stairs. Within the research found it is rarely make use of ramps within bank buildings. Most of banks use lifts for climb upper stairs. Main disadvantage of this lifts is not having enough space for direct wheelchair within inside the lift. Other key requirement is toilet facilities. According to overview of banks it is sufficiently provide toilet facilities. However those are not well suitable for the people who have disabilities. Because of that buildings are not installed grab rails and doors are not position to open outwards.

5.5. RAILWAY AND BUS STATIONS

Railway and Bus services are still not improved for people who have disability, since there is no any Bus or train with Disability Access facilities. Therefore people who have disability can not enter the public transport. While considering Railway and Bus stations it should provide public transport vehicles with facilities of wheelchair access. Railway and Bus stations are provided design requirements for entrance and exit. Therefore it is easy for the people who have disabilities. While considering doors and opening facilities can not be satisfied. Most of railway stations can not enter wheelchair users; because of entrance have not sufficient width and also not enough space for direct their wheelchairs.

Railway stations have staircases for cross the platforms, but those are not provided landings between every 12 steps. Since Railway and Bus stations are not have large number of storey buildings. Therefore those buildings are not provided and no need of lifts. But ramps are essential for wheelchair access. According to research findings there are no any ramps available for Disability Access. Within Railway and Bus stations can not found toilet facilities with necessary requirements. Because there are not provided commode facilities, grab rails or doors which can open outwards.

6. CONCLUSIONS

Disability access is nowadays becoming very critical requirement. Most of Disability organizations and NGOs fight to acquire their social needs. Government Act No 28 of 1996, for the protection of rights of the persons with disabilities also now actively implemented through “*National council for persons with disabilities*”. Therefore it should focus on barrier free environment when designing buildings. Whilst discussing for the creation of barrier free environment, it has been created some draw backs focus on most people neglect the disability access when planning and designing. Because of the fulfillment of some requirements for the access, it should be depleted more useful area; mostly this was happened in private buildings. Increasing disability access is important to acquire there contribution to national economy through employing them in effective manner. By this research discovered existing facilities available for disability access.

Hospital buildings provide sufficient facilities for entrance, doors and openings, staircases and lifts. Banks provide fewer requirements for disability access; ramps are provided only 40% of bank buildings and 20% of ramps only provided hand rails according to requirements. When considering lifts, 90% of bank buildings provided but only 20% of buildings have lifts with required internal

spaces. Ramps are rarely seen within office and administration buildings, it is only 20%. Lift facilities are provided 80% of buildings with fulfilling requirements. However these buildings have toilet facilities those are not made available grab rails and only 20% of buildings provided toilets with doors open outwards.

Within design stage of the school buildings it is given less consideration on disability access. 60% of school buildings have thresholds more than 15 mm height in the entrance, hence it is difficult to enter wheelchairs. Any school building could not found with lift facilities. Other thing is there are no ramps. Railway and Bus stations are not provided satisfactory facilities for the disability access. Railway stations are not enough space for entrance door for the wheelchair access. 70% of buildings use more than 15 mm height thresholds for the doors and opening. Within these buildings not have lift facilities. There are no ramps within entrance for wheelchair access. Toilets facilities are provided very poor quality.

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The Code for Sustainable Homes in the UK: Affordability and Future

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ABSTRACT

UK agreed to reduce 80% of emissions by year 2050. Government therefore expects to ensure sustainable homes with emissions are available to all householders in the UK. Accordingly, new legislations are enforced to ensure that all new homes are adhered to Code for Sustainable Homes (CSH). CSH is a national standard rating system to guide the industry in having sustainable design and construction. Despite the obvious benefits such as lowered emissions and energy efficiencies, CSH indicates problems of affordability especially during current economic downturn.

The paper examines the UK code for sustainable homes and evaluates benefits and challenges it has. The paper also investigates whether the sustainable homes concept along with the green construction could be affected by the economic downturn in the UK. A comprehensive literature review based on recent government reports, journal articles and books is carried out to fulfil the aim of this paper. The research findings witness the up-front cost of integral green features that needs to be used as part of the CSH hence both consumers' and construction clients' incapability to bear the high costs. To improve supply side, the UK government provides "green loans" and other incentive for developers and consumers. With the improvements in the demand market, CSH would lead to create more "green jobs" in the supply chain. Further, the sustainable home development will play an important role to bring prosperity in construction industry and the overall economy.

Keywords: *Climate change, Code for Sustainable Homes, Construction Industry, Recession*

1. INTRODUCTION

The emission of green house gases results in global warming is evident by the increased air and ocean temperatures, melting down of snow and ice, and rising sea level. The world leaders agreed on a global deal in Copenhagen to tackle climate change and to reverse global warming (Watts, 2009). The World Wildlife Fund (2006) added that carbon dioxide (CO₂) emissions have not decreased in United Kingdom (UK) since 1990. Two-third of these emissions is produced from homes, non-residential building and construction industry.

There are approximately 25 million homes in the UK which account for 27% of total emission (Committee of Climate Change, 2009). The UK health secretary has recently warned that the climate change causes the communities to encounter with associated costs to health such as heart and breathing problems. Consequently, UK government has agreed with Committee of Climate Change (2009) on the Carbon Budgets plan to reduce homes emission by 35% on today's level by 2022 and determine to have 80% cut in greenhouse gases by 2050 in return for better environmental and human health (Higginson, 2009).

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The new legislation enforced in April 2008 that, all new homes construction must comply with the standards established by Building Research Establishment Assessment Method (BREEAM) who cooperate with Communities and Local Government to provide guidance in adopting Code for Sustainable Homes. The Code for Sustainable Homes is a national standard rating system to guide the industry in having sustainable design and construction. By year 2016, it is mandatory that all homes build to zero carbon (BREEAM, 2009).

2. RESEARCH METHOD

The paper aims to evaluate the Code for Sustainable Homes, its benefits and challenges based on secondary data collection. The UK government reports, journal articles and books are reviewed to fulfil the aim of the paper. Accordingly, the paper is structured as follows. Component parts of the Code for Sustainable Homes are presented along with examples of green technologies used for sustainable homes. This is followed by the UK governments' incentives that are offered to promote sustainable homes. Benefits and challenges associated with the sustainable homes are evaluated next. Finally, discussions are carried out to ascertain whether sustainable homes can withstand the UK economic downturn.

3. SUSTAINABLE HOMES: WHAT IS IT?

To the forefront, when the target to make all social housing decent by 2010 was first set, a decent home has been defined to be wind and weather tight, warm and has modern facilities (Wilson, 2003). The BREEAM (2009) has established the Code of Sustainable Homes which is an assessment for the design and construction process of new homes in complying with the required standards for energy efficiency and sustainability to ensure for a reasonable degree of thermal comfort. Most importantly, it encourages the households to live in a sustainable lifestyle such as creates less waste, reduction in water and electricity usage in result for a lower running cost. Therefore, the home builders must take into account of the Code rating system which sets the standards for sustainable design principles: energy efficiency, water efficiency, surface water runoff, site waste and household waste, use of materials, pollution, health and well-being, and management and Ecology (Communities and Local Government, 2006).

The levels of Code is ranging from one to six in which all new housing must be built with a minimum of Code level 3 starting from 1st of May 2008. The housing has been divided into two categories as public affordable housing and private housing. For public affordable housing, it has been mandatory to achieve Code level 3 since 2007. From year 2010, all affordable homes must be built with Code level 4. From 2013 onwards, it has to achieve Code level 6. With regard to private housing, it has to achieve Code level 3 starting from 2011 and it will be updated to Code level 4 in year 2013 and Code level 6 from years 2016 onwards (Maunsell, 2007).

The Code levels act as a sustainable rating system indicated by 'stars' to communicate the overall sustainability performance of a home. A home can achieve a rating from one to six stars depending on the extent to which it has achieved code standards (one star is the entry level and six stars is the highest level). The stars are calculated on a 'points out of 100' basis across the nine design principles mentioned above. Among the nine principles, for energy efficiency and water efficiency there are minimum standards at each Code level (Communities and Local Government, 2006). This emphasise the importance of energy and water efficiency towards sustainable homes. For some of the other design principles, there are minimum standards to achieve the entry level and for some there are no minimum standards (refer Table 1). This provides the flexibility for the developer to select the sustainable Code that they are targeting and choose the appropriate green technologies accordingly.

Table 1: Minimum standards of the Code for Sustainable Homes

Design Categories	Flexibility
Energy Water	Minimum standards at each level of the Code from 1 to 6
Materials Surface water run-off Waste	Minimum standard at Code entry level (Code 1)
Pollution Health and well-being Management Ecology	No minimum standards

Points are awarded for meeting or exceeding a combination of principles. Thus, it allows the developers to choose which and how many standards that must be achieved at every level of the Code. Due to the new legislation stating the housing must compliance with a minimum of Code level 3, ratings has to be run from the minimum of 3 Stars, where a house is 25 per cent more efficient. Besides, Code level 6 is a completely zero carbon home which require highest overall point to gain the ratings (refer Table 2). Designers are required to achieve increasingly stringent criteria to reach each level of the Code’s requirements.

Table 2: Summary of points and requirements for each of the six star ratings

Summary of points required for each of the six star ratings, incorporating the design categories’ flexibility allowance						
	Design category 1 ENERGY/CO2		Design category 2 WATER		Design categories 3 to 9	Equivalent BRE Eco- home rating
	Energy standard (% improvement over Part L 2006)	Energy points awarded	Water standard (litre per person per day)	Water points awarded	Other points required	
Level 3 *** 57 points	25%	5.8	105	4.5	46.7	Very good
Example: Level 3 shows that 57 points required to meet compliance: i.e. 5.8 points awarded for category 1 4.5 points awarded for category 2 46.7 points warded for other categories from 3 to 9						
Level 4 **** 68points	44%	9.4	105	4.5	54.1	Excellent
Level 5 ***** 84 points	100%	16.4	80	7.5	60.1	N/A
Level 6 ***** 90 points	ZERO CARBON	17.6	80	7.5	64.9	N/A

4. THE GREEN DESIGNS

This section detail out the difference of green designs criteria integrated among the Code level 3, 4 and 6 where attention will be focused on one of the nine principles: energy efficiency as it is the main factor that contributes to the environment pollution. The comparison will be carried out based on a scenario where detached house is used.

Mead (2009) asserts that the building fabric has the biggest cost impact toward the total sustainable development cost in any of the Code level. Commonly, cavity wall will be used as the fabric or the timber panels are alternately used in which the average cost of building fabric is about £15k. When the building fabric been put into the discussion, the BREEAM (2009) is actually concerning the thermal performance of building which indicating the U-values. Whereby, the thermal bridging at the junctions such as wall-floor; wall-roof; jambs; lintels and other significant junctions where heat can easily escape will be accounted to the design stage. Moreover, the insulation of cavity wall is to prevent the diffusion of heat into the wall (Goulding *et al*, 1992). This is important as the inefficiency of the fabric insulation will leads to power loss in result for higher energy consumption. In Code levels 3, 4 and 6, the U-values are less than 0.15, 0.18 and 0.11 respectively (Mead, 2009). This indicates the thermal conductivity is improving and getting more efficiency in these sustainable homes.

The element of window is considers as part of the building fabric plays an important role that affects the thermal transmission. It is mandatory for all Code levels to integrate with triple glazed windows. It is not only giving internal thermal comfort by preventing heat from escaping, but also providing condensation protection which prevents dropping of indoor humidity during winter (Mead, 2009). It is more energy efficient as the usage of heater and humidifier will be significantly lowered down. In terms of air tightness, the rate of leakage in Code level 3 is not exceeding 3m³/hrm² compare to Code level 4 and 6 of not exceeding 1m³/hrm² (Mead, 2009). This shows that the flow of air through the gaps of fabric is well controlled in Code level 4 and above which reduced the heat loss during winter (Energy Saving Trust, 2002). However, design for natural air ventilation will be still needed in a home for health reasons.

Housing ranging in all Code levels must install Mechanical Ventilation Heat Recovering (MVHR) system where it conserves energy by recovering heat from extracted air and works in both ways. For example, if the outdoor temperature is higher than inside, MVHR helps to maintain internal comfort level. Furthermore, heating systems such as gas boiler (solar water heating and photovoltaic panels), biomass boiler and heat pump will be installed in each Code level. The only difference will be found in the combination of technologies to achieve different level of energy efficiency (refer table 3). For example, water heating in Code level 3 will be using 210 litre dual coil cylinder with 50mm insulation. However, the system of 160 litre dual coil cylinder with 80mm insulation will be employed from Code level 4 onwards. Hence, higher Code levels will be utilising higher insulation to improve the heat from being loss easily, giving more sustainability to the environment. Besides, in terms of the low energy lighting, Energy Saving Trust (2009) recorded that 75% low-energy lighting and appliance is used in Code level 3 and those are of 100% low-energy will be used in Code level 4 to 6.

Through the studies of the Code levels, it is evident that all Code levels are generally utilising the same green technologies which mentioned above and there is a wide range of solutions in delivering the required target.

Table 3: Combinations of green technologies (Maunsell, 2007)

Code Level	Technology Combinations
3	Best practice energy efficiency plus solar water heating
4	Advanced practice energy efficiency plus photovoltaic Best practice energy efficiency plus photovoltaic Part L energy efficiency plus photovoltaic
5	Best practice energy efficiency plus biomass district heating Best practice energy efficiency plus gas fired combined heat and power (CHP) Best practice energy efficiency plus biomass heat and power (CHP)

The technologies are different in terms of its capability to achieve energy efficiency and it tends to be more advance for higher Code levels (refer Table 4). However, the Code level 3 achieves its energy efficiency by depending more on the building fabric improvements. In comparison with Code level 5 and 6, it is massively reliant on the renewable technologies which are expensive and difficult to be achieved. Table 4 below shows the cost transition between the Code levels where the cost ranges from a flat to a detached house.

Table 4: Extra over cost relative to conventional construction (Maunsell, 2007)

Code Level	Extra Build Cost (relative to 2006 Building Regulations in £)
From 3 to 4	4-5% (2,900 - 4,400)
From 4 to 5	5-9% (3,900 - 8,700)
From 5 to 6	10-14% (7,700 – 13,100)0-14% (7,700 – 13,100)

Having discussed some examples of green designs related to energy efficiency, the section below provides the initiatives taken by the UK government in promoting sustainable homes.

5. SUSTAINABLE HOMES: INITIATIVES FROM THE UK GOVERNMENT

Under the new green strategy of Communities and Local Government (2010), the government aimed to insulate 6 million “green homes” by the end of year 2011 across UK. The strategy plan will help to reduce the upfront cost by providing ‘Pay As You Save’ (PAYS) green loan which tied to the property and encompassing two sources of funding (Communities and Local Government, 2010). Firstly, it targets those vulnerable households and tenants with low income and having the energy companies to subsidise them to install the standard insulations as well as eco upgrades such as fitted smart meters which can save approximately £300 a year on bills (Department of Energy and Climate Change, 2010). Secondly, householders who have an eco upgrade or have installed renewable heat technologies are entitle from significantly reduced bills and guaranteed revenue stream (Department

of Energy and Climate Change, 2010). This is to ensure they do save on bills or the revenue from small scale renewable, to cover the costs of eco upgrade. Besides, in order to educate the householders about improvement in energy efficiency that they can make at home, the government established a 'one-stop' shop energy helpline and an online modelling system enabling the householders to access relevant information. In addition, the government provides also an eco show home to demonstrate money saving by integrating the carbon saving technologies at home (Communities and Local Government, 2010).

Apart from cultivating confidence of using PAYS strategy in consumers, the government promotes behaviour change by having Department of Energy and Climate Change for funding new initiatives with a small group of leading employers who in turn mobilise their employees to insulate their homes. This is another way to promote the eco upgrade, leading the staff members to have better understanding about the benefits of practice which then enabling them to achieve money and energy savings.

6. SUSTAINABLE HOMES: BENEFITS

6.1. BENEFITS FOR ENVIRONMENT

One quarter of UK emissions are coming from energy used in homes. With the Greener Homes Strategy to mitigate the emission hurdles, the minimum standards for energy efficiency must be achieved in each of the Code level. This in turn results for a reduction in greenhouse gas emissions and make a contribution to achieve UK's emission cut target agreed in Act on Copenhagen (2010) for tackling climate change. The Communities and Local Government (2006) concluded that with the integration of green technologies, the building make better adaptation to the impacts of climate change. The integrations are such as the minimum standards for water efficiency and other measures that being enforced, including better management of surface water run-off (Communities and Local Government, 2006).

Authors argue that 'better adaptation' would leads to make the building more resilient to natural disasters. By building a more environmental friendly manner, it reduces the possibility of building failure which resulting from weather extremes. The Code level provides a good basis for building design which will not invade by the weather. In addition, Code level encourages the households to create less polluting waste and to practice recycling at home.

6.2. BENEFITS FOR CONSUMERS

The government has been providing facilities to assist the public to identify the Code for Sustainability, thus enabling the public to be able to make a right choice in purchasing a green products or a green home (Communities and Local Government, 2006). It is important to move forward and make sustainability a part of cultural where people start to be aware of energy efficiency and conservation to reduce carbon footprint to achieve sustainability. Besides, a green home emphasises the level of comfort and satisfaction of consumers by improving health and well-being, providing a livable environment.

Consumers are directly benefited from the green technologies usage which cut down bill costs approximately £300 a year through greater energy and water efficiency. The use of fossil fuels to generate energy has not been included in the Code whereby, home owners who purchase a green home are helping to reduce fuel poverty (Department of Energy and Climate Change, 2010). Through the studies, it has drawn to authors' attention that people tend to be more alert on monthly bill costs and neglect about maintenance costs. Logically, the use of green technologies will lead to have a durable and long lifespan property which not requires frequent repairs to maintain (Mead, 2009) and also yield for a higher house value (Kibert, 2008). The authors argue that this is greatly beneficial to

the customers as their investment made in a green home will not depreciate in the long-term as demand for sustainable home is growing higher and sustainability is already part and partial of the world.

6.3. BENEFITS FOR HOME BUILDERS

The public are adopting more sustainable lifestyle, as stressed and as a result, home builders who are able to show their concerns and utilise the carbon saving technologies in the housing construction will perform well to compete in the market (Communities and Local Government, 2006). Use of green technologies and designs provides quality assurance and add value to the builder's professional profile (Howard, 2009). Apart from that, the authors supposed the new legislation has stressed on the proper procedures in design and construction to work out a green home in order to deliver the quality and durability measures. In this regard, it definitely helps to prevent from defects during operation period, reducing builder's liability and the risk of claims and litigation involvement (Kibert, 2008). Besides, Mills (2005) states that any projects that are able to adapt with the climate change will reduce the need of risk management in construction.

6.4. BENEFITS FOR ECONOMY

The transition to low carbon economy, the demand for sustainable sector is getting higher and it has been reported that it yields for 65,000 jobs creation in the construction industry (Department of Energy and Climate Change, 2010). It opens up a wider market for the supply chain in identifying the environmental market opportunities such as solid wall installation and micro-generation installation (Khan, 1997). Hence, the supply chain is able to expand and diversify businesses and benefit from the market segmentation (Osmani and O'Reilly, 2009). The Code for Sustainability encourages the suppliers to be technologically innovative to improve the green designs and functions to achieving higher level of efficiency and effectiveness. Further, the Act on Copenhagen (2010) claims that low carbon business generates £107 billion a year in UK and employs 880,000 people.

7. SUSTAINABLE HOMES: CHALLENGES

In making the way towards a low carbon scenario, it is inevitable to encounter obstacles especially as the UK economy is still in a recession. The section below explores views from demand and supply sides in the market sustainable homes.

7.1. CONSUMERS' PERSPECTIVE

Koerner (2007) revealed that the average consumers are lack of knowledge about energy-efficient designs. Some of the homeowners whose affordability is well above the average may request for a larger home. However, higher level of capability of green technologies such as heating and cooling systems, water distribution schematics, and building envelop design will be needed to apply into a large size homes. It therefore requires significant amount of material and energy to insulate homes that will account into wastage of resources which is discouraged by the sustainable strategies. A survey carried out by WWF (2007) found out that most of the home buyers are environmental conscious and will support for energy efficient scheme. However, the survey has shown that majority of the consumers are not willing to pay more for sustainability features due to two main reasons. Firstly, the economic recession has deprived consumer's saving rates which in turn affecting their purchasing power in the property market. Secondly, the consumers claim the maintenance cost is expensive and expressed their incapability to afford for the fee though maintenance will only be needed for once or twice a year (Bretherton and Pleace, 2008).

7.2. CLIENTS' AND BUILDERS' PERSPECTIVE

The government has recently announced that councils who fail to release land for house-building will experience difficulties in getting approval for their planning system (Gardiner, 2010). In addition with the consumers who are starting to see the environmental impacts and possible costs to their green home operations, challenges the developers to build green homes more cost-effectively (WWF, 2007). However, Mead (2009) claims that developers are usually unaware of the increment of design fee and pre-planning fee for the low carbon development. When a green construction is over budgeted, the developers tend to "value engineer" the costs of green features. Osmani and O'Reilly (2009) point out, UK house builders are using a range of standard house sets across their developments to help reduce costs and defects and as a consequence, they are reluctant to adopt policies which require excessive design changes. This is due to the traditional attitudes are still maintained among the builders, which limit the overall uptake of innovations. In fact, the builders are acting in accordance with the sustainability requirements of the clients as mentioned above who would preferably willing to go without green features. Furthermore, the cost of achieving different Code levels will vary depending on the economies of scale available to each particular house builder and the construction methods employed (Osmani and O'Reilly, 2009). Further, Osmani and O'Reilly (2009) challenge the views of Department of Energy and Climate Change (2010) that mentioned about increased amount of jobs related to green technologies (refer section 6.4). However, the authors believe that the UK government is the prime source of boosting the job creation as it is essential to develop a sustainable community and social housing for those who cannot afford sustainable housing whilst reducing the poverty and unemployment rates in the UK.

Above sections evaluated the benefits and challenges of sustainable homes. At present, the UK economy is experiencing a recession which exerts a certain level of impact on the housing market and further weakening the demand for sustainable housing. Accordingly, the section below discusses whether sustainable homes can defeat the impacts from recession.

8. CAN SUSTAINABLE HOMES WITHSTAND THE RECESSION?

A negative economic growth is indicating low unemployment; cut in mortgages; poverty; shrink in contractor's profit; low interest rates and inflation of fuel and energy prices. The effects from the recession have been witnessed in the housing market where housing prices is falling and urges the lenders to cut mortgage rates to beat competition. This shows the incapability of general public to afford a home albeit with a lower sale price. The aforementioned factors also indicate weakened demand in the housing market and lack of capabilities of the population to afford a home. This is regardless to mention the sustainable homes which need greater investment due to its high initial cost compared to conventional homes (Howard, 2009). Furthermore, the UK Green Building Council (UK GBC) recently investigated whether the financial crisis has impacted on organisations in tackling sustainability (CIOB, 2009). 18% of UK GBC members responded that the credit crunch has had an adverse effect on efforts to address sustainability (CIOB, 2009). Also, the survey revealed that half (53%) of projects tendered for sustainability was not a client's requirement (CIOB, 2009). This shows the weak demand in the sustainable housing market.

On the other hand, there are positive impacts to the sustainable sector during the recession. As indicated in section 6, there are improvements in certain areas of sustainable development. The authors assert that this has a connection with the issue of rising green jobs and skills. The UK businesses have the potential to gain a share of the global market for low carbon goods and services (Act on Copenhagen, 2010) that opens up a new door for the UK market. By providing services and producing the goods, it helps create employment to the community in which we called the 'green job'. It helps also to stimulate the innovation to produce sustainable technologies and design (CIOB 2009).

Throughout all these circumstances, is that really a truth where recession is a major cause that people unable to afford sustainability? Or, are they merely misunderstandings on having sustainable

development? The authors argue that referring to expensive initial cost as a barrier to move forward towards a low carbon premise, is an excuse to confront the recession as consequence of environmental collapse is much greater than the current economic downturn.

Sustainable development is not about cutting and saving cost in the long-run, nor merely making a commitment to the Kyoto Protocol to cut emissions. The 1972 Stockholm Declaration on the Human Environment Conference clarified concisely that environmental, economic and social issues were inseparable and that a systemic approach should be adopted if true sustainable development is to be realised (Birchall, 2003). Furthermore, the sustainable development policy in the UK states that “Sustainable Development does not mean having less economic development: on the contrary a healthy economy is better able to generate the resources to meet people’s needs and new investment and environmental improvement often go hand in hand” (Orsatti, 2006). This is a good view point to oppose the opinion of Victor (2001), who claims that the Kyoto Protocol retards the economy and construction industry. Victor (2001) claims that most of greenhouse gases come from burning fossil fuels for energy and use of energy equipment such as power plants, automobiles that has a long life span. Thus he argues that if we are to comply with Kyoto Protocol, most of the premature energy equipments needs to be disposed, which will reduce the emissions as well as retards the economy.

Some believe that one of the key reasons for the current economic downturn is due to unsustainable business practices and being very much concerned on profits and not adequately focusing on making a balance between monetary gains with social and environmental aspects. Organisations, communities and individuals therefore now have the opportunity to show that they are not just motivated by short-term profits, but a long-term strategy that balances socially responsible initiatives.

9. CONCLUSION

There are varying opinions as to whether the sustainable market survives in the future. However, the authors can conclude that these judgments are no longer an issue when compared to the adverse impacts that could come to UK if actions against climate change are not taken. As revealed by the European Environment and Health Committee (2010), 70% of UK population living in the most polluted areas that severely threatens human health. In fact, it is indeed becoming a major constraint on country’s development as humanity is the main economy driver.

The Code for Sustainable Homes with its nine design principles are focused on reducing emissions and pollutions whilst promoting sustainable development as a whole. As discussed within the paper consumers’ affordability is being highly concerned as it affects the execution of this mandate green scheme. Also, there is lack of collaboration between the contractors and clients due to financial hurdles which causes a barrier to the growth of sustainability. Although it is inevitable to bear the up-front cost, the benefits of adhering to the Code is generally long-term. Homeowners need to pay extra money on top of a conventional house construction to make their homes sustainable. Affordability of a sustainable home adhering to the Code is therefore a challenge for the UK citizens especially during the current economic down turn and even within a normal economic climate. Therefore, continuous government support to boost the demand of the homeowners such as subsidies for installation of green technologies and stamp duty relief etc. are needed. Moreover, a guaranteed market for the suppliers needs to be established so as to reduce the cost to the suppliers whilst increasing the availability of the green technologies in the market. In this respect, introducing legislations related to sustainable homes will motivate and get the commitment of the homeowners to move towards sustainable development and zero carbon homes. Investments made in the sustainable sector will give long-term benefits in return such as better adaption; improve environment and human health; reduce carbon footprint; low operation cost; provide sustainability credentials; risk reductions; insurance cost reduction; long life span of homes and jobs creation.

In promoting the Code for Sustainable homes, the UK government is facilitating financial assistance and enables the public to understand the importance of sustainable development as a whole. In terms

of the construction industry, sustainable housing can be identified as an area that brings technological innovations and opens new dimensions to the construction supply chain. Further, the creation of green jobs related to sustainable homes could be one of the mechanisms that help to recover from the economic downturn. As climate change is a serious and urgent issue, it is vital that everyone supports the sustainable home scheme. Sustainable housing provides us with improved overall well-being and quality of life. It also leads to economic prosperity, stimulates social cohesion, provides security, supports social welfare and is designed to enhance personal community and global health. Therefore, it brings together environmental, social, economic, cultural and political dimensions into a single agenda.

10. ACKNOWLEDGEMENT

The authors would like to acknowledge contributions given by Ms. Ho Sze Wan when preparing this paper.

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Construction Industry Improvement Initiatives: Are We Really Translating Rhetoric into Reality?

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ABSTRACT

For more years than we may care to admit, we have been urged to radically reform the way we work in construction industries across the world. Identified core issues range from adversarial approaches that dissipate energies and waste valuable resources in some jurisdictions, to distorted priorities, poor management and even corruption elsewhere. Such root causes manifest themselves in higher risks, low productivity, depressed 'value' to all concerned, disputes and disappointments to construction clients and end-users. Worse, widely accepted reform agendas in Hong Kong, Singapore, Sri Lanka and the UK for example, have yet to yield some of the significant benefits that were envisaged.

This paper provides overviews of the main thrusts and interim outcomes from the construction industry reform initiatives in Hong Kong and Singapore in the last decade, based on interviews of a cross-section of industry experts in each jurisdiction. Parallels are drawn and some common issues identified. The eventual findings of three recently launched interlocking research projects in Hong Kong, Singapore and the UK, are expected to provide pointers to identifying constraints/barriers, as well as useful enablers/facilitators in implementing such industry improvement initiatives in general, including in some other similar jurisdictions. Meanwhile, the initial findings should also provide a framework for discussion and feedback from other countries as well.

Keywords: Construction Industry Improvement, Constraints, Barriers, Hong Kong, Singapore

1. INTRODUCTION

As an acknowledged pillar of national economies, a reliable and efficient construction industry is essential for infrastructure development and replenishment, and national growth itself. Renewed questions as to adequacies of the industry, its performance levels, working norms and practices in the late 90's, triggered intensive bursts of external scrutiny and self-examination leading to much publicised recommendations for reform in Singapore (C21, 1999), Hong Kong (CIRC, 2001), UK

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(Egan, 1998) and others. A decade after these recommendations, all the expected substantial industry gains are still not evident, although some improvements are seen to have emerged.

While Hong Kong targeted to reform a 'fragmented industry' and replace an 'adversarial culture', with a 'quality culture' and an 'integrated construction industry' (CIRC, 2001), this is still far from reality. Singapore focused on enhancing professionalism and workforce skills and increasing productivity through the integration of design and construction, greater buildability, and more prefabrication, with the view to reducing the number of foreign workers, but some researchers suggested that these targets were not being achieved as quickly as expected (Dulaimi *et al.*, 2003). Also, there have not been systematic reviews of the achievements and challenges of the improvement programme, and little has been learnt on how process improvements can be evaluated and sustained.

In this regard an interlocking study of industry improvements in UK, Singapore and Hong Kong was designed to track implementation programmes against their original objectives, changing priorities, achievements, drivers, enablers and barriers, residual issues and concerns. The findings reported in this paper are preliminary findings from the above study from Singapore and Hong Kong. The observations are also of value to those concerned with construction industry development in other jurisdictions. Although priorities differ from one jurisdiction to another, and may also change from time to time in any country, common core agendas can be discerned in underlying objectives to develop reliable and resilient construction industries. For example, Kumaraswamy (1998) and De Saram *et al.* (2001) traced general construction industry development targets, strategies and tools, drawing on examples from a few Asian countries. For instance, construction industry reforms in Sri Lanka e.g. in procurement practices had been pursued, albeit with limited success in the late 1980's, while more specific initiatives to develop the contracting industry were launched in 1992 (Kumaraswamy, 1998).

2. RESEARCH PHILOSOPHY AND METHODOLOGY

The research philosophy behind this research project stems from the hypothesis that however high-powered the reform agendas and their champions, and however desirable the transformations in 'ways of working' and mind-sets, industry 'cultures' cannot change in just a few years, since industry practices do not develop independently of governing institutional structures. Hence, a successful change in culture needs to be backed by stakeholder institutions.

Industry practices are influenced by institutional structures, for example, as in institutionally-embedded practices (Powell and Demaggio, 1991). According to institutional theory (Ritzer, 2005; Scott, 1995 and 2001), institutional compliance is influenced by the prevalent regulative framework, industry norms and culture (three pillars of institutional theory). Therefore, industry development initiatives should aim for positive changes in the above three pillars to promote desired institutional behaviour. In this regard, this research project effectively aims to (i) trace and explain underlying principal trends amidst the many interacting variables; and (ii) identify how future reforms may be guided towards desirable and sustainable process improvements within the institutional context.

The research aim was considered as consisting of two parts which are (1) evaluating implementation of industry development initiatives and identifying drivers and barriers to implementation and (2) identifying underlying causes and trends. Since, the former part requires broad based data, a questionnaire survey was considered to be the suitable method while interviews were considered to be a better method for the latter part since it requires an in-depth analysis together with contextual data.

Also, being a multi-stage study, periodic validation of interim findings is required and focus group meetings were found to suit this purpose. Furthermore, the study involves multiple stakeholders with divergent views for which consensus building is essential for reliable outputs, and workshops were considered to suit this need. To address the above, the research methodology was designed as shown in Figure 1. The findings presented in this paper are based on the initial (and completed) study

components, and is represented by the research stages above the status lines shown in Figure 1, i.e., after completion of preliminary interviews and a focus group meeting in Hong Kong, and on completion of preliminary interviews and an internal research meeting in Singapore.

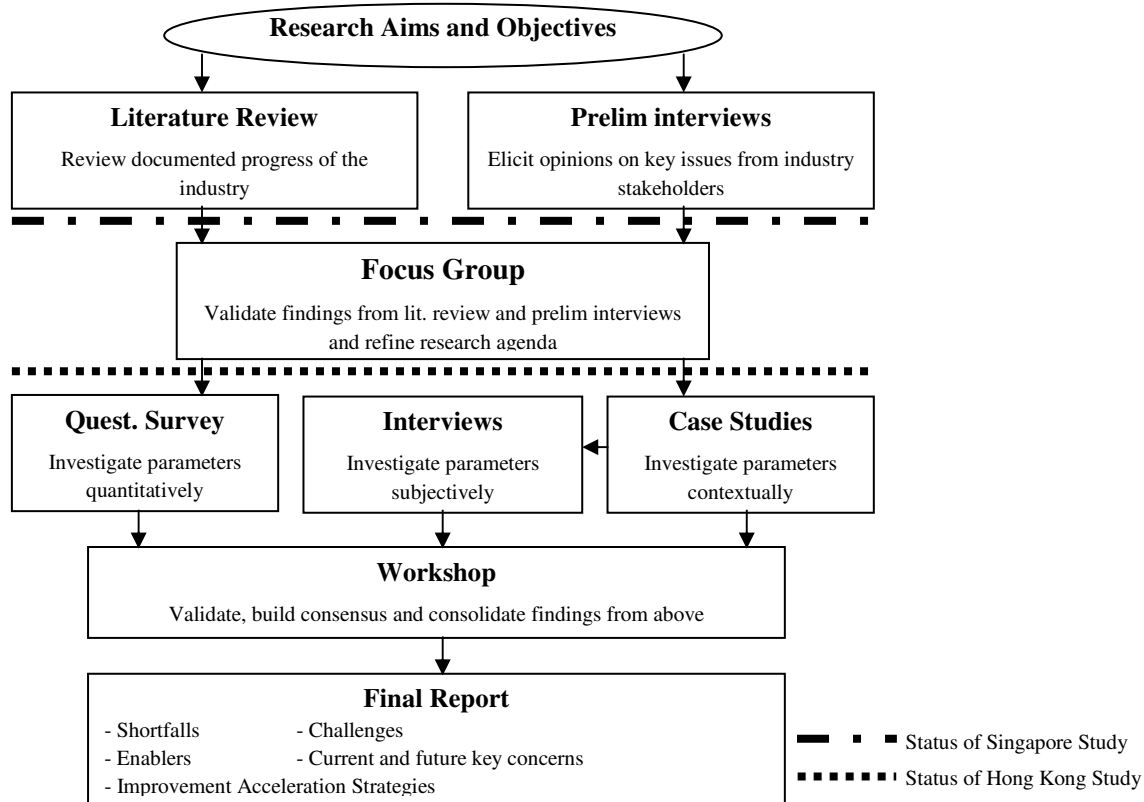


Figure 1: Methodological Chart

3. SALIENT FEATURES OF INDUSTRY IMPROVEMENT INITIATIVES

This section of the paper provides a brief recap of the recommendations of CIRC and C21 reports.

3.1. RECAP OF INDUSTRY IMPROVEMENT INITIATIVES – HONG KONG

Hong Kong’s construction industry reform initiatives stemmed from a spate of non-compliant construction incidents in the late 90’s which prompted widespread public concern about the need for reforming the industry. The Construction Industry Review Committee (CIRC) was set up to recommend improvement measures and came up with a ‘vision of an integrated construction industry that is capable of continuous improvement towards excellence in a market-driven environment’ (CIRC, 2001) and issued 109 recommendations under 7 themes namely: (i) fostering a quality culture; (ii) achieving value in construction procurement; (iii) nurturing a professional workforce; (iv) developing an efficient, innovative and productive industry; (v) promoting a safer work place and environmentally responsible industry; (vi) setting up an institutional framework to drive the reforms and (viii) setting up a review process for implementation progress. Key recommendations under each strategic thrust are as shown in Figure 2.

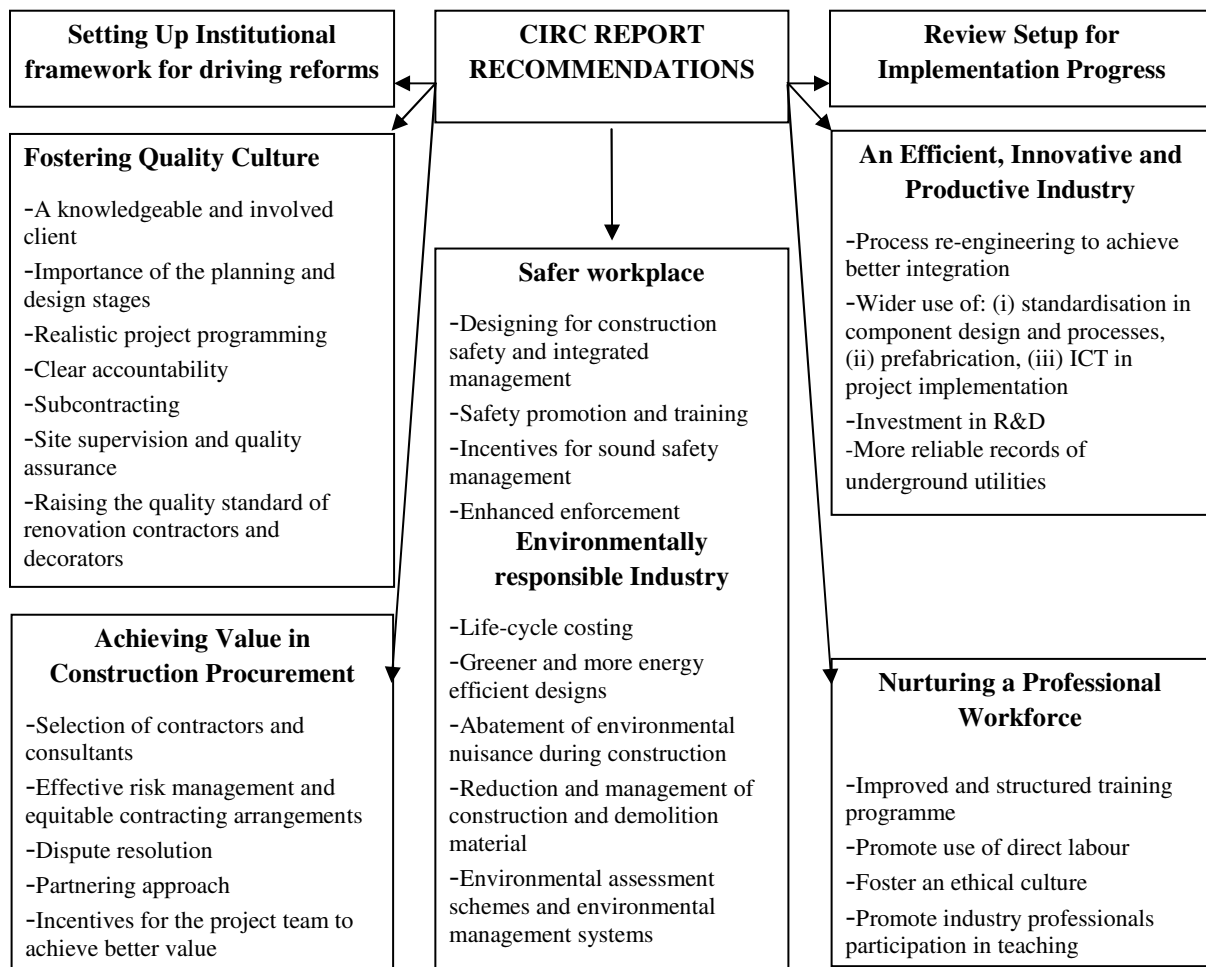


Figure 2: Key CIRC Recommendations

3.2. RECAP OF INDUSTRY IMPROVEMENT INITIATIVES - SINGAPORE

Construction industry development initiatives in Singapore followed by the recommendations of the Construction 21 (C21) review committee set up to address the challenges of the industry in the late 1990s such as low productivity levels, low construction quality and poor safety levels. The review report titled “Reinventing Construction” (Construction 21 Steering Committee, 1999) focused on transforming the industry from a 3D (dirty, demanding and dangerous) to a 3P (professional, productive and progressive) industry with a vision of making Singapore a ‘world class builder in the knowledge age’ under 6 strategic thrusts: (i) enhancing the professionalism of the industry; (ii) raising the skills level; (iii) improving industry practices (iv) adopting an integrated approach to construction; (v) developing an external wing; and (vi) a collective championing effort for the construction industry. Key strategic thrusts and recommendations of C21 are as shown in Figure 3.

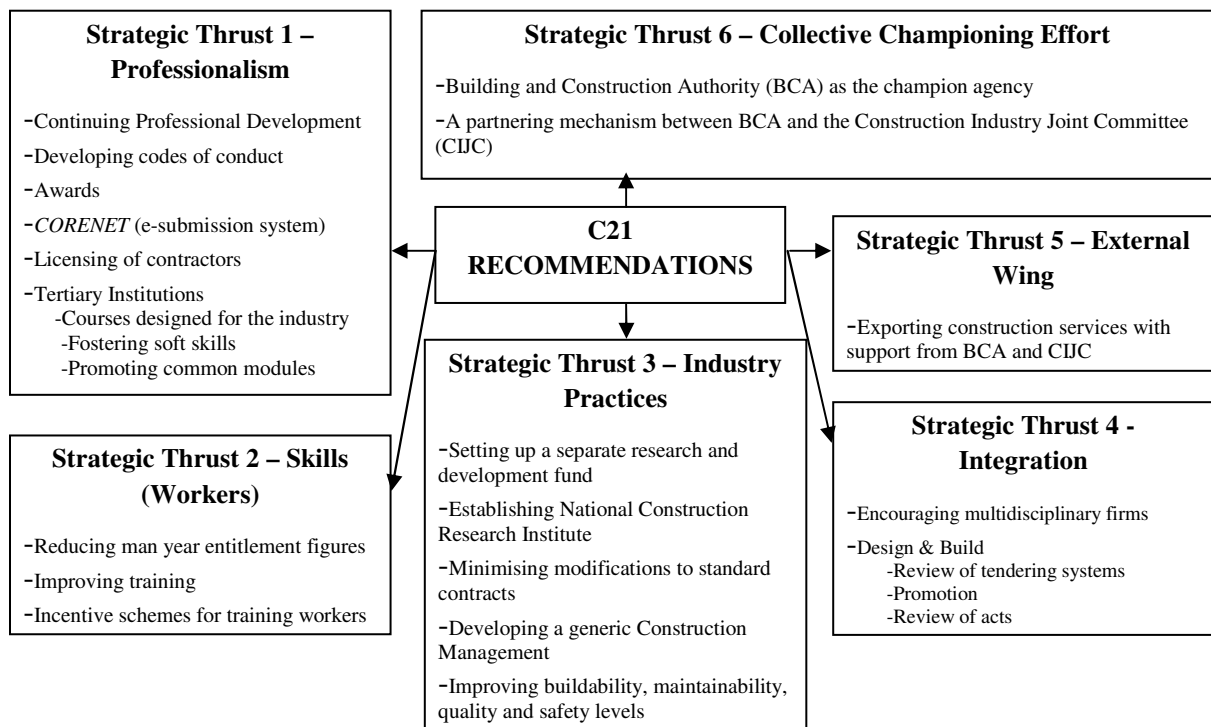


Figure 3: Key C 21 Recommendations

4. RESEARCH FINDINGS

This section of the paper discusses the findings to date from Singapore and Hong Kong separately in the first instance, next identifying some underlying common threads and trends in the Conclusions.

4.1. RESEARCH FINDINGS FROM HONG KONG

The implementation of CIRC recommendations was initiated by a Provisional Construction Industry Co-ordination Board (PCICB) and has now been taken over by the formation of Construction Industry Council (CIC), the statutory industry co-ordinating body as mandated by CIRC recommendations. The main functions of CIC are “to forge consensus on long term strategic issues, convey the industry’s needs and aspirations to Government, as well as provide a communication channel for Government on all construction-related matters” (CIC, 2007). Interim progress reports (PCICB, 2005; ETWB, 2007) list many recommendations as implemented and many others as to be either followed up by the CIC or the Government. Although, there is general satisfaction on the direction towards which the industry is headed, there are areas of concern and / or shortfalls where industry stakeholders expect more to be done, as discerned from interview findings described below.

4.1.1. FINDINGS FROM PRELIMINARY INTERVIEWS

Preliminary interviews in Hong Kong consisted of 8 interviews representing director/equivalent or above levels. The breakdown of present parent institutions of interviewees is as follows: 4 Clients (1 from private sector, 1 from quasi-government, 2 from public sector), 1 consultant, 2 contractors and 1 statutory body (Construction Industry Council (CIC), co-ordinating body for construction industry).

Interviewees were generally satisfied with the institutional framework established from the formation of CIC for co-ordination of the industry. It was perceived that the CIC’s formation has given voice to many ‘outlying’ industry stakeholders by encouraging their participation in this common platform. However, most believed that CIC as a statutory body lacks teeth; and so enhanced regulatory powers

for CIC may be useful for the industry. The progress in formulating and disseminating industry development initiatives was considered to be comparatively slow and this sluggishness was attributed to the difficulty in arriving at consensus in the various large committees.

There was consensus that initiatives over the past decade have tremendously improved safety levels, especially in the case of the public sector due to initiatives such as the 'pay for safety' scheme. However, there was some concern that this success has not been replicated in private sector. Significant improvement has also been seen in quality culture at least among the leading players but was identified as an area where more could be done. Improvement in quality levels were attributed to improved regulation of subcontractors by means of the 'voluntary registration scheme' and of workers through the 'worker registration scheme'. The registration scheme for subcontractors is expected to move to the next level by becoming mandatory, but this has been delayed.

However, compressed project scheduling in the quest for faster delivery times was still seen as a concern affecting quality levels. Also, renovation contractors, significant players in terms of volume in the industry have not been regulated in spite of issues like poor accountability and safety levels. Hence, regulation of renovation contractors was perceived as a key concern area for the near future.

Achieving value through alternative procurement as opposed to price-based procurement was so far only targeted via increased usage of two-envelope tender selection system, the benefits of which were limited as it was difficult to differentiate between technical bids. Use of alternative procurement systems such as design & build or target cost contracts was limited to few projects and players. This has not become the norm as envisaged in the recommendations while equitable risk allocation was still considered a mirage.

Enhanced usage of alternative dispute resolution mechanisms has improved dispute management. However, modifying arbitration clauses in Hong Kong contracts to allow arbitration before the end of the project was considered useful to mitigate payment problems. Cultural changes envisaged such as through 'genuine' partnering and integrated work teams were limited to leading players and projects and have not widely percolated into the industry although the benefits of these are clearly established. Improvements were seen in achieving an environmentally responsible industry and were expected to gain momentum with the establishment of Hong Kong Green Building Council.

Nurturing a professional workforce was identified as an area with clear shortfalls and of immediate concern. The aging workforce was seen as a key problem, with the failure to attract young people into the industry being perceived as particularly detrimental in the long run. The '3D' image of the industry is a key barrier in attracting youth, while the industry was seen to fall short in promoting and nurturing innovations, and research and development in the industry was seen as ad hoc.

Fluctuating and unsustainable workload was identified as a key root cause in many of the above shortfalls. It was perceived that fluctuating workloads threaten employment prospects, resulting in lower skill levels as well as poorer workplace conditions, in turn accentuating the 3D image of the industry and precluding it from attracting young blood. The above lead to lower quality levels, in turn reducing workloads of local construction organisations, thereby generating a vicious circle.

In terms of types of initiatives, mandatory (regulative) initiatives were found to generate more traction and success in implementation whereas the propagation of voluntary initiatives through guidelines/best practices seemed to stop with industry leaders because of limited dissemination/percolation and barriers to these initiatives. However, legislation/ regulations were still perceived to be best left as a last resort, as the stakeholders preferred self-regulation.

In comparing the public and private sectors, it was perceived to be easier to implement agreed changes in the public sector. Extrinsic pressure was seen to be the driver in the public sector whereas intrinsic pressure was a necessity for the private sector. The private sector, except for some leading developers and contractors was seen to be slow in picking up the initiatives. The challenge in wider propagation of industry initiatives for improvement was seen to be in cross pollinating successful

initiatives from public sector to private sector and vice-versa as the drivers for them were considered to be different in nature. Furthermore, given that the context and priorities were necessarily different, it was considered unreasonable to expect identical concerns or implementation trajectories in both sectors. Challenges and drivers for implementing industry initiatives as perceived by the interviewees are summarized in Figure 4 and Figure 5 respectively.

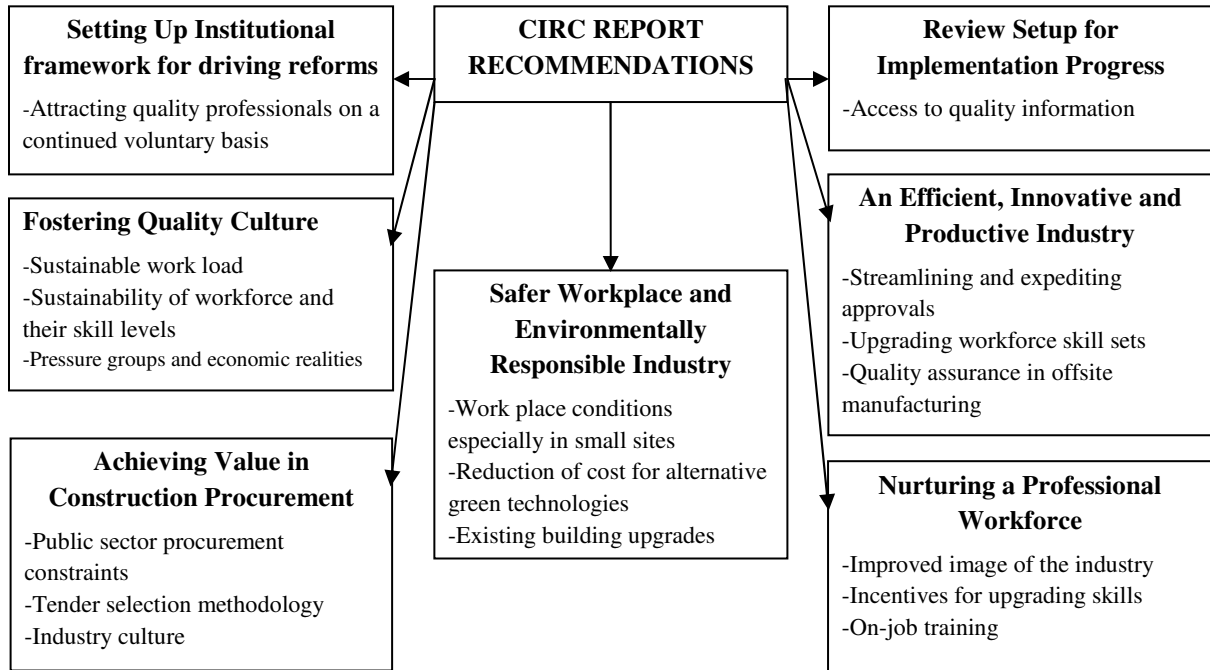


Figure 4: Challenges to Industry Development Initiatives

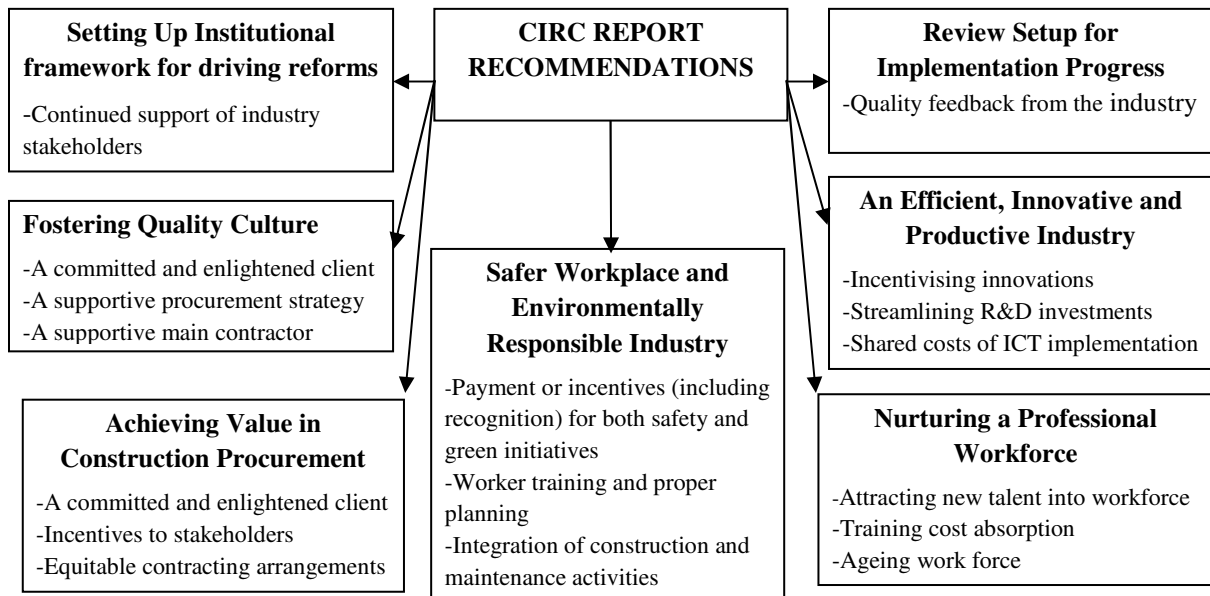


Figure 5: Drivers for Industry Development Initiatives

4.1.2. FINDINGS FROM THE FOCUS GROUP

The breakdown of focus group participants shows representatives from 2 clients (1 from public sector and 1 from private sector, 1 contractor, 1 consultant, 1 academician and 2 from CIC along with 5 research team members. The purpose of the focus group was to present and test/refine/validate the interview findings, and also to firm up on the detailed issues to be investigated through a questionnaire survey, case studies and a workshop in the future course of the research. The focus group was structured into 2 sessions. Interview findings were presented in the first session followed by comments, questions and answers on these. The second session included brainstorming sessions on three specific focus areas for 20 minutes each, following a briefing on the focus area of about 5 minutes each. The three focus areas were: (i) institutional framework for co-ordination of the industry; (ii) drivers of construction industry reforms and (iii) challenges to construction industry reforms.

Feedback on the interview findings was generally positive and the views expressed were in line with the interview findings. Lack of regulatory power for CIC was highlighted, while it was still felt that regulation should be the industry's last resort after all other attempts (i.e. to transform the culture and instil norms) had been tried. It was perceived that although, the Hong Kong construction industry is still facing problems of many kinds, the improvements achieved in the last 10 years should not be forgotten and should provide stimulus, inspiration and building blocks in the 'way forward'. The importance of a sustainable workload for industry initiatives to succeed was continuously stressed.

The key issue that emerged from the focus group was the question of what kind of an industry does Hong Kong want? How should the industry visualise itself in 20 years from now? What should be the right size of the industry? It was felt that any industry development initiative should fit within the answers to the above questions and all efforts should be synchronised to achieve that vision. Also, the vision needs to be revised from time to time, e.g., every 5 years. In the absence of those answers, it was felt that adhoc efforts at improving the industry would continue with periodic lamenting as to lack of improvements.

4.2. INITIAL RESEARCH FINDINGS FROM SINGAPORE

Preliminary interviews in Singapore involved representatives from 1 real estate developer, 1 statutory body, 3 consultant firms and 1 each from associations of contractors, consultants and project managers. An internal meeting of the Singapore research team was also attended by the research team leader from Hong Kong.

According to the interviewees, the transformation of construction from a 3D industry to a 3P industry has progressed reasonably well. Safety level improvements have made work on site less dangerous while the 'demanding' dimension has diminished due to a higher level of mechanisation. However, the image of being a dirty industry has not been changed considerably. The quality of foreign workers is still an issue but efforts such as the setting up of training centres overseas, and the statutory requirement for all workers to pass basic skills tests have helped.

In terms of strategic thrust 1, the general perception is that the CPD requirements have improved professionalism but are difficult to be made mandatory. The common codes of conduct for the entire industry which was highlighted in the C21 recommendations have not been developed. Awards and financial incentives are regarded as being important in encouraging innovation and improvements in practices and procedures. CORENET is considered to be a major achievement as it facilitates coordination and improves efficiency. Licensing as a regulatory tool is also moving in the right direction. Improved courses specifically designed for the industry, are being provided by tertiary institutions and the BCA Academy. Moreover, on-the-job training is still considered important.

The man-year entitlement scheme is perceived to be not working well, and some unexpected practices have developed, which give the impression that the limits might not very tight. Attracting local workers through incentive programmes has not worked as well as planned. The proposal for a generic

construction management system to be developed has not been realised. The recommendation to use standard contracts with minimum modifications has also not been achieved, partly because of a reluctant private sector. Buildability and prefabrication levels have improved and have led to efficiency gains. The formal construction quality assessment schemes have led to significant improvements in the quality of work in the industry.

On strategic thrust 4, it was perceived that design and build makes sense only on certain projects and the decision to adopt it should be left to market forces. The number of multi-disciplinary firms in Singapore has not increased since C21 was launched. However, joint venturing between firms to work together on some projects in Singapore and overseas in an integrated manner was quite common.

Developing an external wing is a continuing activity; design consultancy firms have done quite well abroad. Whereas a number of consortia have been set up to pursue projects overseas, in general it was perceived that the market will decide whether the firms would really want to form consortia to venture out. On the role of the Building and Construction Authority (BCA) and Construction Industry Joint Committee (CIJC) in championing the development of the industry, although the BCA was perceived to be launching and implementing progressive initiatives, it was considered to be a government body while the CIJC was still not seen as a mature institution representing the whole industry.

The interviewees felt that regulations have improved many aspects of the construction industry and the construction process, and have been the main way in which the C21 initiatives have been implemented. For the industry to mature, the development of such norms and culture might also be propagated through peer pressure and market forces, rather than by regulation alone.

5. SIMILARITIES AND DIFFERENCES BETWEEN SINGAPORE AND HONG KONG

The original recommendations were similar in both jurisdictions (C21, 1999; CIRC, 2001) and focused on improvements in procurement, safety, training, quality, industry culture and so on. The main divergence was in Singapore's choice of developing external market as a focus area while Hong Kong then focused on developing an environmentally responsible Industry. However, since then, Singapore has incorporated environmental objectives while Hong Kong is promoting the need for developing external markets.

Some new regulations have registered reasonable success in both jurisdictions but the targeted industry norms and culture have yet to emerge. Stakeholders in both jurisdictions agree that regulation is not always the best solution for improving the industry. However, the industry has been poor at self regulation as evidenced by the lack of depth and breadth of percolation of industry improvement initiatives. The image of the industry continues to be a concern in both Hong Kong and Singapore as it is resulting in failure to attract good quality local entrants into the industry both at the worker and professional levels. Reliance on immigrant labour, albeit to different extents in both jurisdictions, has led to concerns on training of workers by transcending language barriers and improving safety levels. Further, progress from visualising the need for new policy to its enactment is perceived to be faster in Singapore as compared to Hong Kong while governmental intervention in the market is seen to be comparatively less in Hong Kong.

6. CONCLUSIONS

Industry development initiatives have achieved reasonable success but more needs to be done in shaping the industry as projected in the visions of C21 and CIRC reports. Many of the priorities listed in the CIRC report still remain partially addressed priorities. The lack of a clear vision for positioning the industry in the long term is reflected in the difficulties in developing the desired norms and culture in Hong Kong. A sustainable and healthy industry needs a sustainable market which can be targeted by understanding the needs of the jurisdiction, followed by identifying and formulating a vision, framework and strategies to shape the industry to eventually meet these needs. Furthermore, it is

important to revisit the thus identified industry vision from time to time, to 'fine-tune' approaches to address the changing needs and concerns of the community and the industry.

In subsequent stages of this study, an in depth investigation will be conducted on the issues raised above. Next, strategies to overcome the challenges and nurture the drivers will be formulated. Current key concerns will be incorporated into the visions envisaged in the CIRC and C21 reports to reformulate visions for each jurisdiction. Lessons learnt to date will be identified and a framework will be developed to help achieve the desired vision. As indicated in the introduction, some of the generic observations and lessons learned are also of relevance to construction industries elsewhere. Although priorities, and hence thrusts, will differ, a convergence of common objectives is recognised and highlighted to contribute towards the development of a high performing construction industry in each jurisdiction.

7. ACKNOWLEDGEMENTS

The authors gratefully acknowledge the funding assistance received from Hong Kong RGC Grant No. HKU713209E and the National University of Singapore Academic Research Fund. We are also grateful to all interview and focus group participants, as well as our UK partner Professor Stuart Green of The University of Reading for their support.

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Sustaining Cultural Built Heritage in the Asian Region through Resilience

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ABSTRACT

Recent thinking amongst conservationists, and those in the cultural field, has focused on differences in the views and beliefs about cultural heritage. Examples include the approaches to and understanding of conservation in the Asian region that rely on total reconstruction or restoration to preserve monuments. This is underpinned by the belief in the importance of intangible values as opposed to tangible, the spiritual aspects of a site or place and the relationship between landscape and monument within the cultural landscape. There have been attempts to address these differences. Conservation guidelines such as the Nara Document on Authenticity and charters such as the Burra Charter provide flexibility in interpretations of cultural significance. However, the debate remains fractured and the solutions provided remain firmly within the Western/Euro-centric mechanistic reductionist worldview.

Based on a review of literature this paper proposes an approach to understanding and interpreting cultural built heritage adopting the principles of resilience thinking. Resilience thinking engages in a transdisciplinary way the dynamic interconnections and interdependencies amongst the key systems of cultural built heritage. In summary, the work in the field of resilience thinking has made great gains in providing an understanding of the complex nature of social-ecological systems and how these could be better prepared to deal with disturbances and in the long term be sustainable. From the studies on urban resilience there is potential for an exciting opportunity to rethink our understanding of cultural built heritage as a social-ecological system developing a more universal approach to its conservation and ultimately its sustainability.

Keywords: Cultural Built Heritage, Resilience Thinking, conservation, sustainability.

1. INTRODUCTION

Recent thinking amongst conservationists, and those in the cultural field, has focused on differences in the views and beliefs about cultural heritage (Taylor and Altenburg 2006, Seung Jin, 2005, Taylor 2004, Wijesuriya 2004, 2003b, and Chen and Aass 1989). Examples include the approaches to and understanding of conservation in the Asian region that tend to rely on total reconstruction or restoration to preserve monuments. This is underpinned by the belief in the importance of intangible values as opposed to tangible. The spiritual aspects of a site or place or monument rather than any material or tangible evidence are significant. The relationship between landscape and monument within the broader umbrella of cultural landscapes of Australian indigenous cultural heritage is of greater value than any physical monument (Taylor and Altenburg 2006, Seung-Jin 2005, 1998, Taylor 2004, Munjeri 2004, Wijesuriya 2003a, 2003b, Mackee and Briffett 2000a).

These approaches often conflict with current conservation practices as stated by bodies such as the United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the World Heritage Centre (WHC). This particular attitude, often attributed to the Asian region, is not supported by the theories of conservation founded on the large body of Western/Euro-centric cultural and philosophical traditions adopting the Venice Charter (ICOMOS 1965) and other international and national charters

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(Chen and Aass 1989, Agrawal 1975). There have been attempts to address these differences. Conservation guidelines such as the Nara Document on Authenticity (Larsen and Marstein 1995, ICOMOS 1994, Stovel 1994), Hoi An Protocols (UNESCO 2005) and charters such as the Burra Charter (Australia ICOMOS 1999) provide flexibility in interpretations of cultural significance. However, the solutions provided remain firmly within the Western/Euro-centric mechanistic reductionist worldview.

Many people researching in this field have written on how these values manifest themselves in the context of interpreting and protecting cultural heritage in the Asian region and indigenous Australia (Taylor and Altenburg 2006, Seung Jin, 2005, Taylor 2004, Wijesuriya 2004, 2003b, Chen and Aass 1989, Agrawal 1975). Fewer people have attempted to explore these differences and how they might translate to an alternative appropriate approach to conservation in the East. These attempts have only been within the scope of proposing country specific charters (Seung Jin, 2005, 1998, Taylor 2004, Menon 2003, 1994). MacKee's (2009a, 2009b, 2009c, 2008, 2007, MacKee and Hartig 2007, 2006) work attempted to bridge this divide by postulating an approach that used as its starting point the philosophical and cultural traditions of the region linked to established synergies with systems theory. A recommendation for future research from this work was the potential of resilience thinking to provide the foundation for an alternative approach to cultural built heritage conservation.

This paper seeks to further develop the potential merging of cultural built heritage conservation and the field of resilience thinking presenting a literature review and the framework for a way forward and agenda for future research.

2. THE NOTION OF RESILIENCE THINKING

Research has shown, in general, systems are holistic, strongly connected, operate cyclically and to support the cyclical processes rely on feedback loops (Macy 1991, Laszlo 1972, Bertalanffy 1968). In studying the changes that occur in natural eco-systems research has led to the notion that these systems are invariably very complex (Walker and Salt 2006). The highest level of complexity is evident in social-ecological systems, that is the relationship between human systems and ecological systems (Walker and Salt 2006, Berkes *et al* 2003, Holling 2001, Berkes and Folke 1998). Understanding the complexity of these co-evolving systems their interrelationships, change dynamics and transformation has provided the rich foundation for looking at the 'resilience' of these systems (Walker and Salt 2006, Berkes *et al* 2003, Holling 2001, Berkes and Folke 1998). At the heart of resilience thinking is the very simple notion of coherence despite change and the idea that to ignore change is to increase our vulnerability and forego emerging opportunities (Walker and Salt 2006, pp 9-10). In resilience thinking humans and nature are considered as elements of the one system, as they are interdependent. To think of one in isolation of the other is to come up with only a partial solution (Walker and Salt 2006). In essence, Resilience, defined by Walker and Salt (2006) is a systems capacity to absorb disturbances without a regime shift and they see it as the key to sustainability (Walker and Salt 2006, pp. 38).

3. RESILIENCE THINKING IN THE CONTEXT OF CONSERVING CULTURAL HERITAGE

A component of resilience thinking that has direct links to the notion of cultural heritage conservation is the model of the adaptive cycle (refer figure 1). This has been derived from comparative studies of the dynamics of ecosystems and how they recover and reorganize after catastrophic events. This adaptive cycle has four distinct phases that are representative of ecosystems and more significantly for this study social-ecological systems. These four phases are (Resilience Alliance 2009):

- Growth or exploitation (r)
- Conservation (K)

- Collapse or release (Ω)
- Reorganisation (α)

Represented in this cycle are two major phases often referred to as ‘transitions’. The first phase or *foreloop* that runs from r to K is characterised by slow incremental phase of growth and accumulation. The second of these phases is the *backloop* from Ω to α and is the rapid phase leading to reorganization and growth (Resilience Alliance 2009). This adaptive cycle model is used in resilience thinking to explain how ecosystems adapt after catastrophic events.

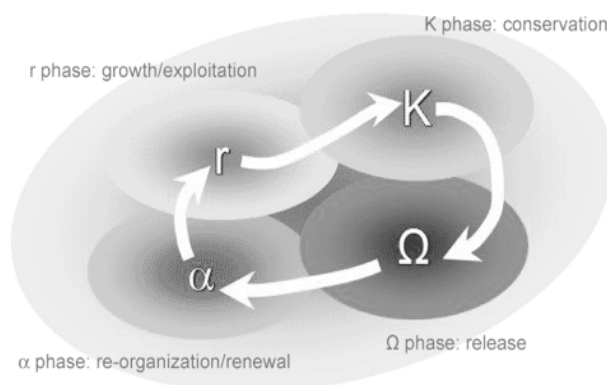


Figure 1: The model of the adaptive cycle developed by the proponents of resilience thinking. (Source: Resilience Alliance <http://www.resalliance.org/570.php>)

Another link between resilience theory and its potential application for cultural heritage conservation is Redman’s (2005) discussion of the notion of resilience thinking in archaeology. He postulates that “...*resilience thinking looks at change transformation and adaptive cycles and archaeology provides the opportunity to study not only one completed cycle but multiple completed cycles* “ (Redman 2005, p70). Redman’s contention is that the study of persistence and change in systems is at the heart of resilience thinking and can be verified by archaeology in the study of many systems historically over time. In so doing archaeology confirms the notions of adaptive cycles of change and transformation and the dynamic changes that occur over time in social-ecological systems (Redman 2005). Redman’s study has implications for the current research in that, as with archaeology, the conservation of buildings and specifically large areas of aging urban centres is about dealing with persistence despite change and transformation. This changes the temporal, utilisation and management contexts. For cultural built heritage archaeology establishes and confirms the changes and transformations that have occurred to the monument over time. This allows us to understand previous life cycles and to plan for the future.

Redmen *et al* (2003) continue the notion of adaptive cycles as evidenced over time in archaeology. This article investigates resilience theory because of its explanation of ‘the role of change in adaptive systems’. This is in order to see the transforming stages making it highly relevant to use to understand archaeology, in particular studying the ‘resilience of past and present societies’ as they are adaptive and changing. They state that this approach is not common in other disciplines. The authors go on to explain resilience theory and then continue to show how when it is used it can have ‘complementary or contradictory conclusions’ and finally they discuss the idea of a ‘long-term integrative perspective for understanding linked social and ecological systems’ (2003 p.14). They offer a detail description of the theoretical framework then show that collaboration has occurred with conceptualisation of these cycles in “ecology, archaeology and economics, among other fields” and they concentrate on Holling’s (2001) use of the concept in ecology for their study. They show that there are paradoxes of resilience and adaptive capacity and critique the panarchy approach. They also state that resilience can solve problems in ‘short run but not in the long term’. In their conclusions they bring in two case studies of archaeological societies to show the similarities in the use of

resilience theory to understand ecological changes and show what parts work and what do not in the theory. They show that this theory is being more and more incorporated by archaeologists to “examine their historical processes within a resilience theory framework” (2007 p.14). The work of Redman (2005) and Redmen *et al* (2003) provides the strongest argument for linking the concepts of resilience thinking to a notion of conserving cultural built heritage. The ideas of change, transformations and adaptive cycles are notions that are related to how cultural heritage can be perceived through time and explored in terms of conserving, incorporating and protecting.

The work of Childs (2001) looking at settlements and cities as complex systems similar to ecology, while not being explicit has implicit links to resilience. He makes direct reference to buildings and how they develop and evolve similar to a system. Childs (2001) uses ‘biological evolutionary theory’ to explain this process of change and interactions of buildings between each other ‘giving rise to collectively made forms’ (2001, p.55). He then considers the city as a civic ecosystem, as a “complex set of interactions among multiple buildings” which may ‘give rise to aggregate forms and that these can change over time depending on flow of resources in communities. Here Childs considered ‘coherence’ and ‘resilience’, he gives the example of how ruins are a result of disaster and examples of resilience or lack of for cities. He states that not all change is ‘cataclysmic’ and that “different systems have different degrees and types of resilience” (2001, p.69). Childs concludes to show that buildings are not isolated entities as they “alter each others fitness” (2001, p.70). This work is informative and useful in looking at how resilience might be considered as a basis for looking at the conservation of cities if they are thought of as complex systems.

This work points toward a method of looking at the conservation of cultural built heritage through the lens of resilience. More specifically for the aims of this research they provide a very useful argument that culture; heritage and built heritage can be considered as systems that are interconnected and interdependent. The application of resilience thinking to the conservation of built heritage provides the opportunity to understand and deal with the persistence and survival of heritage against the persistent forces of physical, social and natural change. That is, resilience thinking engages in a transdisciplinary way the dynamic interconnections and interdependencies amongst the key systems in the built environment.

4. DISCUSSION

Resilience is the capacity of a system to absorb shocks while maintaining function. It provides the capacity for renewal and reorganization. In a resilient system change has the potential to create opportunity for development and innovation. However there are four critical factors that must exist for the success of a resilient system these are presented in table 1.

Table 1: Four Critical Factors for a Resilient system (Source: Folke *et. al*, 2002)

	Critical Factor	Description
1	Learning to live with change and uncertainty	Creating a knowledge base for how to relate to and respond to environmental feedback
2	Nurturing diversity for resilience	Functional diversity and redundancy as per nature
3	Combining different types of knowledge for learning	Integration of knowledge and their sources for a holistic approach
4	Creating opportunity for self organisation towards socio-ecological sustainability	Adaptive co-management by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organised process of trial and error

These four critical factors (Folke *et al*, 2002) provide guidance for developing a framework for applying the concept of resilience to the conservation of the cultural built heritage. The first factor would relate to the fact that cultural built heritage exists through time which impacts in uncertain unpredictable ways. The idea of a knowledge base provides for trying to deal with the uncertainty, again through the life of the piece of heritage, this implies research.

The second factor requires understanding of the nature of the piece of heritage and the diversity of the built environment within which it has come to exist. A requirement for this factor in heritage is an understanding of the conditions of redundancy and obsolescence.

Important for the third factor is the in the context of cultural built heritage is the multidisciplinary approach and the knowledge provided by the many stakeholders. This is imperative for a holistic approach that has been suggested as currently lacking in heritage conservation (MacKee 2009a).

Finally the key to attaining the fourth factor is the understanding that conservation of cultural built heritage can be a sustainable process with the implementation of the appropriate institutional processes. These must acknowledge the dynamic nature of cultural heritage and importance of a suitable management organisation.

Figure 2 shows an initial proposal for a comparative cycle that could be used to describe the life cycle of cultural built heritage. This is developed as a sub-set of the adaptive cycles of resilience to be used as a basis for exploring the cultural built heritage. In this cycle there are transitions. The first can be shown from the first stage of the cycle 'commission and operation' to 'obsolescence'. This is a long slow transition that is subject to the economic and societal demands of the environment in which the cultural built heritage exists. Similarly this is a phase of growth.

The next transition from 'obsolescence' to 'adaption/renewal' is one of decision-making and significant change. In this phase significant decisions are made about how to adapt the piece of heritage. This decision could be supported by scenario planning as suggested by Peterson (2003). In his paper he proposes scenario planning as a tool for decision-making because it "...offers a framework for developing more resilient conservation policies when faced with uncontrollable, irreducible uncertainty" (Peterson, p358, 2003). The notion of uncertainty describes the future of cultural built heritage in the Asian region in the context of rapid urban development occurring.

The third transition is to the planning and development phase. Once a decision has been made regarding how to deal with the piece of heritage then work can proceed on development. Once planning and development is completed then the cycle recommences.

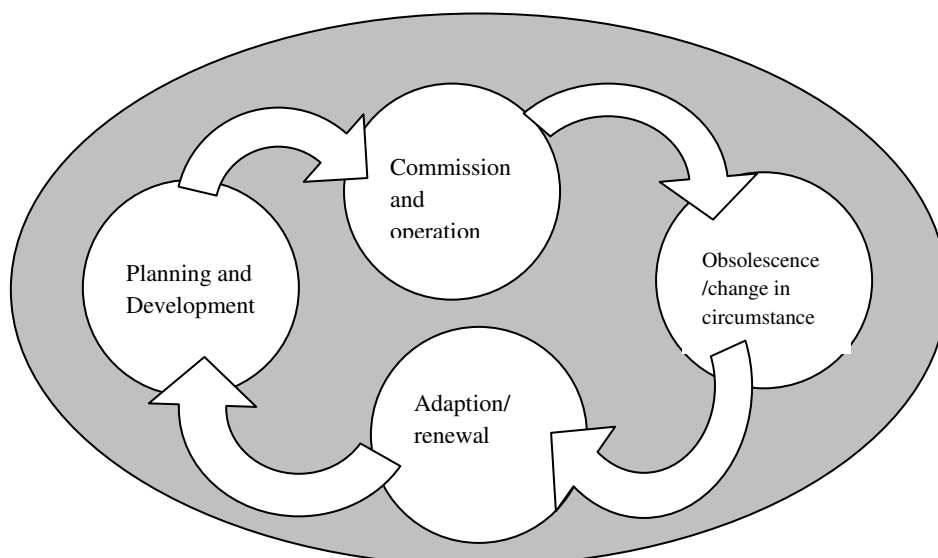


Figure 2: The life cycle of cultural built heritage. (Source: Author)

The description of the life cycle in figure 2 offers the initial proposal for the integration of the adaptive cycles of resilience to the conservation of cultural built heritage. From these very first steps work needs to focus on the further integration of the four critical factors described in table 1. These are important to the success of the integration of resilience and conservation of cultural built heritage.

5. CONCLUSION

This paper has provided a literature of review of resilience thinking to support the merging of this field and the conservation of cultural built heritage in the Asian region. A number of writers in the field have highlighted discussed the differences that occur in the approaches of western and eastern based indigenous conservation practices (Taylor and Altenburg 2006, Seung Jin, 2005, Taylor 2004, Wijesuriya 2004, 2003b, Chen and Aass 1989, Agrawal 1975). This is evident in the rise of locally based conservation charters and guidelines (Seung Jin, 2005, 1998, Taylor 2004, Menon 2003, 1994). MacKee's (2009a, 2009b, 2009c, 2008, 2007, 2006). Documents such as the Nara Document on Authenticity (Larsen and Marstein 1995, ICOMOS 1994, Stovel 1994), the Hoi An Protocols (UNESCO 2005) and the Burra Charter (Australia ICOMOS 1999) are also evidence of this trend.

MacKee (2009a 2009b, 2009c) proposing an alternative approach to conservation in the Asian region has written on the synergies between traditional Asian philosophies and systems thinking. From this came the notion of resilience as an appropriate approach for developing a framework for an approach to conserving cultural built heritage.

The review presented here has outlined the beginnings of a potential method for adopting resilience thinking as a way of conserving cultural heritage. A component of resilience, adaptive capacity, provides the means for realizing this objective. Further work needs to be done however it would appear from this foundation study that great potential lies in the merging of resilience thinking and cultural built heritage conservation.

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Conceptual Framework to Maximise Building Stock ‘Utility Life’ and ‘Whole Life Value’

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ABSTRACT

Appropriating maximum ‘utility life’ and ‘value’ from aging infrastructure including existing building stock is of critical importance for developed countries; while adopting a whole life costing approach is gaining momentum in delivering infrastructure and buildings in developing countries. This is due to resource constraints and the increasing emphasis on sustainability objectives both at project delivery and operation and maintenance management (O&M) stages. Research in the asset management domain has generally focused on delivering whole life value for assets by means of whole life cycle value analysis at design stage and/or preventive maintenance management at O&M stage.

However, the above asset management strategies generally focus on non-building infrastructure assets and fail to address the concerns of delivering and managing building stock. This can be explained as due to buildings being fragmented in ownership and not being part of infrastructure networks as in roads and hence being less critical in terms of interdependence or overall performance. However, there is significant value to be gained for the industry and society if building stock is appropriately delivered and managed. This paper brings out the need for a holistic framework for extracting maximum ‘utility life’ and ‘whole life value’ from building stock. Further, relevant literature is reviewed to identify relevant core issues and best practices that can be harnessed and refined for development and implementation of such a framework. A conceptual framework derived from whole life costing and asset management principles and practices to satisfy the above need is introduced along with a research roadmap for refining the framework and developing implementation guidelines.

Keywords: Asset Management, Building Stock Management, Utility Life, Whole Life Value

1. INTRODUCTION

The problem of ageing infrastructure is well recognized, for e.g., the American Society of Civil Engineers (ASCE, 2009) has assigned an overall D grade to the nation’s infrastructure assets and estimated that it would take a \$ 2.2 trillion of investment to bring them into a state of good repair. Similar scenario has surfaced in Australia (Engineers Australia, 2005). The sudden concern and stampede towards better management of infrastructure assets is mainly due to the huge costs involved in replacing the said infrastructure if allowed to deteriorate beyond repair. Furthermore, the

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environmental cost involved if we were to replace the said assets is immense, given the increased carbon footprint and other major impacts.

Increased research on applications of asset management techniques such as life cycle costing and preventive maintenance together with improved deterioration modelling have demonstrated that the service life of an asset can be extended (Hein and Croteau, 2004; Zaniewski and Mamlouk, 1999). Such measures have been put into practice in some cases. Designing for longer ‘utility life’ and enhanced ‘whole life value’ is also gaining traction in the industry. However, a sector which has received scant attention is upgrading existing building stock to be more energy efficient and to deliver longer ‘utility life’ and thus ‘whole life value’.

In this sector improvements have been limited to large developers with a large portfolio of real estate assets, while owners with single or few assets are yet to give attention to these issues. However, these assets cannot be ignored as they form a large proportion of the available building stock. Also, many previous studies have concluded that it has become necessary to work more efficiently with the stock we have rather than simply opt for demolition and redevelopment (Ball, 2002; Bullen, 2007).

This paper presents the background work of a new research project with a wider scope titled ‘Management of Infrastructure Rehabilitation, Redevelopment or Revitalisation’ (MIRROR), a component of which focuses on the management of existing building stock. The paper delves into the issues facing Hong Kong in terms of its aging building stock and brings out the need for a holistic framework for extracting maximum ‘utility life’ and ‘whole life value’ from them. Also, it introduces a conceptual framework derived from whole life costing and asset management principles and practices to satisfy the above need and to prepare a roadmap for further research for this component of the above mentioned research project.

2. THE NEED TO MAXIMISE

The concept of sustainability in its early ages involved reconciliation of environmental, social and economic demands - the ‘three pillars’ of sustainability (United Nations General Assembly, 2005) and was illustrated using three overlapping ellipses indicating that the three pillars of sustainability are not mutually exclusive, but can be mutually reinforcing. However, this concept is not universally accepted, especially by environmentalists who view biosphere or the environment to subsume society and society in turn to subsume economy (Porritt, 2006) the concept being illustrated as three concentric circles.

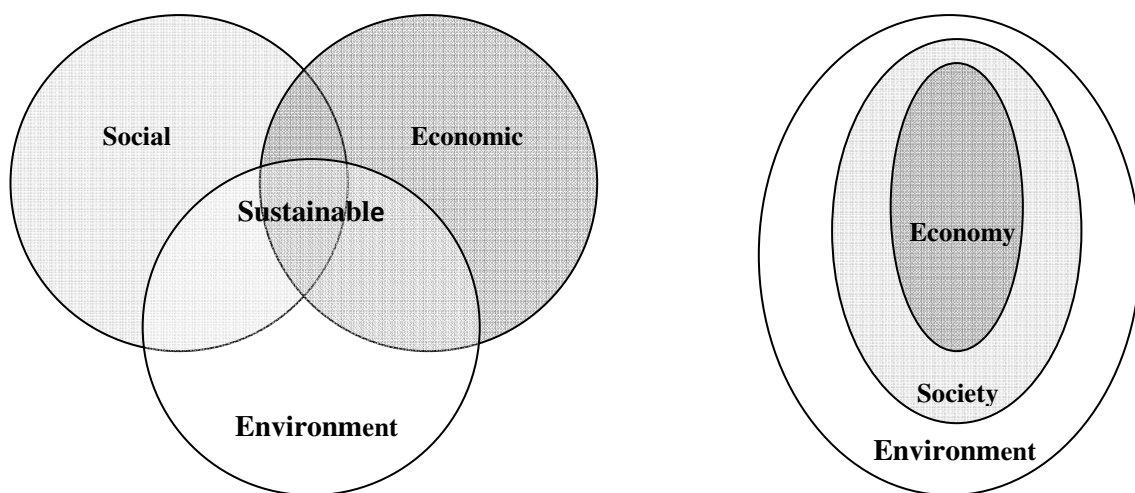


Figure 1: Illustration of Sustainability Concepts

With increased emphasis on environmental sustainability, it is expected that more people will gravitate towards the latter concept which implicitly acknowledges the supremacy of the environment. In this regard, maximising ‘utility life’ thereby enhancing ‘whole life value’ is considered as imperative if we were to mitigate construction industry’s carbon footprint conforming to the old adage that ‘a dollar saved is more than a dollar earned’.

3. AN OVERVIEW OF AGEING BUILDING STOCK AND THEIR ISSUES IN HONG KONG

Hong Kong, being geographically small, is constrained by lack of space to add on new building stock which thrusts the issue of managed building care to the forefront. It is estimated that there are approximately 13000 aging private buildings in Hong Kong and the count will double over the next decade (Kam, 2008). These ageing buildings have been under scrutiny for their presumed danger to public in general, for e.g. falling windows from heights and the recent collapse of a seven storey building during renovation.

Many of these buildings are fragmented in ownership, i.e., are owned by multiple owners making it difficult to improve their condition. Government’s efforts to improve the situation through schemes such as planned mandatory building inspection scheme, Operation Building Bright (Buildings Department, 2010a, 2010b), maintenance cost reimbursement scheme (URA, 2010) are still evolving.

Demolition for redevelopment is an attractive option for Hong Kong given the space constraints; hence aging buildings have been a target for developers, especially in cases of unused Floor Space Index (FSI) changes over time. New legislation which compels ‘holdout’ owners to sell apartments to a developer that already owns at least 80% of a building's units, reduced amidst some protests from the previous 90% is expected to increase this trend, although the government believes that the law quickens the pace of redevelopment. Redevelopment is advisable when the buildings are dilapidated. However, on occasions, it has been seen that buildings with significant ‘utility life’ left in them become targets for redevelopment, e.g. if they are in attractive neighbourhoods. Hong Kong is also on the threshold of implementing Mandatory Implementation of Building Energy Code (EMSD, 2010) which aims for improving energy efficiency of existing building stock.

However, Hong Kong’s proclaimed urban renewal strategy rests on 4R’s, the 4R’s being Redevelopment, Rehabilitation, pReservation and Revitalisation. Under this Strategy “redevelopment at a project site is used as an anchor around which other complementary modes of urban renewal will take place” (URA, 2005). This suggests that redevelopment is the primary choice of urban renewal although other renewal modes such as adaptive reuse have been deployed for e.g., the recent announcement to adapt and reuse more than 1000 industrial buildings (Development Bureau, 2009) while the focus could have been on extracting maximum utility life from existing building stock.

4. ‘MIRROR’ AND BUILDING STOCK MANAGEMENT

The just commenced research project titled ‘MIRROR’, is conceived to address the seismic shift in work demands within the construction industry which has arisen in two stages (1) a gradual but inexorable increase over the last decade, as most new infrastructure needs had been already met in developed countries, while ageing infrastructure ‘cried out’ for renewal and regeneration, rather than demolition and disposal; and (2) the sudden surge propelled by the 2008 financial tsunami where Governments in many countries pumped massive funds into infrastructure redevelopment, in order to jump-start stalled economies.

With the shift in focus, it was perceived that strategic management and project management structures, protocols and approaches in both public and private sectors were struggling to cope with this ‘new’ more complex redevelopment type work for which they are ill-prepared, given that their training and experience has hitherto focused mostly on ‘new-build’. In this regard, this research project is designed to address the above shortfalls by setting the scene with an in-depth investigation

of specific shortcomings and real needs, followed by the formulation of a well-structured and sustainable agenda for developing much-needed new strategies, skill-sets and mind-sets for managing '3R projects'.

In regard to the building stock component of the infrastructure, it was perceived that the lack of a holistic approach to building stock management involving the various stakeholders such as buildings department, urban renewal authority, end users and the construction industry was hindering the efforts to maximise 'utility life' and thereby 'whole life value' of the existing building stock.

5. FRAMEWORK DEVELOPMENT FOR MAXIMISING 'UTILITY LIFE' AND 'WHOLE LIFE VALUE'

Infrastructure asset management principles using a whole life costing approach have been found to be successful in increasing the utility life of an asset. The strategy behind this approach is to optimise the trade-off between maintenance and replacement. A successful asset management strategy involves preventive maintenance based on deterioration models to prevent the deterioration of an asset and ensure a longer replacement interval. This approach can and should be applicable to building stock management. However, there are constraints in applying this approach to existing building stock.

Constraint 1: It has to be noted that applying this approach requires an economy of scale which is derived from ownership of a large number of similar assets. Wilkinson and Reed (2008) state that generally, lower quality building stocks which are owned by individuals are the ones in need of refurbishment and/or adaptive reuse but the least likely to receive attention and repair and maintenance expenditure by owners because they may not be aware of these building related issues. Obviously, this does not provide economy of scale to apply asset management principles and practices.

Constraint 2: The approach of the operating agency is entirely cost based (capital costs + Maintenance costs). Consideration for environmental costs such as embodied emissions from new-build projects as opposed to less energy efficient older buildings are not included. According to Pullen (1999), on average, the embodied energy for residential construction amounted to approximately one quarter of the life cycle energy for an assumed eighty year lifecycle. The figure being significant would have a clear impact on decision to replace an asset.

In selecting strategies to overcome these constraints, it was perceived that asset management principles can indeed be applied to maximise utility life and thus whole life value of existing building stock. The approach taken to overcome constraint 1 was to introduce a nodal agency from the government to oversee and regulate maintenance works to existing building stock after they have attained a certain 'threshold' inspection age. With the mandatory building inspection scheme about to be enforced in Hong Kong, it was felt that it would not pose undue extra burdens on the relevant government agencies.

The role of the nodal agency would be to formulate guidelines as to appropriate preventive maintenance strategies to enhance utility life, and to ensure that they are applied by means of mandatory building inspection scheme for aged buildings. Also, the nodal agency would be expected to promote the need for managed care of building stock and design incentive schemes to encourage their implementation.

The strategy to address constraint 2 was to change decision making on asset replacement to be 'value' based as opposed to cost based at present. The change is based on the premise that the perceived value of an asset is impacted by the importance attributed to different dimensions of value other than cost such as heritage, community, social value etc which are important factors for decision making on whether an asset is to be replaced. Therefore, on evaluating the 'whole life value', environmental costs such as embodied emissions from new-build projects as opposed to less energy efficient older buildings will be included along with other 'value' dimensions such as above to be determined in the

course of the research. Replacement value will also be evaluated by incorporating above value dimensions. The proposed framework is as shown in Figure 2.

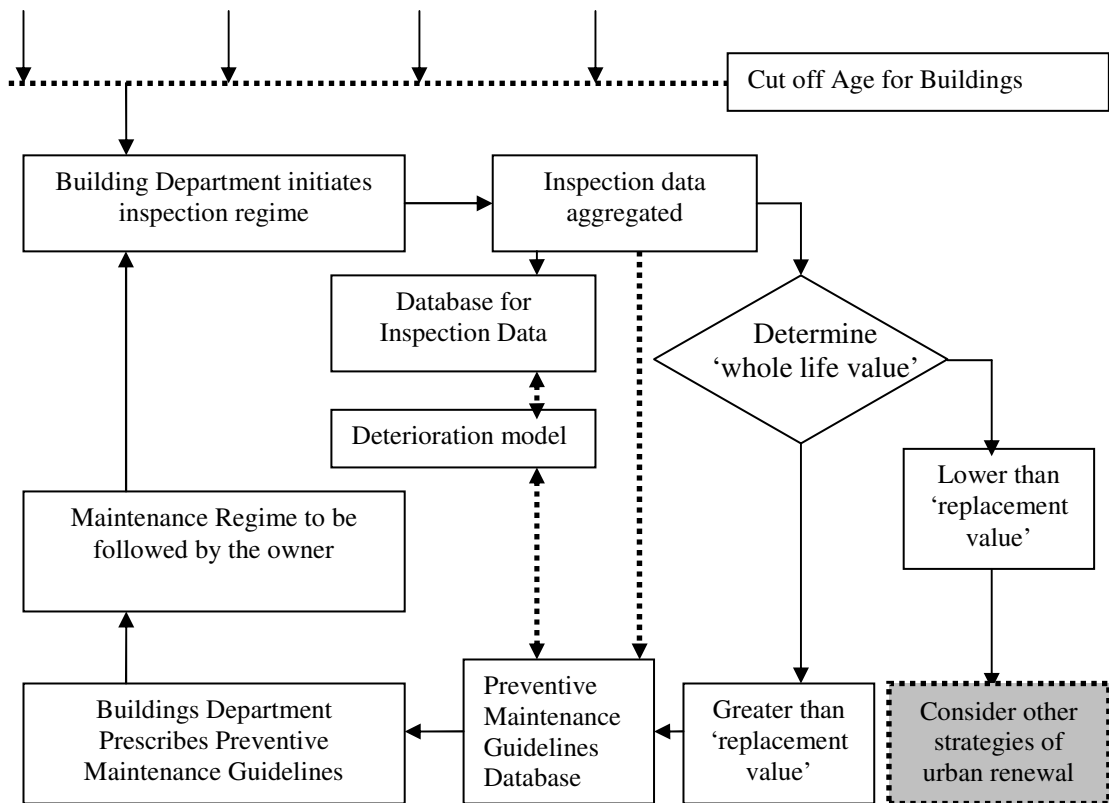


Figure 2: Preliminary Framework for Maximising 'Utility Life' and 'Whole Life Value'

In operationalising the model, various value based decision making concepts such as total quality, systems theory, balanced assessment etc will be evaluated for applicability and an appropriate method will be chosen. Further, value dimensions to be incorporated and decision support system to be designed will draw on experiences of the research team on 'value' based decision making from previous research work on procurement (Kumaraswamy *et. al.*, 2004), stakeholder management (CICID, 2007), project briefing (Chung *et. al.*, 2009) etc and supplemental literature review.

6. LIMITATIONS

The preliminary framework presented here is derived from initial background work for 'MIRROR' research project; and so well short of a fully researched, well structured and tested framework. It needs to be developed and adjusted where needed with the support of empirical data and then validated. Furthermore, a well populated database is required to formulate a deterioration model which should in turn guide the formulation of preventive maintenance guidelines. Another database is required for easy calculation of embodied emission levels for new-build projects to facilitate easy calculation of whole life value along with comparative energy efficiency levels of old building as opposed to new buildings. Many of these limitations will be address as the research project progresses as described below. However, some of them will remain beyond the scope of this study.

7. ROADMAP FOR FUTURE RESEARCH

An in depth investigation on managing existing building stock will soon be launched with an aim to unearth barriers to managed building care in maximising utility life with specific reference to Hong Kong. This will be approached through interviews of relevant professionals and reviews of relevant legislation, regulatory codes, guidelines and other documents. Further, strategies to overcome these barriers will be derived from best practices elsewhere and from inputs from professionals. The framework will be refined to reflect these constraints and accommodate the developed strategies; and will be validated by means of focus group meetings at appropriate stages.

Also, other 'value' dimensions to be considered while evaluating the whole life value will be unveiled and incorporated into the detailed 'whole life value' evaluation guidelines. The findings of this research together with the findings for 'infrastructure' component which forms the other part of this study will be the final output of the 'MIRROR' research project.

8. CONCLUDING OBSERVATIONS

Maximising 'utility life' and thereby 'whole life value' will contribute to reduction of the carbon footprint of construction industry and its products. In this regard, the need for well managed care of existing building stock has been established, especially for properties with fragmented ownership along with a basic approach to deliver it using asset management principles. Also, this approach is seen to be capable of dovetailing well into existing Hong Kong initiatives and in the longer run will help improve the energy efficiency of existing building stock.

The framework is expected to provide the means to deliver maximum 'utility life' and 'whole life value' in the Hong Kong context but can be modified and applied generically to any country. However, the key is how well the role of the nodal co-ordinating governmental agency in promoting and regulating the implementation is defined; and how well it can regulate the implementation. Also, establishing the required databases which must feed into the framework and inform decision making will pose a major challenge.

As in any other such scenarios, the framework needs to be developed and implemented in stages, for e.g., with more judgement based and also more flexible implementation protocols being deployed in the first phase, i.e. until the databases are developed to a satisfactory 'tipping point' for reliable usage, and secondly until community confidence and commitment is built up. There will always be vested interests as well as those who are genuinely adversely affected by such systems who will oppose them, but 'over-riding' public interest should be the overall driver. Professionals and politicians would need to work together to effectively convey the needs for such strategies and tools to maximise building stock 'utility life' and 'whole life value'.

9. ACKNOWLEDGEMENT

The authors gratefully acknowledge the funding assistance received under seed funding for basic research scheme from The University of Hong Kong, Grant No. 200911159118.

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A Sustainability Perspective on Building Condition Assessment in the Maintenance of Health Facilities: A Case Study

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ABSTRACT

Modern man in today's society need buildings to be able to function. The construction of buildings through the carbon footprint thereof have a very significant impact on the environment. Ensuring optimal building life through effective maintenance based on regular building condition assessments will reduce this effect on the environment. This paper highlights the value of regular building condition assessments in assisting the development of maintenance programs based on relevant information with the aim to maximise building life.

Maintenance of real estate and infrastructure owned by public institutions in South Africa or the lack thereof has been a subject of increasing local debate for more than a decade. The health care industry in South Africa is made up of over 4000 facilities with a current replacement value of R180billion.

This paper focuses on Malamulele Hospital in Limpopo Province of South Africa. The facility has a maintenance team and maintenance programs, but the quality of maintenance has been less than optimal and the building condition varies from fair to bad.

The paper evaluates the opinion that building condition assessment is an important part of efficient maintenance programs but that custodians of buildings often have inadequate knowledge about the subject resulting in poor maintenance performance.

By comparison the above maintenance work is compared to that conducted at Transnet Rail Engineering, Koedoespoort depot in Pretoria. Both facilities are public institutions, but Transnet Rail Engineering has been identified as a well maintained facility according to the SAICE Infrastructure Report Card 2006.

Keywords: Sustainability, asset management, planned maintenance programs, building condition assessment, building life.

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1. INTRODUCTION

The paper seeks to illustrate the importance of conducting regular and consistent building condition assessments. It aims to show how and where the condition assessments fit into maintenance programs and how the property owner or manager can benefit from these assessments.

Building condition assessments are an essential part of maintenance as they provide maintenance managers with the information they need to formulate maintenance plans and resulting in maintenance budgets. The paper aims to prove that property owners and managers often have little or no knowledge of conducting building condition assessments resulting in poor maintenance programs being put in place which may lead to pre-mature building failures.

In South Africa the Government Immovable Assets Management Act (GIAMA) No 19 of 2007 makes it a statutory requirement for public institutions to conduct such building condition assessments.

The introductory section of this paper briefly refers to the theory and concepts of the property industry pertaining to the research, including building maintenance and conducting of building condition assessments. This is followed by describing the methodology applied to conduct the research, showing the different sources of information and how the data was obtained.

The activities of the maintenance department of Malamulele Hospital (MH) in Limpopo Province of South Africa are discussed to show how maintenance is conducted at the hospital. Finally, the discussion of the results obtained is made by comparing the results from MH to the results from Transnet Rail Engineering, Koedoespoort (TRE) depot in Pretoria as reflected in the SAICE Infrastructure Report Card 2006.

2. BUILDING CONDITION ASSESSMENTS

Buildings serve several needs of society and can be used for industrial, residential or commercial purposes to mention a few. The built environment expresses in physical form the complex social and economic factors which give structure and life to a community (Lee, 1981). The quality and condition of buildings in a community determine attitudes and social behaviour of people in that particular community. The state of the buildings also reflects the levels of prosperity and is a source of pride to the inhabitants. According to Lee (1981) dilapidated and unhealthy buildings in a decaying environment depress the quality of life and contribute in some measure to anti-social behaviour.

Once built, buildings have to be managed so that they can continue to function and to maintain their value. One of the ways of ensuring that the buildings remains functional is by applying sound maintenance principles and conducting effective maintenance programs. Maintenance is defined as the combination of all technical and administrative actions, including supervision actions intended to retain an item in, or restore it to a state in which it can perform a required function (Smith & Tate, 1998).

Sowden (1990) is of the opinion that all structures inevitably deteriorate towards a state of in-serviceability and collapse. But the rate at which they do so can be controlled by effective maintenance. One of the main components of such maintenance programs is regular, accurate and consistent building condition assessment. This will capture changes in building condition and make management of building maintenance possible. The building's condition gives a measure of the effectiveness of current maintenance programs because it determines the remaining useful life of components or systems and compares it with the full economic life expected, given good maintenance (McDuling, 2008).

The Queensland Department of Public Works in Australia (2007) defines building condition assessment as the technical assessment of the physical condition of an asset, using a systematic method designed to produce consistent, relevant and useful information.

If buildings are not properly managed or if correct maintenance is not conducted the following outcomes may typically result:

- ❖ Failure of a component or element of the building to fulfil its mission (Byron, 2008:3).
- ❖ Increased transmission of hospital-related infections such as airborne tuberculosis and legionella
- ❖ Sick building syndrome - when building occupants experience acute negative health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified (www.epa.gov/iaq/pubs accessed 21/07/2009)
- ❖ Wastage of resources such as water and power from leaking pipes
- ❖ Dysfunctional buildings resulting in overcrowding of other available facilities such as schools and hospitals
(www.millenniumtowers.com.au/fightovercrowding.php 2009)

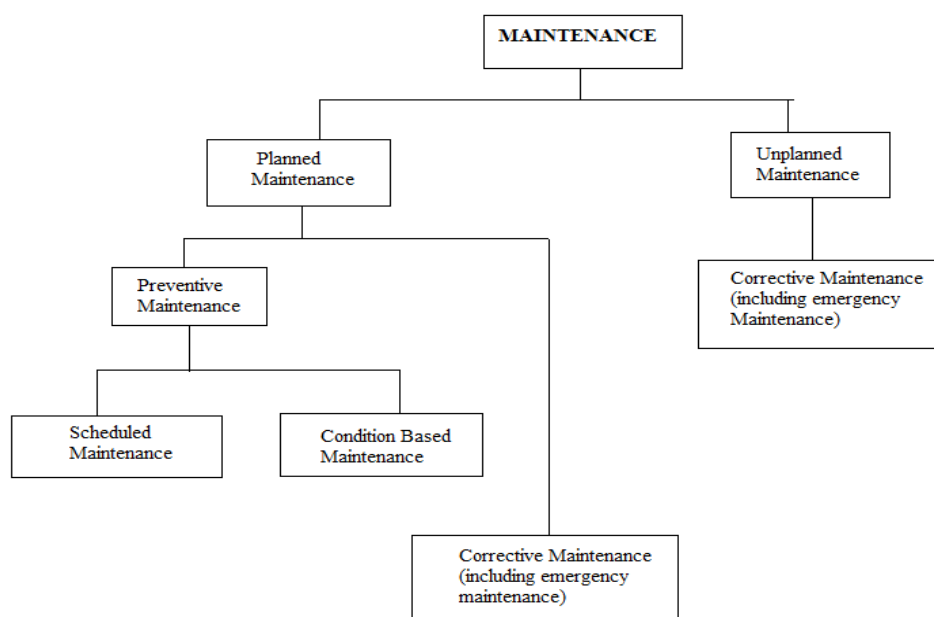


Figure 1: Types of Maintenance (Source: Seeley 1978)

In order to justify the cost of maintenance to the property owner, tangible benefits should result from such maintenance such as:

- Saving money in the long run
- Ensure optimum building life
- Neat and clean buildings create the right impression for visitors
- Improved tenant employee efficiency (Smith, 2009).

3. FACILITY MANAGEMENT OF PUBLIC FACILITIES IN SOUTH AFRICA

In 1996, the first ever public facilities audit in South Africa was carried out, which included 434 hospitals and 108 community health centres. This audit revealed that a third of the health facilities, due to the cost of rehabilitation, needed complete replacement and that a further one third needed upgrading. It was estimated that approximately R12billion would be needed to rehabilitate these hospitals including equipment over a period of eight years.

In order to address the issue of dilapidated health facilities the Government established the Hospital Revitalization Program (HRP) which was officially launched in 2003 with a total budget of R1.9 billion. The HRP aims to redress the backlog of shortage of hospitals and hospital revitalization which

had accumulated in the period from 1980 till 1994. It also aims at improving hospital infrastructure, health technology (equipment), quality of care, management and organizational development within targeted hospitals in the program.

The existing health estate in South Africa is made up of over 4000 facilities, occupying a combined gross area in excess of 10 million square meters, with a current replacement value (buildings and equipment) of over R180billion (DBSA, 2008). The 1996 health infrastructure audit gave public hospitals a 'C' grade rating and public clinics a 'D+' rating (SAICE, 2006: 6). This means that hospitals were found to be in a fair state, while the clinics were generally in a poor state (SAICE, 2006).

4. SUSTAINABILITY'S LINK WITH MAINTENANCE

Sustainability in the built environment focuses on reducing the carbon footprint of the construction and operation of buildings as far as possible. However, regardless of best green building practice and intent of designers, specifiers and contractors, the construction of new buildings will always carry a heavy carbon footprint loading.

In Europe at present up to 60% of the raw materials extracted from the environment and around 40% of the total energy consumed is attributed to the building sector (Zabalza *et al*, 2009).

It is therefore of great importance to ensure maximum building use life as this will spread the initial construction-related carbon footprint over as long a period as possible. The carbon footprint per year of use of the building will thus be minimized.

Ensuring maximum building life is widely agreed to be the result of efficient and regular maintenance and more specifically planned and preventative maintenance. This is also the most cost-effective way of pursuing this goal (Abbott *et al*, 2007). This point of view is also supported by Straub in an evaluation of the use of condition assessment in Dutch housing associations (2009).

A recent case study by McDuling and Abbot (2008) at a major academic hospital in South Africa highlights the effect of inadequate maintenance programs on the long term. Their study revealed that the facility, designed and built with a planned use life of 50 years, had become largely dysfunctional due to amongst others inadequate and poor maintenance after only 30 years. This means that 40% of the use life of the facility had been lost. The calculated carbon footprint per year in use of the facility had therefore been increased by 67%.

5. RESEARCH METHODOLOGY AND DATA COLLECTION

Data for MH was collected from the condition audit reports prepared by the Council for Scientific and Industrial Research (CSIR). The data was supported by interviews conducted with personnel at the facility. The building condition at MH was also observed by means of a walk-through during visits to the facility.

In conclusion maintenance at MH was compared with that of Transnet Rail Engineering infrastructure (TRE). A report card compiled by the South African Institute of Civil Engineers (SAICE) in 2006 showed that the TRE-owned infrastructure which included ports and rail installations, were performing better than other public owned infrastructure due to proper maintenance programs being adhered to

Data collection in 1996 and 2005 by the CSIR was based on the property management system called Professional Real Estate Management Information System (PREMIS). It is a software system that can be applied as a building maintenance management system covering property, legal, people, elements and organisation structure as data table categories.

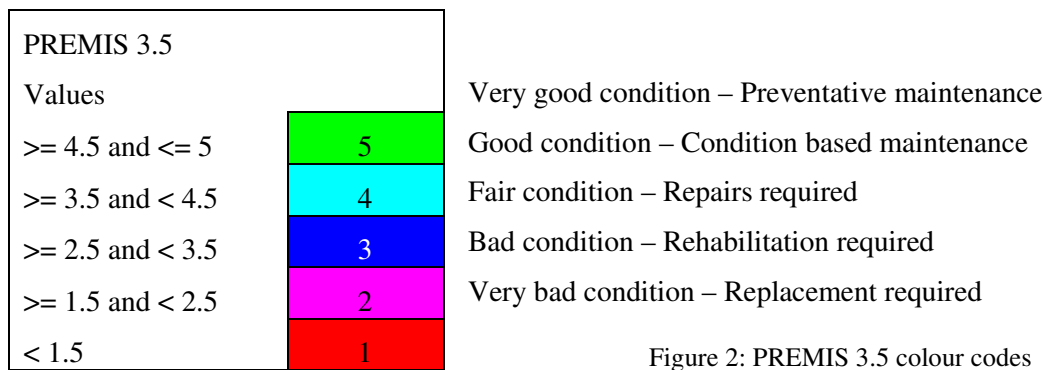


Figure 2: PREMIS 3.5 colour codes

The condition of the different elements of a building is evaluated and assessed and then an overall assessment mark for the facility is calculated. This overall condition mark determines what action is to be taken. The evaluation result of a facility can be presented as in the Figure 4.



Figure 3: Condition Profile of a building after technical assessment (McDuling, 2008)

Condition rating	x	% of facility	=	assessment mark
5 (Very good)		5		0.25
4 (Good condition)		15		0.60
3 (Fair condition)		30		0.90
2 (Bad condition)		35		0.70
1 (Very bad condition)		<u>15</u>		<u>0.15</u>
		100%		Total = 2.60

The total PREMIS assessment of 2.60 reflects the average condition of the total facility and is described as bad to fair. The building therefore need rehabilitation and repair work as the major component of the maintenance program.

Comparative evaluation of the results of 1996 and 2005 indicated that the condition of some of the buildings changed while others remained unchanged. This research focus in more detail on those buildings with changed conditions. These include:

1. D5 (now called B017): this is the staff dining room whose condition changed from condition 2 to 3
2. D6 (now called B017): this is the kitchen whose condition changed from condition 4 to 3
3. F7 (now called B011): this is the laundry and the condition changed from condition 2 to 3.
4. F11/E3/D1 (now called B006/B007/B008): the ambulance department, maintenance workshop and the maintenance office; these changed from condition 2 to condition 4.
5. B22: the maternity ward changed from a condition 5 to a condition 4.
6. B009: the mortuary which changed from condition 5 to 4

To gain first hand impression of the general condition of the facility, a walk-about of the MH facility was undertaken that took note new construction work and noticeable defects. Pictures were also taken of the buildings to complement the research observations.

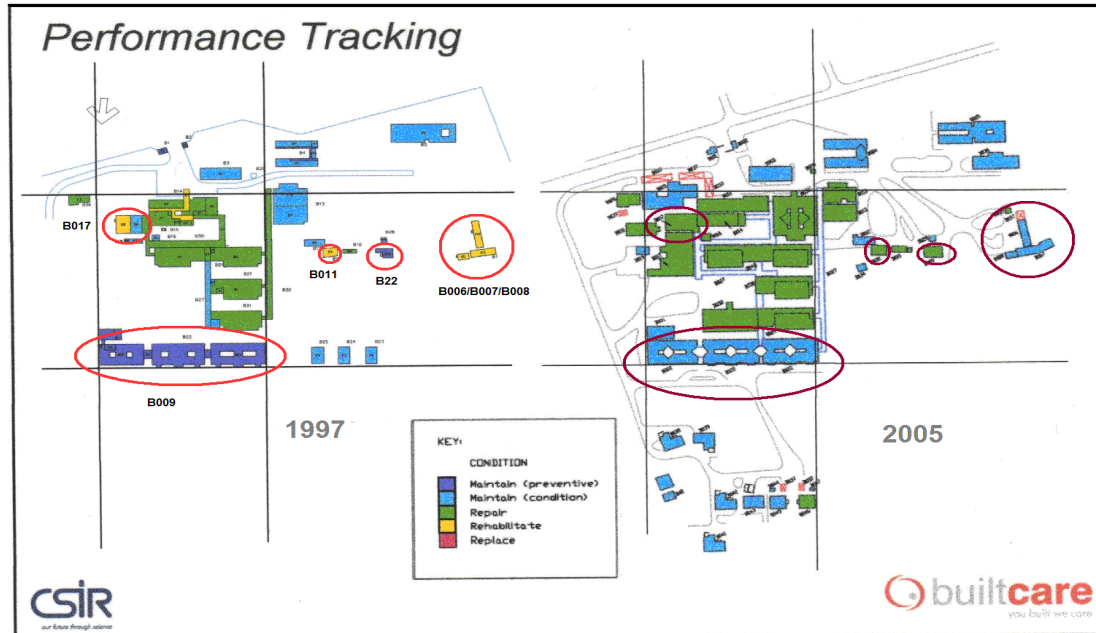


Figure 4: Site plans for Malamulele Hospital in 1996 and 2005 showing the buildings' change in condition.

6. THE RESULTS

6.1. MAINTENANCE PROJECTS

A total of 15 maintenance projects at MH was listed for that financial year. Of those 20% were completed successfully, 27% had not been completed while the remaining 53% had not yet started or had been rescheduled for the next year – largely due to inadequate capacity or budget constraints.

The questionnaires, interviews and walk-about conducted with the Maintenance Department of MH revealed additional information, shortfalls, challenges and some good practices.

6.2. APPOINTMENTS

The department is headed by an Artisan Superintendent who reports directly to the Chief Executive Officer of the Hospital. Currently the department is understaffed with many vacant positions. For some positions, requiring the appointment of a number of staff members, only a single appointment has been made. Should such a staff member be on leave, no one is left to continue performing the duties causing existing maintenance backlogs to further increase.

Maintenance Budgets

Maintenance budgets are normally calculated by adding 5 to 10% escalation on the previous year's budget. However should the previous year's budget have been inadequate, the next financial year would also have insufficient funds. In most cases this leads to backlogs in maintenance work and work being deferred to the following year. In addition to this the total budget amount requested was not always allocated.

It had often also happened that management was unaware of the actual building condition due to inadequate or no information being available resulting in insufficient amounts being requested for maintenance work.

6.3. INTERVIEW

The interview conducted with the Artisan Superintendent revealed that no Safety, Health and Environmental Inspection from the Provincial Health Department took place during the previous year. An indirect consequence of this was an erosion of employees and management motivation to keep up proper maintenance standards. A continued regular inspection program will help to motivate maintenance teams to avoid fines and orders from inspectors to demolish unsafe buildings.

6.4. WALK-ABOUT

The general walk-about revealed that the hospital was generally clean and well looked after. Specific wards had been improved by reconstruction works. Other facilities are totally inadequate. An important facility such as the workshop is a temporary structure and is too small. No improvements or expansions are planned for this facility. No proper storage facilities are available and safety signage have not been installed which create risks and hazards.

6.5. EMPLOYEE INVOLVEMENT

Not all employees at the hospital were assisting in the maintenance work. For instance one of the wards had a broken door which had not been reported by anyone in the ward. In a number of other incidences, broken fixtures or furniture were also not reported by the ward employees. Often small parts such as screws or working components are discarded rather than kept in safe custody for re-use when fixing the damage. Instead new parts now had to be sourced, following prescribed procedures. This often takes a long time and increases the chances for further destruction of the fixtures and fittings.

6.6. INNOVATION

The maintenance department has in some case been innovative in dealing with challenges even with limited resources:

- ❖ The department renovated toilets in the maternity ward and created space for a shower by removing one of the two sinks.
- ❖ A covered and fenced laundry area was constructed which increased security of the laundry and also allowed better protection from the weather.
- ❖ A semi-mobile clinic was constructed to provide Anti Retro Viral treatment. This relieved some pressure on the Out-Patients Department. The clinic is constructed of aluminium structure and cladding sheets and includes a covered outside waiting area for patients.

7. DISCUSSION

7.1. ATTITUDE OF MANAGEMENT

According to the SAICE 2006 Report Card, Transnet infrastructure although ageing, was being maintained in an operationally serviceable condition and proper management practices had extended the infrastructure's useful life.

The attitude of management towards maintenance is often reflected in the performance of organisations. TRE and MH are both public organisations although TRE is currently managed as a private organisation. TRE seems to realise the importance of maintenance and provides adequate labour to attend to the maintenance program. The benefit of the attitude of management and the corresponding availability of maintenance capacity is evident from comparing the difference in condition of the assets of the two organisations.

7.2. GIAMA

The GIAMA No 19 of 2007 prescribes the duty of care of custodians of public property and which must be adhered to by all government departments. To disregard this act is therefore an offence. It is disheartening if government departments responsible for the management and care of immovable assets are not aware of what the GIAMA stipulates. The effect of such ignorance could be that a government department may be conducting non-compliant activities without being aware thereof. This may have serious implications for senior government officials. Such officials may be held accountable in a court of law for the misconduct through ignorance of their subordinates as such ignorance is not part of the law and can therefore not provide them with exemption from prosecution.

7.3. MAINTENANCE POLICIES

Maintenance policies at MH are dealt with and are restricted to the office of the Chief Executive Officer. These documents and their content are however vital tools within the larger maintenance framework. They are to be accessible to and the content to be understood by every member of the maintenance department. If dealt with correctly, it will enable compliance with the prescriptions of prevailing legislature, in this instance the South African legislative framework (such as the PFMA, GIAMA, the Occupational, Health and Safety Act etc.) (Limpopo Provincial Government Department of Health and Social Development, 2007: 5).

7.4. TRAINING AND DEVELOPMENT

From the above, it is clear that substantial scope exist for on-job training and continued professional development of staff members and management alike. Medical ward personnel should be educated to see the larger picture and to understand that they are the eyes and ears of the maintenance program. If all personnel are motivated and comprehend their role in the overall maintenance program, significant progress can be made in a relatively short space of time.

Management should lead by example, should involve and motivated the involvement of staff with maintenance programs. Management will also escape criticism from inspectors and possible prosecution by law if they are aware of policies and the prescriptions of the law.

7.5. CONDITION ASSESSMENTS

The research indicated that building condition assessments at MH are not being done at regular intervals or may not be done all as is advised. This means that although maintenance plans may exist, the information required to support and give effect to the development of these plans may not be available.

7.6. MAINTENANCE BUDGETS

Maintenance budgets at MH are not adequate as they are not based on the condition of a building or asset. Due to limited funds, only critical items are included in maintenance programs. No information resulting from preventative or condition based maintenance is available. Assets of which

the extent of deterioration is not deemed critical, are not dealt with until such a time when major repairs or rehabilitation are required.

Maintenance budgets, plans and programs should be based on the actual condition of the buildings after the condition assessments have been conducted. Since MH did not conduct regular and consistent condition assessments, their maintenance plans and programs are not sufficient or adequate to ensure well maintained buildings and assets.

7.7. ASSET REGISTER

Absence of asset registers at MH is a failure to comply with the Maintenance Policy of the Limpopo Department of Health and Social Development and thus constitutes misconduct by the hospital management.

8. CONCLUSION

The paper set out to firstly evaluates the opinion that building condition assessment is an important part of efficient maintenance programs. This opinion is generally assumed and agreed to by literature on maintenance and is widely applied in practise. Conditions and practise at MH reveals the results of not applying those principles. Building condition assessment at MH could have generated the information for management to plan and prioritized maintenance work. Budgets would not have to be an escalation of the budget of previous years. Instead the costing of planned, preventative and condition-based maintenance prescribed by the building condition assessment would have underpinned the budget.

This information and resulting budget and maintenance program would have driven and supported an adequately staffed department with efficient and safe workshop facilities. The necessity and added benefit of motivated and participating medical employees as eyes and ears of the maintenance program could have been a secondary outcome. It is clear that the maintenance scenario at MH supports the opinion that building condition assessment should form an important part of an efficient maintenance program.

Literature on the subject invariably assumes that management of the maintenance program are knowledgeable and adequately trained to lead and manage the program. Again the scenario at MH, more through the lack thereof and the resulting negative outcomes thereof, lends support to this opinion.

The lack of accurate condition information, inadequate budgets, understaffed and ill-equipped department, unfinished projects and not-participating health employees can often be traced back to management and their lack of knowledge on the subject. The non-conformance regarding GIAMA, departmental policies and asset registers as well as the comparison with TRE supports this viewpoint.

Although maintenance programs are being developed, they lack the necessary information required to determine maintenance needs. Inadequate maintenance programs may often result in assisting premature building failure. The cost of rehabilitation or replacement of such failed buildings can be regarded as the actual cost of inadequate or failed maintenance programs. Proper maintenance programs could have saved these expenses and thereby enable the budget amount to address more needs.

Knowing the condition of a building and its components cannot be over emphasised. The information obtained from the condition assessments determines the priorities and timing of the maintenance program. This ensures that condition based maintenance and preventative maintenance, which are over the life of a building the most cost-effective maintenance strategy, form the core of the maintenance program.

Effective maintenance of a building or technical component thereof and the management of the maintenance program is complex and multi-dimensional by nature. No magic formula for a single maintenance program exists to address the maintenance of all building. The best practice applicable for most general instances is not always the appropriate practice for a specific scenario (Visser, 2008). However it is widely agreed that regular building condition assessment is a basic maintenance activity in support of any effective maintenance program.

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Flood Disaster in Ratnapura Municipal Council Area

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ABSTRACT

Ratnapura Municipal Council (RMC) area is a highly flood prone area in the Ratnapura district. The total area of the RMC area is 2325 Ha. According to historical records, Ratnapura Municipal Council area has had the worst flood scenarios in 1913, 1940, 1947, 1957, 1989 and 2003. Heavy rainfall, topography and man-made activities on the flood plain are the main causes of the flood problem in RMC area. The main objective of this study is to identify flood risk and mitigations for floods in the study area. Data collected for this study are from both primary and secondary sources. Data from the former were collected from published information on flood generation factors such as, rainfall, rain gage level, used by the Survey Department, Metrology Department and Irrigation Department of Sri Lanka. Other secondary sources are from literatures and digital maps (1:10000) collected from the Survey Department of Sri Lanka. The primary data were collected from field survey and interviews. The field observation studied about the drainage system of the Kaluganga, flood prone areas, land use patterns and damages. From the questionnaire, detail relating to the impact of floods such as loss of lives, damage to properties and houses, inundation days inundation height and health problems were collected. Random sampling method was used for the questionnaire by selecting 10 percent units among the flood population. Arc GIS 9.2 software and SPSS 13.0 were used for digitising, calculation for the analysis of the data. Hazard areas were identified and categorized such as high; medium and low. 6.00 sq km inundated and 64.2 % houses are located in the high hazard area. 121 houses inundated under the .0.6 m level. 22 houses were inundated more than 3m flood level. Those are located in the Ratnapura town area. Accordingly, socio economic and environment damages were very high in the high and moderate hazard zones. Therefore, disaster management policies and planning activities are needed very urgently for the study area.

Key Words: RMC, Flood, Disaster, GIS

1. INTRODUCTION

Flood is the most common occurring natural disaster that affects human and its surrounding environment and it is more vulnerable to Sri Lanka. It affects social and economic stability of the country. There are many occurrence of flood in Sri Lanka, the worst flood faced by Sri Lanka is in 2003 and it affected 139,000 inhabitants. 236 were reported dead and 9,300 were homeless (NDMC 2003). There are mainly three types of floods are in Sri Lanka as flash flood, river flood, and coastal flood. Such kinds of flood occurrence are influenced by natural phenomenon alike to rainfall and human involvement like deforestation, land management (timber harvest, reforestation and), industrial development and unplanned land use etc. The most flood areas have been originated in several districts such as Western, Southern and Sabaragamuwa in Sri Lanka due to the torrential rain resulting from the South West monsoon. Flood is a common occurrence in the Ratnapura district with the worst flood scenarios in the years 1913, 1940, 1947, 1989 and as recently as 2003 and 2008. During the period 1978 to 2003, 132 deaths have been recorded with 2980 families displaced and 42, 000 families were affected overall by the flood in the Ratnapura district. The most flood affected areas of

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this district are Ratnapura Municipal Council area, Elaphatha Divisional Secretarial Division, Nivithigala Secretarial Division and Kalawana Secretarial Division.

The Ratnapura Municipal Council area is located at the Ratnapura Divisional Sectatariat Division. The total land area of the area is 22.48 sq.km and located between Northern latitudes 5° 41' and 6° 42' and 80° 23' and 80° 24' East Longitudes respectively. Topographically, RMC area rise to 18m to 305m Southern part consisted of flat low lands. There are 16 Grama Niladari (GN) divisions within the RMC area.

According to the historical records and field work, flood depth and its vulnerabilities have increased significantly in recent years in the RMC area. A high rain fall, unplanned urbanization and in filling of low lands are frequently affected by flash floods in the RMC area. Such situations are influenced to damage river bank erosion, economical losses, damage infrastructure and residential areas and to increase health problems. Hence, the main objective of this study was to investigate the impact of flood disaster in RMC area.

2. METHODOLOGY

Both primary and secondary data were used by the study. Primary data collection involved with field work, questionnaire survey, interviews and discussions. Field work includes field observation activities. Spatial and hydrological data were collected during the field observation activities. Field observations included: studying the drainage system of Kalu Ganga and flood prone areas. Moreover, photographs were taken to identify the vulnerable areas.

Random sampling method was used for questionnaire survey by selecting 10 present units each from the Ratnapura Municiple Council area. The questionnaire helped to gather details relating to impact of disasters such as: loss of lives , extent of damage to properties and houses, house ownership status , value of houses, cost of damage houses, land ownership, drinking water, wells and streams damage to agriculture , land use patterns , aversion to relocate , health conditions , psychological setbacks and inundation height etc.

Information was also collected using the direct interview method involving many organizations in the study area (Disaster Management Centre, District Secretariat etc ;).Interviews generated information purpose of the research. Therefore the two school projects related institutions taken for this research are the Ministry of Education, TERM office, Contracting Organizations, Lead consulting Organizations, Funding agency etc. about the flood, inundation areas, and shelter areas during flood time, physical and human impacts, relocate areas etc.

Secondary data were collected through digital maps (1:10,000, 1: 50000), one inch sheet (1: 63360), land use map, based on contour height and annual flood which was developed flood hazard zone maps (Table 1).

Table 1: Flood risk zone in the RMC area

(Source: Irrigation Department, Ratnapura 2008)

Flood zone	Contour height m
High hazard zone	below 22
Moderate hazard zone	22 -25
Low hazard zone	25 - 32

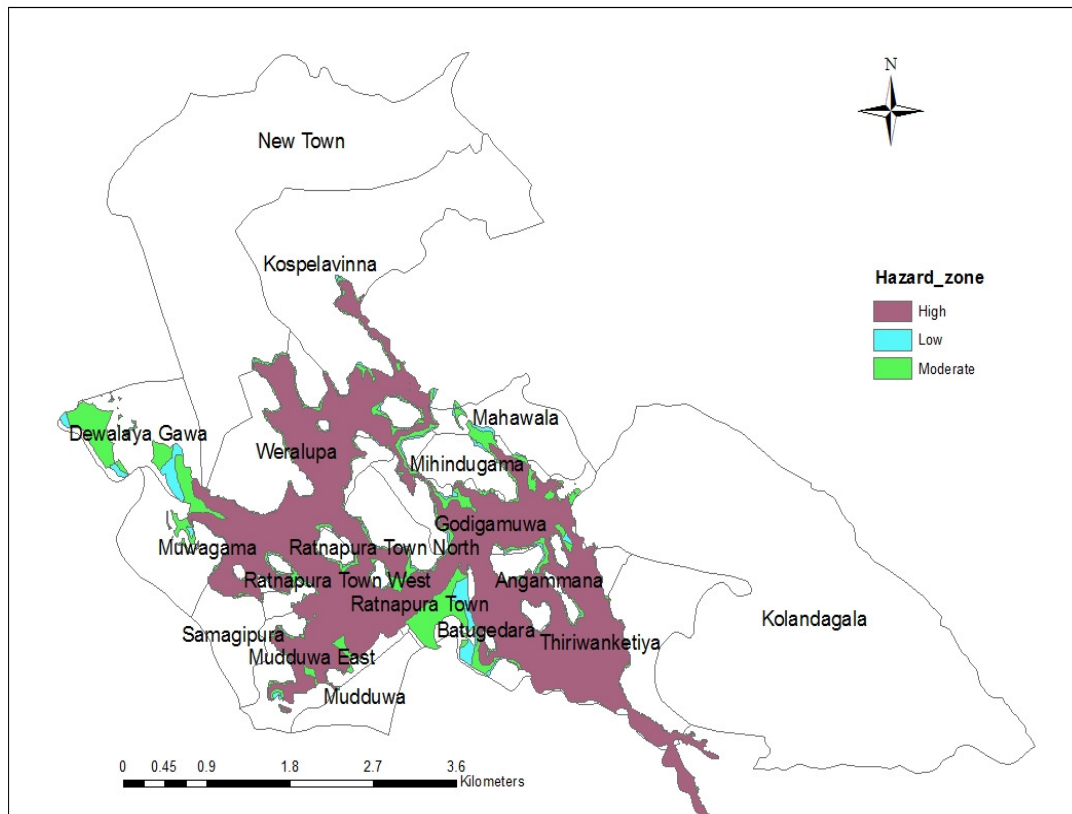


Figure 1: Flood hazard zone in the RMC area

(Source: Survey Department of Sri Lanka, 1: 10,000 digital Contour data (2007) & flood height (2008))

According to the previous flood levels determined as maximum flood level between 1947 (23.9 m) and in 2003 (23.2 m), the maximum flood level showed 24.0 m above sea level and 17.8 m level was recorded as the lowest flood level. Considering all these facts inundation area maps which categorised low, moderate and medium were developed (figure 1). High hazard areas represent 21.35 m gage levels and moderate hazard areas represent 24.40 m gage levels while low hazard areas represent 20.13 m gage levels.

3. RESULTS AND FINDINGS

3.1. FLOOD HAZARD IN HIGH HAZARD ZONE

High hazard inundation areas are mostly located on the middle part of the RMC area which is frequently flooded by the Kaluganga and its tributaries. High hazard flood inundated the total amount 1 6.00 sq km lands such as Ratnapura town (0.21 sq km), Ratnapura town west (0.30 sq km), Godigamuwa (0.75 sq km), Thiriwanaketiya (0.73 sq km) 1.03sq km lands are inundated highly in the Weralupe GN division (Figure 1).

According to the questionnaire survey 64.2 % of the residential houses are located in flat areas in the high hazard area (6m). These houses consist with rooms in-between 1-6. From this 45.3 % of house holds consisted with two rooms, which are highly affected by flood. 32.1% residential houses are located on the middle slope areas that are moderately vulnerable for flooding during the rainy season. 3.8 % houses are located on the upper part of the study area which does not face inundation problem.

According to the questionnaire survey, accumulated water remains in these houses for two or three days and recorded 64.2%. During the rainy season high hazard zone people faced various problems due to the flood such as health problems (64.2%), water problems (73.6%), lack of food (56.6%), and problems related to employment opportunities and income (30.2 %). Therefore, 64.2 % would like to go for safe areas but 34.0% do not like to go to another area because of various reasons such as education problems, loosing of income sources, employment opportunities and relatives and friendship etc;

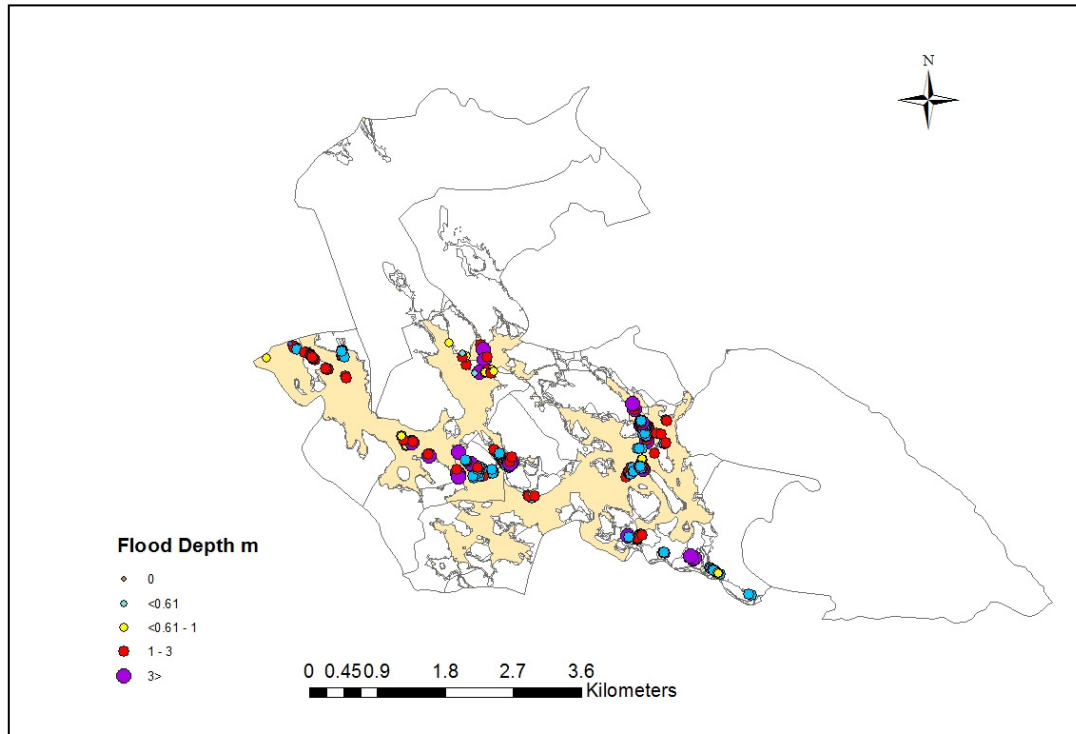


Figure 2: Flood depth location in the high hazard area

(Source: Field work, 2007)

According to the field survey, various flood depths were recorded on the residential point in high hazard area such as less than 0.6 m, 0.6 -1.5m, 1.5m-3m and 3m or more. Figure 2 displays that flood depth points in the high hazard area. This information collected through the field plotting techniques.

121 houses were inundated under 1.5 m -3 m level and 22 houses were inundated under more than 3m flood level. Totally 121 houses are affected by the flood in the Ratnapura town area (Table 2).

Table 2: Flood depth height in high hazard area

(Source: Field data 2007)

GN Divisions	No of Inundated houses <.6 m flood depth	No of Inundated houses .6 - 1.5 m flood depth	No of Inundated houses 1.5 m -3 m flood depth	No of Inundated houses 3>m flood depth
Weralupe	00	07	07	03
Muwagama	06	4	05	05
Triwanakatiya	00	10	02	03
Ratnapura	00	32	22	05
Mudduwa	00	06	04	05
Godigamuwa	00	15	40	09
Dewalegama	03	07	19	00
Batugedara	01	10	08	01
Angamma	03	16	14	02
Total	13	107	121	22

Land use patterns of the high flood hazard zone covered 7.44 sq .km including 2.40 sq.km of paddy lands and 4.08 sq .km of homestead (Table 3).

0.14 km road length is belonging into high hazard area which includes A4 road type category. 48 .4 km length includes in other road type such as un-metal road and foot path. Un-metal road is made up by mud when flood occurs. It gets block up by water and makes large hump and pits which was repaired by community.

Table 3: Land use in high hazard area

(Source: Survey Department of Sri Lanka (2007), 1: 10,000 digital data)

Land use type	Total land sq km
Stream	0.57
Rubber	0.36
Homestead	4.08
Paddy	2.40
Forest	0.01
Tea	0.01
Chena	0.01
Total land	7.44 sq .km

3.2. FLOOD HAZARD IN MODERATE ZONE

Moderate flood hazard areas represent in the between 20-24 m contour height and flood level records 24.40 m above sea level. Total land inundated was 2.25 sq km. Angamma (0.7 sq km), and Dewalegama (0.3 sq km) lands are moderately vulnerable. 74.1 % houses are located in the flat area of the moderate hazard area which is highly vulnerable to flood. This vulnerability is very high comparatively to the high hazard areas. 80.1 % were recorded accumulated water in these houses into two and three days. As a result, health problems have increased in this zone.

1% of inhabitants recorded death by flood in this zone. 6.6% represents the land use in moderate that zone. 1.0 km is covered in homestead. 0.4 km² areas are of paddy lands. The total length of flood hazardous roads represents 8.9 km.

3.3. FLOOD HAZARD IN LOW HAZARD AREA

1.0 Sq km indicated low inundation lands in the RMC area namely Dewalegama (0.7 sq km), Batugedara (0.08 sq km) and Ratnapura New Town (0.06 sq km). 0.16 km² area is covered with settlements and 0.04 sq km area is covered in commercial activities. 0.17 sq km areas of paddy lands, 14 main roads, secondary and tertiary roads are consisted with the flood hazard area. The total length of flood hazardous roads is amounting to 8.1 km.

4. CONCLUSIONS

Flood damages and flood risks are very high in the high and moderate hazard zones. 8.25sq km lands were inundated high and moderate hazard zones. 64.2 % houses are located in high hazard areas which are highly vulnerable. Those houses are located in Ratnapura town, Mudduwa and Muwagama areas which are situated closed to Kaluganga. Flood depths in these houses were recorded more than 3m level. Therefore, flood impact is very high and is destroying their houses, home gardens and death of members' results in. Therefore, it is necessary to introduce flood managing activities and policies for this zone immediately. The flood hazard maps will be helpful to planners and decision makers for the managing of flood in the study area. It will help to identify flood risks before the flood occurring in the study area. The following recommendations are proposed to manage the flood problem in the Ratnapura Municipal Council area.

- Demarcation of buffer zones surrounding the *Kalu Ganga* river bank in the RMC area.
- Control the constructions of dwellings and commercial structures below the 20m sea level.
- Development of an opposite drainage systems in the flood hazard areas.

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Sustainable Property Management Practice in Nigeria

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ABSTRACT

This paper examines the degree of preparedness of the Nigerian estate surveyors and valuers to sustainable property management practice in response to the challenges and benefits of the practice in advanced countries. Using an instrument designed to elicit factual data and opinion from a sample of practising estate surveyors and valuers in Lagos, the study indicates that sustainable property management practice is of little priority in the activities of real estate practitioners as the concept is still new to them. Many of the practitioners, though graduate of a university or polytechnic, were not trained in the science of green building and neither has the professional institution taken any step to train them. The industry has still not developed an adequate response to sustainability due to profitability-oriented focused practice. The consequence is over concentration of activities and efforts on estate agency, leaving the property management arm not globally competitive. The paper suggests an overhauling of university/polytechnic curriculum in response to global trends and the retraining of practitioners to meet emerging challenges in sustainable property management.

Keywords: Sustainable, Green, Property Management, Practice, Stakeholders.

1. BACKGROUND TO THE STUDY

Across the world, professional bodies have increasingly come to realize the importance of globalization of activities and services. They are increasingly recognizing the need for standardization of products and services so as to enable them compete with their colleagues and competitors worldwide. Architect, accountants, quantity surveyors and estate surveyors and valuers are not left behind in aligning their professional practice with the practice in the advanced countries of the USA and U.K. The advantages necessitated by the developments in information technology, rising expectation of employers, advancement in telecommunication and removal of trade barriers have necessitated uniformity of practice (Adewumi and Ogunba, 2005). The result is that every profession strives to meet up with international standards and expectation in the discharge of its functions and provision of service to the people. To this end, Ogunba and Iroham (2005) posit that no profession in the built environment should remain static or inflexible lest it becomes an anachronism. It must learn from the past, adapt to changing realities of the present and at the same time anticipate the needs of upcoming generations. The result is that, the concept of sustainable professional practice is creeping to every profession and property management practice is not excluded in this regard.

Property management traditionally involves the application of specialized skill to care for the investment, often of an individual, household or corporate body in buildings with a view to ensuring a maximum return. It is often carried out for a pre defined objective. Its concern, according to Scarrett (1995) is the optimization of the owner's investment. It is a conscious process of guiding and tailoring an investor's investment in land into profitable ventures. According to Baldwin (1994) it is the total care of the building during the operation stage. It is a main care for real estate (buildings), its components and occupiers for effective and efficient utilization of investment fund in it. In other words, the practice is responsible for management of the largest single form of household wealth (assets) which accounts for between one quarter and one half of the capital stock in developed and

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developing countries (Buckler, 1989). The product being managed is among those activities at the leading edge of a country's economic development (Ogunleye, 2005).

There is however the need to know that the world is changing. According to Pennsylvania Environmental Council (2008) college graduates are choosing where they want to live based on the commitment of a community to sustainability, and companies are choosing where they want to locate based on where those bright young minds want to live. Consumers are increasingly choosing environmentally friendly products and services and want to deal with companies that have articulated their commitment to sustainability and the future. To this end is the demonstration of the critical nature of sustainable practice in the delivery of products and services. Newman, (2007) documents the fact that the push to go and stay green is very much on the minds of commercial property owners and real estate practitioners in the US and UK. In the developed countries, tenants demand for sustainable properties, according to Goering (2009) has risen significantly in the last two years, In the words of the author, corporations have embraced sustainability for sound business reasons, as well as for the public relations value of going green. Energy cost savings, advantages in recruiting and retaining employees, and potential productivity benefits all factors into a corporation's commitment to sustainability. This awakened consciousness has swelled the green tidal wave for sustainable development (Addae-Dapaah *et al.*, 2009).

While it is documented that where properly embraced, sustainable property management practice has been beneficial to making buildings more readily leased, command higher rents and have higher tenant retention rates; generally enjoy lower operating costs through increasing energy efficiency and lessening greenhouse gas emissions; improve business productivity of their tenants, affecting churn, renewals, inducements and fitting-out costs; and benefit occupants to a degree that may exceed the underlying asset's value, similar evidence appears not to be available in developing countries like Nigeria. In other words, the practitioners acceptance and practice of sustainable property management is crucial to the success and/or development of sustainable built environment and thus, requires a study of this nature to evaluate the preparedness of the Nigerian Estate Surveyors and Valuers for embracing the practice of sustainable property management practice so as to ensure that building assets are managed to meet the ever changing business and economic needs of the people.

This is underscored by the fact that although much have been documented by the rapid evolution of green buildings in advanced countries, actions towards the development of green market/ property management practice in Nigeria are still not visible. Yet the challenges about global warming and the need for energy cost-saving and environmentally friendly buildings requires that sustainable property management practice be developed as a means to reducing building emissions which are threats to human comfort and global existence. This makes it worthwhile to investigate the preparedness of Nigerian building industry for sustainable (green) development.

Secondly, Nigeria is an acclaimed giant of Africa and an oil rich nation, with an economic base and market penetration into all other African countries. It will therefore be worthy of note that the multinational corporations and international investors will want to know the readiness of the nations property market for sustainable properties and the preparedness of the stakeholders for necessary implementations.

The paper is structured as follows. Section 1 provides the introduction and the specific aim of the paper. Section 2 provides a brief review of extant literature and some related past studies in the area of property management. The third section discusses the study population, methodology and data requirement while section 4 contains the results the discussions and the concluding remark for the study while providing the way forward.

2. PAST STUDIES IN PROPERTY MANAGEMENT PRACTICE

Property management is a major function of an Estate Surveyor and Valuer whose training in finance, Economics, accounting, Architecture, Quantity Surveying, land Law and Computer Science makes him an expert in the use, development and management of land and property. Property management is an all encompassing subject requiring the application of skill and knowledge towards exploiting the “latent values” of property assets. Macey and Baker (1978) defined it as the application of skill in the caring for a property, its surrounding, and amenities in developing a sound relationship between a landlord and a tenant and between tenants so that the property may give its fullest value to both the landlord and the owner. It is an all involving task. It is the direction, the nursing and sometimes the overall direction of policy of an interest in landed property with a view to obtaining maximum return (Thorncroft, 1976). The main concern of property management is the optimization of the owners investment (Scarrett, 1995). It is a conscious process of guiding and tailoring an investment in land into profitable venture.

Sangosanya (1986) referred to the art of property management as a business as well as a profession requiring an acquisition of knowledge and special skill in a particular field of endeavour. Upholding a similar view, Tomori (2005) viewed it as another business enterprise that is mainly concerned with correct motivation of staff and fairness to tenants by consulting, information and encouraging them so that a sense of partnership and joint venture is established. It is a specialty in which real estate brokers manage homes and duplexes as well as large projects such as office and industrial complexes, shopping centers, apartment houses, and condominium (Colorado State, 2008).

It is however pertinent to note that professional practice all over the world seems to be conscious of the impact of their operations on the environment. The concept of globalization has thrown many challenges requiring the need to standardize operations and unify purpose of activities. Thus, the practice of sustainability has gradually crept into all facets of professionalism.

No study has yet examined the sustainable property management practice in Nigeria. Most of the empirical studies have been limited to the traditional practice of Property management. Examples include Li (1997), Chin and Poh (1999), Han and Lim, (2001), Lai (2006), Yiu, *et al* (2006), Blackwell (2008) and Andrew *et al* (2008). A number of these studies focused on examining the principles and practice of property management (Lai, 2006; Okoro, 2005). Touch Ross (1993) and Institute of Real Estate Management (1991) provided a general direction and development guidelines for property management information system. In a similar study, Han and Lim (2001) Investigated the use of computers in Singapore property management companies. Blackwell (2008) examined the relationship of geographical indicators (GIs) with real property valuation and management. Also, researchers such as Yiu *et al* (2006) and Lai (2006) examined the study via the roles of property management from an institutional economics perspective and the potential contribution of innovative property management to sustainable development. A critical examination of these past studies revealed that none of them have paid detailed attention to the sustainability aspect of property management practice.

In a similar study by Andrew *et al.* (2008) the problems that different public sector bodies face in joint planning to develop and share facilities and property services and how they overcame them were discussed. Christudason (2008a) examined the various legislations affecting common property management in Singapore. The author considered the problems inherent in the existing system of single-tier management corporations for strata property management until 2005 as a basis for a discussion of the solutions presented by new legislation in the form of “two/multi-tier” management corporations. The study revealed that while the multi-tier system could alleviate some of the problems existing under the single-tier management corporation system, other problems could arise; these include increased operational costs, finding sufficient volunteers for the multi-tier management corporations, and increased potential for conflict.

Li (1997) examined the opportunities and problems in property management in China. The author highlighted staffing and training as major problems that could threaten effective property management practice. Apart from the fact that the study was carried out in the context of developed countries such as China with different business environment, the study lacked empirical evidence and did not focus on the practice of sustainable management in developing countries like Nigeria. The same argument can be said of Chin and Poh's (1999) work which examined property management industry's attitude in Singapore to quality. The work of Okoro (2005) examined proper terminologies in use for describing different properties that can be managed by an estate surveyor and valuers in Nigeria. However, this study focused on enlightening professionals about proper usage of terminologies in property management practice.

In summary, there is lack of empirical evidence about the preparedness of stakeholders towards sustainable property management practice in emerging markets like Nigeria. The study is therefore significant because the threat of global warming and the possible impact of climate change are key factors of concern to the continuous existence of the built environment. There is no doubt, the development of sustainable property management practice would extend the economic life of a building in the long run, reduce the negative impact of buildings on the environment. While improving the health status of residents/occupiers of buildings, the practice will also enhance workers productivity. Lastly, the result of the study is expected to be a guide to professionals and policy makers in other African countries towards the development of appropriate framework for sustainable professional practice. A nation like Nigeria therefore has more to gain with the introduction and embracement of green buildings.

3. THE STUDY POPULATION, METHODOLOGY AND DATA REQUIREMENT

The study focused on sustainable property management practice in Lagos State, Nigeria. The state has a high concentration of real estate developers as well as the largest population and proportions of practicing Estate surveyors and valuers who handle the management of all categories of properties. The study area is characterized with relatively big, complex and modern commercial properties capable of being found in any commercial town and centre in the whole world.

3.1. METHODOLOGY AND DATA

The study of sustainable property management practice in Nigeria was carried out in Lagos state, Nigeria. The focus on Lagos state is justifiable because of the affordability of data collection. Lagos is one of the most important commercial cities in Nigeria. Lagos state is the most intensive economic centre in Nigeria, harbouring 60% of the nation's industrial and economic establishment and 80% of the nations' total value added of manufacturing activities in the country. The presence of the headquarters of almost all industrial and commercial corporations in Lagos provides ready platform for the taking off of the practice in the city.

Primary data were obtained through structured questionnaires that were designed to illicit response from practising estate surveyors and valuers on the preparation of Nigerian professionals for sustainable property management practice. The sampling technique was purposive as it deliberately included at least a branch each of all 270 registered estate firms in Lagos. To this end, a total of 270 questionnaires were distributed, out of which 167 were returned completed representing 62% response rate. The data obtained were analysed using descriptive statistics of percentages, arithmetic and weighted mean, while findings were displayed with the use of tables.

Data on respondents' social economic profile and their professional background as well as their degree of involvement in property management were collected with the use of questionnaires backed up with interview where necessary. The data collected were analysed with the use of frequency counts and mean.

4. RESULTS, DISCUSSION AND CONCLUSION

In presenting results of the questionnaire survey, the paper examined, at the first instance, the socio-economic characteristics of the respondents. The second part relates to analysis of the degree of preparedness of estate surveyors for sustainable property management profession in Nigeria.

Socio-Economic Characteristics of the Respondents

The result of this first part of the analysis is presented below. In order to know the status of the respondent's staff within the firm, questions were asked as to their designations. Preliminary questions focused on the background of the respondents. The summary of the analysis are as follows: In response to the questions on the distribution of respondent's profile, 33.3% of the firms have been in operations for 30 years while 16.7% have about 16 years of experience. Of the respondents, 50% of them have up to 4 branches while the remaining 20% maintain between 1 and 3 branches. In response to questions about their numbers of staff, 33.3% have about 3 employees while others have between 10 and 30 staff members. The respondents are all generally graduates of estate management with only 16.7% holding the position of MD. Nevertheless, the 50% of the respondents have up to 5 years post-qualification experience while other 16.7% have between 6 to 10 years of experience. In the same way, the response reveals that 50% of the respondents firm have at least one (1) registered estate surveyors in its employment with 16.7% indicating that they have between 5 and 10 registered surveyors in their employment. The picture indicated here are that the practising firms in the study area have substantial qualified personnel that handle their operations. In addition, the responses in respect of the professional practice of the respondents revealed that all the firms are proportionately involved in the traditional real estate management functions of property management, property agency, property development and valuation; with 16.7% firms indicating of involvement in all of the activities.

Table 1 contains the respondents' perception about their involvement in property management practice. A higher percentage (66.7%) has high involvement while 16.7% indicated that their level of involvement is low. The remaining 16.7% did not indicate any response. This suggests that the estate surveyors and valuers in the area are traditionally occupied with property management practice. A major reason could be the highly commercial nature of the neighbourhood, which requires that professionals be engaged to handle the management of some seeming highly sophisticated properties.

Table 2 contains responses in respect of the number of conferences attended recently by the respondents. Majority (33.3%) have attendance 5 conferences. Other responses are 16.7% each for 2 and 6 attendances. This suggests the respondents' willingness to update their knowledge even after several years of graduating from school.

Table 3 shows the distribution of the respondents' level of awareness of green building and sustainable practice. While majority (66.6%) indicated low level of awareness, 16.7% showed that their level of awareness is high while the remaining 16.7% did not have any idea about it. This could be as a result of our concentration on local seminars and conferences whose theme and focus was to address local problem.

Table 4 shows responses in respect of respondent's expectation as to when property management practices will become critical. 50% were of the opinion that sustainable practice is already critical now while 33.3% considers it critical nature to be in the future period of within 1 -2 years . This suggest that most practitioners are desirous of alternatives to conventional management practice, a major problem of which is the settlement of bills and rates chargeable of property; the most critical of which is electricity bill. Table 5 contains the responses in respect of whether or not sustainable practice is perceived as a threat or opportunity. 33.3% considered it a major threat to the existing practice while 16.7% considered it as a major opportunity. Other 33.3% considered it as minor opportunity. This picture pointed here is that of an institution that is scared of embracing a new

practice which could be more tasking and more challenging than the conventional one. This could be because of the lack of the requisite knowledge by the concerned professionals.

Table 6 indicates the perception of the respondents about the cost of real estate. Majority (50%) of the respondents were of the opinion that green building will have the same cost as conventional building while 33.3% considers it as generally going to be less expensive than conventional properties. The remaining 16.7% however are however indifferent to this. This generally portrays a people without the experience of the benefits of green practice in the country.

Table 7 shows practitioners responses on the perceived preparation for sustainable property management practice. 16.7% each indicated that the preparations of players in the industry are pro active and reactive respectively. However, majority (33.3%) are indifferent. This suggests that majority are still not making any effort to prepare for the anticipated new benefits. The result of Table 7 shows further that the respondents considered their level of preparation as correspondingly at 33.3% as low and high. This might be due to the fact that there has been no example of the practice that others could learn from.

Table 8 reveals the perception of respondents to the factors considered as being likely going to facilitate future attitude for sustainable practice. Majority (33.3%) considered significant increases in energy costs as a major facilitating factor. Other responses are increased influence from customers, 16.7%, implementation of Technology to support improved sustainability (16.7%) and increased focus of CEO on sustainability for your company, Increased regulation of energy & carbon emissions, Increased influence from customers or clients for sustainability, Implementation of technology to support improved sustainability, New or increased energy and carbon taxes, Increased importance of sustainability for employees/potential employees and Meaningful Government incentives to encourage sustainability. This reveals the general attitude and desire of most Nigerians to seek alternative source of power in the country. This suggests that an invention that will reduce the cost of power in the country is a likely welcome development in the country.

Table 9 summarises the responses of the respondents' level of preparation for sustainable property practice in the country. Majority (66.7%) indicated a low level of preparation while the remaining 33.3% posited to a high level of preparation. The picture here is that of a set of professionals who are not bracing up for contemporary challenges in practice. The practitioners appears to be contented with the current level of exposure and the high income potential of the traditional practice and appear not prepared to pay the price for a change of attitude and approach in practice. This however negates the global challenge calling for realignment of efforts and goals with globalisation trends.

In response to questions about the perceived factors that will enhance the development of sustainable property management practice, six major issues were raised namely: development of appropriate legal and regulatory framework, government support, establishment of rating agencies, adequate professional training/development, and incorporation of sustainable property management education in tertiary education, enlightenment campaign for the need for sustainable management practice among practitioners. The summary of the ranking of the expected factors are as contained in Table 10.

A major conclusion from this study is that in spite of their academic attainment, Nigerian real estate professionals are not fully prepared for the practice of sustainable property management. The implication of this conclusion is that acquisition of requisite knowledge and training should be seen as very crucial in policies on sustainable development. This requires the overhauling of the curricula of studies on Estate Management in the Universities and polytechnics to incorporate contemporary studies on environmental sustainability and preservation. This should be followed up with continuous development training for practitioners as a means of putting them on tack with contemporary practice. There is also the need for the enactment of necessary supporting laws and legislation that will serve as appropriate framework for the development of sustainable property management practice in Nigeria.

Table 1: Involvement in property practice (Source: Field Survey, 2010)

Involvement	Frequency	Percentage
Low	28	16.7
high	111	66.7
No response	28	16.6
Total	167	100.0

Table 2: No of Conferences (Source: Field Survey, 2010)

No of Conferences	Frequency	Percentage
2	28	16.7
5	56	33.3
6	28	16.7
15	28	16.7
No response	27	16.6
Total	167	100.0

Table 3: Awareness of Green building (Source: Field Survey, 2010)

Awareness of Green building	Frequency	Percentage
No Response	28	16.7
High	28	16.7
Low	111	66.6
Total	167	100.0

Table 4: Expectation of Sustainability critical to practice (Source: Field Survey, 2010)

Expectation of Critical	Frequency	Percentage
No response	28	16.7
its already critical	84	50.0
within 1-2 yrs	28	16.7
Never	27	16.6
Total	167	100.0

Table 5: Threat or opportunity (Source: Field Survey, 2010)

Threat or opportunity	Frequency	Percentage
Minor threat	28	16.7
Major threat	55	33.3
Major opportunity	28	16.7
Minor opportunity	56	33.3
Total	167	100.0

Table 6: Perceived Cost of real estate (Source: Field Survey, 2010)

Perceived Cost of real estate	Frequency	Percentage
No response	27	16.7
Generally less expensive than conventional	56	33.3
The same as conventional	84	50.0
Total	167	100.0

Table 7: Perceived pro-activities of players (Source: Field Survey, 2010)

pro-activities of players	Frequency	Percentage
No response	55	33.3
Reactive	28	16.7
Neither	56	33.3
Proactive	28	16.7
Total	167	100.0

Table 8: Factors for future attitudes for sustainability (Source: Field Survey, 2010)

Factors	Frequency	Percentage
Significant increases in energy costs	55	33.2
Increased influence from customers	28	16.7
Implementation of Technology	28	16.7
Increased importance for employees	28	16.7
No Response	28	16.7
Total	167	100.0

Table 9: Level of preparation for sustainability (Source: Field Survey, 2010)

Level of preparation	Frequency	Percent
High	56	33.3
Low	111	66.7
Total	167	100.0

Table 10: Analysis of Respondent ranking (Source: Field survey, 2010)

Ranking of Factors	Ranking
Development of appropriate legal and regulatory framework,	1
Government support	2
Enlightenment campaign for the need for sustainable management practice among practitioners	3
Establishment of rating agencies,	4
Adequate professional training/development,	5
Incorporation of sustainable property management education in tertiary education,	6

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Perceptual Analysis of the Benefits and Implementation Difficulties of Green Building in Lagos Metropolis, Nigeria

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ABSTRACT

While buildings and development provide countless benefits to society, they also have significant negative environmental impacts. To address this problem, green or sustainable buildings have been advocated in developed countries as these have less toxic materials and consume natural renewable resources with focus on environmental sustainability. The paper examines perceptions of the prospects and implementation difficulties of the introduction of green buildings in Nigeria. Questionnaires were distributed to 50 purposively selected property developers and 250 tenants in Lagos metropolis that were conveniently selected on the basis of who is willing to respond. With a success rate of 68%, the study adopted the descriptive method of analysis of frequency count, mean, median, standard deviation and proportion method. The findings showed that developers and tenants are of the opinion that green buildings would be desirable for the future, but not for present day investors and prospective tenants in Nigeria since they are not aware of any benefits derivable therefrom. The paper concluded that awareness campaigns should be instituted to enable the populace gain an appreciation of the negative impacts of buildings as currently constructed, and of the potential environmental and commercial benefits of green buildings

Key words: Green building, sustainable building, high performance building, Perception.

1. BACKGROUND TO THE STUDY

Building structures are main assets of human beings. Every household, organisations and governments at all levels invest in building construction and development to house and accommodate themselves, businesses or as a social responsibility to the electorates. There are therefore small and large buildings within cities around the world to accommodate intense, even explosive growth of human activities and uses.

Buildings are used for a variety of uses. Prominent uses include residential, commercial and industrial uses. Residential use purely provides accommodation for living; commercial uses can be office, shops and other trading premises; while industrial uses are factories, warehouse accommodation for production and assemblage purposes. These uses are directed towards satisfying basic human needs of food, shelter and clothing. These uses are often subject to regulations of different nature to enable its production and use conforms to human needs.

Regardless of the type, size and use as well as statutory regulations, buildings often have a significant negative impact on the natural environment. While buildings and development provide countless benefits to society, they also have significant environmental impacts (EPA, 2004). The National Building Museum's introduction to its "Big & Green: Toward Sustainable Architecture in the 21st Century" exhibit, states that "These structures consume enormous amounts of energy in their

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construction and day-to-day use, place great burdens on water and sewer systems, and typically isolate occupants from natural light and air.” According to the author, smaller buildings are also known to have similar impact on the environment and occupant health. In fact, according to EPA, homes and offices use an estimated 36 billion gallons of water per day (The City of New York’s water consumption is 1.2 billion gallons a day, on average, according to New York City DEP) and it is estimated that the construction, renovation, and demolition of buildings, generates 136 million tons of debris per year. EPA also notes that on average, Americans spend 90 percent or more of their time indoors. This also calls for equal concern for the quality of indoor air as a means of eliminating and/or reducing its negative impact on human health and the environment.

These impacts can be reduced through the use of sustainable or green building principles, such as low VOC (volatile organic compounds) paints, use of energy star appliances, water saving technologies and deconstruction and reuse strategies (Monica, 2007; EPA, 2004). According to the authors, building is green when it reduces exposure to noxious materials, conserves non-renewable energy and scarce materials, minimises the life-cycle ecological impact of energy and materials and uses renewable energy and sustainable materials. The “green building” concept, according to Strawman (2007) incorporates, both individually and holistically, a series of practices in the design and construction of buildings and their associated landscapes that serve to minimize adverse impacts to the environment and to building occupants. The goal is to have buildings that will be environmentally friendly from its design to the end of its useful life. To achieve this, sustainable assets management is required.

The concept and practices of green building and sustainable assets management practice are well embraced in the developed countries of USA and European countries. The movement for the adoption of green building is advocated by developers, investors and real estate brokers. The government also is not left behind in this quest to find lasting solution to the environmental and health impact of building activities. The enactments of relevant laws as well as the establishment of appropriate agencies like the LEED and Energy Star rating certification of green buildings are evidence of its acceptance in the western world. The practice among others may benefit from available grants and subsidies through increasing energy efficiency and lessening greenhouse gas emissions; improve business productivity of their tenants, affecting churn, renewals, inducements and fitting-out costs; and benefit occupants to a degree that may exceed the underlying asset's value. Against this background, this paper examines the perceptions of stakeholders in the built environment to the benefits and implementation difficulties of the introduction of green building in Nigeria.

The paper focuses on issues such as providing insight into the degree of awareness of and the level of preparedness of Nigerian real estate industry for green buildings. The expectation of the stakeholders to the accruable benefits of green buildings to the investors, the owner and the occupants, whether there is value in embracing the green buildings, how best to structure the implementation of green buildings and how best to make the green buildings workable and acceptable to all stakeholders. These are some of the constructive questions that each tenant and investor in the study area will need to answer. This paper aims to explore the adequacy of the response of real estate investor and occupants to green buildings challenges and benefits. The paper will draw out implications and suggestions that would be useful to real estate investors, occupants and agents in the drive towards environmental preservation and sustainability.

2. BASIC IDEAS OF GREEN BUILDING

In spite of its newness in the industry, Green building is a subject of many interpretations. The fact that it is closely related to the concept of sustainable development makes it share common features with the concept of sustainable development. Sustainable development has been defined by Brundtland (1987) as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is a building which is an environmentally

friendly and socially and economically viable from design to the end of its useful life (World Commission on Environment and Development, 1987; Cassidy, 2003; Okpoechi, 2004 and Etim, 2004).

Green building is embraced to prevent the negative impacts of buildings and structures on the built environment. These impacts are felt in four broad areas as contained in Table 1. First, impacts related to the aspects of built environment include siting, design, construction, operation, maintenance and renovation. Second, the impact is in form of the consumption of energy, water, materials and natural resources. Third, building generates environmental effects such as waste, air pollution, water pollution, indoor pollution, heat islands, stormwater runoff and noise. Lastly, the ultimate effects of building activities result in being harmful to human health, environment degradation and loss of resources. According to Monica (2007), building is green when it reduces exposure to noxious materials, conserves non-renewable energy and scarce materials, minimises the life-cycle ecological impact of energy and materials and uses renewable energy and sustainable materials.

Green building, which is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction becomes the preferred solution. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high performance building. A LEED certified building in the USA is adjudged to have satisfied five key areas of human and environmental health standards: sustainable site development, water savings, energy efficiency, material selection and indoor environmental quality.

Table 1: Impacts of the built environment:

Aspects of Built Environment:	Consumption:	Environmental Effects:	Ultimate Effects :
Siting Design Construction Operation Maintenance Renovation Deconstruction	Energy Water Materials Natural Resources	Waste Air pollution Water pollution Indoor pollution Heat islands Stormwater runoff Noise	Harm to Human Health Environment Degradation Loss of Resources

Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation

For example, green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g., reduced product emissions); and/or feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering).

3. PROSPECTS /BENEFITS OF GREEN BUILDINGS

Many reasons have been proffered as potentially requiring the need for building green especially by developers and builders in the USA who are leading the movement towards green building. Past works of Russo and Fourt, 1987; Hart, 1995; Leaman, 1999; Baier, 1999; Robinson, 2005, CoreNet, 2008; Heerwagen, 2000 and RICS (2010) documented a number of potential benefits that green building confers on the occupants and the environment. Prominent are:

- 1) Green buildings are more readily leased; That is, the fact that the design, features and all components of green buildings are environmentally friendly attracts high demand for it. Prospective tenants are easily convinced of the less toxic nature of the materials and energy saving costs features of such effective demand for green buildings. This results easily in high preference for green buildings relative to the traditional buildings. Introducing green buildings into the Nigerian market will enhance property liquidity and prevent loss of income to investors, some of who utilise borrowed fund for investment (Baier, 1999).
- 2) Command higher rents; Sustainability can translate into an enhancement of building value and sales prices. Green buildings customarily have quicker absorptions of tenants (lease-up times). Green buildings tend to have higher lease rates, better tenant retention and fewer turnovers.
- 3) Have higher tenants retention rates. This is because tenants are often convinced of the need to continue in the occupation of a building where they have sustained level of productivity. The productivity benefits are estimate to be as ten times the energy savings from green building efforts (Miller *et al.*, 2006). These benefits according to the author come in the form of lower absenteeism, fewer headaches at work, greater retail sales and easier reconfiguration of space resulting in loss downtime and lower costs. The implication is that tenants are willing to continue in occupation for as long as profitability is sustained; a benefit offered by green buildings.
- 4) Green buildings generally enjoy lower operating costs. This result from the use of natural resources, Energy is sourced from sunlight for cooling, heating and other services. This results in lower cost of energy. Water consumption cost is reduced also as main dependence is on natural resources. With the adoption of green buildings, operating costs of businesses are drastically reduced with its attendant effect on increased productivity (Robinson, 2005).
- 5) Green building improves productivity of their occupants. The reduction in health hazard that is offered enables comfort and enhances productivity. Tenants will expect a better performing, highly efficient building or they won't want to be there (Leaman, 1999).

Table 2 summarises the key benefits of green building. Such includes claim that green buildings will save energy (often very substantial amounts), increase service-worker productivity and decrease absenteeism, increase valuation, lower cap rates, decrease operating expenses and even command increased rental rates. Some of the claims for green buildings are truly striking, such as the assertion that putting up a green building certified with a particular rating system will decrease the incidence of asthma, or that increased natural light and access to views will result in better student performance. This is thus graphically represented in Figure 1.

Table 2: Benefits of Green Building Design

(Source: Environmental Concepts and Tools, Five Winds International Page 1)

Environmental Benefits	Economic Benefits	Occupational Benefits
<ul style="list-style-type: none"> • Enhance and protect ecosystems and biodiversity. • Improve air and water quality. • Reduce solid waste. • Conserve natural resources. 	<ul style="list-style-type: none"> • Reduce operating costs • Enhance asset value and profits. • Improve employee productivity and satisfaction • Optimize life-cycle economic performance. • Reduces future liability. • Increase retail sales. 	<ul style="list-style-type: none"> • Improve air, thermal and acoustic environments. • Enhance occupant comfort and health. • Reduce healthcare costs. • Improve employee satisfaction and morale — less absenteeism and turnover.

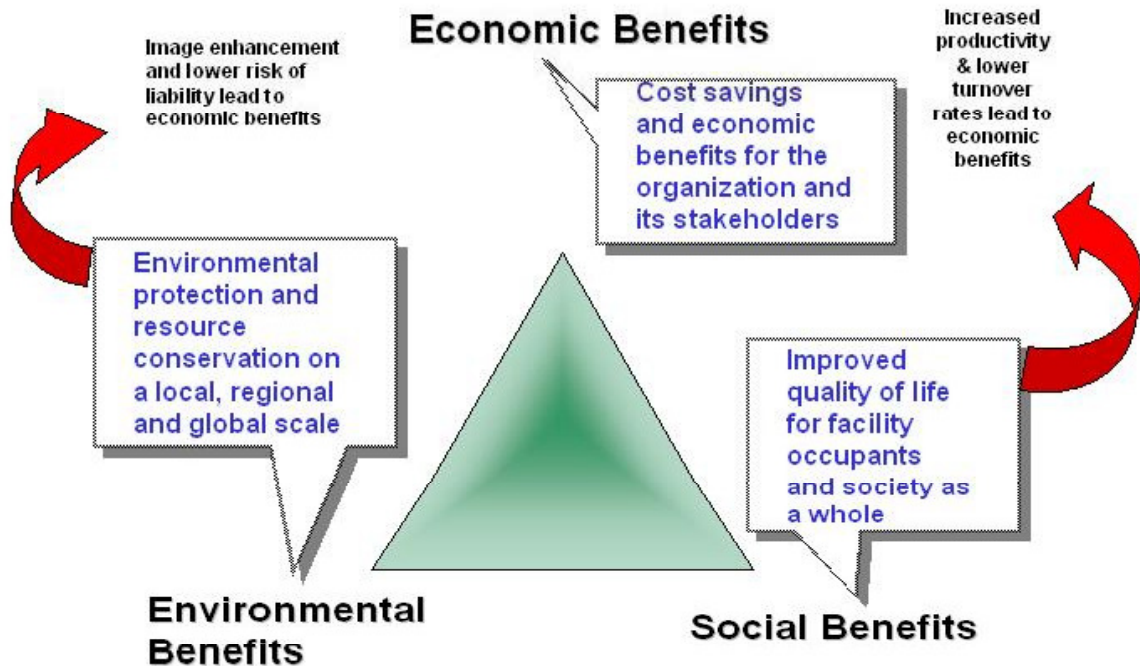


Figure 1: Sustainable Facilities — Three Key Aspects

(Source: Shearer (2002), Developing a Business Case for Sustainable Federal Facilities)

3.1. PERCEIVED IMPLEMENTATION DIFFICULTIES OF GREEN BUILDINGS

Authors have identified the barriers that could impede the smooth taken off and operations of green buildings in the advanced countries as lack of political will and strong leadership at the top levels of government, lack of leadership will in the country for code reform, among others. This is summarised in table 3 thus:

Table 3: Perceived Implementation Difficulties of Green Buildings (Source: Author's Field Survey, 2010)

Barriers/Perceived Implementation Difficulties	Source
Lack of political will and strong leadership at the top levels of government.	Esty and Winston (2006)
The benefits of green certification are not clearly understood by many of the Country's decision makers.	Esty and Winston (2006)
Lack of conceptual understanding among leaders about sustainability and its long-term, systemic benefits to the residents and the economic vitality of the Country.	Esty and Winston (2006) Choi (2009)
Absence of governmental authority responsible for implementing the adoption of green buildings.	Esty and Winston (2006)
The lack of good examples of green buildings and green technologies in the Country	Esty and Winston (2006)
Absence of legal /Plumbing Code specifying the use of green water conservation and storm water strategies and technologies.	Esty and Winston (2006)
The Country's Zoning Codes don't support and often inhibit green design strategies and technologies.	Esty and Winston (2006)
A general lack of understanding about green building principles and technologies by City policy makers.	Esty and Winston (2006)
Misconceptions about the cost and efficacy of green building and sustainable development.	Esty and Winston (2006)
Lack of good craftsman and subcontractor education adds difficulty to the process of green building that inhibits adoption by builders and developers.	Esty and Winston (2006)
A lack of sustainable design experience among the engineering community (Mechanical, Plumbing, Electrical, Civil) will make it difficult for the Country to implement green building strategies	Esty and Winston (2006)
Lack of leadership will in the country for code reform	Esty and Winston (2006)

4. EMERGING SYMPTOMS OF NEED FOR GREEN BUILDING IN NIGERIA

The need for green building is becoming more evident in Nigeria. To the authors mind, there are about nine of such symptoms:

- 1) Green building has become inevitable in the country because of the inefficiency of power-that is, the inability of successive government to guarantee the supply of adequate electricity consumption in the country. This follows from the fact that regardless of the privatisation effort of the government in the power sector, not much impact or success is recorded in improving the supply of electricity. Most industrial and commercial concerns currently rely of generating sets to power production and commercial endeavours. The resultant effect is

high cost of production; the development which makes locally produced goods to be costlier than imported goods. There is therefore high propensity and preference for imported goods at the expense of the economy. Nigerian economy as of today is therefore better described as a dumping ground for adulterated and out of use goods and services. There therefore is the need for buildings that will use less of electricity but more of natural resources approaching quantifying the sustainability value proposition.

- 2) Arising from reliance on generators by households and industrial and commercial users in Nigeria is high rate of environmental pollution attributable to the emissions from generators. The health hazard
- 3) The over dependence on oil as a major source of income and its resultant environmental degradation has attracted a lot of restiveness and militancy from youth of the host neighbourhood. This struggle overtime has witnessed series of killings and other forms of assault. A lot of colossal losses are daily recorded by oil companies located in the region. This suggests the need for buildings that would function anytime with the aid of natural resources.
- 4) The expected duration of the renewable energy system in Nigeria is in doubt in being a permanent resource. This calls for pro-active measures and policies to encourage the adoption of green building in Nigeria.
- 5) Cities and towns in Nigeria are characterised with high rise office complexes of different shape and magnitude. Most of the buildings cost more to service in view of the energy inefficiency in the country. Sustainable buildings would however have higher net operating income and consequently a higher value.
- 6) There is increasing demand for qualities and products of international standard. This is because, as Ogunba and Iroham (2006) put it, customer needs are becoming more international homogeneous through communication technologies. There are indications that the property market is currently an international market. While many of the multinationals sources for properties for their business accommodation and staff members from their head offices in the UK, USA and China. Many of the foreign investors will also require buildings of international standard. This suggests the existence of a viable market for green building.
- 7) Most businesses want to enhance their reputations as supporters of responsible environmentalism. They often want to be seen as good corporate citizens who abide by the laws of the state. This presupposes that most corporations in the country will do everything possible to support the effort of the government at preserving the environment. Introducing green buildings into the market will be a welcoming or acceptable endeavour by most stakeholders in the built environment.
- 8) Business organisations find the rising cost of energy detrimental to the success of their organisations and hence will aptly embrace the alternative of natural source of energy. They are out for energy cost saving source of generating power.
- 9) Growing concern about aging infrastructure often threatens the survival of businesses, especially small scale industries that probably would prefer injecting their equity capital into expanding the business network as against repairing and maintaining infrastructure.

5. METROPOLITAN LAGOS: THE STUDY AREA

5.1. THE STUDY AREA

The study was undertaken in Lagos state of Nigeria. The state is situated in the extreme south – western part of Nigeria on the narrow coastal plain of the right of Benin.

The city, a former federal capital, is the commercial nerve of the country. With an annual population growth rate of about 13.6% (about 5 times as fast as the national growth rate of 2.8 percent) (Omoogun, 2006), Lagos is Africa's second fastest growing urban centre after Cairo (Aluko, 1999). It

is a focal point for regional, national and international commercial activities. The population figure of over 14 million residents.

The state has a high concentration of industrial and commercial concerns. The focus on Lagos state is justifiable because of the affordability of data collection. Lagos is one of the most important commercial cities in Nigeria. Lagos state is the most intensive economic centre in Nigeria, harbouring 60% of the nation's industrial and economic establishment and 80% of the nations of the total value added of manufacturing activities in the country.

5.2. METHODOLOGY

The subject of study in this work are the real estate developers and tenants that reside and or handle property development in Lagos metropolis, Lagos and they also constituted the respondent group for the purpose of questionnaire administration within the study area. Questionnaires were distributed to 50 purposively selected property developers and 250 tenants in Lagos metropolis that were conveniently selected on the basis of who is willing to respond. With a success rate of 68%, the study adopted the descriptive method of analysis of frequency count, mean, median, standard deviation and proportion method

From review of literature, a number of factors were identified as potential benefits and likely difficulties in the implementation of green building. These possible factors were measured by asking the respondents to rank the requirements based on their perception on a five point ordinal scale. The analysis involves selection of likely factors that are perceived as benefits and implementation difficulties from a list of identified factors. This involves data reduction and could therefore be appropriately analysed by techniques such as proportion, relative importance index and chi-square (χ^2) test (Ojo, 2005). The technique of analysis adopted in this paper is the proportion method. Proportion method is a statistical means of representing the significance of a variable relative to all other variables under consideration. Statistically, it is represented by the total score of the variable divided by the overall sum of scores of all variables being considered and it is usually expressed in percentage. Proportion is useful in depicting at a glance, variables which are very significant and those which are not significant. The technique is very apt when the task involves ranking of variables in order of significance (Ojo, 2005).

Questions relating to the involvement of respondents were earlier analysed with the descriptive method of analysis of frequency count, mean, median, and standard deviation.

5.3. RESULT, DISCUSSION AND CONCLUSION

Analysis of the result of the data collected was done in two phases. The first phase obtained data on the involvement of the respondents in property issues and their level of awareness of green buildings. The result of the first part of the analysis is presented in Tables 1-6. The second part relates to the analysis of their perception about the benefits and implementation difficulties of green building and the result presented in Tables 7-9.

First, respondents were asked to provide an indication of their level of involvement in property dealings. Table 1 shows the distribution of the respondents' involvement in property. The result indicated that 72% of the respondents have high level of involvement in property while the remaining 27.3% had low involvement in property related issues. The purposive sampling of property developers and residents population of the study population appears to have been responsible for the high involvement of the respondents in property. While property developers deal in property as their main task, others are either owners or occupiers of buildings in any way. Table 2 shows that majority of the respondents (36.4%) had no knowledge of the benefits of green building while 27.3% have appreciable high and low levels of awareness respectively. This indicates further that 54.5% have one way or the other had an appreciable knowledge of green building and its accompanied benefits. This

suggest that though the concept of green building is an apparently obscure, and new concept of interest in Nigeria, a significant portion of the developers and residents of the high brow Lagos metropolis have working knowledge of green building. This could be as a result of the relatively high exposure of the respondents.

Table 3 reveals respondents' responses on their perception as to when green building will be critical. The responses show that 18.2% see it as being critical now while 72.7% indicated that green building is likely going to be critical within the next one to two years. It shows further that 9.1% are indifferent to this. This picture here is that despite the global awareness campaign about climatic change and global warning, green building is not currently being seen to be of paramount importance in Nigerian. This is probably because of the absence of legal framework and institutional support for its take off. Table 4 contains the respondents responses in respect of their perception about whether the introduction of green building in Nigeria will be a threat or an opportunity. The responses show that 18.2% see it as major threat while 9.1% regarded it as a minor threat. Other responses are 36.4% as neither threat nor opportunity and 18% as minor opportunity. This suggests that most Nigerians are currently indifferent to the effect of green building which could be because much ado about green building is still theoretical without anyone yet a beneficiary. Table 5 shows that majority of the respondents perceive that the supply of and occupation of green building will likely be at the same rate and cost as the conventional buildings.

Table 6 contains the respondents' responses in respect of their willingness to pay for green building premium. The responses show that 33.3% admitted that their expectation is to pay less than what is currently being paid for conventional buildings while 16.7% indicated that they will only be willing to pay not more than between 1-10% . Other 16.7% indicate that they will likely be willing to pay premium of greater than 10%. The result of the respondents' unawareness of the benefits of green building is depicted in their unwillingness to pay additional premium for green building. Table 7 contains the responses on perception of the benefits of green building in Lagos metropolis, Nigeria by means of proportion method. Results of analysis from the table show that in rank order, the perceptions of the expected benefits were: improved wellbeing, improved quality of work life, reduced turnover and increased ability to attract high quality workers, increased work process efficiency. This is not unexpected as there is much desire for health consciousness among Nigerian. This suggests a high willingness to embrace properties that will reduce health expenses of workers and residents. The mean figures for the four factors are: 4.00, 3.723, 3.723 and 3.723 with corresponding standard deviation of 4.000.

Results of the analysis also showed that the benefit process innovation ranked had a mean value of 2.2727 and was rated by respondents as the least expected benefits from green building. Results of the ranking of the remaining twelve factors in order of significance are contained in Table 8 with process innovation the least. Table 8 contains the results of analysis of respondents' perception of the implementation difficulty of green building in Lagos Metropolis, Nigeria by means of proportion method. Results of analysis from the table show that in rank order, the factor that respondents perceived as most cumbersome were: Lack of political will and strong leadership at the top levels of government, The benefits of green certification are not clearly understood by many of the Country's decision makers, Lack of conceptual understanding among leaders about sustainability and its long-term, systemic benefits to the residents and the economic vitality of the Country, and absence of governmental authority responsible for implementing the adoption of green buildings.

The Proportion values for the four factors (requirements) are: 85.6%, 68.2%, 65.2% and 56.4% respectively. Results of the analysis also showed that Lack of leadership will in the country for code reform had a Proportion value of 41.2% and was perceived by respondents as the least factor of implementation difficulty of all factors. This shows that effective implementation of green building into the Nigerian system requires strong government and political will demonstrated by the enacted of necessary legislation and development of appropriate framework for its implementation. The current leadership of the country will need to acquire the requisite knowledge about the benefits of green

building which will then be translated into enacting necessary policies and legislation for implementing green building in the region. A timely embracement of green building is a necessary condition for Nigeria to retain its leadership role in Africa towards reducing gas emissions and climatic change effect.

6. CONCLUSION

A major conclusion of the study is that there has been a lack of political and in support of green building at the top level of government. This has resulted in low level of awareness of the benefits of green buildings by estate developers and residents of Lagos metropolis. The study also revealed that lack of good examples of green buildings and green technologies in the city inhibits adoption of both the public and private sectors.

A major implication of this study is that the political will for the development of the legal framework for the implementation of green buildings in the country. This will be followed by intensive awareness enlightenment and publicity about the benefits of green building. In other words, the government will be required to mobilise the people as well as give necessary incentives towards the implementation of green building.

Table 4: Involvement in property management practice (Source: Field survey, 2010)

Involvement	Frequency	Percentage
High	148	72.7
Low	56	27.3
Total	204	100.0

Table 5: Awareness of Green Building Practice (Source: Field survey, 2010)

Level of Awareness	Frequency	Percent
High	56	27.3
Low	56	27.3
No response	74	36.4
5	18	9.1
Total	204	100.0

Table 6: Expectation of when green building becomes a critical requirement (Source: Field survey, 2010)

Expectation of criticality	Frequency	Percent
Critical Now	36	18.2
Critical within 1-2 years	148	72.7
6	18	9.1
Total	204	100.0

Table 7: Indication of the willingness of respondents to pay additional cost for occupying green

(Source: Field survey, 2010)

Additional Cost of Green Building	Frequency	Percentage
Generally less expensive than conventional	73	36.4
The same as conventional	93	45.5
1-10% more expensive	19	9.1
More than 10% expensive	19	9.1
Total	204	100.0

Table 8: Willingness of prospective occupiers to pay for green building (Source: Field survey, 2010)

Willingness to pay	Frequency	Percent
No response	34	16.7
Expect to pay less	69	33.3
Expect to pay the same but	34	16.7
Willing to pay 1-10%	34	16.7
Willing to pay greater than	34	16.7
Total	204	100.0

Table 9: Perception Of Benefits From Green Buildings (Source: Field survey, 2010)

Perception of Benefits	Mean		Std. Deviation	Variance
	Statistic	Ranking		
Reduced resource utilisation	3.4545	6 th	1.75292	3.073
Reduced operating ad operating cost	2.9091	15 th	1.44600	2.091
Reduced risks/avoided costs	3.4545	6 th	1.50756	2.273
Increased Resale value of property	3.4545	6 th	1.29334	1.673
Reduced absenteeism	3.1818	13 th	1.47093	2.164
process innovation	2.2727	17 th	1.27208	1.618
increased work process efficiency	3.7273	2 nd	1.19087	1.418
improved public image	3.0000	14 th	1.26491	1.600
increased ability to sell to pro-environmental customers	3.7273	2 nd	1.27208	1.618
community outreach and education	2.8182	16 th	1.16775	1.364
improved ability to work with community stakeholders	3.2727	11 th	1.55505	2.418
improved quality of work life	3.7273	2 nd	1.19087	1.418
improved personal productivity	3.3636	9 th	1.43337	2.055
improved wellbeing	4.0000	1 st	1.00000	1 st
reduced turnover and increased ability to attract high quality workers	3.7273	2 nd	1.19087	1.18
Increased overall productivity	3.3333	10 th	1.11803	1.250

Table 10: Analysis of Perceived Implementation Difficulties by means of Proportion method

(Source: Author's Field Survey, 2010)

Barriers/Perceived Implementation Difficulties	Proportion	Ranking of factors (perceived barrier)
Lack of political will and strong leadership at the top levels of government.	85.6	1
The benefits of green certification are not clearly understood by many of the Country's decision makers.	68.2	2
Lack of conceptual understanding among leaders about sustainability and its long-term, systemic benefits to the residents and the economic vitality of the Country.	65.2	3
Absence of governmental authority responsible for implementing the adoption of green buildings.	58.4	4
The lack of good examples of green buildings and green technologies in the Country	56.4	5
Absence of legal /Plumbing Code specifying the use of green water conservation and stormwater strategies and technologies.	55.1	6
The Country's Zoning Codes don't support and often inhibit green design strategies and technologies.	53.1	7
A general lack of understanding about green building principles and technologies by City policy makers.	52.1	8
Misconceptions about the cost and efficacy of green building and sustainable development.	47.5	9
Lack of good craftsman and subcontractor education adds difficulty to the process of green building that inhibits adoption by builders and developers.	46.2	10
A lack of sustainable design experience among the engineering community (Mechanical, Plumbing, Electrical, Civil) will make it difficult for the Country to implement green building strategies	42.6	11
Lack of leadership will in the country for code reform	41.2	12

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Evaluation of Existing Vulnerabilities and Disaster Risk Reduction Practices of Infrastructure Reconstruction Projects

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ABSTRACT

Communities and built environment have been exposed to various threats since a long ago with diverse effects and resultant losses. Thus it is not only people, but also built-environment structures are vulnerable to disasters. In this context, disaster risk reduction (DRR) has become one of the important solutions to mitigate and to prevent disaster risks and for speedy recovery after disasters. The best way of doing this is through 'vulnerability reduction' and thus disaster risk reduction should be aimed at vulnerability reduction. However, there is a need to identify the most advantageous disaster risk reduction strategies which can of course result in vulnerability reduction. As a part of this main aim, this paper seeks to explore the presence of various vulnerabilities within infrastructure reconstruction projects and to evaluate the disaster risk reduction practices within these projects with particular emphasis on their importance and level of implementation. This study adopts the case study research strategy and this paper is entirely based on data collated from semi-structured interviews and questionnaires within one case study conducted within a water supply and sanitation reconstruction project in Sri Lanka. The results show that while water supply facility is found to be somewhat economically, technologically, politically, developmentally and physically vulnerable, it bears cultural and social vulnerabilities to a very little extent. Further, in terms of the communities benefited from the water project, the highest level of vulnerability was found within physical vulnerabilities. Further, the technological, political and social vulnerabilities are also respectively presence within the communities. Other than that cultural and economic vulnerabilities are found to be somewhat presence. In terms of the DRR practices within the case study project, the physical/technical strategies were identified as the most important group of DRR strategies while emergency preparedness strategies also very important. Although emergency preparedness strategies are considered very important, none of them are satisfactorily implemented to the extent they important to the project while most of the physical/technical strategies are adequately implemented.

Keywords: DRR, infrastructure and community vulnerability, infrastructure reconstruction

1. INTRODUCTION AND LITERATURE REVIEW

1.1. BACKGROUND

People have been living with risks ever since they first joined efforts, shared resources and assumed responsibilities (Jeggle, 2005). Thus, communities and built environment have been exposed to various threats since a long ago with diverse effects and resultant losses (Bosher *et al.*, 2009). In this

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context, disaster risk reduction has become one of the important solutions to mitigate and to prevent disaster risks and for speedy recovery after disasters (Palliyaguru and Amaratunga, 2008).

1.2. VULNERABILITY REDUCTION OF BUILT ENVIRONMENT AND COMMUNITIES

According to the UN/ISDR (2004a), vulnerability to hazards is expressed as the degree of exposure of the population/property and its capacity to prepare for and respond to the hazard. The term 'vulnerability' is defined as '*a set of conditions and processes resulting from physical, social, economic and environmental factors that increase the susceptibility of a community to the impacts of hazards*' by the UN/ISDR (2004a, 2004b). On the other hand, vulnerability is viewed as a product of four components by McEntire (2001), which are risk, susceptibility, resistance and resilience. In here, the entire environment is classified into two as physical environment (which consists of natural systems, built environment structures and technological structures) and social environment (which consists of individual and groups of individuals, cultural systems, political systems and economic systems).

Buckle *et al.* (2001) recognise different levels of resiliency and vulnerability. Although the concept of resiliency is defined outside vulnerability here, the view presented by them is useful in understanding different levels of various vulnerabilities. Accordingly, it is evident that it is not only people are vulnerable to disasters but also built-environment structures such as road networks, water supply and sanitation projects etc. Furthermore, McEntire (2001) claims that there are innumerable variables interacting to produce future of increased vulnerabilities which in turn have been categorised under physical, social, political, economic and technological headings. In relation to all above views, it is apparent that all different types of vulnerabilities are commonly applicable to people and built-environment structures.

Prevention or mitigation of disaster risk can be achieved by prevention or mitigation of hazard and/or prevention or mitigation of vulnerabilities. The best way of preventing or mitigating disaster losses has been identified as preventing (eliminating) or mitigating (reducing) vulnerabilities, which is commonly called 'vulnerability reduction'. Stenchion (1997) reiterates the fact that '*development and disaster management are both aimed at vulnerability reduction*'. For these reasons, it is imperative that our future paradigm incorporate a broad scope of variables and consider the importance of vulnerability reduction through development and disaster management activities alike (McEntire *et al.*, 2002). Thomalla *et al.* (2006) identify disaster risk reduction as one of the four ways of reduction of vulnerability to natural hazards. Thus, it is evident that disaster risk reduction should be aimed at vulnerability reduction. In other words, vulnerabilities are reduced through disaster risk reduction strategies.

1.3. TOWARDS A MORE PROACTIVE APPROACH TO VULNERABILITY REDUCTION: DISASTER RISK REDUCTION

The impetus for the disaster risk reduction came largely with the severe losses of lives and property due to natural and human induced disasters. UN/ISDR, (2002) views disaster reduction as '*taking measures in advance to address vulnerabilities, reduce risk and anticipate hazards, which involve environmental protection, social equity and economic growth, the three cornerstones of sustainable development, to ensure that development efforts do not increase the vulnerability to hazards*'. Thus, disaster and risk reduction is emerging as an important requisite for sustainable development (UN/ISDR, 2003). UN/ISDR (2009) defines it as '*systematic development and application of policies,*

strategies and practices to minimise vulnerabilities and disaster risks throughout society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development’.

However, it is evident from these definitions that the concept of disaster risk reduction is not only referred to structural or technically advanced measures but also soft methods such as policies, planning and knowledge management measures also form a part (Mileti, 1999). Disaster risk reduction strategies can be categorised in various ways and thus literature identifies various classifications of DRR strategies. Among all, DFID (2005) has a classification of DRR strategies as (i) Policy and planning measures (ii) Physical preventative measures (iii) Physical coping and/or adaptive measures (iv) Community capacity building measures.

Within the grounds of closer two-way relationship between disasters and development, it is apparent that disasters provide windows of opportunities for development. There are many authors, such as Lewis (1999), Jigyasu (2002), UNESCAP (2006), Thiruppugazh (2007) and so on who discuss about opportunistic nature of disasters. Disasters can highlight particular areas of vulnerability, for example in areas where there is serious loss of life and physical structures indicates the general level of underdevelopment (Stephenson and DuFrane, 2005), because the losses from natural disasters are sometimes viewed as results of development that is unsustainable (Mileti *et al.*, 1995 cited McEntire, 2004). This underdevelopment may be due to social factors (social vulnerabilities), or economic factors (economic vulnerabilities) or some other. Reconstruction can therefore of course be used as development opportunity to help reduce these various disaster risks through the particular attention to various vulnerabilities (Jayaraj, 2002). Application of this concept of disaster risk reduction into infrastructure reconstruction projects can be done at different levels. Starting from the policy and planning strategies, they are extended to physical/technical strategies, emergency preparedness strategies, natural protection strategies and knowledge management strategies. However, there is a need to identify the most advantageous disaster risk reduction strategies which can of course not only make built environment facilities more disaster ‘resistant’ but also make them less ‘risky’ and the communities benefited from the facilities more ‘resilience’ and less ‘susceptible’ to disasters: basically, the ability of disaster risk reduction strategies on vulnerability reduction.

2. RESEARCH METHODOLOGY

The case study approach was selected as the main research strategy for this study. This paper is entirely based on the data collated from one case study conducted within a water supply and sanitation reconstruction project in Sri Lanka. Accordingly, the data were gathered using three semi-structured interviews and five questionnaires from individuals attached to infrastructure reconstruction projects. While semi-structured interviews were analysed using NVivo software, the questionnaires were analysed using descriptive statistics techniques.

3. CASE STUDY FINDINGS

3.1. LEVEL OF VULNERABILITY OF INFRASTRUCTURE FACILITY AND COMMUNITIES

Vulnerability of Infrastructure Facilities

Questionnaire survey was conducted among the water supply project stakeholders in order to identify the level of vulnerability of the water supply project. The data were gathered using likert scale as follows:

1 and below = Not presence at all; Above 1 to 2 = Presence to a very little extent; Above 2 to 3 = Somewhat presence; Above 3 to 4 = Presence; Above 4 to 5 = Presence to a great extent

As tabulated in table 1, the mean values were calculated against each factor forming water supply project vulnerability and total mean values were calculated against each type of vulnerability.

Table 1: Vulnerabilities of Water Supply Reconstruction Project

Types of Vulnerabilities	Factors Forming Water Project Vulnerability	Mean	Total Mean
Physical Vulnerabilities	Proximity of water supply facility to natural hazards	2.50	2.33
	Degradation of the environment due to water supply project	2.00	
	Interdependencies of water supply project with other infrastructure (two or more infrastructures depend on each other)	2.50	
Technological Vulnerabilities	Project participants' over-reliance upon or ineffective warning systems	2.50	2.50
	Project participants' inadequate foresights regarding new technology for reconstruction	2.50	
Social Vulnerabilities	Project participants' limited education (including insufficient knowledge) about disasters	2.50	1.75
	Marginalisation of specific project participants (e.g: women)	1.00	
Cultural Vulnerabilities	Project participants' lack of concern towards disasters and inadequate foresights regarding consequences of disasters to water supply project	2.00	2.00
	Project participants objection to safety precautions and regulations	2.00	
	Loss of traditional coping measures within water supply project	2.00	
	Dependency and absence of personal responsibility within water supply project	2.00	
Political Vulnerabilities	Minimal support for disaster programmes amongst elected officials	3.00	2.38
	Inability to enforce or encourage steps for mitigation within water supply project	2.00	
	Over-centralisation of decision making within water supply project	1.00	
	Isolated or weak disaster related institutions related to water supply reconstruction	3.50	

Types of Vulnerabilities	Factors Forming Water Project Vulnerability	Mean	Total Mean
Economical Vulnerabilities	Lack of funding for water supply project	3.00	2.63
	Project participants' pursuit of profit with little regard for consequences	1.50	
	Failure to purchase insurance against potential economic losses of water supply project	3.00	
	Lack of resources for disaster prevention, planning and management within water supply project	3.00	
Developmental Vulnerabilities	Lack of detailed planning of water supply project	2.00	2.38
	Project participants' carelessness/ inadequate foresights regarding designing and reconstruction of water supply project	2.00	
	Lack of structural mitigation in water supply project construction	2.50	
	Inadequate routine and emergency preparedness	3.00	

According to table 1, although none of vulnerabilities are found to be 'presence at a greater level' or 'presence', the highest total mean values are found to be associated with the economical (mean 2.63), technological (mean 2.50), political (mean 2.38), developmental (mean 2.38) and physical (mean 2.33) vulnerabilities respectively, which presence at a level called 'somewhat presence'. The next in line are cultural (mean 2.00) and social (mean 1.75) vulnerabilities which presence at a level called 'presence to a very little extent'.

In terms of the factors forming vulnerabilities, the highest mean values are obtained by 'isolated or weak disaster related institutions related to water supply reconstruction' (mean 3.50), 'minimal support for disaster programmes amongst elected officials' (mean 3.00), 'lack of funding for water supply project' (mean 3.00), 'failure to purchase insurance against potential economic losses of water supply project' (mean 3.00), 'lack of resources for disaster prevention, planning and management within water supply project' (mean 3.00) and 'inadequate routine and emergency preparedness' (mean 3.00), of which the first two factors form political vulnerabilities, the next three factors form economical vulnerabilities and the last factor form developmental vulnerabilities respectively.

Level of Vulnerability of Communities Benefited from Infrastructure Facilities

The same procedure was adopted to figure out the level of vulnerability of community who is benefited from the water supply project. As shown in table 2, the mean values were calculated against each factor forming community vulnerabilities and total mean values were calculated against each type of vulnerability.

Table 2: Vulnerabilities of Communities Benefited from Water Supply Reconstruction Project

Types of Vulnerabilities	Factors Forming Community Vulnerability	Mean	Total Mean
Physical Vulnerabilities	Proximity of people to natural hazards	4.00	3.75
	Degradation of the environment	3.50	
Technological Vulnerabilities	Community's over-reliance upon or ineffective warning systems	3.50	3.50
	Community's inadequate foresights regarding new technology for reconstruction	3.50	
Social Vulnerabilities	Community's limited education (including insufficient knowledge) about disasters	3.50	3.25
	Massive and unplanned migration to urban areas	3.00	
	Marginalisation of specific social groups and individuals	3.00	
	Inadequate routine and emergency preparedness	3.50	
Cultural Vulnerabilities	Community's lack of concern towards disasters and inadequate foresights regarding consequences of disasters to water supply project	2.50	3.00
	Community's objection to safety precautions & regulations	2.00	
	Loss of traditional coping measures within communities	4.00	
	Dependency and absence of personal responsibility within communities	3.50	
Political Vulnerabilities	Minimal support for disaster programmes amongst elected officials	3.00	3.50
	Inability to enforce or encourage steps for mitigation	3.50	
	Over-centralisation of decision making within communities	3.00	
	Isolated or weak disaster related institutions	4.50	
Economical Vulnerabilities	Growing divergence in the distribution of wealth	1.50	2.88
	Community's pursuit of profit with little regard for consequences	1.00	
	Community's failure to purchase insurance against potential economic losses	4.50	
	Lack of resources for disaster prevention, planning and management within communities	4.50	

According to table 2, the highest total mean values are shown by physical (mean 3.75), technological (mean 3.50), political (mean 3.50) and social (mean 3.25) vulnerabilities in terms of the community vulnerabilities, which are found to be presence at a level called 'presence'. Being seconded to these four types of vulnerabilities, the communities are identified as culturally (mean 3.00) and economically (mean 2.88) vulnerable at a level called 'somewhat presence'.

In terms of the factors forming vulnerabilities, the highest mean values are obtained by 'isolated or weak disaster related institutions' (mean 4.50), 'community's failure to purchase insurance against potential economic losses' (mean 4.50), 'lack of resources for disaster prevention, planning and management within communities' (mean 4.50), 'proximity of people to natural hazards' (mean 4.00) and 'loss of traditional coping measures within communities' (mean 4.00), of which the first factor form political vulnerabilities, the next two factors form economical vulnerabilities, the fourth factor form physical vulnerabilities and the last factor form cultural vulnerabilities respectively. Although two factors have obtained highest mean values out of four factors those forming economical vulnerabilities, the total mean value of economical vulnerabilities has obtained lowest total mean value among all other types. This can be mainly attributed to the low rate of responses from the respondents on two factors of 'growing divergence in the distribution of wealth' and 'community's pursuit of profit with little regard for consequences'. Most of the respondents have indicated that they have no opinion about existence of these two factors.

3.2. CURRENT POSITION OF DISASTER RISK REDUCTION PRACTICES WITHIN INFRASTRUCTURE RECONSTRUCTION SECTOR

Information regarding the current position of DRR practices within the water supply project was gathered through questionnaires. The questionnaire survey was intended to collate data regarding importance of integration of disaster risk reduction into post-disaster infrastructure projects and their satisfactory level of implementation within projects.

According to total mean value calculations, the physical/technical strategies (mean 4.70) were identified as the most important group of DRR strategies while emergency preparedness strategies (mean 4.60) are also found to be 'very important'. In addition, natural protection strategies are considered as 'important' with a mean value of 4.00 and knowledge management strategies were identified as least important group of DRR strategies, still with a total mean value of 3.93, indicating that they too are 'important'. Figure 1 depicts comparison of importance of physical/technical strategies and their level of consideration/implementation within water supply and sanitation project.

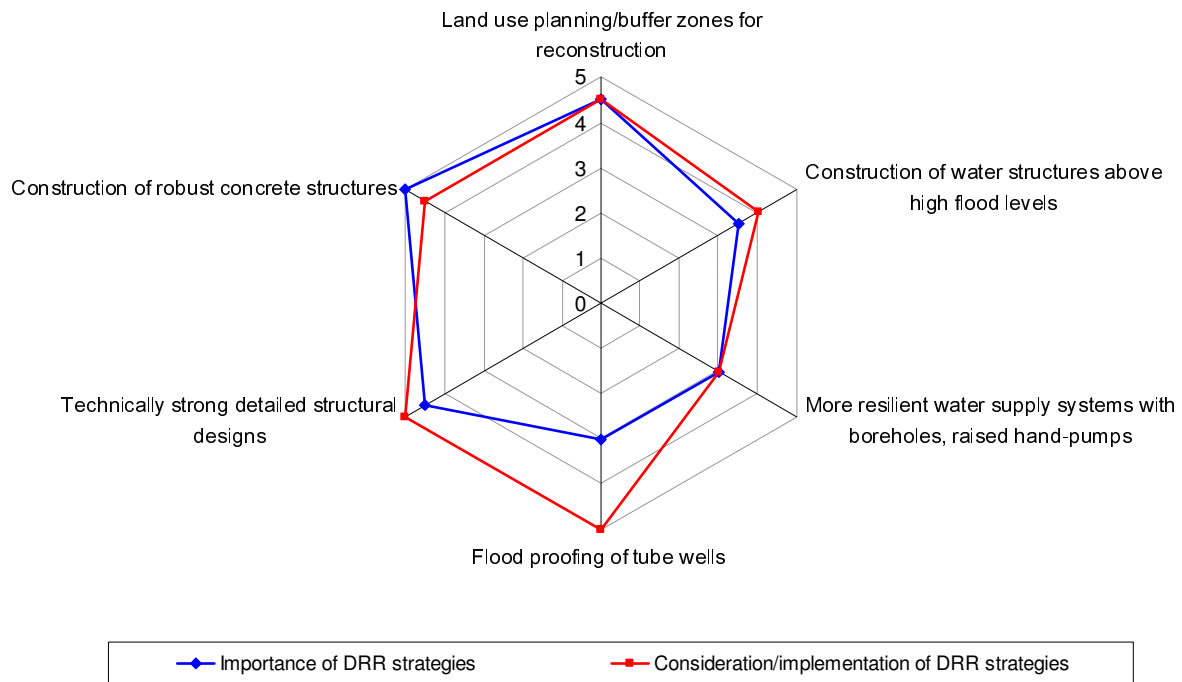


Figure 1: Comparison of Importance of Physical/Technical Strategies and their Level of Consideration/Implementation

According to figure 1, it is evident that most of the physical/technical strategies are considered as ‘very important’ or ‘important’ except the strategies called more resilient water supply systems with boreholes, raised hand-pumps and flood proofing of tube wells. However, all of them seem to be adequately implemented within the project, sometimes even to a greater extent than its level of importance.

Figure 2 depicts a comparison of importance of emergency preparedness strategies and their level of consideration/implementation. Accordingly, although most of emergency preparedness strategies are considered ‘very important’, none of them are satisfactorily implemented to the extent they are important to the project. More importantly, it is discovered that ‘pre-positioning/strategic stock piling of relief material’ and ‘construction professionals (project participants) disaster preparedness after reconstruction’ are two strategies which are not adequately implemented at all.

As far as the natural protection strategies are concerned, although they are identified as ‘important’ group of strategies, they too are not adequately implemented.

Figure 3 depicts a comparison of importance of knowledge management strategies and their level of consideration/implementation. Accordingly, ‘project participants engagement in training & educational/awareness programs on infrastructure safety’ and ‘communication, information management and sharing inside the project’ are considered ‘very important’ strategies while others are considered ‘important’ except ‘communication, information management and sharing outside the project’ which is identified ‘moderately important’. Most of all knowledge management strategies are adequately implemented to the extent they are considered important except ‘community engagement in project decision making and physical reconstruction’. Although this strategy is considered ‘important’, it is not adequately implemented. Further, ‘communication, information management and sharing inside the project’ need some improvements as it is considered a ‘very important’ strategy.

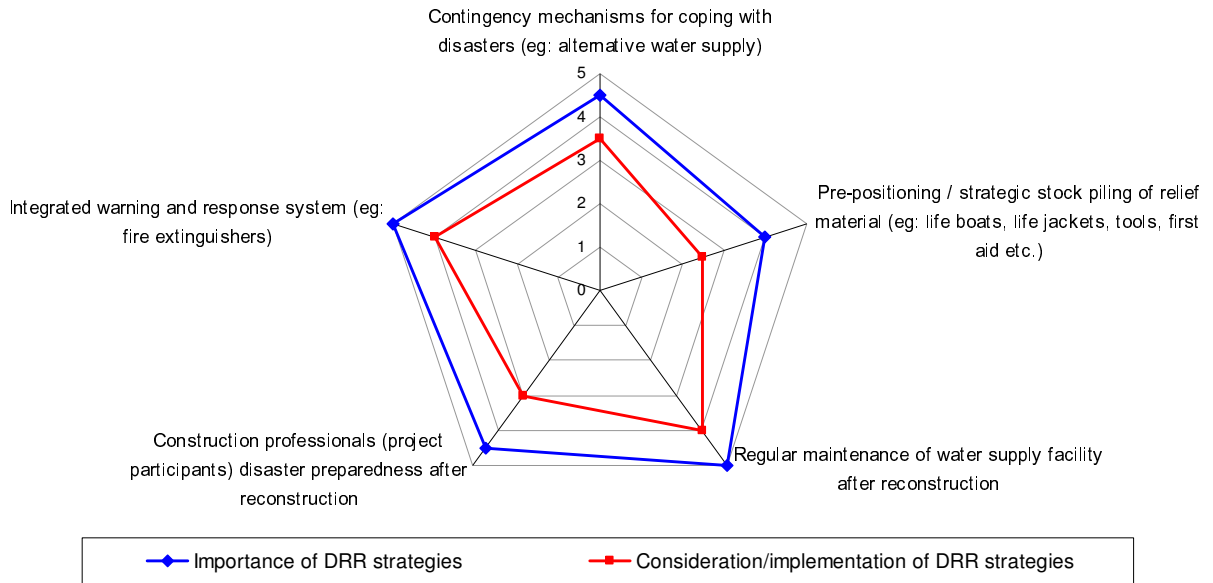


Figure 2: Comparison of Importance of Emergency Preparedness Strategies and their Level of Consideration/Implementation

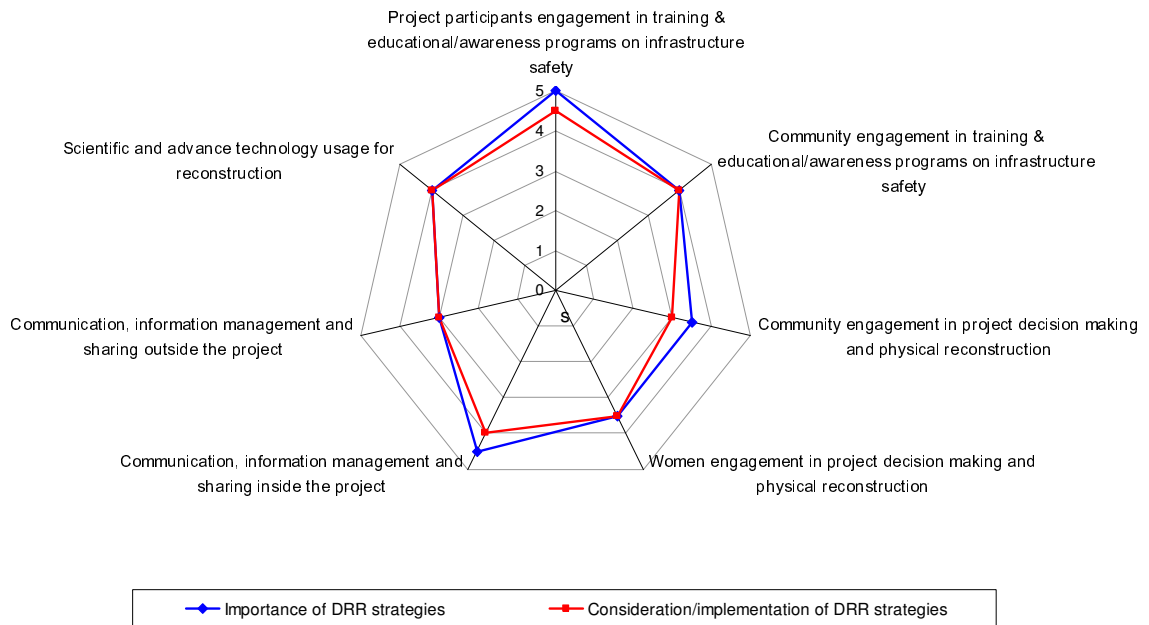


Figure 3: Comparison of Importance of Knowledge Management Strategies and their Level of Consideration/Implementation

3.3. THE INFLUENCE OF INTEGRATION OF DISASTER RISK REDUCTION INTO INFRASTRUCTURE RECONSTRUCTION

This section is intended to present the semi-structured interview respondents' views regarding the influence of integration of disaster risk reduction into infrastructure reconstruction. The interview respondents identified a range of benefits and disadvantages of disaster risk reduction practices within the water supply and sanitation project.

Positive Influence of Integration of Disaster Risk Reduction into Infrastructure Reconstruction

Achieving quality is one of the basic success criteria of construction of any built environment structure. It is in fact considered as a key parameter of project success. The term 'quality' is applicable to every key phase of a construction project life cycle up to the quality of the final product as a whole. All interviewees view application of disaster risk reduction strategies to reconstruction of water supply project as a measure of strengthening the structures. As stated by respondent 1 (R1) *"when you strengthen the structures it will definitely increase the quality of it, no doubt about it"*. In here, R1 referred the term 'quality' to the final product quality. The respondents perceive a view that the ability of infrastructure to resist or withstand against future disasters as a quality improvement of the final product. Improving the quality of water generated by the water supply system is another major focus of this project. As stated by respondent 3 (R3), *"disaster risk reduction measures help maintain the quality of water by preventing them being contaminated in an emergency situation like a flood"*.

There is a general consensus that construction industry is a part and parcel of the economy and thus creation of employment opportunities is one of its key features. As R1 and R3 describes, providing job opportunities for tsunami affected people and people around the area is one of the key objectives of initiation of this project. As R1 states *"a new station of the National Water Supply & Drainage Board was established there soon after the completion of reconstruction project and new employees from the area were recruited there on full-time, permanent basis"*. *They are responsible for maintenance and everything"*. In the context where regular maintenance of the water supply system was identified as a key DRR strategy, it is not only through regular maintenance but also the job opportunities could have been created through involvement of tsunami affected community for the reconstruction work, which had not adequately been taken place in this project.

Disaster risk reduction practices bring in the benefit of motivating the construction staff. As per the respondent R3, *"recruiting trained people for construction supervision has been a problem, mainly due to skilled people emigration to Middle-East. The new employees' poor understanding of required quality and their lack of moral towards achieving the project success is a major a challenge, whereas the construction supervision has been mainly limited to signing papers"*. However, various capacity building programs on DRR and infrastructure safety for project participants such as training & educational, awareness programs have the potential of motivating them. According to him, the new generation has lack of moral to do things accurately. In his words *"their dedication towards the project is less"*. Project participants engagement in training & educational/awareness programs on infrastructure safety would not only motivate them toward achieving the project success but also expect cultural and attitudinal changes of their behaviours together with improving knowledge on construction techniques, infrastructure protection and various other necessities. Respondent R3 explained that *"the Water Supply and Drainage Board in Sri Lanka presently conduct training programmes/capacity building programmes to uplift the employees' moral, eradicate cultural*

barriers etc. This lack of construction supervision can be improved by conducting things like workshops to alter their moral and the culture. Presently there are management tools to do such things. We are currently conducting some of these exercises”.

As it is repeatedly noted, one of the key objectives of this reconstruction project is to provide purified drinking water to the tsunami affected people and Samurdhi people (a group of people receiving benefits of national program called ‘Samurdhi’ introduced by the Sri Lankan Government to alleviate poverty) at reasonably a lower price. Besides the normal times, it is needed to maintain an uninterrupted supply of water to the community during emergency situations. This implies that access to the water system must be available in every possible means. Having established various preparedness strategies such as contingency mechanisms for coping with disasters (eg: alternative water supply means), the water supply system has taken necessary steps to improve the access to the uninterrupted supply of water at every time. According to the respondent R3, *“most common type of damage we face is pipe lines burst. In such a situation we repair the pipe lines very immediately. Contingency planning for pipe line burst is there. If repairing takes 2 or 3 days we provide a bowser supply for people”.*

One major challenge that developing countries are encountered with is lack of investment funding. While infrastructure sector’s key role in people’s daily activities and socio-economic growth of a country is evident, these countries do not fulfil sufficient infrastructure needs of their people. Further, there is a high propensity to deteriorate the existing infrastructures due to various reasons such as lack of maintenance, lack of prevention methods etc. However, proper practice of relevant DRR strategies such as regular maintenance, construction of more robust concrete structures have the potential of improving the life time of infrastructure facilities. In that way, as it was established from the literature review, integration of disaster risk reduction has a number of benefits. Confirming the fact further, the empirical investigation too identifies various advantages generated by disaster risk reduction strategies towards the infrastructure facility, the community benefited from the facility and ultimately towards the development needs of the country.

Positive Influence of Integration of Disaster Risk Reduction into Infrastructure Reconstruction

The first and the foremost disadvantage they recognised was the high cost involvement. This is recognised by them as a disadvantage of disaster risk reduction as well as a challenges faced by them with regard to integration of DRR into the project. Loading into the same problem, the integration process involves many resources such as human resources which could ultimately result in high financial burden on the project. Furthermore, the maintenance aspects involve a high cost mainly due to the fact that this water supply scheme has sophisticated features compared to other local systems. According to the respondent R1 *“some systems are seen as not much familiar with other local systems. This project will definitely involve high maintenance cost than other local systems currently functioning in Sri Lanka. We need to clean the well heads. This will involve removing structures in regular intervals like in every 3 months and so on. We have now given enough equipment like brushes for the moment. But those are not enough in long term wise. But in other water supply systems in Sri Lanka, they directly pump water from rivers without having systems such as tube well as we have done in this project. Otherwise, the systems tend to corrode in the long term usage. If these corrode like this and become ill function then the whole system will be out of work”.*

The next major disadvantage is the effect on time taken for project completion. Spending extra time on detail design and construction of structures would delay the project completion which would ultimately negatively affect major expectations of the project. The next key issue is the nature of uncertainty about the infrastructure facility's resistant capacity for future disasters. What so ever the strategies are taken, as long as the nature of future disasters is unknown, no 100 percent guarantee could be placed on the structures.

4. CONCLUSIONS

The concept of disaster risk reduction has become one of the important solutions to mitigate and to prevent disaster risks and for speedy recovery after disasters. The literature suggests that 'vulnerability reduction' can accomplish this task. This paper identified different types of vulnerabilities exist within water supply facilities and communities those who are benefited from water supply facilities. The empirical results show that DRR strategies should mostly aim to reduce economical, technological, political, developmental and physical vulnerabilities of infrastructure facilities and physical, technological, political and social vulnerabilities of the communities benefited from the facilities, in that particular order of priority. Other than that community faces cultural and economic vulnerabilities to some extent. However, DRR strategies have a limitation on its ability to address all these types of vulnerabilities due to the fact that some of them are out of project control, for example, political vulnerabilities. The secondary attention must be given to the cultural vulnerabilities of both infrastructure facility and communities and social vulnerability of infrastructure facility.

Further, the existing practice of the concept of disaster risk reduction within a water supply project was evaluated in terms of their importance and level of implementation. The physical/technical strategies were identified as the most important group of DRR strategies while emergency preparedness strategies also very important. Although emergency preparedness strategies are considered very important, none of them are satisfactorily implemented to the extent they are important to the project while most of the physical/technical strategies are adequately implemented. Further, the paper discussed positive and negative influences of integration of disaster risk reduction into infrastructure reconstruction. Accordingly, increasing the quality of structures, creating of job opportunities, motivating the construction team, improving knowledge of construction team, improving access to infrastructure facility and improve life time of infrastructure facility were identified as main positive influences. The negative influences are high cost involvement, high maintenance cost, delaying project completion, high resource involvement, unsure nature of infrastructure's resistant for future disasters and new systems do not match with other local systems.

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Factors Affecting Construction Safety Management in Sri Lanka

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ABSTRACT

Safety at work is an important fact at construction sites. The subject of safety attitudes and safety performance of both management and workers in the construction industry is even more so. In general, accidents at work occur either due to lack of knowledge or training, lack of supervision, lack of means to carry out the task safely or alternatively, due to an error of judgment, carelessness, laziness or total irresponsibility. The standards on quality of physical working conditions were developed based on the lessons accumulated on past accidents and are still based on the investigations and follow-up measures taken after accidents occurred at site. Thus the purpose of this paper is to explore the key factors affecting to Construction Safety Management and utilize the data to enhance the involvement of management to construction safety. The literature survey identifies the key factors affecting to the Construction Safety Management as a whole. To achieve the degree of significance of each factor affecting to the Construction Safety Management in Sri Lanka, a questionnaire was developed and sent to a random sample of top Sri Lankan construction companies. Relative Importance and the Mean Score were calculated to rank the key factors according to their importance. Through this method, it has been identified that the following factors like Management Commitment, Implementation of Safety Supervision, Management Measures (Safety Meetings and Safety Training etc.), Project Nature, Individual Involvement, and Economic Investment on Safety are mainly affecting to the Construction Safety Management. The final results enable how to enhance the safety performance of the management with greater involvement.

Key words: Construction Safety Management, Factors, Sri Lanka

1. INTRODUCTION

In the Sri Lankan industry, the extent of construction accidents is more severe when compared to other industries, almost as in other countries (Rameezdeen *et al.*, 2003). Bandara *et al.* (2006) have identified that inadequate safety precautions, lack of implementation of rules, limited fund; knowledge and qualified officers are affecting for the unexpected accidents and social problems in the construction industry in Sri Lanka. Further, they state the annual report published in 2002 by ICTAD also has highlighted that the safety practices which are being adopted at construction sites are far below the acceptable standards and on the other hand, low educational levels of many construction workers may be one of a main barriers to imply the safety at sites.

Nevertheless, the key factors influencing the safety management have not been focused yet. Therefore, this gap is supposed to be filled with this study on Factors Affecting Construction Safety Management in Sri Lanka. In this paper, the general overview on the construction safety in the world and the work done by the other researchers on the construction safety are mainly discussed to identify the factors affecting the construction safety management through a comprehensive literature synthesis. A questionnaire was then developed to get the industry opinion on those factors and the survey was conducted assuming the respondents' honesty towards the questionnaire since researcher's

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control over environment would be somewhat limited in conducting a questionnaire survey. According to the responses of the industry experts, the data were analyzed in statistical means.

2. LITERATURE

All human plans, projects and ideas involve both risk and safety. Work in a socio technical system deals with danger and failure as well as with safety. The construction site is a place accustomed to work accidents, and it is the task of managers, workers and trade unions to balance the possible favourable outcomes of given arrangements against their possible adverse consequences (Gherardi *et al.*, 1998). As Gambatese and Hollowell (2009) stated, although construction safety and health management has improved significantly following the Occupational Safety and Health Act of 1970, in the construction industry the risk of a fatality is five times more likely than in a manufacturing based industry, while the risk of a major injury is two and a half time higher.

According to Abudayyeh *et al.* (2006), the rates of fatal and nonfatal injuries and illnesses in the construction industry are relatively high and have not dropped significantly during the past 10 years, despite the adoption of safety procedures and programs such as those developed and required by the Occupational Safety and Health Administration (OSHA).

As mentioned by Ng *et al.* (2005), in a market driven society, it is common for construction stakeholders, especially those at the lower end of the supply chain, to concentrate exclusively on completing projects to the required quality standard with the minimum time and cost. Safety is, therefore, regarded as a secondary concern.

More recent studies by Hinze *et al.* (1998 cited Abudayyeh *et al.*, 2006) explain that construction injuries directly impact on the individuals involved in construction as well as on the work itself. These impacts include personal suffering of the injured worker, construction delays, productivity losses, higher insurance premiums that result from injuries and the possible liability suits for all parties involved in the project. Also the construction injuries indirectly impact by revenue losses on the part of the owner for late project delivery and reduced morale of the work force.

A study by Janadi and Assaf (1998 cited Fang *et al.*, 2004) has established a standardized check list to assess safety on construction sites which assess the both physical and technical safety aspects but not the management aspects. Based on studies of human behavior by Duff (2000 cited Fang *et al.*, 2004), it is mentioned that evaluation of human behavior and of safety management should be combined.

Coming across many studies, Fang *et al.* (2004) conclude that the conventional benchmarking approach in construction safety is to assess safety performance by evaluating the physical safety conditions on site as well as the accident records, while no attention has been paid to the management factors that influence site safety. Also the worldwide practice in this is still same and this method of safety assessment ignores the factors related to safety management (Fang *et al.*, 2004).

By a comprehensive literature synthesis, following factors were identified as important factors that should be thoroughly concerned when managing the construction safety. They are,

- Developing safety policies
- Assigning safety responsibilities to site personnel
- Provision of plant and equipment maintenance
- Conduction of site safety inspection and supervision
- Employment of safety officer and safety supervisor
- Provision of safety working environment
- Safety meetings

- Developing in house safety rules
- Establishing of safety management system with adherence to legislation, codes and standards
- Communication between management and worker at site
- Safety plan and records
- Safety rewards/incentives
- Number of sub contractors
- Safety knowledge
- Safety attitude
- Safety investment
- Workers' compensation insurance
- Safety training
- Size of the project
- Complexity of project

3. RESEARCH METHODOLOGY

This research was commenced by reviewing the relevant literature on construction safety published as Academic Journals. A questionnaire survey was chosen as an appropriate means for soliciting views of various project participants within the relatively short period of time. With an understanding of the literature pertaining to construction safety practices and records, the questionnaire survey was designed. All the factors identified in the literature review were categorized under six main factors and asked to establish the importance of both main and sub factors. For establishing the degree of significance of each factor, a Likert bipolar scale of 1–5 representing “very low ” to “very high” was provided to gather and analyze the level of importance of each factor.

The study was targeted a mix of well experienced professionals with different backgrounds who were randomly selected to minimize the possibility of bias. The participants were assured that their identities and their companies' identities will be kept confidential. The data collected from the questionnaire survey were then analyzed according to the Mean Score (MS) and Relative Importance (RI).

4. RESEARCH FINDINGS

A total of 30 completed questionnaires were returned. Data from these returned questionnaires were recorded and analysed. A summary of the findings are as follows. Table 1 shows mean scores and the relative rankings of the main factors whereas the table 2 shows mean scores and the relative rankings of each sub factor.

As shown in the table 1, management commitment in developing safety policies, assigning safety responsibilities to site personnel, developing in house safety rules, establishing of safety management system with adherence to legislation, codes and standards and communication between management and worker at site etc are the most critical factors in construction safety management. Further, individual involvement like safety attitude and safety knowledge also should be highly concerned in

construction safety management. In contrast, when comparing with other factors, economic investment on safety has been less concerned in managing the construction safety.

When considering the entire sub factors separately, “complexity of the project” has become utmost important while “Safety training”, “Conduction of site safety inspection and supervision” and “Workers’ compensation insurance” have been achieved considerable importance. This implies that the management should consider the complexity of project when they are managing the construction safety and there should be special precautions with the extent of complexity. Also it is very critical that they should conduct safety trainings, safety inspection and supervision as well as should buy workers’ compensation insurance.

Although here safety rewards/incentives and safety investment have been less concerned, it is essential that those factors are also included among which should be considered in managing the site safety. According to the ranking of the main factors, the sub factors can be improved through a management discussion as suitable to the company itself. As well as according to the rates given by the respondents, the most critical sub factors can be also developed as main factors that must be considered in the construction safety management. For an example the “complexity of project” could be developed alone considering technologies to be used and design issues etc. as it is one of most critical factor.

Further, safety attitude, establishing of safety management system with adherence to legislation, codes and standards, assigning safety responsibilities to site personnel and developing in house safety rules are also among the highly concerned safety factors. However, having a less rank is not really meant that those factors should be avoided. Since the MS of all the factors are greater than the neutral score “3 – Medium”, they all should be considered as key important factors. Though, among those key factors, some may have been given less concern by the industry. Therefore, these limitations are better to be minimized in managing the construction safety.

Table 1: Summary of mean scores and relative importance of main factors

Factors	Mean Score	Relative Importance	Rank
1. Management Commitment	4.40	0.182	1
2. Implementation	4.10	0.170	3
3. Management Measures	3.93	0.163	4
4. Project Nature	3.90	0.161	5
5. Individual Involvement	4.13	0.171	2
6. Economic Investment	3.70	0.153	6

Table 2: Summary of mean scores and relative importance of sub factors

Factors	Mean Score	Relative Importance	Rank
1. Management Commitment			
· Developing safety policies	4.17	0.051	10
· Assigning safety responsibilities to site personnel	4.27	0.053	5
· Developing in house safety rules	4.27	0.053	5
· Establishing of safety management system with adherence to legislation, codes and standards	4.30	0.053	5
· Communication between management and worker at site	4.10	0.050	11
2. Implementation			
· Provision of plant and equipment maintenance	3.90	0.048	14
· Conduction of site safety inspection and supervision	4.37	0.054	2
· Employment of safety officer and safety supervisor	4.10	0.050	11
· Provision of safety working environment	4.23	0.052	9
3. Management Measures			
· Safety meetings	3.83	0.047	16
· Safety plan and records	3.87	0.048	14
· Safety rewards/incentives	3.50	0.043	20
· Safety training	4.37	0.054	2
4. Project Nature			
· Size of the project	3.57	0.044	18
· Complexity of project	4.47	0.055	1
· Number of sub contractors	3.73	0.046	17
5. Individual Involvement			
· Safety knowledge	3.97	0.049	13
· Safety attitude	4.30	0.053	5
6. Economic Investment			
· Safety investment	3.57	0.044	18
· Workers' compensation insurance	4.37	0.054	2

5. CONCLUSION

In this paper, rely on a review of literature survey; six main factors could be identified as the factors which may affect the construction safety management in Sri Lanka. These factors were quantified by the respondents through a questionnaire survey and the importance of those factors was identified by ranking them according to mean score and relative importance. It was found that management commitment towards the construction safety is the most important main factor and economic investment on safety has been given less concern. Under each main factor, there are also sub factors which were identified during the literature and categorized later for the questionnaire. By calculating the relative importance of them, they were also ranked separately without considering the effect of their relative main factor. Among the sub factors it can be concluded that complexity of project is highly concerned in contrast to safety rewards and incentives.

Since the work environment in construction is generally more hazardous than other industries, it is very important that a focused dedication and effort towards safety is needed especially from the management. Based on this study, the presence of above mentioned factors in managing the construction safety might significantly contribute to the improvement of company safety records. Finally, it is emphasised that the management has the opportunity to influence and enhance the sense of safety.

6. ACKNOWLEDGMENTS

The authors thank the professionals participated in the questionnaire survey and contributed to this study.

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Review of Methods for Mitigating Payment Risks in Construction: The Case of New Zealand

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ABSTRACT

Traditional payment methods in the construction industry create risk of payment delays and losses. The issue has been persistent since the early 1960's, with constructions parties suffering dire consequences. Many legislative & contractual, and administrative solutions are in use but these measures have not adequately addressed the payment losses experienced by lower tier parties due to the insolvency of upper tiers, especially losses to contractors due to client insolvency. This paper reviews some of the solutions that could be used to protect against client insolvency.

It is revealed that legal provisions in security of payment Acts cater for losses due to deferred payments but not for insolvency payment losses. Acts provide adjudication for non-payment which is not effective in cases of insolvency when a company goes into liquidation because claimants may not be able to recover monies due. Some of the Acts have abolished contingent payment provisions' while some have counter clauses with similar objectives. However as a contractual solution, the conditions of contract in New Zealand (NZS 3910:2003) enables contractors to obtain payment bonds from clients as security. If a client fails to provide the bond, contractors could terminate the contract at inception.

Other security mechanisms such as Buildsafe security scheme and direct payments are in practice; while potential solutions like bonds and guarantees, payment default or insolvency insurance; registration and prequalification of upper tiers; are in consideration. Further study is needed to assess these solutions in terms of their costs and benefits as viable solution(s) to payment losses.

Keywords: Construction Industry; Payment Risks; Insolvency

1. INTRODUCTION

Payment default is a serious problem in the construction industry of many countries. This could be attributed to the nature, consequences and risk associated with the industry. Payment problems were reported in Banwell (1964) and three decades after, Latham (1994) and Egan (1998) contend that it is still an issue worthy of consideration. Payment delays and losses create problems of cash flow, stress, and financial hardship to contractors (Ang, 2006). Further, it leads to a potentially crippling effect of insolvency. Head contractor's insolvency due to owner's payment default affects other parties in the project chain. The lower parties in the supply chain could be faced with the prospect of losing their money (Eugenie, 2006). In China, the owner's payment default is seen as a major obstacle in project execution, it gives a lot of suffering to the contractors and also affects the development of the industry (Meng, 2002). To mitigate this effectively Chinese contract law enables the contractors to establish a legal mortgage, thereby giving contractors strong support to prevent unfaithful owners from delaying payments. In Kuwait, Kartam and Kartam (2001) found that delayed payment is the second highest risk after financial failure that causes project delays. Kartam and Kartam had investigated the level of significance of 26 types of project risk items.

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Thus financial failure is a consequence of payment default because of negative cash flows that could impact on project progress (Akintola and Malcolm, 1997).

Delayed and non-payment risk is primarily due to counterpart's 'cannot', 'would not' pay attitude or both. It is evidenced in large number of construction projects where the owners simply refuse to pay the contractors once the project is completed. For some projects sufficient funding sources are not secured before project start and the contractors often agree to be paid after the work is fully or partly completed (Meng, 2002).

Payment risks may be associated with payment systems and culture within particular construction industries. It is often the case that contractors' payments are settled on an interim basis followed by final payment on completion. It is usual for certain percentage (5-10% of the contract sum), called retention to be withheld until the completion of the project. Thus payment risk results from delayed or non-payment of interim, final or retention sums.

Construction payment-specific Acts and several other contractual and administrative solutions are being implemented in countries like the UK, USA, Australia, Singapore and New Zealand, to mitigate payment risks. However, most of these solutions remedy late payments but fail to provide protection against payment losses to lower tier construction parties where the upper tier experiences insolvency. For example there was a decline in the frequency of late payments since the introduction of the Building and Construction Industry Security of Payment Act 1999 of New South Wales (Brand and Uher, 2008), but the Act is being under utilized by contractors and subcontractors who are the beneficiaries. Similarly in New Zealand, the Construction Contracts Act (CCA) established in 2003 and which replaced the Wages Protection and Contractors Leins Act in 1987, provides little mechanism for losses in insolvency. The New Zealand CCA prohibits conditional payments and provides the statutory right to suspend works due to non-payment. The Act also allows for the speedy resolution of disputes through an adjudication process. Payment losses due to insolvency have become increasingly significant because of the recent economic downturn causing many construction companies to go into liquidation.

Slade (2008) reports that a property developer in New Zealand was declared bankrupt and owed at least NZ\$6 million to creditors, including its design consultants. Another developer is in receivership and liquidation owing NZ\$ 290,000 to the Inland Revenue Department and unsecured creditors about NZ\$ 400,000. In another report (Gibson, 2009a), a company went into voluntary liquidation with 55 claims against it while owing over NZ\$6.5 million. In some of these cases unsecured creditors will most probably not get a cent in compensation.

Having presented the nature of payment risks in construction contracts, the next sections cover a review of the solutions used in New Zealand and other global perspectives in order to see their aptness as a security to payment losses in insolvency situations. This paper is part of a larger study that explores viable solutions to payment risk problems experienced in New Zealand.

2. STRATEGIES USED TO MITIGATE PAYMENT RISKS

This section gives a brief outline of strategies that are in use for mitigating payment risks in the construction industry. Some of the strategies differ from country to country and they range from administrative, contractual to statutory measures. The strategies address the critical risks which causes suffering to construction parties at the lower tier because of the action of the upper tier parties.

Traditionally most of these measures have been used to protect the owners' risks against contractors and subcontractors default. However the recent inclement economic climate has changed situations with the contractors and subcontractors requiring protection from project owners, should the owners' default. Thus, these solutions may require amendment on a case by case basis to incorporate the risks of lower tier parties.

2.1. LEGAL AND CONTRACTUAL PROVISIONS

Brief Review of World Practice

It is of note that most of the developed countries and local jurisdictions have enacted construction payment-specific legislation to facilitate regular and timely payment between construction parties. Some of these legal and contractual provisions are similar, but there are subtleties which are described in the following paragraphs. For example, the UK, and Western Australia (WA) provide statutory payment rights in the absence of contractual rights. While New South Wales (NSW), Victoria (Vict), Queensland (Qld), in Australia and Singapore (Sing) act have payment rights which are applicable along with contractual rights (Bayley, 2007). The latter states have adjudication provisions for disputes that may arise from payment and non-payment issues. Some of the legal documents containing payment provisions in these countries include:

- Housing Grants Construction and Regeneration Act 1996
- Building and Construction Industry Payments Act 2004 (Queensland, Australia)
- Building and Construction Industry Security of Payment Act 2004 (Singapore)

Kansas State in the US enacted legislation called “the Fairness in Private Construction Contract Act in July 2005 to address the problems associated with slow payment, non-payment and out-of state litigation. Unlike in the UK, Australia and Singapore, Kansas legal provisions incorporate contingent payment clause which has no effect on the right of a contractor or subcontractor to file a mechanic’s lien or payment bond claim. The right to file a mechanic’s lien (briefly described below) or payment bond claim can never be waived by a construction contract (Anonymous, 2005).

The mechanic's lien right is one way for a contractor to manage the risk of owner insolvency or failure of payment and used in some Western countries, including the United States, in case of client’s insolvency. The mechanic’s lien gives unpaid contractors a right to place a lien on the property on which the project was built. These rights give the contractor a security interest in the construction project.

The Miller Act is another legal instrument used in the United State to cover subcontractors and suppliers of material who have direct contracts with the prime contractor through a payment bond provision. The payment bond is what differentiates this from the mechanic’s lien. The Act requires contractors who undertake projects exceeding US \$100,000 to furnish a payment bond for the protection of its labour and material suppliers before the contract is awarded to contractor. There is a limit however to the limit of parties covered by the Act. Parties further down the contract chain are considered too remote and cannot assert a claim against a Miller Act payment bond posted by the contractor. The amount of the payment bond shall be equal to the total amount payable by the terms of the contract unless it is prescribed by the client that a payment bond in that amount is impractical, in which case the amount of the payment bond shall be set by the client. The amount of the payment bond shall not be less than the amount of the performance bond.

In Germany, legal provisions require the contractor to assess the enrichment of the client as a result of the building work rendered (Fischer, 2008). This provision contained in its Securitization Act helps to remedy any loss suffered by contractors as a result of clients’ insolvency or late payments.

Probably recognising the seriousness and the extent of payment problems that have hampered the development of the construction sector in China, project owners have to provide contractors a payment security (Heong, 2006). This allows contractors to establish a legal mortgage, thereby giving contractors strong backing to prevent unfaithful owners from delaying payment (Meng, 2002). Such provisions are applicable to projects whose contract value exceeds Rmb 10 million. This form of payment security and the mechanism of its operation need further exploration.

A Review of New Zealand Practice

The Construction Contracts Act (CCA) 2002 is a legal instrument that was enforced in April 2003 following the liquidation of several high profile construction companies. The companies were liquidated because clients' and developers' failed to pay for the works executed by the companies and their subcontractors. The CCA facilitates regular and timely payment between project parties by prohibiting conditional payment provisions (in particular pay-if paid and pay-when-paid clauses) (s 13) and adjudication as a speedy disputes resolution mechanism. The removal of conditional payment provision enables subcontractors, sub-subcontractors and suppliers to get paid by head contractors whether or not the head contractor is paid by the principal. As per Section 13 of the Act, conditional payment provision has no legal effect and may not be used as a basis for withholding progress payments that are due and payable under the contract. Thus the principal's insolvency should have no effect on subcontractors' payment but practically it affects the payment of subcontractors and supplies due to tripling effect.

Traditionally CCA sets out a mechanism for claiming any amounts due under the Act by serving payment claims and payment schedules. These provisions have fundamentally changed the way that cash flows in the industry and creates rights and obligations on parties which were not previously in place. If a party fails to provide a payment schedule within 20 working days (or such other time as may be agreed in the contract conditions) the claiming party is entitled to recover the full amount of its payment claim as a debt due (including its associated costs). The claiming party can proceed straight to court to recover the debt due.

CCA provides a party to a construction contract the right to refer a payment dispute (or non-payment) to adjudication (s25 (1) (a)). Adjudication process takes as little as 6 weeks to conclude and provides a cost effective and timely option for all parties involved in construction disputes and that determination is binding on the parties. The Act also provides a statutory right to suspend works due to non-payment. However, in the case of a residential contract, there is no right of suspension of the works. The party who suspends the work has to seek for adjudication or any other dispute resolution mechanisms to claim payment for work done and any retention money withheld by the client before suspension. There is anecdotal evidence to suggest that some clients refuse to pay the amount and could engage other contractors to execute the works. It would seem that there is no security to protect the loss in these instances.

CCA does not interfere with contractual right for payment but provide statutory rights for payment in the absence of any contractual right. This enables parties to claim payment even if there is no contract between parties. On the other hand, if the standard forms of contract have any strong/viable provision to secure parties at lower tiers against the insolvency of upper tiers, lower tiers are guaranteed for payment even if the CCA fails. Thus it is recommended that standard form of contracts should incorporate better mechanisms for insolvency losses.

New Zealand standard forms of contract

Common form of construction contracts used in New Zealand include the NZS 3910:2003, NZS 3915:2005, NZIA SCC1, Standard Master Builders Contract and other forms. These form of contracts incorporate basic guidelines and procedures for payment and payment schedules to parties to deal with payments smoothly. Contractors have a right to serve the progress and final payment claim for work done within a specified time period. If the principal fails to issue a payment schedule and subsequently fails to pay the scheduled amount by the due date, the contractor is entitled to interest, compounding monthly on the scheduled amount from the date on which it would have been payable if the delay had not occurred.

In case of progress payments the principal retains a certain percentage of the amount payable to the contractor and releases them in three stages thus:

- after the issuance of a certificate of completion
- after the of defects liability period, and
- 10 days after the date of the issuance of the defects liability certificate.

Alternatively, contractors can provide a bond in lieu of retentions, called retention bond, along with other bonds required by the contract and in that case the bond will be released only after the issue of defects liability certificate.

The NZS 3910:2003 provides under special conditions clauses to use a payment bond as a security for principal's payment obligations. This could be used as a best way to deal with principal's insolvency risk. The amount of the bond could be as stated in the special conditions or approved by the contractor. Principal and principal's surety are released from this bond within 5 working days after the receipt of final payment as per the final payment schedule. This could also be after payment as per an Arbitrator's award in case of dispute on final payment schedule. If a principal fails to pay the contractor the amount due under any payment schedule; obstructing the issue of any payment schedule; principal bond is not executed and delivered to the contractor within the required time; and the principal becomes bankrupt or going into liquidation; the contractor can notify the Engineer and if the principal's default is not remedied within the specified time contractor can suspend the work and subsequently terminate the contract.

2.2. OTHER ADMINISTRATIVE MEASURES

Review of Possible Administrative Measures

Maintaining a separate escrow bank account

It is usual in liquidation to give preferential treatment to creditors with the available assets of a private client while unsecured creditors are left with nothing. Maintaining a separate escrow bank account to hold the construction contract monies, especially final payment and retention money because they are at the risk of client's insolvency, is desirable. However in insolvency, progress payments have the tendency to be lost or delayed than the final payment.

This account could be in the joint names of the client and the contractor and could be set up in such a way that funds would be held in escrow and would not form part of the client's assets for liquidation purposes, although interest on progress and final payment could accrue to the client.

It is essential to have two separate accounts for progress/final payment and retention money as the amount and releasing time is different. In the case of progress/final payment the amount could be equivalent to final account value or an amount agreed by the parties while for retention as per the contract. The money lying in the accounts could be released once the purposes are served.

Bond and guarantees

Bond and guarantees could be considered as a useful means for creating financial security against client's payment default or insolvency risk. The following bonds and guarantees could be used:

Payment (insolvency) bond: This is a type of bond where a client provides a payment bond to a contractor to ensure payment in case of insolvency. The value of the bond could be equivalent to either two progress claims, because it is usual for contractors to work for 1-2 months in advance without payment. Payment bond could be provided at the beginning of the contract in order to avoid the contractor's failure to perform the work due to client's failure to submit the bond.

Advance payment bond: Traditionally most of the South Asian countries contractors are given an advance payment, within a fixed period of time following commencement of the contract, of 10 to 20

percent of the contract sum. An advance bond is used as a security for the client to recover any advance payment from the contractor if the contractor fails to perform its obligations under the contract. Advanced payment bonds could be used as a risk mitigating mechanism of contractors due to owner's payment default or insolvency risk. Clients could provide the contractor an advance bond as security for insolvency risk. Advance bond usually contain a recovery clause whereby the amount of bond is reduced from the progress claim but when it comes to insolvency security, the bond can be released once the contractor's final account is settled.

Retention bond: Retention monies are normally viewed as a security for the cost of rectifying defective works. The money is retained as a fixed percent from every progress claim totalling to the amount stipulated in the contract and released in two stages after the practical completion and defects liability period. This way of retaining the money could be replaced by a bond which will ensure the security of retention money in case of client's insolvency. The bond could be submitted at the beginning of defects liability period and released after the completion of the defects liability. The release of performance bond by client could be made conditional upon the submission of a retention bond.

Owner's payment guarantee

Contract guarantee is a risk-transfer mechanism designed to protect creditors from losses due to a debtor's default. In contract guarantee, three party relationship, the surety lends his or her good credit to the debtor and guarantees the debtor's proper performance to the creditor. In case of the debtor's failure, the surety assumes the debtor's obligation to the creditor. Before issuing a guarantee or a bond, the surety will carefully evaluate the debtor's financial status, technical experience, management capability, and performance record for the purpose of prequalification. Owner's payment guarantees are being implemented in China for construction projects financed in whole or in part by loans from the World Bank.

Registration and prequalification of construction parties

The registration and prequalification of construction parties could be used as a mechanism to prevent losses by parties from the upper to lower tiers. The nature and the characteristic of the construction industry is such that it has absolutely no barriers to entry thus companies or individuals with no capital base and very limited experience are able to set up construction business. Even worse, individuals associated with companies that have gone bankrupt and had questionable business practices are able to re-establish themselves a day after they have gone bust. Thus payment risks could be minimised if it is made mandatory requirement by an Act or contractual conditions for construction parties to be qualified on the basis of financial viability before undertaking any project. This is particularly important for project owners and main contractors.

Companies could manage themselves against the risk of owner insolvency or non-payment by working for very rich owners. Though contracting with a very rich owner is not a guarantee of payment because the seemingly rich owner may have financial problems. In this situation, however companies could pre-assess clients for their financial status, and creditworthiness. If it is adjudged that the client is likely to become insolvent, a contractor could request adequate security such a client.

Payment default or insolvency insurance

Similar to other insurance policies contractor can obtain payment default or insolvency insurance coverage for protection against client's insolvency. If the client fails to provide any security, contractors could use this as a last resort for protecting themselves from client payment default insolvency.

A Review of New Zealand's Administrative Measures

The BuildSafe Security of Payment Scheme

BuildSafe security of payment scheme was recently formed in September 2009 as an independent and external private security of payment scheme to protect construction parties from their counterparts. It protects owners from losing money in over-claims by contractors, defective work, and going into liquidation, while it protects contractors from delayed payment, especially final payments by client. It secures subcontractors or specialist trade contractors from non-payment for work they have done or materials supplied. Buildsafe security has been developed specifically for the residential house and light commercial building construction market in New Zealand.

Under the BuildSafe security of payment scheme, BuildSafe security holds an amount of money, security amount, paid by a project owner. The security amount is calculated to be roughly the equivalent of the deposit required by most contractors under typical building contracts. That amount is roughly equivalent to any final payment due to the contractor under the contract. The security amount is held in trust by Buildsafe security until the contractor has performed its obligations under the contract. Buildsafe security releases the security amount to the contractor and subcontractors as the case may be, and the service is completed. Of course, if the contractor fails to perform its obligations, the money will be given back to the project owner.

The owner is protected by not having to pay the contractor a deposit at the start of the project at such time as there is little or no work in place and the contractor is protected by knowing that the security amount is available to meet any payment claim in respect of which the project owner may default.

To safeguard parties, all payments into and out of the trust account are subject to the scrutiny and approval of an independent custodian, perpetual trust. Buildsafe provides fair formal conditions of contract that operate by default and a fair payment regime that operates notwithstanding any other agreement the parties to a contract may have made.

Buildsafe also provides parties with the tools to assist them to contract sensibly and safely in accordance with best practice. This minimises the chance of costly and destructive disputes occurring on a project. Buildsafe is partnered with the Building Disputes Tribunal to back up and support the scheme by providing specialist dispute resolution procedures and to ensure that any disputes that do arise, are resolved fairly, promptly and cost effectively.

Direct Payment Agreement

In New Zealand direct payment is considered as a mechanism which has saved the industry from company failures and ensured that banks have completed assets. Direct payment agreement ensures builders can get their money from a secured source which is usually a bank rather than a developer. It seems the scheme has increasing patronage in New Zealand. "Given the number of developers that have gone under if contractors were operating in the old manner where banks pay the developer and developer pays the builder, it would have potentially pulled building companies under and caused subcontractors a lot of cash flow issues" (Gibson, 2009b).

3. DISCUSSION

In general legislation in most countries have got powerful provisions for statutory right for payments and adjudication of payment disputes. These legislations cover contracts that are written, oral, partly written and oral, and allow either party to contract to refer the disputes. Adjudication periods are usually limited to 20 working days and further extendable with consent. It is anticipated that legislation would eliminate disputes or lessen issues related to payment in construction projects. However, evidence from New Zealand show that the number of court cases increased rapidly since the introduction of the CCA in 2002. This is depicted on Figure 1.

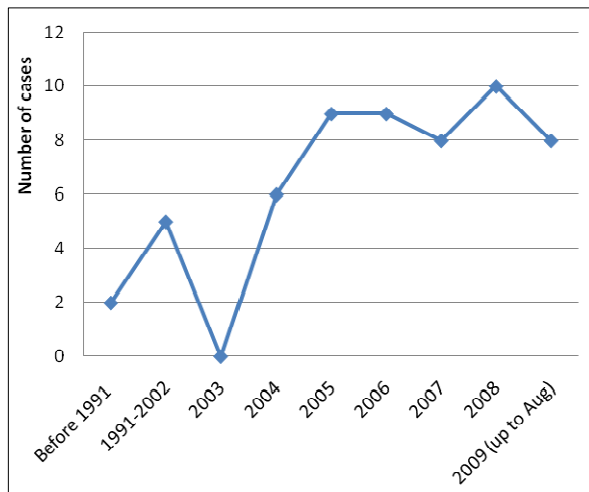


Figure 1: Number of court cases from 1984-2009
(Source: Choi, *et al.*, 2010)

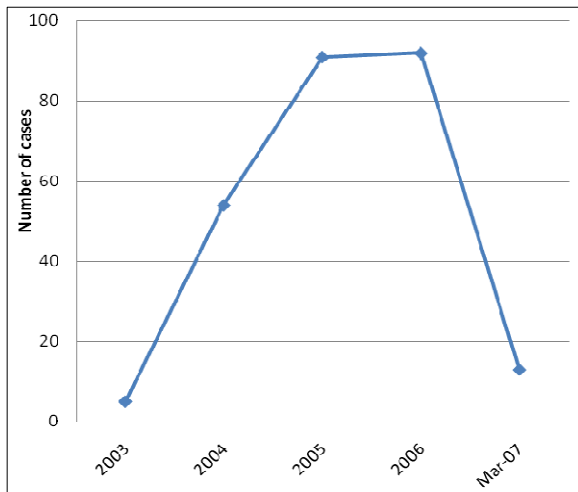


Figure 2: Number of adjudications from 2003-2007
(Source: Bayley, 2007)

On a similar note, the number of adjudications applications to the authorized nominating authority (ANA) increased over the same period reaching a total of 264 in 2007 (see Figure 2). It would seem that the CCA improved the payment culture, but is still under utilized by the main beneficiaries (contractors and subcontractors) of the legislation.

Payment risks depend on the nature of the industry and its' payment culture. Traditionally the industry has less capital backing it, but companies with little capital are able to transact business. This could be improved if it becomes a statutory requirement for clients and contractors to be qualified on the basis of their capacities to undertake certain category of projects. Payment delays and losses may be attributed to contractors as well. Often contractors agree to be paid after the work is fully or partly completed. Contractors choose not to take action against project owners because of future job prospects in exchange of deferred payment or payment of lesser sums. Further, contractor and subcontractors in construction have little or no bargaining power whereas clients capitalize on this to refuse or delay payment after the work has been done.

Third party guarantees in the form of bonds and guarantees on the other hand, could be considered a viable solution because they could allow construction parties to transfer financial risks to third parties. This is the primary reason behind federal and state governments' requirements for contractor performance and payment bonds (Hansen, 2004 and Bausman, 2009). In obtaining either a payment or advance bond it could be repudiated by a client as issuing bonds and guarantees involve bank, surety companies, and insurance companies to prequalify the clients for his payment, performance history as well as financial stability. Alternatively if it is made a regulatory requirement for clients and contractors to be qualified and certified to undertake certain project categories, the issues around the obtaining of bonds and guarantees could be avoided. Conversely, there could be a system where the construction industry could set up a common contract guarantee fund which allows construction parties to get bonds and guarantees at a concessionary rate.

If a project owner fails to provide a security in the form of a bond or a guarantee at his own cost, contractors may have to obtain a principal's payment default or insolvency insurance and try to incorporate the cost into overheads. This cost will be reflected in the contract figure, and ultimately this is taken up by the project owner.

4. CONCLUDING REMARKS

Though many countries have established and are implementing several schemes to secure payment to lower tiers due to insolvency of upper tiers, payment problem is still prevalent in the construction industry. The paper has reviewed some of the legislative, contractual and other administrative schemes for reducing payment risks; and their possible extension to deal with payment losses due to insolvency. Mostly legal provisions in security of payment Acts cater for losses due to deferred payments but not to insolvency payment losses. Some of the Acts have abolished contingent payment provisions, while some have counter clauses with similar objectives. For example the UK has contingent payment provision which is effective only when there is insolvency in the chain; Kansas city (US) clauses have no effect on the right of mechanic's lien. In any case, these provisions protect subcontractors from contractors but not the contractors from their clients.

In New Zealand, the CCA provisions take effect in the absence of contractual provisions. Further the CCA has no mechanism to tackle losses due to insolvency. In this sense, payment bond under special conditions of NZS 3910:2003 could be used as a better mechanism to secure payment losses to contractors. NZS 3910:2003 provides contractor suspension and termination rights in a contract as remedies for client's default of non-payment of scheduled amount; failure to submit payment bond; and becoming bankrupt or going into liquidation. Subsequently contractors could place the company in liquidation and claim their money. It is common for construction industry contractors and subcontractors to fall into unsecured creditor category whereby they receive nothing in the event of liquidation. Contractors' progress and final payments could be secured with payment/principal insolvency or advance bond while their retention can be secured by a retention bond. It is not impartial to retain payments from inception and hold it till the end of the defects liability period.

In the case of administrative solutions, this paper believes that bonds and guarantees; payment default or insolvency insurance; and registration and prequalification of upper tiers before undertaking any works; are viable measures though this may not be applicable to the New Zealand construction scene. Maintenance of separate escrow accounts or Buildsafe security of payment schemes are relatively new mechanisms with obvious merits that could be explored further.

Insolvency of upper tiers is due to factors outside of the contract and the industry itself. As a result insolvency prevention mechanisms would need to be considered when seeking viable solutions to payment problems. Future studies would need to make detailed assessments of these solutions in terms of costs and benefits. An assessment of their practicability and ease of use could generate the most feasible solution(s) to payment problems that are due to insolvency.

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Stakeholder Management in Relocation and Reconstruction of Public School Buildings Affected by Tsunami Disaster

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ABSTRACT

Disaster reconstruction is a challengeable job in the construction industry. As it influence, and be influenced by many stakeholders. Stakeholder management is one of the major important disciplines in construction industry projects. This is further emphasized when projects are large and complex by nature such as Tsunami reconstruction. This research starts with basic definitions of the concepts of stakeholder management. It then explores the process involving stakeholder management in disaster reconstruction projects after Tsunami. Case studies were used as the methodology for the research. The semi structured interviews were used to establish the perceptions and the importance of stakeholder management and their impact on project performance. The examination of previous projects by documentary survey was done to identify the relationship and level of stakeholder involvement. The literature review related the findings with research and theories. The findings of research concluded that a large percentage of the delays, difficulties and cost overruns are attributed to risks related to poor needs identification by stakeholders and the absence of clear strategies for risk and stakeholder management. The Author recommends that proper stakeholder management is an important measure for the success of project delivery. The Author further recommends that proper monitoring and coordinating, risks and uncertainties are the key factors to ensure successful project delivery in disaster reconstruction. This approach necessitates the identification of key stakeholder in the project environment at the outset of the project.

Keywords: *Projects, Stakeholders, Stakeholder Management, Disaster Re-construction Projects*

1. INTRODUCTION

Disaster reconstruction is a major task of post tsunami restoration process. Tsunami reconstruction projects for instance are a challengeable work in Sri Lanka, after the Tsunami disaster in 2004. There were many stakeholders involved in 'Rebuilding the nation - Sri Lanka' after the Tsunami, in the areas of Housing, Health, Infrastructure and School reconstruction projects. Today almost every project takes place in a context where stakeholders play a major role in the accomplishment of the tasks. Often the project is sensitive to actions and decisions taken by the stakeholder. Project stakeholders can include clients, end users, contractors, consultants, labor unions, line organizations, and public authorities, and financial institutions, insurance companies, controlling organizations, media, third parties and competitors (Karlsen, 2002). According to Jegeas *et al.* (2000) and Cleland (1986), cited (Karlsen 2002, p.19) shows efficient management of the relationship between the project and its stakeholder is an important key to project success.

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This research explains the implementation of stakeholder management strategy by a case study method in the order of manner, developing implementation strategies for dealing with them, organizational policy and making plans, procedures and allocation of resources to make a stakeholder management an on-going activity in the project. The research case study is on reconstruction and relocation of fully fledged schools with primary and secondary levels (1AB).

1.1. RESEARCH PROBLEM

Some Tsunami reconstruction projects have failed in stakeholder management and as a result, projects have not been completed within given time frame and set budget. Quality of construction works suffered due to these reasons to a greater extent as described before. Some Tsunami projects have not been completed within the given timeframe and quality of some of them has not been up to the required standard. Some projects also had cost overrun mainly due to extension of time.

1.2. AIM OF THE RESEARCH

The main aim of this research is to identify areas where stakeholder management has failed and to propose methods to overcome such situations for future projects to achieve its objectives effectively and successfully. In view of achieving this aim it is necessary to identify major issues particular to each stakeholder, behavior in performing their role and effects of such behavior for achieving the successful completion of the project.

1.3. OBJECTIVES

In view of the above aim the objectives of the study are derived as, identification of causes of delays, cost over runs and low quality with a focus on stakeholder management, identify the areas in which and why stakeholder management has failed and resulted as ill effects on cost, time and quality and to identify strategies of the stakeholder management in order to overcome above aspects of cost, time and quality in management.

2. STAKEHOLDER MANAGEMENT

Projects are influenced by the environment, and will also attract interest from people and organizations outside the project. Freeman (1984 cited Smith, 2003) suggests that a stakeholder in an organization is any group or individual who can affect, or is affected by, the achievement of the organizations objectives. The stakeholder analysis is conducted to identify influences on projects. There are positive and negative influences and groups of stakeholders can be identified. Stakeholder analysis is important to conduct for social infrastructure projects such as health, education and disaster reconstruction projects. It develops strategies to get the most effective support possible for the project and reduce any obstacles to successful implementation. Therefore, stakeholder management is a key factor for the project success (Smith, 2003).

The following table explains the Stakeholder Management process.

Table 1: Stakeholder Management Process

STEP 1	Identification of stakeholders
	Each project has its unique set of stakeholders, Stakeholders can be categorized as: Primary Stakeholders and Secondary Stakeholders.
STEP 2	Gathering Information
	The following Questions to be answered for gathering information of stakeholders in the projects. <ul style="list-style-type: none"> ▪ What needs to be known? ▪ Where and how can the information be obtained? ▪ Who will have the responsibility for gathering, analysis, interpretation of the information? ▪ To whom the information to be distributed? ▪ Who will use the information? ▪ How can the information are protected from leaking
STEP 3	Identification of the mission of the stakeholders
	Identify the nature of the stakeholders' mission or "STAKE". Mission can be explained supportive or adverse.
STEP 4	Determine Stakeholder's Strength and weakness
	Evaluate the strengths and Weakness of each stakeholder An adversary stakeholder's strength may be, availability of resources, political alliances, public support, quality of strategies, and dedication of members.
STEP 5	Predict Behavior
	How will the stakeholder use resources to affect the Project? Judge how much influence the stakeholder might have on the project and its outcome Stakeholders usually perceived a vested interested in a strategic issue: mission relevancy, economic interest, legal right, political support, health and safety, opportunism, survival.
STEP 6	Implement Stakeholder Management Strategy
	Develop implementation strategies for dealing with them, Organizational policy Make plans, procedures, and allocation of resources to make stakeholder management and on-going activity in the project.

For the successful completion of the project, all stakeholders both internal and external have to perform their role with high sense of dedication and responsibility. To achieve these objectives, every project should formulate a stakeholder management strategy and strategically manage the stakeholder from the project formulation to completion of the project (Karlson, 2002 and Smith 2003).

3. STAKEHOLDER MANAGEMENT IN CONSTRUCTION PROJECT AND TSUNAMI RECONSTRUCTION

3.1. STAKEHOLDER MANAGEMENT IN CONSTRUCTION PROJECTS

Construction projects are unique in their nature. Construction projects inevitably bring degree of deterioration and change at the local level, not least at the construction site. Representative of these interest are referred to as the project's stakeholders. A project stakeholder can be defined as a person who has a vested interest in the success of a project and the environment within which the project operation (Olander, 2006). Project Managers are unlikely to be able to influence these situations unless they identify the potential impact of stakeholder's early stage in the project life (Smith, 2003).

Construction project stakeholders mainly consist of client, contractor, and lead consultant, funding agency, suppliers and end users. Project managers' role is to identify these stakeholders and involvement of stakeholders at each stage of the project from inception to completion

The projects stakeholders are also involved in the final costing of the project. The ability of the stakeholders to influence the final characteristics of the project's product and the final cost of the project is highest at the start, and gets progressively lower as the project continues.

3.2. STAKEHOLDER MANAGEMENT STRATEGIES IN CONSTRUCTION PROJECTS

Stakeholder management is a major component of construction project management. Therefore the Project Manager is responsible for stakeholder management. Successful completion of project deliverables, however is critically dependent upon, relationship management skills, amongst these the need to achieve project objectives that fully address stakeholder expectations through the project lifecycle (Cleland, 1999 cited Bourne and Walker, 2005).

3.3. TSUNAMI RECONSTRUCTION PROJECTS AND STAKEHOLDER MANAGEMENT

Tsunami reconstruction projects undertaken by the Ministry were no exception and the stakeholders exceeded in number of stakeholders that emerge than for a normal construction.

Therefore, the post-disaster reconstruction required an institutional framework that identified the specific agency with overall responsibility for managing this task, and other supporting agencies responsible for the range of specific services to be provided.

Most countries have their own institutional arrangements for disaster management, including reconstruction. The challenges and the number of stakeholders are higher than an ordinary construction project. Each stakeholder has a specific role to play in a timely manner in relation to all the other stakeholders.

The Sri Lankan Government also created a single government agency to focus on reconstruction and development issues across all sectors and stakeholders in affected areas.

Hence, the Reconstruction and Development Agency (RADA) was the primary organization established to handle all Tsunami reconstruction work. Under the purview of RADA three separate task forces were established. These were the Task Force for Rebuilding the Nation (TAFREN), Task Force for Relief (TAFOR) and Transitional Action Project (TAP). The relevant line ministries led all the other recovery sectors such as social sector and infrastructure with limited coordination by RADA.

As a result of re organization TAFEREN identified and empowered the Ministry of Education as Key Stakeholder for the re habilitation of school buildings.

3.4. STAKEHOLDERS IN TSUNAMI RECONSTRUCTION WORKS IN SCHOOL PROJECTS

There are number of stakeholders involved for tsunami reconstruction work. The key stakeholders were the government, community group, civil society, donor agency, private/corporate sector, professional groups and the media. All the key stakeholders were required to be involved and coordinated successfully for reconstruction work. This was also done to help to overcome problems and face challenges in reconstruction process.

3.5. ISSUES AND CHALLENGES OF RECONSTRUCTION AND SCHOOL RECONSTRUCTION METHODOLOGY

Disaster reconstruction is an added challenge to the conventional construction process. It was a tremendous challenge for all key stakeholders such as government, international communities, professional practitioners and the civil societies. Reconstruction of school projects was the one of the major challenging jobs after the tsunami disaster occurred.

Issues

The overall assessment of issues affecting the reconstruction process.

- Very high transactions costs and major coordination problems caused by a large number of donor organization,
- Rapid increases in demand for labour and raw materials leading to construction cost escalation,
- Excessive focus on the quantity of aid disbursement that undermined the effectiveness,
- Lack of adequate local capacity to provide the information necessary for effective coordination and monitoring of aid distribution,
- Lack of clear and transparent information-sharing mechanisms between various governmental and nongovernmental agent

Challenges

Many scholars have identified the challenges of reconstruction as follows. All key stakeholders faced challenges when handling reconstruction work due to constraints such as land acquisition problem, time pressure, unavailability of facilities during project implementation, time taken to adapt to a new environment, time taken for local construction industry, non availability of plan, material and equipment, unavailability of proper of professional groups and shortage of skilled and unskilled workers (Chamruk, 2007).

School Reconstruction Methodology

To overcome the above challenges, the ministry of education (MOE) as a key stakeholder of the tsunami reconstruction process introduced the guidelines for donor agencies regarding rehabilitation, relocation and renovation of the tsunami affected schools.

4. RESEARCH METHODOLOGY

The literature survey was done using related articles about stakeholder management related topics that were relevant to the case study research. There literature including books, journal articles, research papers, unpublished dissertations, Sri Lankan magazines, news paper articles, Ministry of Education guidelines and web based sources and web based journal and other research related documents are reviewed.

Case studies also allow generation of a new theory and these findings of case study can lead to some form of replication of existing theory.

The methods used for data collection are as follows. Every stakeholder was subjected to the fact finding through the following methods of studies.

Step 01: professionals who were involved in the projects were interviewed.

Step 02: The field survey and project experience of the author as progress review meetings, site meetings and site inspections

Step 03: Observations - Secondary Stakeholders such as community, media....etc. and also followed documentary evidence

This research includes two descriptive case studies from the observations made during two real life projects.

The piloting interview questions were done with professionals of the school works branch of the Ministry of Education which helped to develop the interview structure.

The field work involved using interviews semi- structured questions with various categories of organizations, professional staff, technical officer, and other staff. Researcher observed management of each organization involves these selected two projects. As well as interviewing and observation, the fieldwork included analysis of documentary sources in each organization. Documents were allocated from the organizations resource center, individual file records, were made available for the purpose of the research. Therefore the two school projects related institutions taken for this research are the Ministry of Education, TERM office, Contracting Organizations, Lead consulting Organizations, Funding agency.....etc.

As the interview was the primary data gathering instrument for the research a semi-structured interview was chosen where question were carefully designed to provide adequate coverage for the purpose of the research. The interview was done covering all areas of the project. The interview group covered professional groups, such as project managers, architects, engineers ...etc. The interviews were recorded to secure on accurate observation and to avoid losing data since everything could not be written during interviews. The interviews were based on open-ended questions. The result were transcribed, tabulated and codified in order to develop the data analysis. Answers were codified according to the most common responses provided by users, professionals therefore the information was classified into answer categories and expressed.

Documentary evidence is important to case study research. It acts as a method to cross validate information gathered from interview and observation given from people. Additionally, documents provide guidelines in assisting the researcher with his inquiry during interview. Official and unofficial documents and records pertaining to the process of training activities in the organizations were analyzed. Thus, corroboration of multiple qualitative techniques for this case studies research therefore enhances the validity and reliability of findings (Noor, 2008). The documentary analysis was based on the availability of data in organizations.

The methodology used in this study was based on the research questions, the problems to be addressed and also based on the theoretical base. The case study methods used were interviews,

practical experience, and analysis documentary sources which were considered to be useful methods used by many authors in the theoretical based of this study. With the data collected from this research information is provided that for developing stakeholder management for construction of building complexes related to school/ education sector physical infrastructure.

The evidence obtained through initial research questions were cross checked when analyzing the two case studies. A comparative cross check of the conventional construction project and disaster reconstruction project was carried out to observe how it conforms to stakeholder management. The evidence was mainly taken from a detailed analysis of documentary survey of the selected two case studies.

5. CASE STUDY ANALYSIS

5.1. SELECTED PROJECTS FOR CASE STUDIES

CASE STUDY PROJECT 01: Panadura Sri Sumangala Maha Vidyalaya.

This boys' college at Panadura in Kalutara district was completely damaged and had to be rebuilt. The existing school was located in close proximity to the sea. The government of Sri Lanka implemented the 100m-200m building line away from the sea. Therefore, the school had to be relocated to a safe location and to abide by the 100m rule set by the government, adjoining state lands had to be acquired to rebuild the school. The proposed site allocated seven acre land and for the school was located at the Panadura city centre. It was a safe and a prime location for the school. Estimated cost of the project is 275Mn and construction cost would be borne by the Japan International Cooperation Agency (JICA).

CASE STUDY PROJECT 02: Rathgama Devapathiraja Vidyalaya at Rathgama

Devapathiraja Vidyalaya, Rathgama which has been severely affected by the tsunami is proposed to be relocated at Monrovia Estate in Rathgama. Ten acres of land have already been allocated for this location. This school is a secondary school coming under 1AB category having student population of approx 2500 students. Space requirement of this school is 73,000 sq.ft. plus play ground and other infrastructure facilities according to MOE guidelines for physical facilities. Estimated cost of the project is approximately Rs.250Mn. The construction cost would be born by the Japan International Cooperation Agency (JICA).

5.2. CASE STUDY FINDINGS

These were the major findings though case studies conducted.

Case Study 1

- The investigation involved identifying the major issues that resulted in project delays and how these factors impacted the different stakeholders.
- This project had an eight months suspension of work with cost over runs from project inception to completion. It was due to the lack of communication and coordination of the different stakeholders.
- The project issue was caused be the client party, the primary stakeholder. The primary stakeholder did not properly address the secondary stakeholder issues and concerns: previous land owners and school community.
- Improper or absence of risk assessment and management can lead to risk manifesting as a cause of the project delay. In this case the team had not prepared contingency plans to deal with the risks when they occurred. If projects are to be delivered on time, risks need to be identified,

analyzed, monitored and contingency plans prepared to deal with them to minimize overall impact to the project.

Case Study 2

- Analyzing the case study found, the proposed school project took twelve months
- The community, media ,all opposing it,
- It is expected that as a result of this process, there will be considerable difficulty in ensuring that the original cost targets are achieved.
- The inflationary impact of delays will require a rethink of the budgets.
- The high-profile project has met a great deal of community resistance, ensuring that a comprehensive enquiry was undertaken.
- This case demonstrates how projects can be frosted if there is opposition on any major scale by secondary stakeholders.
- The impact of secondary stakeholders can have varying degree of influence. In this case, it was disruptive.
- A key factor in this behavior is that secondary stakeholders often have to live with the outcomes of the project over its whole life cycle, rather than the limited period experienced by project managers or primary stakeholders.

5.3. RESULT ANALYSIS

The above analysis has given new light to body of knowledge to improve the knowledge of project stakeholder management strategies. As such it is possible to state that,

The project stakeholders play a major role in project implementation stage.

Stakeholders create both problems and uncertainty regarding project execution. According to the case follows, these problems and uncertainty are caused by

- Decisions that were not taken in a timely manner
- Unexpected changes in specifications
- The stakeholder did not understand his or her role in the project.
- Political guide lines that caused unexpected changes
- End user did not know his or her needs

Finally result shows that clients, end users, contractors/suppliers, line organization, and public authorities are equal when it comes to causing problems and uncertainty to the project. Clients, who define and finance the project and the end user, decide the usefulness of the project.

5.4. DETAIL DESCRIPTION OF CASE STUDY ANALYSIS

Analyzing the above two cases, it was found there was poor coordination among stakeholders. The client did not coordinate among themselves and also not with secondary stakeholders. According to project management, coordination with each party is very important for successful project implementation. Regular progress meetings are held to identify third party requirements and accommodate them during the planning and in early phases of the project.

Many causes identified relate to communications and stakeholder analysis. (Ali Mohomed, 2002). Proper communication ensures that the right information is passed to the right persons or organizations thereby mitigating their possible impact on project progress. Analysis of case study 01,

found the proper communication strategies among project teams and external stakeholders. After second commencement of construction work, all parties communicated together and successfully completed the project. However case study 02, it was found there were no proper communication channels on project implementation with each stakeholder.

Project is a temporary organization. A project has its own team. The project team development is critical to the management of the project. Team building is an essential part of any project. (Ali Mohamed, 2002). Considering the above two cases, it was found there were cost over runs to the project. However the project teams consisted of experienced and skilled persons. Walker (2000) argues that the capabilities of the construction management team in planning, building, and communication were found to have a strong positive relationship with construction time performance. Therefore case study 01 found, proper project management team for successful implementation of the project. However case study 02 has not properly managed the project team. This was because several times the construction management staff was changed.

The Management of risk is an ongoing process throughout the life of the project and risk will be constantly changing. In both case 01 and 02 risks were encountered in different stages. In the case 1, the uncertainty was in the “commencement of work stage”. But at that time there were no contingency plans established to recover the project. In case study 02 there were risks and uncertainty from project inception to completion. The secondary stakeholders empowered by the media were responsible for the risk. In summary it is found that risk and uncertainty is a major challenge in stakeholder management of a project.

6. CONCLUSIONS

This research was designed to study disaster reconstruction projects, (school reconstruction) for the examination of stakeholder management strategies. The case study method was used to recap views of professionals who had direct involvement in the management of projects, from inception to completion. A focused study was then carried on stakeholder management strategies in two projects.

Issues and stakeholder management in construction project environment are interrelated tasks. The discussions were aimed at highlights of causes of delays and managing stakeholders of the projects. Many causes were identified as having impact on program, such as non realistic work program, inadequate planning variations, poor communication, unforeseen issues, and poor monitoring of projects. Effective engagement of stakeholders can result in better management of their needs and hence more predictability of timely project delivery. Effective and professional project management methodology is recognized as a tool that can eliminate or mitigate the causes and their effects. Hence, the importance and influence of the stakeholder should be identified and classified for a well planned and comprehensive project management strategy.

Monitoring and coordinating is a major role in project stakeholder management. It is important to manage mega scale projects by a professional project organization. Construction project management is a major duty of a constructional professional organization. There is more focus on monitoring and coordination of construction activities. These activities are continued through the life cycle of the projects by different stakeholders those who are involved at each stage of life cycle. Therefore monitoring and coordination of stakeholders is the most challenging duty in project management.

The two case studies show that the absence of comprehensive stakeholder management strategy caused cost overruns and time overruns of the projects.

Accordingly it can be concluded that the stakeholders are important for the existence of the project.

Projects are mostly affected by secondary stakeholders such as community, media...etc. Secondary stakeholders are more powerful than primary stakeholders. However the Primary stakeholders' internal relationship is necessary for successful project implementation.

However, Stakeholders' behavior is unpredictable. So there is a need for proper contingency plans to recover the unforeseen issues. Project managers should evolve and develop proper coordination and communication skills among stakeholders. For any project of this nature, a proper project management team is required from inception to completion.

In further conclusion, the early involvement of key stakeholders and continuous representation in the project planning stage makes a significant improvement in the mitigation of potential difficulties and risks encountered in the project. It is also critical that timely representation of stakeholder take place during the entire lifecycle of the project to facilitate prompt decisions making, approvals and request changes in requirements which will serve to reduce re-work and control delays and cost over runs. It also generates valuable team spirit, collaborative understanding and common objectives, thus contributing to successful project delivery.

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The Effect of Textual Complexity of Contract Clauses on Contractual Disputes

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ABSTRACT

The heart of every construction project is a contract, which plays a dominant role in preventing and resolving disputes by providing comprehensive coverage of all the items of work, duties and responsibilities of the contracting parties, and conflict resolution mechanisms related to all contingencies. By developing an acceptable level of communication among parties through standard and particular contract clauses, a smooth functioning of a construction project without contractual disputes can be achieved. Textual complexity can be described as the difficulty of a text to read and understand it by the users. Readability is text-centred; while understandability measures text-reader interaction and is a broader concept. Readability thus measures the textual difficulty of a passage; while understandability measures the ability of a reader to gain knowledge from a text, and is contingent not only on syntactical difficulty, but also on reader characteristics such as the reader's background, prior knowledge, interest, and general reading ability. The readability together with understandability will offer a better measurement on the level of textual complexity.

The author identifies that the textual complexity of contract clauses in terms of readability and understandability has a relationship with the frequency of referring to them in contractual disputes. When the readability and understandability of contract clauses are low, the frequency of those clauses being referred to in contractual disputes increases. Further, the study revealed that even though the particular conditions are prepared with the intention of making the contract clauses easier, the readability of them become more low and complex at its alteration.

Keywords: Textual Complexity, Contractual disputes, Conditions of Contract, Readability, Understandability

1. INTRODUCTION

Construction disputes may be avoided by using good management techniques regarding people, policy, and communications (Jahren and Dammier, 1990). Towards the success of a construction project, proper communication between the parties becomes essential since they involve in different capacities in the process of delivering the product (Emmitt and Grose, 2003). As Rajapakse (2004, p.36) stated, "high degree of commonality in the interpretation of contract clauses by contracting parties to a construction project is undoubtedly a prerequisite for its successful completion". According to Rameezdeen and Rajapakse (2007), when readability of a contract clause is high, the chance of that clause being interpreted with high degree of commonality by different readers is high.

Readability is defined by Karle as "the ease of understanding or comprehension due to the style of writing" (1963 cited DuBay 2004, p.3) while DuBay (2004) defines readability as what makes some texts easier to read than others. Some researchers (Courtis, 1995; Sydserff and Weetman, 2002) demonstrated the limitations of using only readability as a measure of textual complexity as it is only

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text focused dimension and Sydserff and Weetman (1999) criticized the applicability of readability formulas to technical texts. "Understandability is reader centred and is contingent on the reader's background, prior knowledge, the purpose of reader, interest and general reading ability" (Jones 1996, p.86). Smith and Taffler (1992) also has suggested that understandability is related both to complexity of the context and to education and experience, and constitutes a different measure to readability indices calculated independently of either context or user. Further Clatworthy and Jones (2001) commented as researchers may sometimes misinterpret the results of readability formulas when they report their findings in terms of understandability rather than readability.

According to Smith & Taffler (1992), the usefulness of narrative disclosures will depend partly on the complexity of the display (their readability) and also on the capability of users discerning the appropriate meaning (their understandability). Therefore, when considering construction related technical communication narratives such as Standard Conditions (SC) and Particular Conditions (PC) of contract, it is obvious that both readability and understandability become vital aspects in determining their complexity in practice.

With this background, this research aims to determine the relationship between contractual disputes and textual complexity of contract clauses. The specific objectives are to identify the clauses which are most frequently referred to in contractual disputes, evaluate the readability and understandability of the contract, to analyse how the contractual disputes, readability and understandability are associated with each other and to examine how the readability of contract clauses differs from standard conditions to particular conditions.

2. LITERATURE REVIEW

2.1. CONTRACTUAL DISPUTES

Disputes may arise due to numerous reasons including unfair contract clauses allocating disproportionate risks on parties, ambiguity in contract clauses leading to varied interpretations and applications, discrepancies and inconsistencies among various documents, and conflicting interests of owners and contractors in the contracts (Iyer *et al.*, 2002). Contract documents should play a dominant role in preventing and resolving disputes in construction contracts by providing comprehensive coverage of all the items of work, duties and responsibilities of the contracting parties, and conflict resolution mechanisms related to all contingencies. As Jahren and Dammeir (1990) stated that implementing good management techniques with regard to communication, people and policy as more effective means of avoiding construction disputes than resorting exculpatory clauses in contracts or narrowing the scope of services. According to Semple *et al.* (1994), avoiding construction claims and disputes requires understanding of the contractual terms, early non-adversarial communication and understanding of the causes of claims.

2.2. READABILITY

Stamboltzis and Pumfrey (2000) explains readability as a cognitive constructive process through which individuals make meaning. Razik (1969) illustrated that the level of readability significantly affects the reader's choice of reading material, reading speed, and degree of comprehension. Besides Smith and Richardson (1999) emphasised that the success of readability is the extent to which they understand it, read it at optimum speed, and find it interesting.

The very first readability study was originated in the assessment of children's writing as response to demands by junior high school science teachers (Sydserff and Weetman, 1999). From the earliest efforts to date, readability tests have been designed as mathematical equations which correlate measurable elements of writing - such as the number of personal pronouns in the text, the average number of syllables in words or number of words in sentences in the text (Courtis, 1995). Readability

formulas can be used to predict the level of difficulty of a text (Harrison and Bakker, 1998). They are based upon surface linguistic elements, such as the number of syllables in a word and the number of words in a sentence (Prins and Ulijn, 1998).

Some of the popular readability formulas can identified as follows.

- Flesch Reading Ease Score (FRES)
- Simple Measure of Gobbledygook (SMOG)
- Automated Readability Index (ARI)
- Spache Readability Formula
- Coleman Liau Index
- Gunning fog index
- Fry Readability Graph

The formula used to assess the readability of contract clauses in this research is Flesch Reading Ease Score (FRES). It can be identified as the most widely used and one of the most tested and reliable readability formulas (Rameezdeen and Rajapakse, 2007).

The formula for the Flesch Reading Ease Score (FRES) test is:

$$\mathbf{FRES = 206.835 - \left[\frac{\mathbf{total\ words}}{\mathbf{total\ sentences}} \right] - 84.6 \left[\frac{\mathbf{total\ syllables}}{\mathbf{total\ words}} \right]}$$

Flesch described his Reading Ease scale as shown in Table 1 (1949 cited DuBay, 2004).

Table 1: FRES guide to compare the readability

FRES	Difficulty Level	Estimated Reading Grade
00 - 30	Very Difficult	Post Graduate
30 - 50	Difficult	College
50 - 60	Fairly Difficult	High School
60 - 70	Standard	8 th to 9 th Grade
70 - 80	Fairly Easy	7 th Grade
80 - 90	Easy	5 th to 6 th Grade
90 - 100	Very Easy	4 th to 5 th Grade

In recent studies many reasearchers (Courtis, 1995; Jones, 1997; Clatworthy and Jones, 2001; Sydserff and Weetman, 2002) have found that the readability formulas should be used as predictors of reading ease but as not the only method for determining readability and therefore they do not help to evaluate how well the reader will understand the ideas in the text. Further they argued that the formulas' applicability to technical texts is questionable since they have originated in the assessment of children's writing. Also readability formulas do not examine the match between the conceptual background of the reader and the conceptual load in the text (DuBay, 2004). Even though there are some critics on readability formulas as such formulas do not consider the other rhetorical factors that require attention such as organization, content, coherence, and design and yet some of them offered alternatives to readability formulas, researchers like Johns (1996), Rutherford (2003), and Velez and Ashworth (2007) argued that still the readability formulas offer us valuable results and predictions on readability.

2.3. UNDERSTANDABILITY

Passages that are difficult to read will generally be difficult to understand, but the two concepts are not perfect correlates. In effect, readability and understandability measure two closely associated, but essentially different, attributes. Readability measures the textual difficulty of a passage; while understandability measures the ability of a reader to gain knowledge from a text, and is contingent not only on syntactical difficulty, but also on reader characteristics such as the reader’s background, prior knowledge, interest, and general reading ability (Jones, 1997). The CLOZE procedure, which relies on the direct assessment by readers of textual complexity, has been used as a measure of understandability (Smith and Taffler, 1992). The readability formulas concentrate on syntactical difficulty, whereas the CLOZE procedure focuses on readers’ understandability (Smith and Taffler, 1992).

The CLOZE procedure was developed by Wilson L. Taylor in 1953. Taylor views the CLOZE procedure as “a new psychological tool for measuring the effectiveness of communication” (1953, p. 415 cited Jones 1997, p.107). A CLOZE test uses a text with regularly deleted words (usually every fifth word) and requires the subjects to fill in the blanks. The percentage of words correctly entered is the CLOZE score. When the score is lower, the text is more difficult (Smith and Taffler, 1992). Having at least 30 to 50 blanks in the reading selection increases the reliability of the test (Taylor, 1953 cited Smith and Taffler, 1992). In this study the CLOZE test was used as a measure of understandability in order to determine the textual complexity of construction contract clauses. To find the score, the percentage of all words that are correctly entered is calculated. DuBay (2004) defines the CLOZE results as explained in Table 2.

Table 2: CLOZE scores guide to compare understandability

CLOZE	Understandability Level	Estimated Reading Level
60% - 100%	Easy	Unassisted Reading
35% - 60%	Standard	Instructional, Assisted
0% - 35%	Difficult	Frustration Level

Reader’s prior knowledge is the key variable in comprehension and as an alternative, the CLOZE test provides a means to measure how “average” readers actually understand key sections of written material (Fanguy *et al.*, 2004). Anyhow despite the disagreements and ambiguity surrounding CLOZE tests, language professionals maintain their interest in the test and are apparently unwilling to abandon it as a useful tool in second language teaching and assessment, citing its ease of construction, administration, and scoring as the primary reasons (Gamaroff, 1998 cited McKamey, 2006).

3. RESEARCH METHODOLOGY

This study analyses the contract clauses of FIDIC (1999) standard form of contract. Pilot survey interviews were conducted with eleven professionals in the industry who had more than five year experience to find out the contract clauses which mostly referred to in contractual disputes. Sampling was based on peer selection of professionals from the industry who had routinely involved in contract administration and are familiar with contracts based on FIDIC conditions. The clauses which were identified by more than four interviewees were selected for the study.

Then the FRES readability values were calculated for the selected clauses as readability measures and CLOZE scores were obtained as understandability measures. CLOZE test was conducted in two stages. First stage was carried out among 30 Quantity Surveying undergraduates. Then it was followed by the second stage of the test, which involved 30 practitioners of the industry. All the 60 respondents were selected based on random sampling. Finally, the relationship between frequencies of references related to contractual disputes, FRES readability values and CLOZE understandability scores were determined by using the Pearson’s Correlation Coefficient.

As the second part of the study, contract documents of projects based on FIDIC conditions of contract were collected to examine the readability of their particular conditions of contracts with the intention of observing how the readability scores differ from standard conditions to particular conditions. Twelve contract documents were collected for the study. Six of them were based on FIDIC 1987 and other 6 were based on FIDIC 1999. Then the FRES readability scores of both standard and particular conditions were compared and analysed to see how the readability differed from each other. As an overall analysis the difference between two readability values from standard clause to particular clause, was tested using a “Two Sample Paired t – Test”.

4. DATA ANALYSIS AND RESULTS

As stated in the Research Methodology section, clauses of FIDIC 1999 identified by more than four interviewees were selected for the study. The readability and understandability statistics for the selected clauses are summarized in Table 3.

Table 3: Readability and understandability scores for selected clauses

Sub Clause	Title	Number of responses (out of 11)	Percentage of Responses	FRES	CLOZE Score
8.3	Programme	10	90.91%	24.15	49.21
8.4	Extension of Time for Completion	10	90.91%	35.59	52.92
13.1	Right to Vary	9	81.82%	11.59	57.54
13.3	Variation Procedure	9	81.82%	32.78	59.60
14.3	Application for Interim Payment	9	81.82%	22.86	56.25
20.1	Contractor’s Claims	9	81.82%	34.01	59.38
8.1	Commencement of Works	8	72.73%	37.44	61.54
8.2	Time for Completion	8	72.73%	41.44	51.11
12.3	Evaluation	8	72.73%	38.27	57.25
14.6	Issue of Interim Payment Certificates	8	72.73%	16.82	62.15
8.5	Delays Caused by Authorities	7	63.64%	12.99	52.78
8.10	Payment for Plant and Materials in Event	7	63.64%	6.25	64.10
12.4	Omissions	7	63.64%	33.80	59.62
8.6	Rate of Progress	6	54.55%	47.34	58.08
14.7	Payment	6	54.55%	28.87	54.55
14.8	Delayed Payment	5	45.45%	44.17	63.58
16.2	Termination by Contractor	5	45.45%	36.40	50.40
8.8	Suspension of Work	4	36.36%	63.49	64.44
8.9	Consequences of Suspension	4	36.36%	52.59	56.67
15.5	Employer’s Entitlement to Termination	4	36.36%	43.42	65.15

Figure 1 and 2 shows the results for the readability and understandability levels of the selected clauses, respectively.

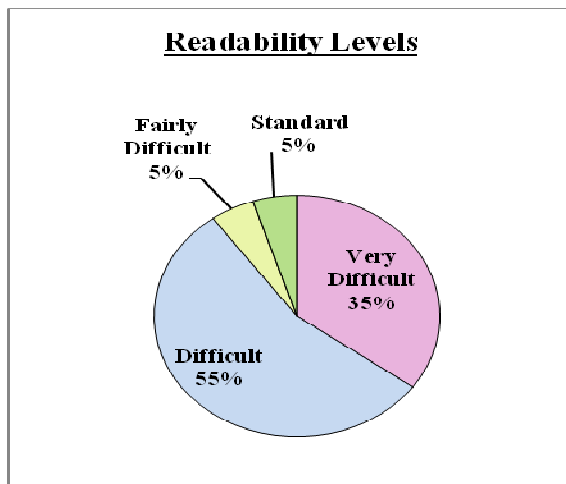


Figure 1: Readability Levels of selected clauses

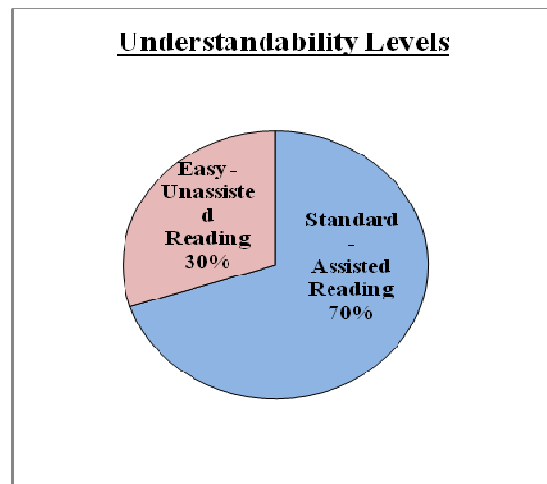


Figure 2: Understandability Levels of selected clauses

The readability levels of the clauses which are most frequently referred to in contractual disputes were within the range of Very difficult to Standard. None of the clauses had fairly easy, easy or very easy readability levels. This is reasonable as the construction clauses are written for a target audience group and therefore it does not need to be more easy and simple. Besides one can argue that it is not good to have a very difficult or difficult reading level and standard or fairly difficult level of readability may suit best with narratives such as conditions of contracts. The understandability levels were within the range of standard, instructional, assisted level to easy, unassisted level. None of the clauses had difficult frustration level. This is sensible as the understandability measures depend upon the person or the user. The undergraduates and industry practitioners were familiar with and had knowledge of the FIDIC conditions and would be expected to have easy or standard understandability levels of the contract clauses.

Pearson's Correlation Coefficient was used as the measure of association to express the extent to which the variables are related. Values vary between +1.00 and -1.00 and both extremes represent perfect relationships between the two variables and 0.00 represents the absence of a relationship. The following formula was used to determine the Pearson's Correlation Coefficient (r).

$$r = \frac{N \sum XY - (\sum X)(\sum Y)}{\sqrt{[N \sum X^2 - (\sum X)^2] [N \sum Y^2 - (\sum Y)^2]}}$$

Where;

- N = The number of subjects
- XY = The sum of each X score times the Y score
- $\sum X$ = The sum of X scores
- $\sum Y$ = The sum of Y scores
- $\sum X^2$ = The sum of squared X scores
- $\sum Y^2$ = The sum of squared Y scores

The correlation values obtained through the analysis are as follows.

- “r” of Percentage of Responses and FRES Values = **- 0.554**
- “r” of Percentage of Responses and CLOZE Scores = **- 0.376**
- “r” of CLOZE Scores and FRES Values = **0.165**

The negative sign of the Correlation Coefficient of first two relationships indicates that the relationships between the two variables are negative. That means high readability and understandability scores tend to have low percentages of responses relating to contractual disputes. The coefficient size is 0.554 can identify as a moderately strong relationship and 0.376 can identify as moderate relationship. The strength of the relationship here is not high or very high and is quite mild and as such, the reasons for problems arising will not be due in any major way to the communication aspect of the clause. However, as there is a moderately strong relationship, the readability aspect has some moderate bearing on the occurrence of contractual disputes and also the understandability aspect too have some bearing on the occurrence of contractual disputes.

The positive sign indicates that the association is directly proportionate. That means high readability scores tend to have high understandability levels. When the readability level becomes low of the contract clauses, they will be harder and difficult to understand. Here, as the coefficient value is 0.165, it can define as a moderately weak relationship. The strength of the relationship here is weak as such; the level of understandability of a construction clause may not strongly influenced by its readability score. There may be more specific and solid reasons which effect the understandability level such as prior experience and knowledge regarding the clauses, but readability also has some bearing upon it up to some extent.

The results of the analysis of the readability score differences of standard conditions and particular conditions are shown below in Figure 3 and 4.

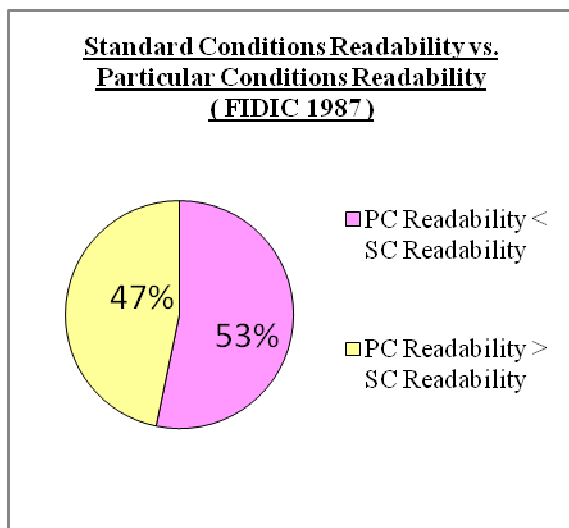


Figure 3: SC vs. PC Readability of FIDIC 1987

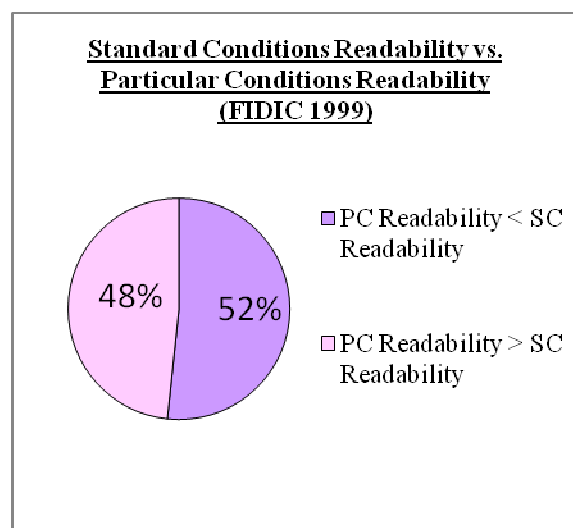


Figure 4: SC vs. PC Readability of FIDIC 1999

The difference between two readability values from standard clauses to particular clauses was statistically tested by a “Two Sample Paired t – Test”. Paired readability observations for SC and PC were concerned to determine the difference between the readability scores produced under each of the two different conditions. All the 167 clauses of FIDIC 1987 and 149 clauses of FIDIC 1999 projects were considered for the test and there were 316 paired observations. It was assumed that the differences of the FRES scores are normally distributed. The results for the test obtained from Minitab software are described below.

The confidence interval for the mean difference between the two readability scores (- 0.004) was greater than the t-value (-1.65), which suggested the PC readability score is higher than the SC readability score. The low p-value ($p = 0.049 < 0.05$) further suggested that the data are inconsistent with $H_0 : \mu_{0D} \geq 0$, that is, the PC readability is equal or high than the SC readability. Specifically, FRES of SC (mean = 24.07) readability level better than FRES of PC (mean = 22.76). Therefore enough evidence is there to reject the null hypothesis of H_0 and it can be interpreted that the

readability of SC has not become lower or simple as they are altered and modified as PC. According to the analysis of the findings, the results revealed that even though the PC are prepared with the intention of making the contract clauses easier, the readability of them has become much lower and complex by its alteration.

5. CONCLUSIONS

Contract plays a dominant role in preventing and resolving disputes by providing comprehensive coverage of all the items of work, duties and responsibilities of the contracting parties, and conflict resolution mechanisms related to all contingencies. Therefore contract clauses need to be read and understood well by all parties to a contract. Though the provisions of the contracts are so documented by contract clauses in conditions of contracts, instances of contractual disputes are not uncommon in the construction industry. It gives rise to a question as to whether the contract clauses are readable and understandable by the parties who agree to abide by those conditions. Hence, the aim of this research was to determine whether there is any bearing or relationship between the contractual disputes and textual complexity of contract clauses in terms of readability and understandability. Further the study was extended to examine how the readability differs from standard conditions to particular conditions.

The analysis revealed that the readability of clauses which are more prone to contractual disputes were at very difficult to standard level and none of them were at fairly easy, easy or very easy readability levels. As far the understandability, dispute related clauses were at standard instructional and easy unassisted levels. None of them were at difficult frustration level. Statistical analysis revealed that there is a relationship between contractual disputes and textual complexity of the contract clauses in terms of readability and understandability. A moderately strong relationship between disputes and readability as well as a moderate relationship between disputes and understandability proved that even though there are other major and concrete reasons, the readability and understandability aspects too may have some bearing on the occurrence of contractual disputes. The negative sign of the aforementioned relationships expressed that; when clauses are more readable and understandable, they are less frequently referred to in contractual disputes and when they are less readable and understandable, they are more frequently referred to in contractual disputes. Therefore, the simplification of the textual complexity of the contract clauses, without distorting their original intended meaning would be helpful to the industry.

Analysis further confirmed that there is a moderately weak relationship between the readability and understandability of contract clauses and the positive relationship between them means that the high readability scores tend to have high understandability levels. In other words, when the readability level of contract clauses become low, they will be more difficult to understand. The strength of the relationship here is weak as such, the level of understandability of a construction clause may not be strongly influenced by its readability score. There may be more specific and solid reasons which effect the understandability level such as prior experience and knowledge regarding the clauses, but readability also has some bearing on it up to some extent.

A key aspect of particular conditions is making the contract provisions more readable, understandable and easy for the users. But results of the study revealed that even though the particular conditions are prepared with the intention of making the contract clauses easier, their readability has become much lower and complex during the alteration. Therefore the modification process of standard conditions to particular conditions should carry out with suitably skilled experience, guidance or training and if not do so, they may put either or both parties of the contract in a much worse position than their standard form. Much more attention is needed by the relevant bodies responsible for drafting and revising the standard form of contracts for the construction industry. Further if contract administrators can prepare the particular conditions as a way that they carry less textual complexity than the standard conditions, the contractual disputes can be minimized or avoided up to a certain extent and the factor of comprehensibility of the contract clauses have to be considered in relation to all other factors, which contribute to disputes.

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The Economic Cost of Flood in Ratnapura: A Case Study from Dewalegawa and Ratnapura Town

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ABSTRACT

The economic loss of a flood creates a considerable burden on economy due to the financial and the physical risk and uncertainty in economic decision making. The main objective of this study is to calculate the economic cost of flood in Ratnapura which is the highest risky area of flood hazard.

The study used primary data collected through a survey covering Dewalegawa village and Ratnapura town highly affected by flood in 2003. 20% of the flood affected families with 115 samples was selected by the study in Ratnapura town. Descriptive statistics and multiple regression models were used for the analysis. The total value of the harm and the Willingness-To-Pay (WTP) to prevent flood related issues were used as dependent variables of the two regression models while different geographical, risk and socio- economic factors were used as explanatory variables.

The study found that 40% of the houses were affected once by flood per year; 27%, twice and 17%, thrice. 44%, faced one day flood; 24%, two days and 25%, 3 days. 93% of the households live with flood while 68% of people do not like to leave the place. The highest damage was recorded for furniture. 20% of the employed were absent from their work for more than 4 days due to the year 2003 flood. 81% of the households is willing to pay to prevent flood related issues. One's monthly household income, being government worker, days absent to work have positive relationship with WTP, while the distance from the river to one's house has a negative relationship. The total replacement cost was positively related with such aspects as family income, number of days flood last, being unsatisfied with the information provision by the risk management centre, being self-employed and being urbane while the distance from the river has a negative relationship. Some possible policy interventions were further suggested by the study as the final contribution to address the policy dialogue in the area.

Key Words: Economic Cost, flood, Ratnapura

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1. INTRODUCTION

Flood is the major natural disaster faced by Sri Lanka relatively to the other types of natural hazards. South Asia is one of the key regions affected by the flood disaster in the world. India, Nepal, Bangladesh and Sri Lanka are the leading countries among them.

In Sri Lanka ten rivers out of 103, are identified as high risky rivers for flooding and *Kelani*, *Gin*, *Kalu* and *Walave* Rivers carry the highest risk of flood due to the flowing of 64% of water from the rain experienced from North-East and South-West monsoons. Kegalle, Ratnapura, Kalutara, Colombo, Gampaha and Galle are highly affected by South-West monsoons while Ampara, Trincomalee, Badulla, Polonnaruwa, Baticaloa, Mathale and Monaragala are affected by North-East monsoons. 1940,1957,1965,1968,1978,1989,1992 and 2003 are the years during which Sri Lanka were affected highly (Wilegoda, 2003).

Ratnapura town, situated in the middle basin of river *Kalu*, is highly affected by flood and the highest harm to the district was reported in 2003 which was about 50.6 billion rupees. Ratnapura town, Godigamuwa, Dewalegawa, Kahangama, Weralupe, Batugedara, Mudduwa, Angamma and Muwagama in Ratnapura Divisional Secretariat were highly affected by flood (Annual Report of Center for Risk Management, 2004). Flood in 2003 recorded the highest damage for both physical and human resources in the district; the numbers of affected families were 34473 and the number of deaths was recorded as 122 due to the flood in 2003. The number of fully damaged houses was 2544 and 8683 houses were partially damaged while 47 schools were damaged (Rajapakshe, 2007).

The value of damage for housing in year 2003 flood was 600.7 million rupees and the damage for school buildings and equipments were recorded as 22 and 7 million rupees respectively. 78.4 million rupees damage was calculated for the industries while it was recorded as 75 million rupees for the agricultural sector. The damage of flood on rural roads (144 million rupees) was higher than the major roads (79 million rupees) in 2003 in Ratnapura district. The electricity network was highly damaged accounting the damage cost as 62.7 million rupees (Rajapakshe, 2007).

Many countries made several attempts to calculate the economic cost of flood using different valuation techniques. Jongejan *et al.*, (2007) made an attempt to find out “method of economic valuation of loss of life” due to Flood in Netherlands. The economic valuation of the loss of life was calculated using behavioral valuation based on micro economic concepts and non behavioral valuation based on productivity of people and opportunity cost of people. However, many economists believe that economic valuation of a life is not ethical and impossible.

Wagemaker *et al.*, have done a research on “Economic valuation of flood damage for decision makers in the Netherlands and the lower Mekong river basin” using cost benefit analysis based on the techniques of damage cost, replacement cost, cost of productivity loss, and conditional valuation method. Replacement cost was calculated through the values of physical harm to the buildings, instruments and infrastructure facilities.

Willingness To Pay (WTP) to avoid from flood related issues was another approach in valuing economic cost of floods. Brouwer *et al.*, (2006) used this approach to measure the flood harm for Bangladesh. This study found that willingness to pay could not only be valued by using monetary factors but also several other socio-demographic factors of the people. 80% of the sample in this study does not like for WTP. Some believe that flood helps to increase soil fertility levels and fishermen think that a project against flood would negatively affect their fishery. Some do not believe about the success of flood avoiding project while some do not like to pay due to lack of income.

According to the above studies the majority of flood related economic valuations has been done using damage cost and replacement cost methods and contingent valuation method based on WTP. Therefore, this study also used these two techniques for the economic valuation of flood in Ratnapura town.

2. RATIONALE OF THE STUDY

Number of flood related studies was carried out in the Ratnapura district on risk management, town planning and geographical backgrounds. However, the number of studies done on economic valuation of flood is very few. Direct economic cost of flood such as damage cost, prevention cost and replacement cost and indirect cost such as time cost of people and opportunity cost of flood were not calculated in many studies especially in the economic aspect. Flood in Ratnapura is a continuous event every year, and therefore, the economic cost of flood is also a continuous event there. The rationale of selecting this topic is the need of valuing economic cost of flood to identify the direct and indirect financial harm of flood.

3. OBJECTIVES OF THE STUDY

3.1. MAIN OBJECTIVE

The main objective of this study is to calculate the economic cost of flood in Ratnapura which is the highest risky area in flood hazard.

3.2. SPECIFIC OBJECTIVES

- To identify the determinants of the replacement cost of the flood damage
- To identify the determinants of the willingness to pay of flood affected people to prevent from flood related issues.

4. METHODOLOGY

4.1. DATA

The Study used primary data collected through a survey covering Devalegawa GN division and Ratnapura town which were highly affected by the flood in 2003. Questionnaire method was used to collect data including demographic, geographical, and economic and flood related factors in the area. Family information, economic status of residents, flood related factors such as the duration of living with flood, number of times inundated within the life time and within the last year, distance from the river, information on last flood, pre identification of risk and the way of dealing with risk, nature of the house, information on damage, replacement cost, flood subsidies, absenteeism to work and Willingness To pay to avoid from flood are mainly included in designing questionnaire.

4.2. SAMPLING

Three stage sampling technique was used for the study. Considering Ratnapura DS division, two GN divisions including Ratnapura town and Dewalegawa were selected at the first stage through cluster sampling. The reason for selecting these two is that they were highly affected by the flood in 2003. In the second stage, stratified random sampling was used by the study representing 20% of households in each GN division proportionately to the population of each area. 41 out of 206 flood affected families from Ratnapura and 74 families out of 371 flood affected families from Dewalegawa were selected. At the third stage houses were selected using systematic random sampling with the gap of five houses. The total sample size is 115 households. 100% response rate is recorded in the study.

4.3. THE MODEL

Descriptive statistics and two multiple regression models were used for the analysis. The total value of replacement cost and the willingness to pay to avoid flood related issues were used as dependent variables of the two regressions.

Multiple regressions Model:

$$Y = \beta_0 + \beta_1 Z_1 + \beta_2 Z_2 + \beta_3 Z_3 + \beta_4 Z_4 + \dots + \beta_n Z_n + \varepsilon$$

The explanatory variables of the first model with the dependent variable of replacement cost of flood damages included three dummy variables including being urban, being self-employed and being unsatisfied with the information provision by risk management center and three continuous variables of household income, the number of days experiencing flood and the distance from the river meters.

The second regression model to find out the determinants of WTP was used four explanatory variables including monthly household income, distance to house from the river, days absent to work and being a government worker.

5. RESULTS AND DISCUSSION

The sample of the study included 35% of urban residents and 65% of rural residents in two *Grama Niladhari* divisions of Ratnapura (35.7%) and Devalegawa (64.3%). The majority of the sample represented the income group of 10001-20000 rupees (Figure 1). 72% of the houses selected by the study are permanent houses and 28%, temporary ones. 22% of houses have upstairs to face bad influences made by the flood.

The characteristics of the houses are important to determine the flood damage of a house. 57% of the walls of the houses were constructed using cement blocks; 38%, bricks and 5%, other materials. The floor of 85% of houses was cement; 13%, tiled and 2%, other sources such as wood. 46% of houses were roofed with asbestos; 29%, Takaran and 25%, roof tiles.

Flood related characteristics should be further considered in determining the economic cost of flood. The distance from the river is such an important factor in determining the nature of flood faced by the households. 61.7% households were located in the distance less than 100 meters from river *Kalu* in the sample while 20.9% houses were located at a distance between 101-200 meters (Figure 2).

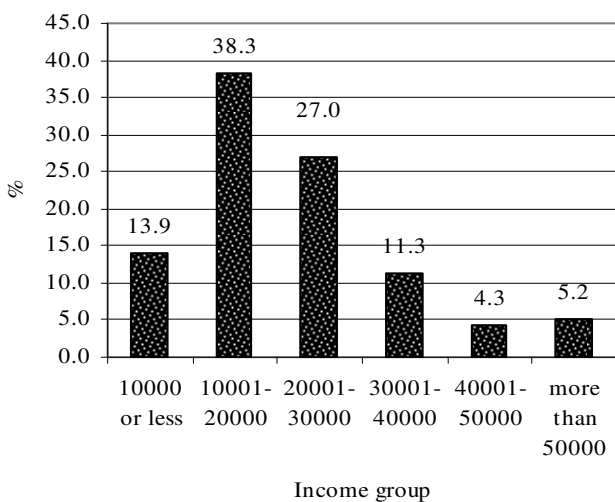


Figure 1: Family income of households

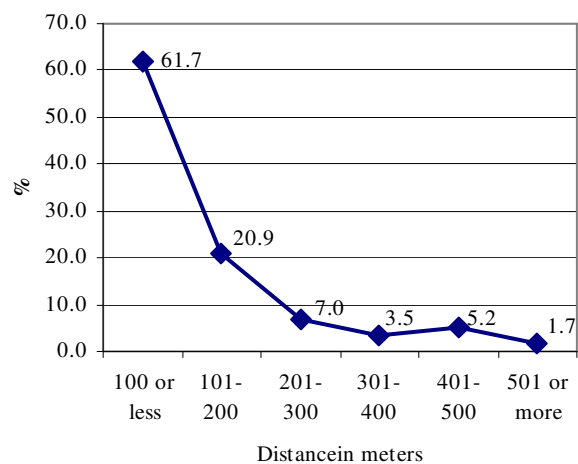


Figure 2: Distance from the river

The number of times was inundated the house per year is another important factor to determine the flood risk and the economic cost of flood. All houses in the study area have been facing for the flood at least once a year. 40% of the houses were inundated once a year while 27%, twice and 17.4%, thrice (Figure 3). It further indicates that 60% of the total samples were facing the flood more than twice a year, bearing huge risk and the economic losses. The number of days the house was having the year 2003 flood varied between one to five days. 44.3% houses had one-day flood; 24% two days, and 25%, 3 days while 6% of houses faced four or five-day flood.

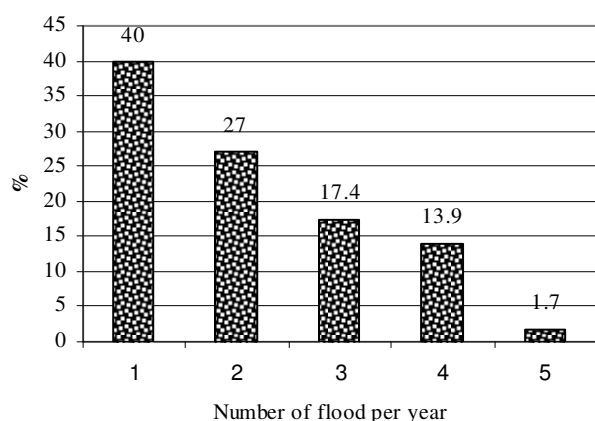


Figure 3: Number of floods per year

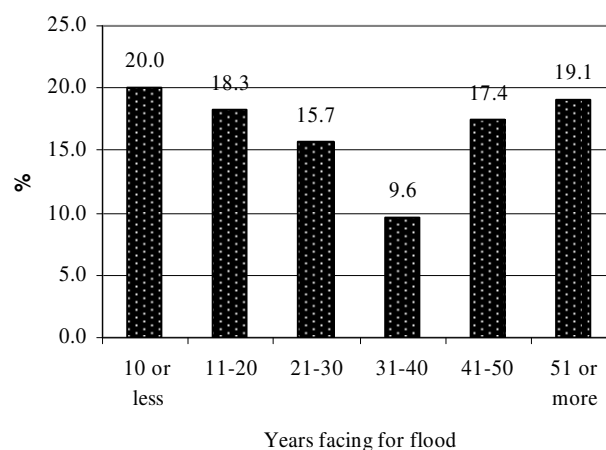


Figure 4: Years living with flood

The majority of the people in the study area have a proper knowledge about the flood and 96% of people could identify clearly the risk of the flood, by observing the climatic conditions, the amount of the rainfall and the content of the flow of river *Kalu*. The pre judgment helped people to avoid the high flood damage. Therefore, people in this area live with flood for a number of years without moving out from the area. 93% of people said that they used to live with flood for years.

According to Figure 4, 19.1% people in the area live with the risk of flood for more than 50 years. However, the majority of the area faces the risk of flood for less than ten years. The houses were built to match the requirement to face sudden flood. Even if people in the study area face a huge threat from the flood, 68% of them do not like to leave their residence due to the flood. Risk management center of the Ratnapura Divisional Secretariat office is conducting flood information programme to make people knowledgeable on flood and 5% of people are very satisfied with the service while 17% satisfied, 39% average and 39% say weak.

The economic cost of the flood is calculated according to the damage created by the flood. The damage is basically related to housing, housing equipments, agriculture and self employments. Table 1 shows the total economic value of the harm in the above four categories.

Table 1: Economic cost of last flood for all households

Sector of harm	Number of household faced to the harm	The economic cost of the harm	As a % of total cost
houses	112	212600	35.7
housing equipments	114	252350	42.3
Agricultural sector	34	46200	7.7
Self employment	35	85000	14.3
Total		596150	100.0

According to the Table 1 the highest proportion of damage is recorded in relation to housing equipments while the second and third costs are recorded for houses and self employments. Agricultural sector harm is relatively low in the year 2003 flood.

Table 2: Damage cost for houses and equipments

Damage in Rupees	Damage for houses	Damage for housing equipments
1000 or less	59.1	58.3
1001-2000	25.2	24.3
2001-3000	7.8	8.7
3001-4000	0.9	1.7
4001 or more	7.0	7.0
Total	100	100

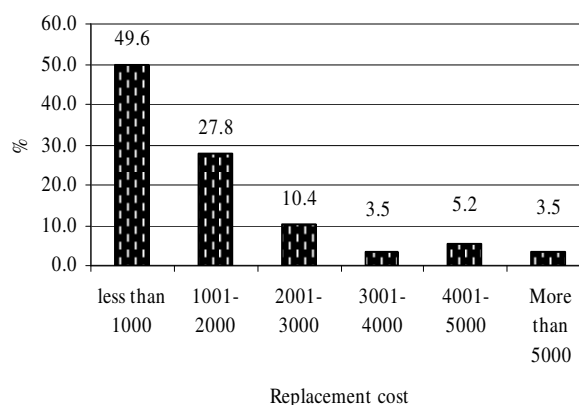


Figure 5: Replacement cost

According to Table 2, 59.1% houses and 58.3% of housing equipment were damaged amounting less than 1000 rupees. Considering the loss of agricultural production 28.7% accounted for the damages up to 1000 rupees while 5.2% recorded the damage more than 1000 rupees. 15.7% of self employments were damaged in the amount less than 1000 rupees while 8.7% of the damaged self employment accounted for more than 1000 rupees harm.

In view of replacement cost 49.6% households spent less than 1000 rupees while 8.7% spent more than 4000 rupees (Figure 5). 61.3 % of flood inundated households were given subsidiaries and it consisted of money (21.8), goods (16.5%) and both (33%).

Table 3: Absenteeism

Days absent to work	%
0	2.6
1	19.1
2	37.4
3	19.1
4	10.4
5	5.2
6	0.9
7	0.9
More than 7	4.3

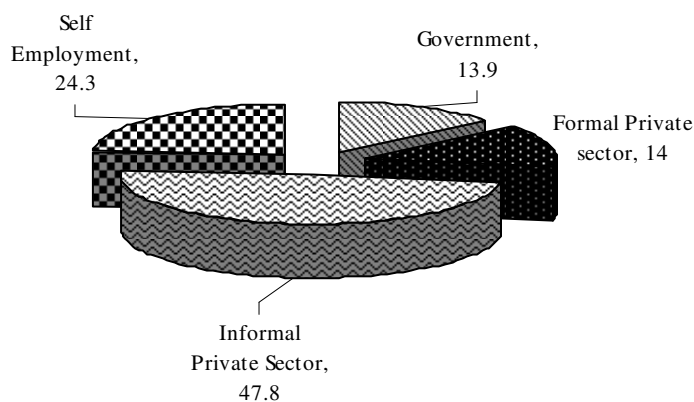


Figure 7: Employment sector of household head

Flood has a huge indirect economic cost as a result of the loss of productivity of workers due to the huge absenteeism to work. The indirect cost of absenteeism is determined according to the sector of employment. Some employees were paid their wages even if they were absent and that caused to reduce the indirect cost of time which is out of work due to the flood. Considering the employment of the household heads 73% were absent to work without having payment creating huge indirect cost of flood to the family. The employment sector of the household head and the number of days absent to work are given as follows (Figure 7 and Table 3).

According to Figure 7, household heads represented informal private sector and self employments were the larger proportion in employment sector and that created a huge indirect time cost to the absenteeism from work. Informal private sector included the employment such as gem mining and wage labour. Majority of household heads were absent in year 2003 flood for two days while 4.3% were absent for more than one week (Table 3). The earning of the household head per day is multiplied with the number of absent days and calculated the indirect cost of time of the household head as follows (Table 4).

The majority of household heads recorded the indirect cost category of 1001-2000 rupees related to the last flood while 10.4% household heads had the indirect cost more than 5000 rupees.

Figure 8 shows another main concern of this study with respect to the Willingness to pay to prevent from flood by the people who are facing always for the risk of flood. The majority would like to pay 100 rupees per month to prevent from flood while 2.6% of the sample is willing to pay more than 1000 rupees per month to prevent from flood related issues.

Table 4: Indirect cost of time of HH

Indirect cost of absenteeism by household head	Percent
1000 or less	29.6
1001-2000	32.2
2001-3000	12.2
3001-4000	12.2
4001-5000	3.5
More than 5000	10.4
Total	100

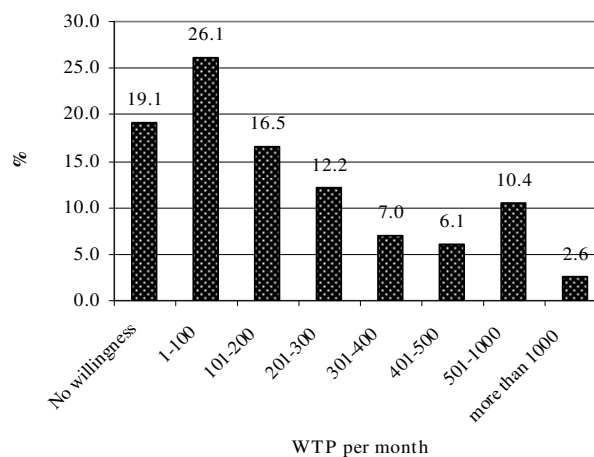


Figure 8: WTP to prevent from flood

5.1. DETERMINANTS OF THE REPLACEMENT COST OF FLOOD DAMAGE

The damage cost of the flood is determined by several important socio economic and geographical factors as follows (Table 5).

Table 5: Multiple regression model for determinants of replacement cost of flood damage

Variable	B	Std. Error	t	Sig.
Constant	78.0401	758.5162	0.1029	0.9182
Family income	0.0728	0.0180	4.0484	0.0001
Number of days having flood	361.6182	157.0292	2.3029	0.0232
being unsatisfied with the information provision by risk management center	1676.0879	659.3565	2.5420	0.0124
Being self Employed	2360.2242	659.6783	3.5778	0.0005
Distance from the river in meters	-2.7226	1.3581	-2.0047	0.0475
Being urban	1590.2970	631.5212	2.5182	0.0133
<hr/>				
R	R Square	Adjusted R Square	Std. Error of the Estimate	
0.7255	0.5263	0.5000	2765.9886	

According to the Table 5, family income and replacement cost have a positive relationship. When the family income increases from 1000 rupees, the replacement cost will increase from 72 rupees. Financial capability of a household is an important factor determining the expenditure for replacing the damage. Number of days having flood was also recorded positive relationship with the replacement cost. If the days increased from one the replacement cost increased from 361.61 rupees.

The households which are unsatisfied with the information provision by the risk management center at Ratnapura have to spend 1676.08 rupees to replace the damages relatively the households which were satisfied with the provision of information.

Being the household head self employed, replacement cost increased from 2360 rupees. The place of employment for self employment is most probably the same place of living. Therefore, when the house was affected by the flood the damage for self employment also increased.

Distance from the river in meters has negative relationship with the replacement cost of flood. When the distances from the river increased from one meter the replacement cost reduced from 2.72 rupees. Far away houses from the river had less damage from the flood and it caused to reduce the replacement cost.

Being an urban household has a positive relationship with the replacement cost allowing for Rs. 1590 increase in replacement cost of them than the other residential sectors. The R² of the model 52% and therefore the explanatory variables are adequate to explain the dependent variable.

5.2. THE DETERMINANTS OF THE WILLINGNESS TO PAY (WTP) TO PREVENT FROM FLOOD RELATED ISSUES

The following multiple regression model was derived to find the determinants of the willingness to pay (WTP) to prevent from flood related issues as given in Table 6.

Table 6: Multiple regression model for determinants of WTP to prevent from flood related issues

Variable	B	Std. Error	t	Sig.
(Constant)	2013.5115	1025.0073	1.9644	0.0520
Distance from the river in meters	-4.6188	1.5080	-3.0628	0.0028
Income of the household	0.1359	0.0423	3.2157	0.0017
Being government worker	2400.6146	1361.0103	1.7638	0.0805
days absent to work	761.0775	186.0851	4.0899	0.0001
	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.6150148	0.3782432	0.355633837	5066.260901

According to the above model, income of the household affected positively for the WTP. When the income increased from 1000 rupees, annual WTP increased from 139 rupees. Being the household head government worker increased the annual WTP from 2400 rupees than the other employment sectors. When the days absent to work in year 2003 flood increases from one, annual WTP increases from 761 rupees. Distance from the river to the house has a statistically significant negative relationship with annual WTP. The explanatory variables only explained 38% from the dependent variable of the above model.

6. CONCLUSIONS AND RECOMMENDATIONS

This study seeks the cost of flood in the economic aspect by using the primary data collected from Ratnapura town and Dewalegawa including 115 households. The economic costs of flood were determined by several socio economic and geographical factors. Family income, housing particulars and employment status of household head indicate economic strength of a household and those factors have an influence on the amount of the expenditure to replace the flood damage. Economically, well off people spent more to replace the economic items which they lose during the period of flood immediately. The nature of houses (permanent /temporary/ with upstairs or not) has an influence in determining the economic loss of the household. Considering the geographical related factors such as distance from the river to the house hold, number of floods occurred per year, number of days of year 2003 flood also determine the economic damage from the flood. The flood damage is high with the households located near the river and the number of times inundated per year directly deals with the risk and uncertainty of the flood and it created a huge uncertainty in the minds of people. But the majority of people do not like to leave the place and they use to live with the flood risk. Nearly 20% of the people in the sample are living with flood more than 50 years.

Economic cost is basically calculated by the study by using damage cost and the replacement cost. Considering the selected households the total damage cost for last flood is recorded as Rs. 596,150.00 rupees. The damage for housing equipments, houses, self employments and agricultural activities are basically concerned by the study and the highest damage was recorded related to the housing

equipments. Considering the replacement costs the majority spent less than 1000 rupees in last flood. The indirect cost of time is another important consideration with respect to the opportunity cost of flood. But indirect cost is calculated only with respect to the house hold head and not for the other employees in the household. That was a limitation of the study. Considering the employment sector of the household heads, the majority represented informal private sector and self employments. It created a huge indirect cost of absenteeism from the work because they were not paid for the absent days. Majority had the indirect cost between 1001-2000 rupees.

81% of the sample has a willingness to pay for prevention the flood related issues. The study further found several determinants of damage and replacement cost of flood as family income, number of days having flood, being unsatisfied with the information provision by risk management center, being self-employed and being urban with positive relationships and the distance from the river with the negative relationship. Willingness to pay for preventing flood related issues were positively related with the household income, days absent for work and being government worker while distance from the river showed a negative relationship.

According to the above conclusions some policy suggestions are possible as follows.

- The willingness to pay of people to prevent the flood will open a good market for flood related insurance in the area. Currently proper insurance scheme was not implemented with respect to this particular flood risk and uncertainty.
- Water reservoir projects related to the upper basin of river *Kalu* and *Ve ganga* were already suggested to prevent flood issue in the area but the financial strength of the project is poor. Government could pay attention on this issue under the current development projects related to the infrastructure for the purpose of preventing flood in Ratnapura and also for generating electricity.
- The damage of the urban sector is high with the flood because of improper drainage system of the town. Building proper water drainage system in the town will help to reduce the harm of the flood to the town with the intervention of the municipal council.
- The role of risk management center should be more active to provide information to the people to reduce their damages. Especially, people far away from the main road should be addressed by the center further.

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Evaluation of Stakeholder Satisfaction in Tsunami Damaged School Reconstruction Projects in Sri Lanka

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ABSTRACT

Sri Lanka is one of the worst affected countries by 2004 Tsunami, which destroyed two third, of the Island's coastline. This necessitated massive reconstruction drive for recovery in all sectors including housing, healthcare, educational and infrastructure. Achieving stakeholder satisfaction is the key for the success of any project and disaster reconstruction projects are of no exception in this regard. The reconstruction of schools has been virtually completed but it is not yet known whether the stakeholders' interests have been properly addressed. This study therefore aimed at evaluating the stakeholder satisfaction in tsunami damaged school reconstruction projects in Sri Lanka.

A literature survey has been carried out on the Tsunami phenomenon, historical facts of disasters in Sri Lanka and damage due to 2004 Tsunami. Data gathered from preliminary interviews and literature survey was used to establish factors of stakeholder satisfaction in questionnaire survey. Data collected using the questionnaire survey was then analyzed using Box Plot analysis.

The research reveals that the stakeholders of all categories are satisfied with most of the factors especially with the physical reconstruction aspects such as standard of school buildings, adequacy of classroom and infrastructure facilities, adequacy of disaster preparedness measures and child-friendly zoning of buildings. But measures such as disaster early warning systems, practice of warning drills and persistent attention on trauma counselling for affected victims were found to be wanting.

Keywords: *Tsunami, Disaster Reconstruction, Stakeholder Satisfaction, Box Plot Analysis*

1. INTRODUCTION

The 2004 Asian Tsunami disaster devastated the shores of many Asian countries including Sri Lanka, killing thousands of people and leaving millions of people affected in various aspects such as shelter, education and livelihood, which necessitated huge outside relief aids for recovery. Naturally, in most disaster situations, the immediate relief phase is successfully managed since it is flooded with eternal aids, but how well an affected nation fares in the long term relief phase which involves major reconstruction work, governs the prospects of early recovery for the stakeholders and the nation as a whole. The 2004 Tsunami disaster attracted donors and sympathizers of unprecedented numbers to Sri Lanka creating a hive of activity both on early relief phase and reconstruction phase. While there is a debate on whether the influx of donor aids was properly arranged, it is an accepted fact that the volume of reconstruction work achieved, especially in the education sector, was beyond the country's expectations. Although most of the reconstruction work has just been completed, the stakeholders' perceptions about these projects have not been established yet.

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This study therefore aimed at finding out whether the stakeholder satisfaction has been achieved in the 2004 Tsunami damaged school reconstruction projects in Sri Lanka. This paper presents brief introduction to disasters, Tsunami 2004 and the extent of damage to Sri Lanka's education sector due to 2004 Tsunami. Section 4 presents stakeholder involvement in 2004 Tsunami reconstruction work and next section presents research methodology employed for this study. Section 6 presents data analysis followed by conclusions and recommendations.

2. DISASTERS

Over the last half century, there has been a significant increase in the number of reported disaster events and the number of people affected by disasters. As per Khanna (2005), disaster is a serious disruption of the functioning of a society, causing widespread human, material, or environmental losses, which exceeds the ability of the affected society to cope with using its own resources. According to International Federation of Red Cross and Red Crescent Societies (2003), disaster defines as an exceptional event, which suddenly kills or injures large numbers of people or causes major economic losses. Further, Centre for Research on the Epidemiology of Disasters (CRED) defines disaster as *"a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance"*. Having considered these definitions, disasters can be broadly defined as; *"A sudden unexpected calamitous natural or man-made event causing serious damages and disruption to normal functioning of a society which overwhelms the local capacity to successfully respond, thereby necessitating external assistance for recovery and mitigation"*.

Natural disasters intimately connect to the processes of human development (UNDP, 2004) and cause devastating losses to communities around the world. The Indian Ocean tsunami (2004), Kashmir earthquake (2005), Hurricane Katrina in New Orleans (2005), Cyclone Nargis at Myanmar (2008), Haiti earthquake (2010) and Icelandic volcano (2010) are few examples for recent devastating natural disasters. Since the beginning of this millennium, natural hazards have resulted in human disasters, which have in some instances reversed years of development work (Schipper and Pelling, 2006). The destruction of infrastructure, the erosion of livelihoods, damage to the integrity of ecosystems and architectural heritage, injury, illness and death are direct outcomes of a disaster. Disaster aggravate other stresses and shocks such as a financial crisis, a political or social conflicts, diseases and environmental degradation. Such disaster losses may set back social investments aiming to ameliorate poverty and hunger, provide access to education, health services, safe housing, drinking water and sanitation or to protect the environment as well as economic investments that provide employment and income (UNDP, 2004).

The Asian psychology is that natural disasters and conflicts are unusual events and people always prefer to focus on better times. This psychology works against them due to the absence of early warning systems as the 2004 Asian Tsunami has shown. The time has come for the world to accept that it should expect the unexpected and its inevitability and prepare for it; constant vigilance not only provides adequate time for evacuation but also help take preventive actions to counter the disaster (Shaw, 2008).

Research on resettlement and rehabilitation issues in Uttaranchal, India (Pande and Pande, 2007) with reference to natural disasters, disaster prevention and management describe that disasters required rehabilitation assistance from Government and the government policy and it helps to tackle the problem immediately and efficiently. Therefore, governments have to play an important role in disaster management.

Natural disasters are not strange phenomena for Sri Lanka with constant flash floods and cyclonic winds having savaged the Island's Southern and Eastern coastal belts in several occasions in the past, but the unexpected nature of the 2004 Tsunami and the extensive scale of the damage caused by it

added a new dimension to disaster studies in Sri Lanka. Table 1 shows the natural disaster damage statistics for the 10 year period from year 1994 to year 2004, including the Tsunami disaster in 2004.

Table 1: Natural Disaster Damage Statistics in Sri Lanka from 1994 – 2004 (Source – Hettiarachchi, 2004)

Year	Number of Deaths	Number of Houses Damaged	Number of Families Affected
1994	18	52,927	357,333
1995	1	11,707	91,921
1996	13	9,343	216,208
1997	19	3,608	466,153
1998	3	7,937	38,002
1999	9	3,803	167,416
2000	15	86,845	257,682
2001	6	11,445	458,008
2002	2	N/A	20,201
2003	254	39,521	140,310
2004	35,322	98,000	250,000

2.1. TSUNAMI 2004

The massive earthquake registering 9.0 on the Richter scale on 26 December 2004, at 0059 GMT, that struck off the West Coast of Northern Sumatra, Indonesia (Daily Mirror, 2004), setting off a series of other earthquakes and aftershocks lasting for several hours resulting in a Tsunami in the Indian Ocean. Tsunami is a Japanese word meaning ‘Harbour Wave’, which is popularly called tidal wave. These waves, which affect distant shores, originate from undersea or coastal seismic activity, landslides and volcanic eruptions, whichever is the cause, sea water is displaced with a violent motion and swollen up, ultimately surging overland with great destructive power (Khanna, 2005).

The 2004 Tsunami, an event unheard before in the nation’s recent history left the entire country in panic on how to face a disaster of that scale (ADB, 2005). The people were caught virtually unaware as it struck relatively thin but spread to long coastal area stretching over two thirds of the Sri Lanka’s coastline. In addition to Sri Lanka, this led to widespread disaster in shores of the countries like, India, the Maldives, Indonesia, Thailand, Malaysia, Bangladesh, Somalia, the Seychelles and Kenya. ADB (2005) statistics further identified Sri Lanka as one of the worst hit countries along with Indonesia in terms of loss of life, infrastructure, and economic assets; and not surprisingly the 2004 Tsunami is widely acknowledged as the largest and the most devastating natural catastrophe in the history of the Island.

According to UNEP (2005), the unprecedented disaster left 35,000 people dead, thousands of people homeless, destroyed over 98,000 houses leaving 250,000 affected families and damaged 168 coastal schools disrupting education of over 350,000 children in Sri Lanka. It also caused immeasurable damage to natural eco-systems and coastal infrastructure. The total number of displaced persons by January 2005 was estimated at 98,525, from whom 56,000 were in government camps (transitional shelter) while the rest were with families/friends (RADDA, 2006). The East and North-East are the regions’ worst affected by Tsunami obviously due to flat ground running miles islands. The percentage of the coastal population affected in Eastern and Northern regions ranges from an estimated 35% in Kilinochchi to 80% in Mullaitivu and 78% in Ampara coastal district divisions compared to the Southern districts of Galle, Matara, and Hambantota with less than 20% of the coastal population affected, albeit with scattered pockets of severe damage.

3. EXTENT OF DAMAGE TO SRI LANKAN EDUCATION SECTOR BY 2004 TSUNAMI

The government official statistics by Ministry of Education, Sri Lanka (2005) show that total of 182 schools had been damaged, and out of which 72 schools that had been situated in close vicinity of sea were fully damaged, where all buildings have crumbled into debris. Some buildings that remained had to be replaced by new buildings, as these buildings were severely damaged or too close to the sea. The worst hit was the coastal schools of Southern and Eastern parts of the country where the Tsunami had its worst toll, and the estimated damage in Education sector was approximately LKR 2.7 billion (Sri Lanka Department of Census, 2005). Table 2 summarizes impact of Tsunami on education system in Sri Lanka.

Table 2: The Tsunami Impact on the Education System (Ministry of Education, 2005)

Impact	Quantity
Affected schools	182
Fully damaged schools	72
Partially damaged schools	110
Total students of all damaged schools	92,692
Schools to be relocated	102
Schools used as IDP camps	444
Students in IDP schools	275,166

As per MoE, the major portion of damage has been to primary and secondary schools, which account for over 90% of the number of institutions. Physical damage to schools, state-run universities and vocational / technical education training institutions includes classroom buildings, equipment, machinery and tools, furniture, books and other library resources, and consumable teaching learning material such as chemicals, and stationary. Apart from the physical damage, the number of students and teachers affected by the Tsunami exceeds 95,000. According to Table 2, 182 schools affected by Tsunami and 444 schools had been damaged due to their use as shelter for Internally Displaced People (IDPs). Table 3 shows the district wise statistics for both damaged and IDP schools.

Table 3: Schools Directly Affected by Tsunami and Schools Used as IDP Camps (Ministry of Education, 2005)

Province	District	Number of Schools Affected	Number of Schools Used as IDP Camps
Southern	Hambantota	05	20
	Matara	12	24
	Galle	27	49
Western	Kalutara	07	16
	Gampaha	02	23
Eastern	Ampara	40	05
	Batticaloa	37	114
	Trincomalee	26	48
Northern	Jaffna	11	20
	Mulaitivu	14	17
	Kilinochchi	01	00
Total		182	444

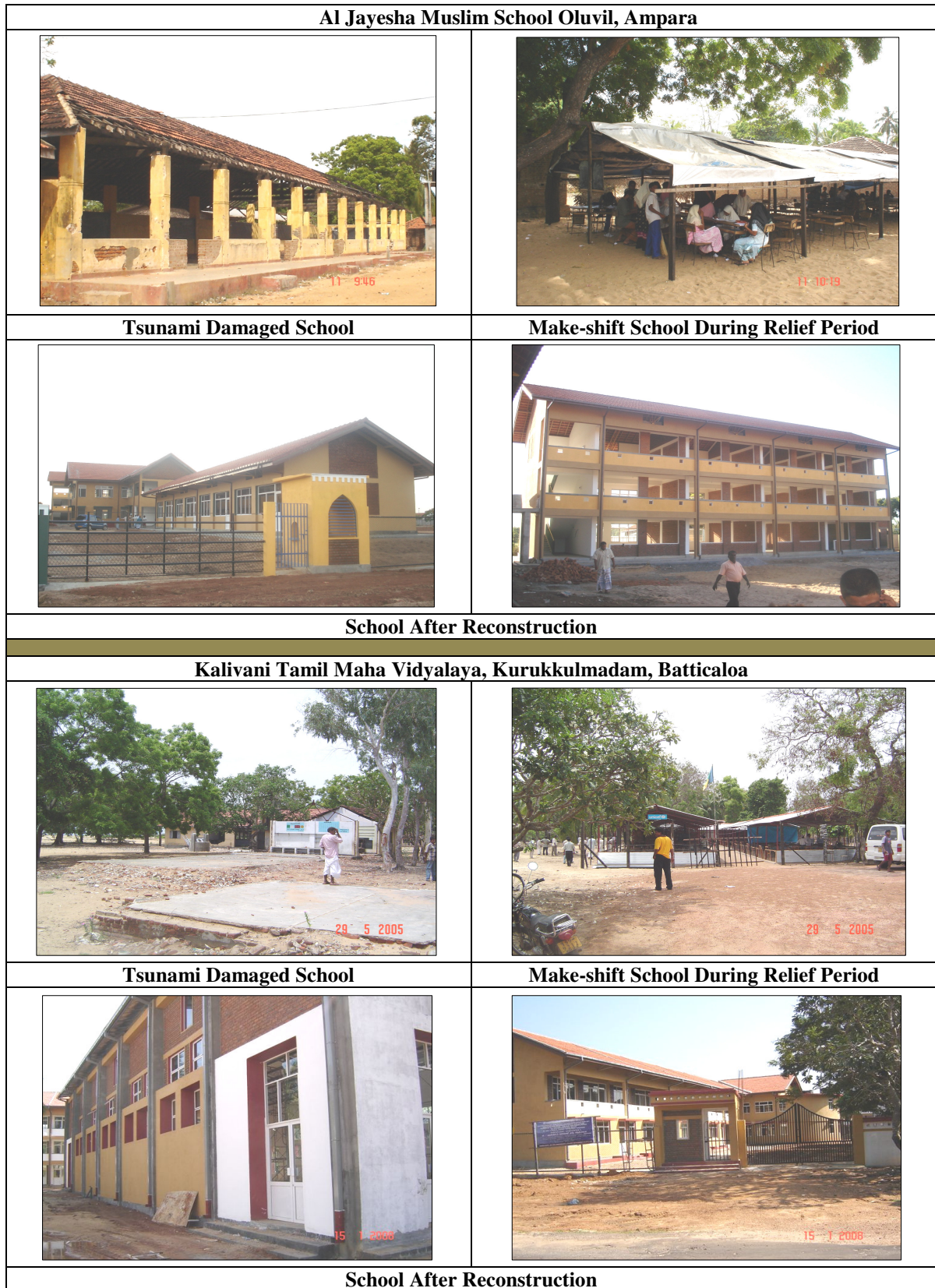


Figure 1: Tsunami Damaged Schools – Before and After Tsunami Reconstruction

Figure 1 presents photographs of two schools located in two worst Tsunami hit areas. It shows damage caused due to Tsunami, make-shift school during relief period and appearance of schools after reconstruction.

4. STAKEHOLDER INVOLVEMENT IN TSUNAMI DAMAGED SCHOOL RECONSTRUCTION PROJECTS

The success of any project is measured in terms of the degree of stakeholder satisfaction achieved. In the last few decades, the word "stakeholder" has become more commonly used to mean a person or an organization that has a legitimate interest in a project or entity (Freeman, 1984). The identification of stakeholders is the most important step in planning reconstruction works since the guidelines for reconstructions should be par with their requirements. The Mendelow's Power/Interest Matrix was a good tool for this purpose. This identification gives the decision making authorities the luxury of incorporating stakeholder perspective into design, which make it more likely to gain acceptance from the stakeholders for design recommendations. It also makes the implementation phase much easier since stakeholders become more familiar with the project's own goals and methods.

In Tsunami damaged reconstruction projects, school children, principals and teachers of the schools, members of the school development society (SDS), Ministry of Education (MoE), TERM and donor organizations were identified as the main stakeholders. The extreme passive nature of the students in responding to reconstruction works during construction stages leaves greater responsibility on the stakeholders of decision making echelons to safeguard students' interests. The reconstructions are become more fruitful and meaningful only if the ideas of school principals and teachers are given proper consideration during reconstruction planning as they have the access to the reconstruction sites. The decision making authorities could obtain important information about the schools and help from the SDS members, who have high interest with high influence during planning and implementation stages of reconstruction work. The Government as the decision making stakeholder of school reconstruction projects, was responsible for reconstructing affected schools through the Ministry of Education (MoE). The donors such as OXFAM Netherlands, Education International, United Nation Office for Project Service (UNOPS), funded the school reconstruction projects were also among the key stakeholders of the project as the party who is focused with high interest and high influence on the final outcome of the project, whilst providing quality educational facilities being their primary objective of funding the project.

5. RESEARCH METHODOLOGY

This study considered ten Tsunami affected and reconstructed schools selected from worst affected coastal districts in Eastern and Southern parts of the Island funded by Education International and United Nations Children's' Fund (UNICEF). In order to establish factors of satisfaction in Tsunami reconstruction works, a literature review and structured interviews were conducted covering a range of stakeholder representatives. School children, school teachers and principals, members of school development societies, officials of the Ministry of Education (MoE), officials of TERM, where the school children, teachers and SDS members were basically the direct beneficiaries of the final outcome, while MoE, TERM and donors who were at the decision making echelons of the project were also subjected to interviews. The survey instrument was designed with 45 factors of stakeholder satisfaction identified through literature review and preliminary interviews, where 12 factors are common to all stakeholders. Other factors are related to individual stakeholder categories. Total of 162 respondents from students, teachers, SDS, MoE and TERM officers and the two donors were participated to the structured interviews. Likert scale was used to assign weightages to stakeholder responses, so that the strengths of their perceptions could be established. The box plot technique was used to analyse the levels of stakeholder satisfaction of schools before Tsunami and after Tsunami reconstruction. This paper presents only the findings of 12 factors that are common to all stakeholders.

6. DATA ANALYSIS AND DISCUSSION

The Box Plot comparisons of 12 factors common to all stakeholders’ satisfaction, before Tsunami and after Tsunami reconstruction are shown in Table 4.

Table 4: Comparison of stakeholder satisfaction before Tsunami and after Tsunami Reconstruction

F	Question (Factor)	Box Plot of Stakeholder Satisfaction Before Tsunami	Box Plot of Stakeholder Satisfaction After Tsunami Reconstruction
		1 2 3 4 5	1 2 3 4 5
F1	Location of the school		
F2	Standard of school buildings and facilities provided		
F3	The adequacy of classroom in the school		
F4	School infrastructure facilities such as play area, toilets, water, electricity		
F5	Zoning of the school buildings (Age wise separation of classroom area)		
F6	Recognition and popularity of the school in the area		
F7	Adequacy of disaster preparedness measures provided in school such as evacuation provisions		
F8	Disaster warning devices and practice of regular warning drills		
F9	Introduction of disaster management subjects into school curriculum		
F10	Availability of counseling facility		
F11	Students’ interest in education		
F12	Sense of safety from disaster		

According to Box Plot Table 4, medians and inter-quartile ranges (IQR) of stakeholder satisfaction factors, F2, F3, F4, F5 and F7 have shifted towards the highly positive region. This shows that the stakeholders are extremely satisfied with the physical progress achieved. This is obviously due to the provision of ample school buildings and infrastructure facilities (F4) provided during reconstruction phase. This shows that the infrastructure planning and quality of physical resources such as taller buildings to accommodate classrooms, laboratory facilities and administrative offices have achieved greater results. The zoning of classrooms (F5) is paramount importance in planning schools layouts to achieve child-friendly schools. This aspect seems to have been well addressed by the MoE. The quality of new buildings provided (F2) and their structural stability to withstand disasters, facilities for future disaster evacuation provisions (F7) and most importantly the adequacy of classrooms to accommodate all the students of school going age in the area (F3), have come for very high regard from the respondents.

Students' interest on education (F11) and the recognition and popularity of the school in the area (F6), of which the medians and IQR were lying in the middle region before Tsunami, are showing phenomenal satisfaction levels after reconstructions. The appearance of new schools and the advanced infrastructure facilities must have contributed to the higher interest levels in the students and naturally resulting in better recognition for the school in the area.

The relocation of schools was a major issue even during the reconstruction phase. The government found it hard to secure alternative lands mainly due to the unavailability of suitable crown lands in close proximity to relocate affected schools. Since the people in the area were reluctant to shift schools too far away from the original location, it was compelled to stick to the original location in most cases transgressing its own rules for buffer zone. Although the majority of the new structures built are tall buildings, the closeness to the sea seems to have had its psychological effect on the stakeholders. But the other most noteworthy observation is the lack of satisfactory improvements in the factors such as disaster management subjects into school curriculum (F9), availability of trauma counselling facilities in the schools (F10), sense of safety from disasters (F12) in the school premises and presence of disaster warning devices and practice of regular warning drills (F8). All these were lying in the negative zone before Tsunami. The installation of disaster warning devices and practice of regular warning drills (F8) is a major pre-requisite for preparing vulnerable communities to face future disasters. As it was revealed during the interviews, regular warning drills are not practicing in any of the schools at present. In some schools it had been practiced only once under the guidance of donors who had funded the reconstruction. It is even worse now since people in vulnerable areas are sensitive enough to realize the importance of regular warning practices due to the effective disaster awareness programmes conducted in the post Tsunami relief period. The introduction of disaster management subjects into school curriculum (F9) only as a small part of one subject in the aftermath of 2004 Tsunami devastation has not been well received by the stakeholders. Further, there is not enough attention towards trauma victims in schools after addressing the initial recovery phase and adequate guidance is not available to victims to seek counselling even when the facilities are available in some schools. Therefore, the availability of trauma counselling (F10) in schools has received extremely low positive value. The respondents have not expressed much satisfaction about the overall safety from the disasters (F12) in the school premises. Though enough high grounds, escape routes, tall buildings and disaster awareness raising programmes are available, the absence of (or, the confidence in) proper early disaster warning systems both in school level and national level has left the stakeholders in serious doubt about their safety in case of a future disaster.

The worst of the balance factors is the vulnerability of the location of the school (F1) of which the median and IQR were lying in the negative zone before Tsunami, has not yielded any considerable change.

7. CONCLUSIONS AND RECOMMENDATIONS

The 2004 Tsunami disaster caused severe damages to Sri Lanka both in terms of loss of human lives and destruction of properties and infrastructure in an unprecedented scale. The initial relief is virtually guaranteed with plenty of both local and foreign assistance. Quantum of reconstruction output achieved in Sri Lanka is excellent and beyond the expectations of any nation especially in the education sector. But whether the quality aspects and actual stakeholder requirements have been properly addressed during the reconstruction process is a common question, for which no analytical answer have been found to date. This study therefore aimed to investigate whether stakeholder satisfaction is achieved in the 2004 Tsunami affected school reconstruction projects.

Ten Tsunami affected schools in Southern and Eastern parts of Sri Lanka and total of 162 respondents, belong to students, teachers, SDS, MoE, TERM and the two donors were subjected to structured interviews during the research. Box Plot technique, which gives a clear idea about the central tendency of the respondents' perceptions together with the strengths of perceptions before and after a certain item was subjected to a treatment, was used for the data analysis.

Generally, the reconstruction process has yielded great levels of satisfaction for all stakeholders. All the stakeholders are fully satisfied with the physical reconstruction output, both infrastructure and buildings provided in the Tsunami School Reconstruction Projects. It has been verified by the stakeholders of lower echelons who are the direct beneficiaries of resources provided, that due considerations have been given to disaster mitigation aspects during reconstruction planning and the overall quality of final reconstruction output is satisfactory. According to analysis, quality of education and students' performance in these schools, have drastically improved with the addition of new physical resources.

The stakeholders are not satisfied with the MoE's decision of not relocating the schools from the present vulnerable locations inside the buffer zone citing unavailability of alternative lands. There is no commitment or responsibility seen in the actions of the authorities in adhering to coastal buffer zone.

The stakeholders are not satisfied with the quality of disaster mitigation measures provided in the school premises. Apart from incorporating disaster mitigation aspects into design of school buildings, all the other important aspects of disaster mitigation and prevention such as introducing Disaster Management subjects into curriculum and Practice of Regular Disaster Warning Drills have not been properly addressed. It is a noteworthy failure on the part of the authorities not to introduce disaster management subjects more vehemently into school curriculum. Although, the National Disaster Management Council is in the process of installing Tsunami warning towers in coastal areas and streamlining the disaster alert chain with the participation of schools, temples and police stations, such measures will not be fruitful without having regular warning practices.

Having considered aforementioned factors, it can be concluded that the stakeholders are satisfied at least to a certain extent with the Tsunami damaged school reconstruction projects.

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Designing and Building Eco-Friendly Houses Using Building Information Modelling and Off-Site Manufacturing

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ABSTRACT

Timber framed houses have been a common type of residential buildings in Australia. The houses are traditionally designed using two-dimensional computer aided design tools and majority of the timber components are cut to size by skilled workers on site. While quality houses can be delivered under this approach, it has limitations on achieving eco-based design and minimising the wastage during construction. These limitations are being overcome with the advent of multi-dimensional Building Information Modelling (BIM). This paper presents a case study on the use of this BIM-based approach with particular focuses on eco-based design and automated off-site manufacturing. It demonstrates how a building model was simulated and analysed to obtain more energy efficient design. The framing plans, drawings, materials, panel manufacturing information and cutting list were generated precisely and automatically. The geometric data was then transferred to machines for fully automated off-site production of individual framing components. In addition to the eco-friendly design, the components can be produced more accurately with minimal material wastage as compared to the traditional method. The same BIM-based approach can be applied in designing and manufacturing both timber and steel framed houses. The latter are termite and fire resistant and can be recycled at the end of the lifecycle.

Keywords: BIM, eco-friendly houses, off-site manufacturing

1. INTRODUCTION

In Australia, aboriginal people built shelters that varied according to the weather in their area and what materials were available on their land (Ciddor, 1999). This principle applied to other tribes in different countries in earlier times, resulting in varying aspects of shelters, such as materials, construction methods, shapes and architectural styles. These simple shelters have evolved to modern residential buildings in line with civilisation and globalisation over time. Now two identical buildings can be built in two continents. Nevertheless, there are still fundamental differences in the aspects of residential housing due to varying conditions in different countries. For example, most residents in Australia live in single story brick veneer timber framed houses instead of high rise reinforced concrete apartments. In recent years, the Australian Government has put more efforts in reducing the carbon emissions generated from residential housing. These efforts include giving rebate for installing roof insulation and free replacement of incandescent light bulbs with compact fluorescent bulbs. However, the design and construction of these houses are still very traditional and labour-intensive. As Bonin (2010) states, “*the goal of sustainable or green home design is to eliminate the negative impact of construction on the natural environment, eliminate the consumption of non-renewable resources, minimize construction and fabrication waste, and promote a healthy living environment*”. This goal has not been given much attention in Australia. The objectives of this paper are (i) to discuss the current state of design and construction in the residential sector in Australia based on literature review, and (ii) to examine the use of Building Information Modelling (BIM) and Off-Site Manufacturing (OSM) in achieving the goal of sustainability based on case studies. The research is still on-going and this paper will report the initial findings.

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2. TYPICAL AUSTRALIAN HOUSES

2.1. COMMON BRICK VENEER TIMBER FRAMED HOUSES

Australia has an estimated resident population of 22,066,000 persons distributing over 8 states and territories covering a total area of 7,617,930 km² (ABS, 2010). The population density in terms of km² per person in Australia ($7,617,930/22,066,000=0.34523$ km² per person) is far less than that in Hong Kong ($1,104/7,055,071=0.00016$ km² per person) and Male ($1.95/103,693=0.00002$ km² per person). Thus, 79% or 5.7 million out of 7.2 million of homes in Australia were separate houses with single or double storey according to the previous survey administered in 1999 (ABS, 1999). In the early days, weatherboard timber framed construction was mainly used when many people built their own homes after the World War II. Over the years, brick veneer timber framed construction became more popular when machine-made bricks were readily available (Ciddor, 1999). According to the Australian Bureau of Statistics, majority (71%) of these 5.7 million houses featured timber frames with brick veneer (ABS, 1999). In essence, the external walls of brick veneer houses have an outer layer of brick and an inner layer of wooden frames with insulation and plasterboard (Ciddor, 1999). The roof and floor slabs also made of timber frames and are covered with terracotta tiles and timber floorboards respectively. The sub-floor is usually suspended above the ground level to allow ventilation and termite attack (Simpson and Hodgson, 2008). Figure 1 shows the brick veneer and the timber frame under construction. A typical example of a completed 2-storey brick veneer house is shown in Figure 2.



Figure 1: A brick veneer timber framed house under construction

Figure 2: A completed brick veneer timber framed house

2.2. DESIGN AND BUILD AND ECO-FRIENDLY CONSIDERATION

The design and construction are provided by a number of home builders who already have a diverse range of house designs. The clients usually select one of these existing designs or tailor a design to suit personal needs (National Builders Group, 2010; Burbank, 2010 and Hotondo Home Designs, 2010). Although the plans and display houses are available for inspection, there is no information regarding any eco-friendly features or energy efficiency rating of the designs.

The construction of these timber framed houses is mainly in-situ on site. This labour-intensive process involves cutting a lot of timber components and fixing them into position. On-site waste of timber is unavoidable and depends on the care taken by the workers, the dimensions of the building and its various components. It can range from 3%-15% for framing members to 10%-30% for boarding and

sheathing (Schuette and Liska, 1994). The site activities also add environmental impact to the proximity.

3. INNOVATIVE TECHNOLOGIES IN ECO-FRIENDLY DESIGN AND BUILD

To achieve more eco-friendly houses, BIM and OSM are advised to be introduced to the current design and build processes. Currently, the uptake of these technologies in the housing market in Australia is very limited. The following sections will give an overview of BIM and OSM and discuss how these technologies can enhance sustainability.

3.1. BUILDING INFORMATION MODELLING

Building Information Modelling (BIM) is an emerging technology which is rapidly revolutionising the construction industry. It has received increasing attention in the construction industry all over the world in recent year. An increasing uptake of BIM in large-scale real projects, such as Freedom Tower in the United State, Eureka Tower in Australia, One Island East in Hong Kong and Pan Peninsula in the United Kingdom have been documented extensively, thus giving BIM world exposure (Tse, 2009). In essence, BIM is defined as "...a data-rich, object-based, intelligent and parametric digital representation of the (building) facility..." (GSA 2006). Unlike traditional 2 dimensional Computer Aided Design (CAD), all the views/schedules in a building project are generated from a single model instead of separate and independent CAD files. As such, the views/schedules are always coordinated, consistent and correlate, whenever an action is taken in a building information model. Different software vendors describe BIM in slightly different ways and in accordance with their views or means of identification of the key procedures, despite the fact that their BIM software has similar characteristics (Tse, 2009). The data-rich object-based characteristics of BIM has opened up applications of the models by different professions throughout a project lifecycle. These applications include, but not limit to 4D simulation, energy efficiency analysis, precast concrete modeling, heating and ventilation simulation, clash detection, security analysis, OSM, material take-off and cost estimation (Tse, 2009).

3.2. OFFSITE MANUFACTURING

The benefits offered by OSM have been well documented in the literature (Arif, 2009). A recent study by the Cooperative Research Centre for Construction Innovation (CRCCI) found that the drivers and the benefits of OSM in Australia include reducing construction time, simplifying construction processes, providing higher quality products, reducing costs when resources are scarce, improving working conditions, reducing on-site risks, alleviate skills shortages, revitalise 'traditional' manufacturing regions, reducing waste on and off site, improving housekeeping on site, facilitate the incorporation of sustainable solutions and achieving better energy performance. Nevertheless, the uptake of OSM in Australia is limited despite of these documented benefits (Blismas, 2007). It has commonly recognised that the better control of OSM production can reduce onsite waste and consequently reduce the amount of landfill. Besides, the design and performance testing of panels can improve energy efficiency of buildings, especially where insulating materials are used and interfaces are carefully designed. However, the main challenge is that the Australian construction industry has limited OSM skills and knowledge. The study by CRCCI indicates that there is limited investment in OSM development in Australia. Nevertheless, the increasing awareness in environmental sustainability in recent years is a key driver to OSM. The wealth of information contained in BIM enables direct interfacing between different project participants (Blismas and Wakefield, 2008).

4. CASE STUDY AND INITIAL FINDINGS

This section will discuss the application a BIM tool for design and OSM for a typical brick veneer steel framed house. It should be noted that steel is not the mainstream material for brick veneer framed houses but the design, eco-analysis and OSM process is similar to the timber ones. The study is still on-going and this section is aimed to provide the initial findings.

4.1. THE SELECTED BIM TOOL AND THE MODEL

Tse *et al* (2006) reviewed a bunch of BIM tools available in the market. However, only a few of them can interface directly with OSM. In this case study, Vertex BD has been selected as the BIM tool as it is specialised in modelling framed houses and OSM (Vertex, 2010). Similar to other BIM tools, the house can be quickly defined using the parametric components and building structures (Figure 3). Detailed representations of walls, floors, roofs, ceilings and other building components were created automatically based on the specifications. Everything can be instantly seen in an easy-to-understand visual 3D model. High quality renderings can also be created without any additional work for marketing presentations and to help in making the design decisions.

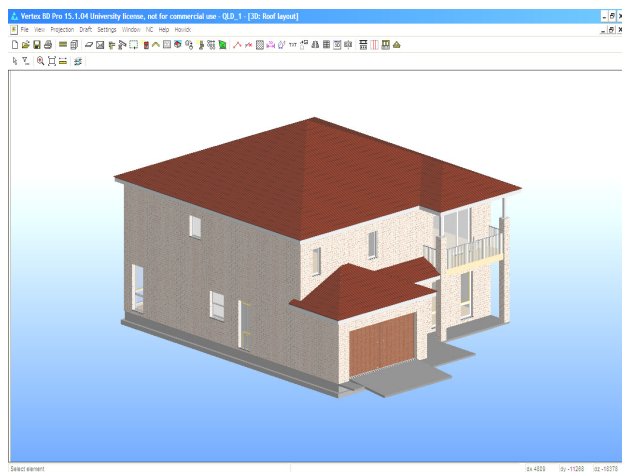


Figure 3: The BIM model of a case study
(source: Vertex, 2010)

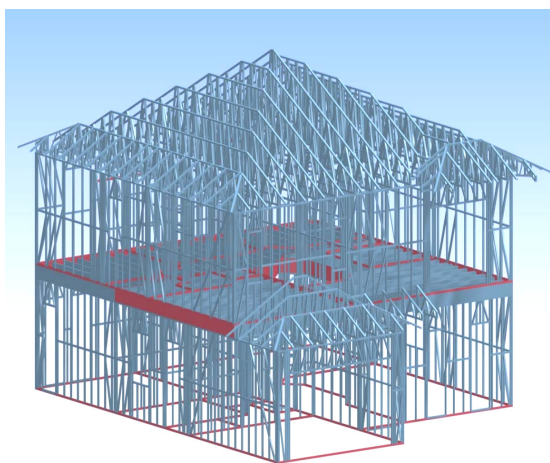


Figure 4: The framing components
(source: Vertex, 2010)

The wall framing components were automatically generated based on the wall layout of the architectural plans and the wall type specific framing rules (Figure 4). This guarantees that the framing components will be compatible with the rest of the plan and every component will fit in place at the construction site reducing delays and speeding up the entire construction process. The floor framing layouts were automatically generated based on the floor deck areas and the associated framing parameters defined by the user. The automatically generated joist layout can be easily customized by inserting, cutting, trimming and deleting pieces. The joists were labelled and the accurate cutting schedules were generated automatically. These features provide the subcontractors with detailed floor joist layout drawings and cutting information, helping them to frame the floor to be compatible with your design – with the minimum waste of materials.

The roof truss and rafter layouts were automatically generated and can be easily modified. Similar to the floor framing, all the components were labelled and schedules. Roof truss profile drawings were generated based on the geometry of the walls, ceilings and roofs. The roof framing components to be compatible with the other parts of the building can be verified and adjusted. VERTEX BD can be applied to both wood and light steel gauge structures. Its user definable, rule-based framing system generates all framing plans, materials, panel manufacturing information and cutting lists for design,

construction and manufacturing. The Vertex Light Gauge Steel Framing System generates all the framing information for walls, floors, and roofs for light Gauge steel buildings. For roofs the system generated detailed rafter schedules and cut lists or dimensioned truss profile drawings that can then be printed or transferred to separate truss design and engineering systems.

Detailed framing drawing, schedules and cut lists are automatically generated with framing rules that can be set by each company. Because the system models each framing element, additional tolerances can be defined by the user and included in material length calculations. The system also allows the user to include additional structural elements such as diagonal bracing, backers, tie-downs, etc., quickly and easily. These elements can be included automatically as part of the system defaults settings or the user can add or modify them interactively as required. This information is represented both graphically on the construction documents and also on the comprehensive material lists. The system automatically tracks framing material quantities, lengths, locations, and uses in the structure. For manufactured building companies the system can automatically panelize walls and floors and generate complete production drawings and documentation.

4.2. ECO-ANALYSIS

Vertex Systems does not have built-in eco-analysis features and therefore the analysis had to be done with a third-party analysis software. The available software packages include IES, ECOTECT, EnergyPlus, VIP and RIUSKA (Brewster, 2009). In this case study ECOTECT was adopted because of the availability of the software. Since ECOTECT can open 3D studio (*.3ds) files, the model was exported as an AutoCAD (*.dwg) file in Vertex. Then the file was opened in AutoCAD and subsequently saved as a 3D Studio (*.3ds) file. This conversion process was needed because Vertex cannot directly export 3D Studio files. This 3ds file was opened in ECOTECT for interactive sun studies, shadow, thermal and acoustic analysis.

4.3. OFFSITE MANUFACTURING

Vertex BD can interface with a number of frame machines including Howick, Hundegger K2 and SC-1, Omnisaw Floor, Optimaster, Randek, Studmeister, Weinmann and Z-laser (Vertex 2010). This paper studied the interface with the Howick frame machine (Figure 5). The dimensioning and cutting information of the wall panels were generated automatically providing accurate and detailed manufacturing information quickly and efficiently (Figure 6). The data files are directly supplied to the frame machines for offsite production. In fact, the machine not only accepts Vertex's data files but also other CAD framing software's data files. All the required fixing holes and location dimples can be placed on the steel frames through computer control (Howick, 2010). The frames can then be delivered to site for fixing without further manipulation (Figure 7).



Figure 5: The Howick Framing Machine (source: Howick, 2010)

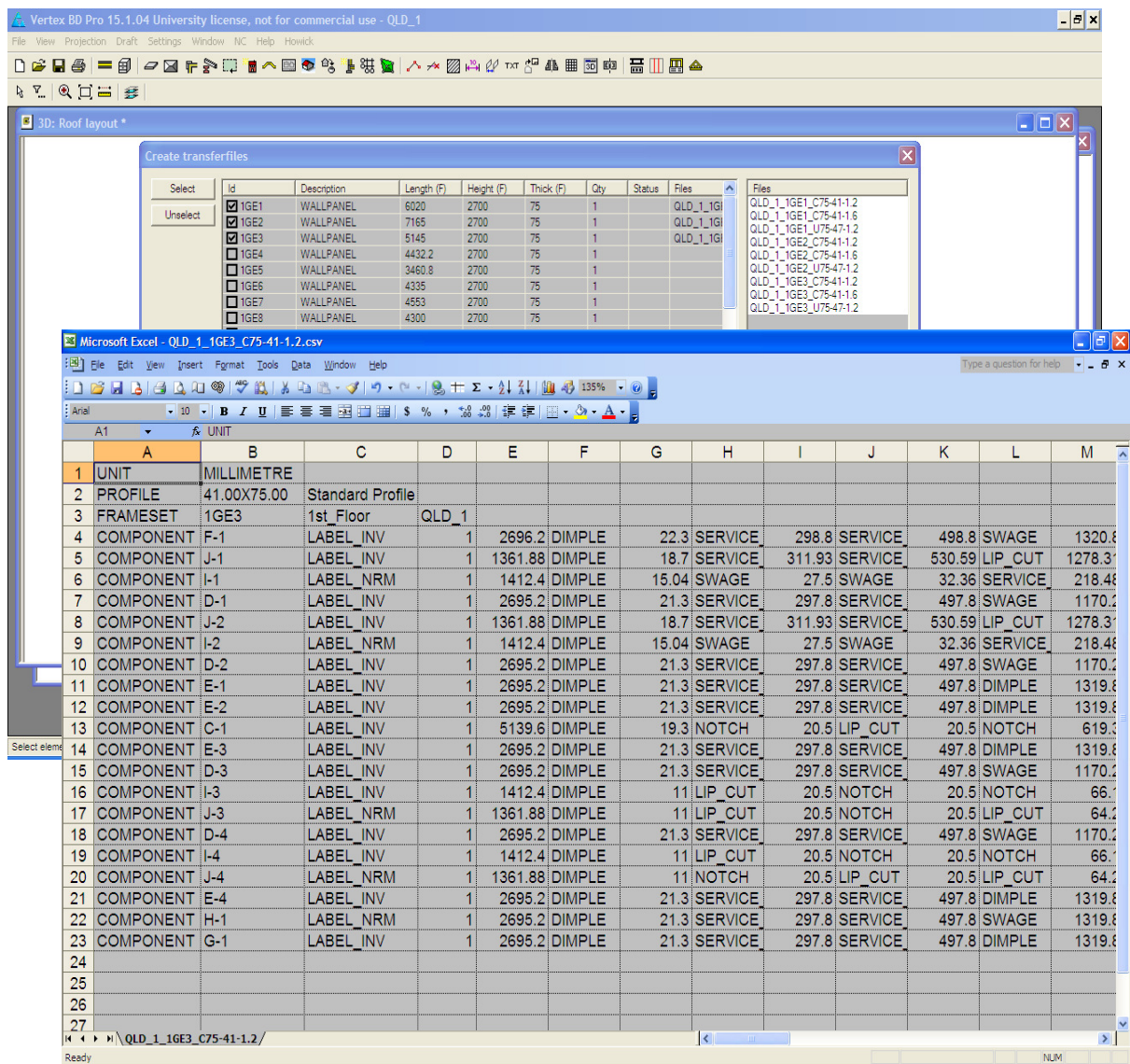


Figure 6: The dimension and cutting information of the wall panels



Figure 7: Fixing the steel frames on site (source: Howick, 2010)

The whole OSM process is environmental friendly. According to Howick (2010), all scrap steel, paper, cardboard, lubricant and waste oil are recycled. The machines are European Conformity (CE) certified and fitted with energy efficient drive motors that comply with all European and International

Standards. All unused components in the machines are switched off to lessen the power consumption and reduce carbon emissions. In addition, the machines can be recycled at the end of their lifecycle.

5. CONCLUSION & FUTURE RESEARCH

This paper reviewed the current status of the design and construction of residential houses in Australia and discussed how BIM and OSM can deliver more sustainable houses. The study is on-going and the initial case study findings of a brick veneer steel framed house was reported. The findings show that BIM models can be used for not only seamless OSM but also advanced eco-analysis such as sun studies, shadow, thermal and acoustic analysis. The initial findings will be consolidated when more case studies are completed in the near future. One special point to note is that the case study reported in this paper used steel as the material for a brick veneer framed house. Steel framed houses are rare in Australia but steel is commonly recognised as termite and fire resistant, more stable and durable. Steel is also one of the primarily natural resources in Australia and steel manufacturers also claim that it is a cost effective alternative to timber. Although the steel frame manufacturing process as reviewed is environmental friendly, the manufacture of steel sheets from raw material does result in carbon emissions. On the other hand, over cutting of trees also has impact on the environment. Further scientific comparison between the use of steel and timber in brick veneer framed houses should be conducted to provide more concrete answer.

6. ACKNOWLEDGEMENTS

The author would like to thanks Vertex CAD/PDM Systems Pty Ltd for providing the necessary information for this study.

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Implementing Value Stream Mapping Tool in the Construction Industry

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ABSTRACT

The purpose of this paper is to understand the applicability and adoption of the value stream mapping technique in the construction industry. The applicability of the adopted value stream mapping methodology was tested in a pre cast concrete yard which supplies pre cast concrete segments to a bridge construction site. A process mapping tool has been used for value stream mapping since it contains high correlation to the existing wastes at the sites. A detailed value stream mapping procedure was developed and validated within this case study. The effectiveness of the value stream mapping methodology was also evaluated at the same site as it was producing approximately five hundred units continuously. The research findings will contribute to a better understanding of the applicability and potential benefits of value stream mapping tool in terms of cycle time reductions and quality improvements.

Keywords: Value stream mapping, lean philosophy & Value adding activity

1. INTRODUCTION

The construction industry plays a major role within any economy and it influences, and it is influenced by, the nation's gross domestic product (GDP) ((Enshassi *et al.* 2007). But the construction industry is commonly characterized as a backward industry, one that fails to innovate in comparison to other sectors. While the other sectors modernized through the introduction of interchangeable parts, then assembly lines, new management concepts and automation with continuous improvements where as construction retained its craft method of operation and fell further and further behind the rest of the manufacturing industry in terms of productivity, quality and hence value for money (Alinaitwe 2005).

Around the world construction processes and practices are under examination and the Construction Industry Institute has found that 57% Waste and only 10% Value Added inputs result in a construction industry compared with 62% Value Added and 26% waste in a Manufacturing industry. The performance of the construction industry in terms of productivity, quality and product functionality has been low in comparison to other industries, and a low rate of innovation has been provided as the major explanation to this situation(Winch 2003) .

Major motivator for this study is to identify wastages exists in the construction industry and consequently application of lean tools and techniques to minimize those losses. This paper presents a case study of application of value stream mapping tool at a Pre Cast Concrete Yard. Major objective of this study was to eliminate prevailing quality issues and reduce the cycle time. Through the study the process information was collected and current value-stream map was created reflecting the current operation status. Waste generating activities for each work centre were identified and different analysis tools (Five why, Cause and effect diagram) were used to reveal the root cause for each issue proposing kaizen events as solutions.

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A future value stream map was then proposed to serve as a guide for future lean activities. In this case study, the Study board approach was used to monitor the progress of each kaizen as well as visual control tools for employees. With the implementation of VSM as a lean tool to the construction site, which differs greatly from a manufacturing organization, researchers identify the correlation between lean theory and its practice in construction.

2. LITERATURE REVIEW

Having identified the chronic problems existing in the construction industry such as low productivity, poor safety, inferior working conditions, poor product delivery to planned budget and quality, lack of innovation and client satisfaction(Koskela 1997, Forbes, Ahmed and Barcala 2004). These problems of in construction have led to various development efforts such as industrialized construction, computer integrated construction and construction automation(Koskela 1997). These research projects mainly focused on new technologies to speed up the process which is an “end” side of the construction process. Analysis done by Koselka (Koskela 1992) shows that those concepts initially have been based on the traditional conceptualization, but the negligence of flow processes seems to have become a barrier for progress. But afterward, most of the research projects carried out to enhance productivity by focusing on “in” side of the construction process. As a result, Koskela(1992)] found that construction processes can be characterised by a high content of non value-adding activities (NVA) which lead to low productivity as shown in table 1.

Table 2- Waste in Construction: Compilation of existing data (Koskela 1992, Weeleng 2004, Abdel-Wahab, Dainty and S.G. 1999)

Waste	Cost (total of project cost)	Country
Quality costs (non-conformance)	12%	US
	30%	UK
	30%	Australian
External quality cost (during facility use)	4%	Sweden
Lack of constructability		
	6-10%	US
Poor materials management	10-12%	US
Excess consumption of materials on site	10% on average	Sweden
NVA activities on site	Approx. 2/3 of total time	US
Lack of safety	6%	US
	3-6%	UK
Potential labour efficiency	40%	UK

Basically, according to Koksela’s study, he has identified the evidences of waste and value loss due to quality of works, material management, non-productive time, safety and constructability. As a result, Alarcon(Alarcón 1997) developed some tools to identify and reduce methods which are deduced from other industry applications. In addition, Alfredo(Serpell and Alarcón 1998) developed a general methodology for waste reduction to improve the construction process(Serpell and Alarcón 1998).

In addition to the existence of high non value adding activities, resource flow variability also hinders productivity (Serpell and Alarcón 1998, Weeleng 2004, Forbes et al. 2004). A study of Ballard (Ballard and Howell 1997) showed that the causes of process variability are complexity, complicated supply chains, environmental conditions, market pressure, extensive process and design changes. Bertelsen (Bertelsen 2004) presented a study in this regard and it described the two states of a system: ordered and chaotic. An ordered system reduces its variability and has controlled disorders with diligent use of buffers, well defined process and procedures and elimination of sources of errors. Construction projects are highly labour intensive with basic hand tools and equipment, as labour costs comprise 30 to 50 % of overall projects costs (Guhathakurta and Yates 1993). Organisations have found that, by identifying and removing waste, as well as implementing key lean tools, they can continuously improve their productivity, increase quality, and become more cost effective (Imai 1997). However numerous construction labour productivity research studies have been undertaken, but only a few have addressed the productivity issue with respect to lean principles. The primary goal of lean principle is to avoid waste of time, money, equipment etc and focused on productivity improvement and cost reduction by stimulating all employees (Shingo 1992). Therefore primary objective of this paper is to study the implementation of lean tools in the construction industry in order to improve productivity.

Lean is a management philosophy and its aim is to identify and remove every activity in design, production and supply chain management-related processes that does not add value from the customer's point of view (Womack, Jones and Roos 1990, Womack and Jones 1996, Marchwinski and Shook 2003). Lean approach focuses on the elimination of all kind of wastes. Waste takes many forms and can be found at any time and in any place. It may be found hidden in policies, procedures, processes and product designs, and in operations. Waste consumes resources but does not add any value to the product (Singh and Sharma 2009). In order to identify existing waste generating processes in the system different tools can be adopted where VSM tool is one.

The ultimate goal of VSM is to identify all types of waste in the value stream and to take steps to try and eliminate these (Rother and Shook 1999). Waste is anything that creates no value for the parties involved in the process namely owner, customer, and consumer. Therefore waste is defined in terms of value and there is no absolute definition of waste, it is all relative. Therefore the definition of value stream map should be extended as a tool which uses to identify the waste and waste causes exist in current process and find appropriate process design for removal of wastes which only add value to the process. Value stream map is identified as an essential tool because it helps to visualise the process, waste and its sources, information and material flow.

Further it provides a common language for process owners to identify the current process and process deficiencies.

The major steps involved in mapping are as follows:

- Preparation –Identify the mapping team, the product or project to study and how the project or product will be mapped
- Current state map-All the data for current state map were collected according with the consultation to workers, supervisors, engineers and managers
- Future state map-After analysing current state map, the gap areas identified some changes were proposed
- Planning and implementation- Develop an action plan to achieve future state map and implement (Rother and Shook 1999)

3. RESEARCH METHODOLOGY

This section describes the methodological approaches adopted for this research. The selected study will substantially benefit by undertaking a case study based methodology to advance knowledge. According to the findings of O'Brien, action research follows several steps namely systematic cyclical method of planning, taking action, observing, evaluating (including self-evaluation) and critical reflecting prior to planning the next cycle. Since it is more suitable for a known problem and it is a process to test new ideas and implement actions to change. But the selected case study still does not identify the existing issues and therefore prior steps must be adopted before considering the action research cycle.

This research can also be classified as an exploratory research case study due uncertainty and little or no information available on similar research issues. Initial stage of this research covers the fieldwork and data collection to diagnose the problem. According to Yin's (2003) definition exploratory research case studies are condensed case studies, undertaken before implementing a large-scale investigation to identify research questions, select measurement constructs, and develop measures. Exploratory Case Studies Where considerable uncertainty exists about program operations, goals, and results. This Research Methodology is a combination of exploratory case study research technique and action research technique. This initial study used the basic value stream mapping steps recommended by Rother & Shook (1999) with some addition of structured tools.

3.1. PREPARATION STAGE

In this stage on quick walk through along the entire process was done in order to get sense of material flow and sequence of flow. General template was used for every process which includes series of questions to get back ground information of the individual value stream. It was designed in order to gain more detailed information about each of the process with regards to their suppliers, customers and processes which allow a greater understanding of the process. After that all information were summarised in to one page document called Supplier Input Process Information Output Customer (SIPIOC) as shown in appendix 1.

Finally select the product/project to be considered based on the production/process matrix. Finally select a product family which represent more than 10 % of volume of production capacity to create value stream map. (Maskell and Baggaley 2003)

3.2. CURRENT STATE MAP

The data collection was started in the raw material receiving bay through each of the individual processes identifying the linkages between the states of production and establishing the flow of information and material resources. Different variables such as cycle time, waiting time, set up time; First Time Through (FTT) was obtained through work study techniques namely time and motion study and activity sampling. The current value stream map contains three layers mainly communication, process and time line (See appendix 3)

3.3. FUTURE MAP

Having completed the current state map, data was analysed to identify areas in which improvements may lie and possible solutions to these were discussed (see table 2).

Table 2 Identified issues and counter measures

Process	Issue	Solution
Process 1	Excessive material and people movements	Eliminate temporarily relocation of raw material
	Unavailability of right raw material at right time in right order	Process standardisation at steel plant
Process 2	Poor distribution of work elements among workers	Work balancing
	Undefined job allocation among workers	Work standardisation
	Search for material and equipments	Implement good housekeeping system
Process 4	High set up Time	Identify external set up work
	Poor distribution of work elements among workers	Work balancing
	Undefined job allocation among workers	Work standardisation
	Search for material and equipments	Implement good housekeeping system
Process 9	Low First Time Through (FTT) %	Standardize the process
	Wasting time to search material & equipments	Implement good housekeeping practices
	Less standardised work process	Standardize the process
Process 3,5 &7	Low FTT% - Levelling done by trial and error	Improve the sensitivity of equipment Introduced visual gauge system to machine

3.4. PLANNING AND IMPLEMENTATION

When the future state map was completed for each issue highlighted an action plan was developed which is used as visual control tool to share information about kaizen projects. (See Appendix 2)

4. CONCLUSIONS

This section summarises the results obtained and conclusions reached during the research. At this stage of the research it is difficult to reach a concrete conclusion about the end results mentioned at the SIPIOC. One major issue has been addressed at the site and the results demonstrate successful application of VSM. Since the successes of the other kaizen projects, identified with VSM current state map, are progressing differently with operational and managerial difficulties, these are not analysed in this article. Therefore, at this point it can be concluded that the VSM process has served as a guide and has met the desired objectives quite satisfactorily, of course with some limitation in relation to the field of construction.

The VSM tool is a useful method which simply transfers information of the value stream to a user friendly visual format. But it still has few limitations especially when trying to apply it to other fields since it was originally adapted in the automobile industry. The organization considered under this study has a narrow span of product family with relatively constant demand of medium complex product which has almost similar features as an automotive plant. Since VSM has been developed and implemented successfully in the automotive industry, it is evident from the study that the applicability of the VSM tool in the said pre cast concrete yard is appropriate.. However since VSM considers a

process in a broad macro level view, it is difficult to identify the process level kaizens. In such situations other process mapping tools are preferable. Furthermore it can be improved by adding more information such as available resources and process constraints whenever possible. Meantime VSM does not address high variety of product families; Group Technology is recommended in VSM for such high variety product families. But it still does not reflect the variation within the product family.

The major difficulty in this study was to identify the waste activities with the help of the literature review for which the decision tree in Figure 1 was developed to identify those waste activities.

Even though, it is unfair to generalise on a conclusion at this early stage of the study, it could be concluded that the implementation of VSM tool in the construction industry is appropriate and advantageous of course with relevant customisations to suit the context.

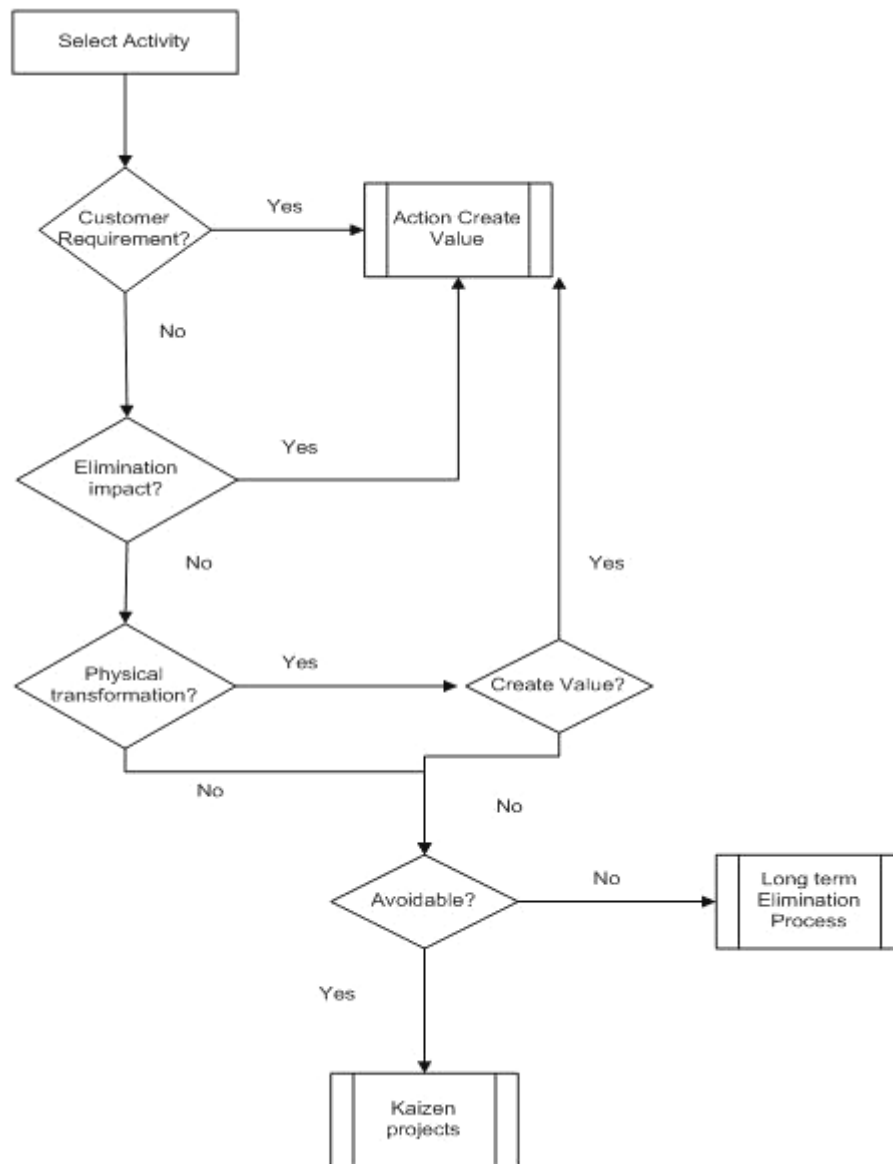


Figure 1- Test for Waste Activity

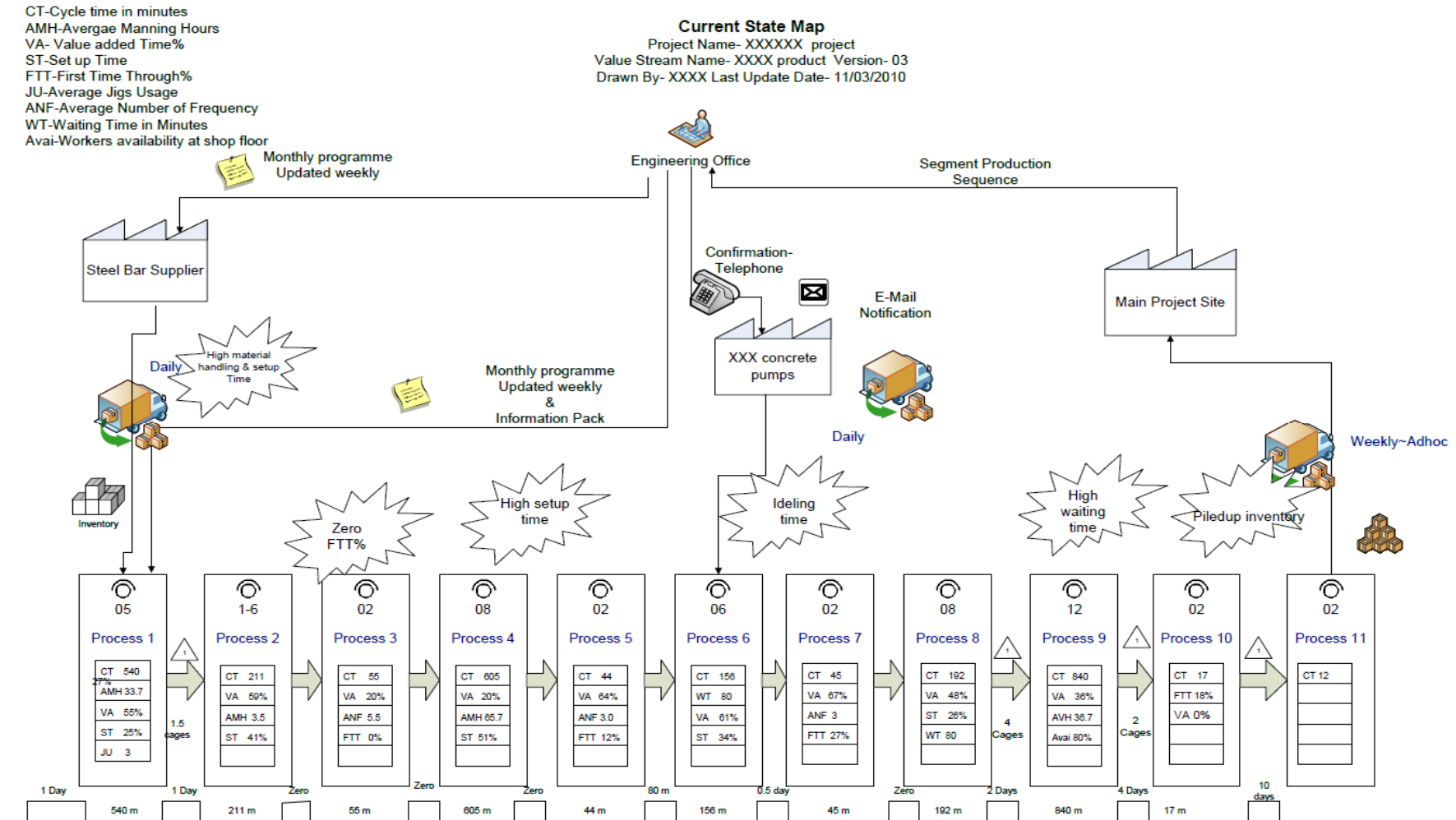
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Appendix 1 Supplier Input Process Information Output Customer (SIPIOC)

Objective				Project name: XXXXXXXXXXXXXXX construction Project				Start Date	End Date																																			
To improve existing construction process				Place:XXXXXXXXXXXX				Goals																																				
								Reduce Cycle time by X%																																				
								Reduce conversion co Y%																																				
Suppliers		Inputs		Sub Processes and Information				Out Put	Customer																																			
Reinforcement Steel Supplier	Lead Time	No. Of Orders/day	Frequency of Visits/Day					Product Details		Customer																																		
Concrete Supplier	Lead Time	No. Of Orders/day	Frequency of Visits/Day					Product		Name XXXXXXX																																		
Concrete Pump Supplier	Lead Time	No. Of Orders/day	Frequency of Visits/Day					0		Order frequenc																																		
Other Materials Supplier Cement	Lead Time	No. Of Orders/week	Frequency of Visits/Day					1		Back Order																																		
								2		Order																																		
Cement blocks	Lead Time	No. Of Orders/week	Frequency of Visits/Day					3		Demand/day																																		
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Quality Issues	FTT%					0	F1	5																																				
Labour absentism	Absetis m					1	F2	20																																				
Safety Issues	Acciden ts/week					2																																						
High cycle time	Cycle time					3																																						
Low Output	Output/ Week					4																																						
								5		F3	66%																																	
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Appendix 2-Current Status Map



Appendix 3-Study board approach for solution

Future Plan

Issue 1- Excessive material and people movements

Section- Rebar Fabrication

Reason for selecting the theme

Contribute to unproductive time

NVA 25%

Present condition Data

Material transfer Time- 22%

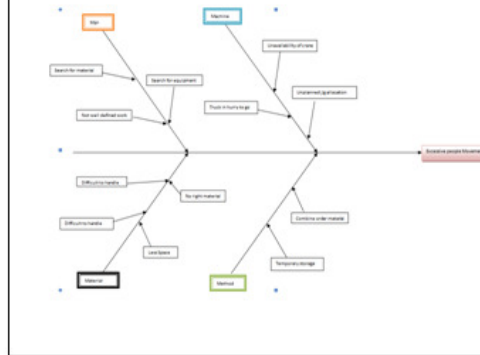
Target Goal

Reduce material transfer time to 11%

Plan of Action

- Eliminate temporary storing process
- Directly transfer rebar near to relevant work centre
- Improve current layout

Analysis (Figure 3)



Results

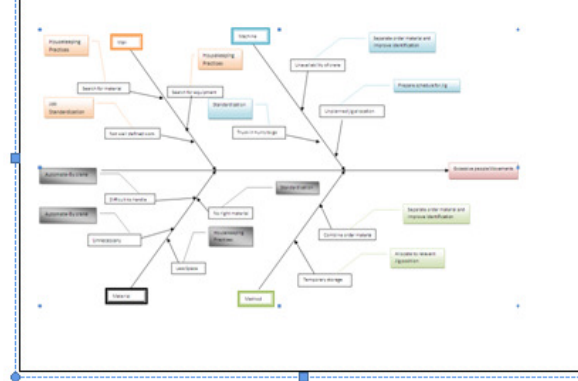
Before

Material transfer Time- 22%

After

Material transfer Time- 15%

Counter Measures (Figure 4)



Standardisation

- Implement raw material order tracking system-Colour coding system
- Eliminate combining or order material
- Develop a jig schedule and transfer material accordingly
- Sort unwanted raw material stored in floor

A Concept of Weather Window (WW) in Managing the Rain Risks in Construction Projects of Sri Lanka

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ABSTRACT

Different weather conditions such as rain, wind and snow would directly impact on the performance of any construction project. Being a tropical country, the effect from rain would be experienced mostly in Sri Lanka. Within this context, risks caused from rain can be defined in financial terms as a loss or gain due to a change in weather conditions over a period of time.

Weather records available in the Meteorological Department of previous years are analysed to establish the different rain risk categories based on dry spell, rain spell, and wet spell which are derived from a “wet day” as defined by the Meteorological Department. In this research, the value used to define the wet day is modified to establish the “weather windows (WWs),” under above rain risk categories, namely as major weather window, moderate weather window and minor weather window.

These established WWs are applied to a completed project and analyzed at different risk conditions. It was identified that the concept could be used effectively to manage the rain risks. The results showed that 3.5% of the total project cost would have been saved, if the weather sensitive items such as excavation and earth works, landscaping and external works, etc., of the project were scheduled by analysing the WWs, during the planning stage, even though the rain is considered as an Act of God and a totally uncertain event..

Keywords: *Weather risk, weather sensitivity, weather windows, uncertainty, act of god*

1. INTRODUCTION

The weather risk can be defined in financial terms as financial gain or a loss due to changes in the weather conditions over a period of time (Weather Bill, 2002; Zubair, 2003; Guaranteed Weather, 2009; Daily News, 2009; Irida Lankadeepa, 2009; Weather Risk Management Association [on line]). That period of time can be hours, days, months, or even years. However, it is difficult to find a period where there is no rain for three continuous months in Sri Lanka except during some El-Niño periods. Since any mid scale project spans over six months, weather is a potential risk factor.

Sudden rain or intermittent drizzling would negatively impact on most outdoor activity; hence it would impact negatively for construction projects. However, if the risks of rain are properly identified, the repercussion could be mitigated or even transformed to an opportunity in for certain construction activities. Weather records of previous years could be studied and analysed during the planning stage to take the decisions on potential rain risks and to schedule the items for minimum threat. Further in construction projects, the impact from rain would be high at early stages where bulk of the weather sensitive items such as earth works including cutting and filling are carried out. For instance in a building site, works up to DPC level and in a road project works up to sub-grade or sub-base preparation level, the impact of rain is very high. During this stage the losses from rain would

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not be directly measurable since the costs of indirect losses would be very high and even eleven times (11) times as per Health and Safety Measure (Health and Safety Executive, 1993). As the building progresses the potential risk and impact of rain risk becomes lesser.

In most of the practical situations, weather risk is being considered when the problem has occurred. In fact, contractors are entitled for claiming an extension of time for the delays caused by the exceptionally adverse climatic conditions (ICTAD Conditions of Contract, 2007). Thus, this could be a way of controlling the weather risks for contractors' point of view and therefore, most of the contractors pursue to take time extensions which in turn become a financial loss for clients. Under certain circumstances, the weather risk is controlled by project the contingency sum which is allocated as a fix percentage. In general, this allocation is 10-12% which is not decided by a detailed analysis of the project cost. However, the risk exposure is not homogeneous across the globe, thus this contingency would not be a fix percentage for all projects.

1.1. RAIN PATTERN IN SRI LANKA

Sri Lanka is a tropical country, which has an annual rainfall of 1861 mm which spreads into four seasons as follows (Department of Meteorology, 2008). The rainfall pattern is influenced by the monsoon winds of the Indian Ocean and Bay of Bengal and is marked by four seasons.

- From mid-May to October, when winds originate in the southwest, bringing moisture from the Indian Ocean. When these winds encounter the slopes of the central highlands, it receives heavy rains up to 2500 millimeters per month on the mountain slopes and the southwestern sector of the island.
- From October to November, the country receives inter-monsoonal rains which give periodic squalls and sometimes tropical cyclones bring overcast skies and rains to the southwest, northeast, and eastern parts of the island.
- From December to March, monsoon winds come from the northeast, bringing moisture from the Bay of Bengal. The northeastern slopes of the mountains may be inundated with up to 1250 millimeters of rain during these months.
- From March to April, the country receives inter-monsoonal rain with light, variable winds and evening thundershowers during afternoons or evenings.

The Figure 1 illustrates the variations of weather conditions over a year.

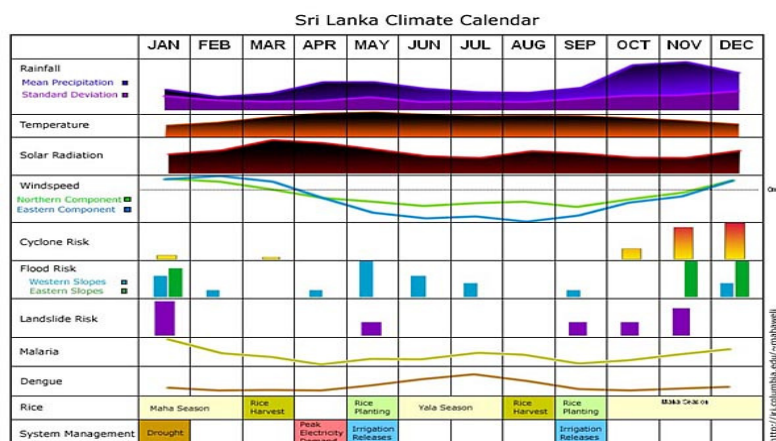


Figure 1: Sri Lanka's annual climate calendar

Source: Zubair, 2003

2. RESEARCH METHODOLOGY

The rainfall data of the Meteorology Department were obtained to analyse the weather risks. It was taken as monthly records over 30 continuous years, from 1960 to 1990 and from 2005 to 2009. Further, the following terminologies developed by the Department are used for calculating the risks.

- Rainfall (RF) : The amount of rain fallen to a particular location during a day normally for 24 hours period. It could be expressed as the daily rainfall.
- Rain Day (RD) : If the daily rainfall is more than 0.3 mm, it is called a rain day. If this happens for 15 continuous days, it is called as a “Rain Spell.”
- Wet Day (WD) : If the daily rainfall is more than 1 mm, it is called a wet day. If this happens for 15 continuous days, it is called as a “Wet Spell.”

In this research, the above terminologies are modified due to their less effectiveness in quantifying the risks of weather related to the construction industry. For instance, outdoor activities can be carried out even during a wet spell if the rainfall of a wet day is closer to 1mm. Since the concreting is the most expensive and weather sensitive item, it is considered to modify the lower limits of the wet day to make it effective tool for risk analysis (Guaranteed Weather, 2009). In USA approximately 2.5mm is taken for insurance claims of losses caused by the rain. The same value, 2.5mm is taken for this research to set the limits for the modified wet day, as above which concreting is not possible. Thus the following modifications are introduced, (Bowers 1994)

- Modified Wet Day (MWD): If the days rainfall is more than 2.5 mm then it is called a modified wet day. If this happens for 15 continuous days it is called as a modified wet spell.
- Weather Windows (WW) : The months where high risk of MWDs encounter is defined as critical WWs. (High percentage of risk months are classified as Critical WW)

The following procedure is applied to quantify the weather risks.

- a) Identify major weather sensitive items of the project.
- b) Estimate the duration of each item and prepare the project schedule accordingly.
- c) Establish the average number of rain days (RD) per year. According to the Meteorological Department, it was 99 rain days in year 2008.
- d) Distribute RD equally to each month. This is considered to establish the number of permitted working days.
- e) Establish the number of rain days of the particular area, from the past records of the Meteorological Department. Then the modified wet days are established.
- f) The difference between above (d) and (e) would give the actual permitted working days per month.
- g) The above value obtained in (f) could be presented as a percentage. The highest values could be regarded as the high risk; critical Weather Windows. For instance, in above case illustrated in the Figure 1, the months of October and November have high risks.
- h) This is presented in financial terms since the cost/day is known; then the cumulative saving / loss could be established.

3. ANALYSIS AND DISCUSSION

The derived WWs are applied to analyze the risks conditions of a past project. The project analyzed in this research is a mixed development project at Kurunegala. The project duration was twelve months, from January 2008 to December 2008, and the project cost was Rs. 150 million.

Weather risks of the project are analyzed using six different scenarios. The WWs are applied to schedule the project activities from January 2008 to December 2008, in such a way that the risks caused from the rain are planned at a minimum level. The tables 1 and 2 show the application of WW to the actual project schedule. The coloured columns in the tables are indicated the critical WWs (i.e. high weather risk periods). The Table 2 elaborates the actual schedule with monitory values.

Table 1: Scenario A-Actual project schedule

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1													
2													
3													
4													
5													
													(1.80)

Table 2: Scenario A- Actual project schedule with actual monitory values

No	Description	Days of work												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	Earth works & sub structure works	4.5	4.5	4.5										13.5
2	Super structure works				15.4	15.4	15.4	15.4						61.5
3	Internal finishes & fittings							9.5	9.5	9.5				28.5
4	Building services									12.0	12.0	12.0		36.0
5	External works										3.5	3.5	3.5	10.5
A	Planned days of work (A)	4.5	4.5	4.5	15.4	15.4	15.4	24.9	9.5	21.5	15.5	15.5	3.5	150.0
B	Total calendar days per month (B)	31.0	28.0	31.0	30.0	31.0	30.0	31.0	31.0	30.0	31.0	30.0	31.0	365.0
C	Forecasted rain days when evenly distributed (C)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	96.0
D	No of days lost due to rain (0.5* Rain days)(D = C/2)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	48.0
E	Dry days per month (E= C-D)	27.0	24.0	27.0	26.0	27.0	26.0	27.0	27.0	26.0	27.00	26.0	27.0	317.0

F	Average planned amount of daily work (F = A/E)	0.2	0.2	0.2	0.6	0.6	0.6	0.9	0.4	0.8	0.6	0.6	0.1	0.5
G	Ave. actual rain days	10.0	3.5	11.0	12.3	10.5	9.8	8.5	10.3	11.0	18.3	12.8	9.0	126.7
H	Actual modified wet days due to rainfall	5.8	2.8	10.3	10.3	8.8	7.0	5.8	7.0	7.8	15.3	11.5	6.5	98.5
I	Non-working days due to rain (0.5* MW days) (I=H/2)	2.9	1.4	5.1	5.1	4.4	3.5	2.9	3.5	3.9	7.6	5.8	3.3	49.3
J	Actual dry days permitted to work per month (J= B-D)	28.1	26.6	25.8	24.8	26.6	26.5	28.1	27.5	26.1	23.4	24.2	27.7	315.7
K	Difference in dry days (K=J-E)	1.1	2.6	(1.1)	(1.1)	(0.4)	0.5	1.1	0.5	0.1	(3.6)	(1.6)	0.8	
L	Risk as a percentage (L= (B-K)/B*100%)	9.4	5.0	16.8	17.3	14.2	11.7	9.4	11.3	13.0	24.6	19.3	10.6	
M	Saving due to seasonality of rain (M = F *(J-E))	0.2	0.5	(0.2)	(0.7)	(0.2)	0.30	1.04	0.18	0.10	(2.1)	(1.0)	0.10	(1.8)

Alternatively, five other scenarios are analyzed to obtain the optimum schedule (refer Tables 3 to 7). The principle behind in developing the alteration schedules to minimize the risk caused by rainfall by considering the weather window periods. Particularly, the high weather sensitive activities are managed by avoiding the critical WWs.

Thus, the alteration 1 is developed by squeezing and accelerating the item No. 1 to complete within three months that is by March, so that a part of the WW could be avoided. Other items are kept unchanged (Table 3). However, the result was worse than actual project schedule and thus a significant change in the program is needed.

Therefore, in the alteration 2, major weather sensitive items were scheduled completely out of WW and other items were dragged and decelerated so that the work scheduled in WW periods are less than in alteration 1. This alteration given a huge improvement and in fact became the best alterations.

This strategy indicated that scheduling of the project by shifting its weather sensitive items out of the WW period would have a financial impact on the project. Other alternations 3, 4 and 5 were tried with different programs scheduled out of WWs for all weather sensitive items (Tables 5-7). They were shown better results compared to the actual project schedule which was developed without considering the WWs.

Table 3: Scenario B- Alteration 1

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	■	■	■	■						■	■		
2				■	■	■	■			■	■		
3							■	■	■	■	■		
4									■	■	■		
5										■	■	■	
										■	■		(2.07)

Table 4: Scenario C- Alteration 2

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	■	■								■	■		
2		■	■	■	■	■	■	■	■	■	■		
3					■	■	■	■	■	■	■		
4							■	■	■	■	■		
5							■	■	■	■	■	■	
										■	■		3.18

Table 5: Scenario D- Alteration 3

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	■	■								■	■		
2			■	■	■	■	■	■	■	■	■		
3							■	■	■	■	■		
4							■	■	■	■	■		
5									■	■	■	■	
										■	■		0.03

Table 6: Scenario E- Alteration 4

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	■	■								■	■		
2		■	■	■	■	■	■	■	■	■	■		
3							■	■	■	■	■		
4							■	■	■	■	■		
5								■	■	■	■	■	
										■	■		1.10

Table 7: Scenario F- Alteration 5

Item No	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	■	■								■	■		
2		■	■	■	■	■	■	■	■	■	■		
3							■	■	■	■	■		
4							■	■	■	■	■		
5									■	■	■	■	
										■	■		(0.39)

In each scenario, the cumulative actual saving / loss is calculated and presented in the right bottom cell in the tables 3 to 7. The best schedule with the minimum impact under the rain risk is observed in

the alternation 2 (Table 4). It has shown a total of 3.5% saving compared with the project schedule of the lowest scenario as follows,

The difference between the highest and lowest scenarios =	3.18 – (-2.07)
	= 5.25 Millions
Total project value	= 150 Millions
The loss as a percentage	= $5.25/150 \times 100\%$
	= <u>3.5 %</u>

4. CONCLUSIONS AND RECOMMENDATIONS

The early identification of risk and uncertainty is very important, as it focuses the attention of the project management on the strategies to control of risks. The proposed WW concept opens a new dimension in the field of project management in Sri Lanka where in some other developed countries this issue had been addressed to suit their conditions.

The research observed that there is a clear relationship between the weather sensitive construction items and the weather windows. It was proved using the case study of Kurunegala project which indicated about 3.5% saving of the total project cost, after adjusting the project schedules of weather sensitivity items to avoid critical WWs. This is a significant outcome and most interestingly, no investment cost has involved in managing the weather risks. Therefore, in policy planning and implementation stages of national projects, the consideration of weather could play a major role in national economic achievements.

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