

REDUCING THE CONCRETE WASTE WHILE OPTIMIZING THE COST, TIME & QUALITY IN SRI LANKAN CONSTRUCTION INDUSTRY

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Abstract - Construction projects attempt to reduce wastage. In the present days, many projects are moving towards sustainable development while minimizing construction wastage. Among these construction waste material, waste has been recognized as a major problem in the construction industry. Construction Industry consumes a relatively large volume of material that have been wasted due to various reasons. It can happen due to the labour attitude towards the material, labour arrangement, and lack of knowledge in reusing or recycling the material. The main problem arising out of this waste is that it directly influences the project characteristic (Cost, Time & Quality). Along with this material waste 'Wasting Concrete' takes a high percentage that must be given considerable attention. The cost related to this concrete waste directly creates unnecessary expenditure for the employer's budget. As a result, most countries have found several factors to minimize the concrete waste where all stakeholders can collaborate with the project. This research aims to analysed analyse those factors within the Sri Lankan construction projects to reduce the concrete waste based on case studies of three on-going construction projects. Data will be collected by interviewing few stakeholders from each of the selected on-going construction projects. Based on the case study findings, a framework will be developed for the reduction of concrete waste in construction projects, which can lead to a cost effective and on-time completion of projects.

Keywords: Reducing concrete wastage, financial expenses, construction projects, Stakeholders

I. INTRODUCTION

A. Background

Construction industry comprises a wide range of activities that covers the erection, repair, and demolition of all types of buildings and civil engineering structures. Generally, in this industry includes for different types of construction activities that will be carried under namely by "Projects". Project represents a discrete piece of work with a clear start and finish dates, providing specified benefits at the accepted cost (Frank Harris, Ronald McCaffer, 2005). To choreographed above mentioned construction activities the involvement of the stakeholders are essential who are the once gain the benefits and have the interest for the final product directly or indirectly to complete the project in successful manner. In order to successfully complete the project, there was a most important factor as 'Project Characteristics' that need to be considered by the stakeholders. In construction, there were three main project characteristics as Time aspects (speed construction), Cost aspects (level of price), and the Performance (quality of the final product) that is essential to fulfilled in order to complete the project successfully.

To go for the stated aims and targets, it is essential need to maintain a proper management within the project for resource handling. Material, Labour, Plant and Machineries be the main inputs or the resources in the construction project. Both during the construction and demolition creates a large percentage of waste (Allain & Veuille, 2010). Material waste has been recognized a major problem in the construction industry. Construction Industry consumes relatively a large volume of material,

which have, being wasted due to various number of reasons. It can be the labour attitude towards the material, labour arrangement, and lack of knowledge in reuse the material. Every year, most of the countries sent these material wastes to landfill instead of being reuse and recycled those materials for new construction.

Now a day, many projects are moving towards sustainable developments while minimizing this construction waste. According to (Kulatunga, U, Amaratunga, RDG, Haigh, R and Rameezdeen, R, 2006) define the construction waste “by-product generated and removed from construction, renovation and demolition work places or sites of building and civil engineering structures”. Therefore, due to this waste most of the construction projects are suffer with the material waste that create direct impact on project characteristics. (Jeyaraja Jayamathan; Raufdeen Rameezdeen, 2014) Stated that material waste can be non-site based which occurs due to design errors, design changes, ordering excessive material and site based which occurs at the time of construction carry out due to the labour attitudes, arrangement of storage and workforce. Out of this material waste, concrete wastage take a greatest place.

The problem arising out of this waste is directly influenced on the project characteristics. Among this material waste ‘Wasting Concrete’, take a high percentage that must take a considerable attention. The cost relates to this concrete waste directly creates an unnecessary expenditure for the Employer’s budget. In most countries found that concrete is used as recycled aggregate in construction (R.A, Silva; J, de Brito; R.K, Dhir, 2014). The main problem raised for the concrete waste directly creates due to the human behaviour, their attitudes and as well as the arrangement of the work. (J, Saunders; P, Wynn, 2004) Found that the attitudes towards the waste minimization among labour and the other contracting parties in the construction. This minimization of the concrete waste will increase the productivity and it will optimize the main project characteristics.

The best way to minimize those concrete material wastes by reusing and recycling concrete or adding new techniques to the construction projects. Further (Allain & Veuille, 2010) discuss that the use of recycle material provides environment benefits as well as creates cost effective construction project. Therefore, the current trend in most of the countries are to use recycled waste and by-products in concrete to replace binders and aggregates (Allain & Veuille, 2010).

The main aim and the objectives of this research is to identify the factors effects to concrete waste and how it impact to the project characteristics while comparing the minimizing techniques that used by the other countries and propose most suitable precautions to reduce this concrete waste in Sri Lankan construction industry.

II. METHODOLOGY AND EXPERIMENTAL DESIGN

This study has adopted qualitative research approach, the essence of which, according to Wigren (2007), consists of focusing on understanding the naturalistic setting, or everyday life, of a certain phenomenon by the investigator. Qualitative methods are essentially descriptive and inferential in character and focus primarily on the kind of evidence that will enable to understand the meaning of what is going on. Accordingly, among various approaches available in the qualitative approach, case study (Yin, 2003) has been selected.

The case study research method provides an in-depth investigation by studying ‘cases’ in an uncontrollable environment. According to Yin (2003), case studies are the preferred strategy when ‘how’ or ‘why’ questions are being posed, when the investigator has little control over events and when the focus is on contemporary phenomenon within real-life context. Considering these points, the case study method was seen as suitable for this study.

In this study, cases were selected from the construction industries, which are focusing on reducing concrete waste to reap the potential advantages to uplift their standards. Accordingly, three industries were selected. From each case, three semi-structured interviews were conducted with three representatives from top management and middle management.

Altogether, nine (9) interviews were conducted and each normally lasted for 30 minutes to 45 minutes.

Table 1 provides the case studies and interviewees’ with the details of reducing concrete waste in construction projects that were taken into account with the intention of collecting more accurate data for the research project.

Table 1. Details of Case Studies

Project	Project A	Project B	Project C
Interviewees	supervisor	Project Manager	Project Manager
	Project Manager	Supervisor	Labourer
	Quantity Surveyor	Labourer	Civil Engineer

Key themes (codes) emerging from the findings were identified within each case and replication of findings were tested using ‘cross-case analysis.’ The research results are presented and discussed next.

III. RESULTS

A. Material waste define in the context of Sri Lankan Construction Industry.

Many ways have been applied to classify the types of construction waste. Waste can be classified by their state, by their characteristics or by their origin. Construction waste has been defined in various countries in different ways.

Cost relates with the waste that creates a significant impact to the Sri Lankan construction industry. Wastage of materials in most of the construction sites in Sri Lanka is beyond the acceptable limits. In Sri Lankan context, construction waste debris from construction, refurbishment and repairing work and can emerge at any stage of a project from inspection to completion.

Many factors contribute to the generation of material waste. These factors can be grouped by under four categories as, design, procurement, handling of material and in the operational period.

Through the case studies that were taken into account, it shows that there is a majority who were not properly aware of construction as well as material waste; thus, it is clear that the knowledge matters are the main reason for not taking the best use of construction waste.

However, as per the Project Manager in project C and the Quantity Surveyor in project A states that, “there were mainly few causes of waste as design, procurement, handling of materials, and at the time of operation”.

Human factor involvement within the both pre and post contract stage has an influence for the increment of material waste. Further, the Supervisors in both project A and project B emphasized that, “causes of waste directly and indirectly affected by the attitudes and perception involved in construction industry”. Civil Engineer in the project C states that, “most of the material waste cause due to design issues where the improper design results unnecessary amount of material waste”. The challenge is likely to arise from the resistance to change and fear with relates to use new methods in reduce the material waste in construction. To receive the true benefits of reducing material waste, changes in procurement, processes, cultures and attitudes become necessary. Project B supervisor states that, “Important need to focus on labourers’ attitudes towards waste and on waste generated as a result of construction site activities”. Project Manager in project B expressed that, “Material reconciliation was carried out by comparing the difference between the store records and actual requirement of the material as the items in the bill of quantities (BOQ)”.

The challenge may not be severe as much as the current experience would suggest. There has been evidence of positive changes in cultures and attitudes with the change of traditional strategies of material handling within the projects.

B. Stakeholders involvement in Construction Industry via Concrete Waste

Construction Industry is comprises with wide variety of complex activities where having relationships with large number of parties known as ‘Stakeholder’. These stakeholders are the people who has an interest on the outcome of the project. Mainly the stakeholders be the Employer, the Architect, the Engineer, Project Manager, Quantity Surveyor, Contractors and other respective parties. Among the number of material waste, wastage in concrete directly effects to the construction projects.

The Quantity Surveyor in project A expressed that, “there was number of concrete waste due to variations which also happens due to design changes”. Supervisor on project B states that, “attitudes regarding the concrete waste differs from one person to another”. However, in project C the Civil Engineer emphasized that, “concrete waste within the site is huge due to improper arrangements and the lack of storage facilities”. In project B and project C, Labourer states, “they were not very much aware of the material waste within the construction and the material

arrangements”. Quantity Surveyor in project A, “Concrete waste minimization practices must be employed during the design stage where that need to conduct feasibility study of waste estimation by the designers”. In project C, Civil Engineer states that, “due to delivery method and delivery schedules a huge percentage of concrete waste occur”. Project Manager in project B expressed, “people in the construction industry in Sri Lanka are not much aware with the new methods as reuse of concrete for the projects will create huge loss in their projects”. Supervisor in project A expressed that, “due to using useless concrete transport pipes create a large amount of concrete waste”.

When considering on above findings and the stakeholder in construction industry who are likeable to optimize the cost, time and quality within the project by reducing the concrete waste by using different techniques and recycling methods in Sri Lanka.

C. Drivers and Barriers created due to use of new technology in reducing concrete wastage

To optimize cost, time and quality by reducing the concrete waste will bring both drivers and barriers to the construction industry. Development of new technologies, the amount of wasting concrete can be reduced by involving with new techniques as, recycle concrete, use value engineering methods and few more. As per the findings, the Project Manager in project A expressed that, “to reduce the concrete waste within the project they mainly use value engineering techniques” and as barriers, “Most of the people relate within the construction is not much aware with those new techniques”. Supervisor in project B expressed that, “lack of attitudes on workers regarding new technologies”. When considering and observing all the findings, the drivers and barriers that create while implementing new techniques to reduce concrete waste can commonly be gathered to a one place as follows.

Drivers:

- Reduction of landfill space required for concrete debris.
- Cost saving within the project.
- Enhancing the stakeholder collaboration on projects.
- Introduce new technologies to the construction industry.
- Creates more employment opportunities when introducing new methods to the industry.
- Financial benefits.
- Ranked up the contractors’ standards among the others by using waste management practices.
- Barriers:

- Technical problems occur when implementing concrete reduction techniques.
- People are afraid to change their usual practice and they refuse to learn innovations and resist to alteration in roles.
- Huge cost need to invest to implement those innovations.
- Lack of skill persons.
- New techniques for the reduction of concrete may bring lower quality aggregates.
- Lack of experience in the use of recycled products.
- Huge investment in management systems.
- Difficulties in placing new machineries in the project area.

D. Competitive advantages of using new technology for the reduction of concrete waste

New technologies for the reduction of concrete waste will gain more advantages to the on-going projects in the construction industry. While considering on the findings of the case studies, it clearly expressed the projects who are not very much aware about reducing the concrete waste by use of these new techniques that gain advantages. The Quantity Surveyor in project A expressed that, “Most of the time they apply various mechanisms or build up norms to stop unnecessary cost for wastage in concrete”. Additionally, the Project Manager in project C emphasized that, “Concrete recycling practices within the projects are newly going to develop within the projects”. In project B, Project Manager states that “Developed countries as Japan, United Kingdom and few use of recycled aggregate concrete in construction”. Similarly, Quantity Surveyor in project A explains that, “most of the construction projects tend to use prefabricated elements rather than use in-situ concrete within their projects”. Finally, observing the findings the advantages can be categorized as follows:

- Reduce unnecessary expenses.
- Improve the bottom line of the project.
- Save resources and greenhouse emissions by breaking down landfill areas.
- Saving project cost by using recycled materials.
- Bring out value to the final product.
- Increasing the competitiveness among other contractors.
- Changes in drawings and other modelling will update automatically.
- Saving the use of natural materials.
- Leads to handover a neat and a quality work.

E. Optimization of time, quality and cost via Recycled concrete

Construction Industry has main three words as Time, Cost and Quality. These three words are going hand in hand. These three words also known as ‘ Project Characteristics’. As the Quantity Surveyor in project A emphasized, “In cost wise concrete recycling method will reduce unnecessary costs spending for new raw materials”. In addition, “time reduction is really essential”. Further, “quality productivity may create and brings a huge value by use of value engineering techniques”. While observing other findings the Project Manager in project B stated that, “the material cost, installation time and the wastages in construction materials be minimize due to the practice of new techniques”. Supervisor in project C expressed, “the type of attitude that with the labourers through minimizing concrete waste will help to reduce high accuracy on cost estimation and project time save”.

Finally, these observations are pertaining to optimize the cost, time and quality in a certain construction project due to the new methods for concrete wastage.

F. Challenges arise while use of new methods to reduce concrete waste in Sri Lankan construction projects

Recycled concrete and new techniques gained advantages as well as challenges to the construction projects. There should be proper planning and management system when using those new techniques and recycle methods within the construction projects. However, projects needs to assess those challenges and collectively as a team must addresses for them with the help of rapidly changing technology.

Project Manager in project A states that, “most of the wastages occurs due to design changes where variations creates will effects for concrete wastage”. Further in project B the Supervisor emphasized, “when ordering the concrete without having a knowledge relates to the actual work on site will also create wastages”.

Finally, the observations of the all findings on challenges can categorize in common as follows:

- Affordability recycling machineries to the project.
- Untried liability issues.
- Design changes by the Client or the Architect.
- Improper storing capacities.
- Lack of knowledge in new techniques and the use of recycling concrete.

- Attitudes with the construction professionals.
- Improper placing and the delivery methods.
- Improper planning in the operational stage.

IV. DISCUSSION AND CONCLUSION

Massive generation of concrete waste causes a serious problem to the environment. Most of the developing countries are making efforts for minimization of the construction waste and reuse of waste in construction. Among number of construction waste, concrete waste tends to make huge lose in the project cost. Therefore, most of the stakeholders in the projects tries to bring number of ways to reduce this concrete wast by introducing value-engineering techniques, build up notes, and recycling the waste and some few other ways.

The main aim of this paper discuss the reduction in concrete wastage through different aspects while proposing new techniques to optimize the project characteristics in Sri Lankan construction industry by interviewing few stakeholders in an on-going construction projects. As per the result, that revealed that most of the professionals who were involved in the Sri Lankan construction field are seemed reluctant to adopt and not very much familiar with the use of recycled concrete and new methods for the construction projects. Therefore, a change in attitudes and perceptions towards concrete waste recycling and use value engineering techniques as ‘Post Tensioning’ will effect to minimize the concrete wastage in the construction projects.

To encourage the use of new technologies and recycle materials, there should be a proper communication method within the organization, provide proper information regard to the waste management practices, and provide clear technical specification or standards in use of recycled concrete for construction and thereby optimize the cost, time and quality within the construction project.

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PROOF