TOWARDS THE SUSTAINABLE CONSTRUCTION THROUGH MINIMISING SITE WASTE IN SRI LANKA

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ABSTRACT: The term 'Sustainability' is one of the critical issues that caused multiple repercussions in the global arena. The concept focuses economic, social and environment well being of a whole nation and there is an identical link between construction activities and the environment. Construction products and processes create considerable impact on the environment and it is significant to protect the environment for our future generations too. Construction site waste is one of the big issues that diminishes the environment soundness. Therefore minimization of site waste is becoming extremely attractive to management as a strategy to save costs while improving overall sustainability. The success in site waste reduction usually depends upon worker awareness and the commitment of the management. Most of the construction firms are not aware of waste minimization strategies at all. Therefore it is inevitable to suggest some ways or strategies for construction firms to reduce construction site waste. Identification of types and sources of waste would lead to suggesting ways and strategies to reduce construction site waste. Further, it was identified that poor performance of workers directly contributes to the generation of waste in construction. This paper is focused on how environment sustainability could be achieved through minimizing site waste and the factors that affected the generation of site waste in the Sri Lankan context. A comprehensive literature survey and a structured questionnaire survey were carried out to achieve the research aim of this study.

Keywords - Construction Materials, Labour, Site Waste, Sri Lanka, Sustainable Construction.

1. INTRODUCTION

The relationship between construction activities and the environment is well recognized (Ofori, 1997) and the effect on the environment due to the construction waste is significant. A considerable amount of waste is generated by the building and construction industries in most of the countries. On the global scale, the construction industry and its products consume a critical amount of material and energy sources and are responsible for a very significant portion of pollution by harmful and damaging emissions and wastes (Hajek, 2001). At present, the construction industry has become increasingly aware of the importance of waste minimization in construction sites. Recycling of construction waste is an important component of environmentally responsible construction, as it reduces the amount of waste directed to landfills (Chandrakanthi and Ruwanpura, 2002). Therefore it is important to maximize the environment sustainable values through minimizing construction waste. According to Gibbere (2003) sustainability is the simple idea of ensuring a better quality of life for everyone now and for generations to come. Hayles (2003) further suggested that sustainability could be described in terms of social, economic and environmental states that are required in order for overall sustainability to be achieved.

At present, most of the researches are concerned with sustainable construction. Waste minimization is one of the important elements of sustainable development since it will benefit both the environment and construction firms. Thus, it can be said that any significant reduction in construction waste will inevitably lead to a considerable reduction in the overall waste stream.

It was identified that the wastage of materials and labour on most construction sites are beyond acceptable limits, in Sri Lanka (Jayawardana, 1994). Therefore construction firms are liable to reduce waste levels. They should have a clear knowledge of the types of waste and how waste occurs before implementing ways or strategies to reduce wastage on sites. On the other hand, waste reduction is becoming extremely attractive to the management as a strategy for achieving cost savings while minimizing environmental degradation. Further, construction firms are anticipating potential benefits through adopting proper waste management techniques.

2. TYPES OF WASTE

Construction waste is one of the by-products generated and removed from construction, renovation and demolition work places or sites of building and civil engineering structures (McDonald and Smithers, 1998, citied Skoyles, 1978).

It can be generated through direct or indirect processes of construction. The complete loss of materials which are irreparably damaged or just lost from the site is known as direct waste. Through transport and delivery, site storage and internal transit, excess materials/production, waste due to conversion, residue, misuse, cutting, fixing and lack of proper material management strategies and poor application of standards are just some of the sources of direct waste.

The indirect waste occurs, where materials are used either for purposes other than those specified or in excess of measured quantities to meet the dictates of production. Materials are not physically lost but there could be a monetary loss and failure to recognize and record indirect waste. Waste due to substitution, production, negligence is considered as indirect means of waste generation.

2.1 Sources of Waste

Practical waste reduction strategies require a detailed understanding of what causes construction waste. There are number of reasons, which cause wastage during construction process. Therefore identification of sources of waste is important to wastage.

Sources of waste can be found throughout the project life cycle from the initial design to the end of a facilities life. It is more important that the origins of construction waste should be studied to determine the most effective methods for dealing with these wastes at their source. The construction process accounts for the physical generation of material waste through a number of factors such as poor delivery and storage technique, lack of supervision and trades person's error. Bernold and Gavilan (1994) have developed a construction waste source identification model and are able to identify some important sources that contribute to waste. These are, design and detailing errors, design changes, procurement errors, errors due to inadequate material handling and other external disruptions.

2.2 Wastage of Human Resources in Construction Sites

Many of the challenges faced by the construction industry arise through a need to maintain a skilled and unskilled work force. In Sri Lanka, as with other developing countries, 90% of building construction work is carried out by skilled and unskilled labour forces rather than

machinery. Wastage is therefore considered as significant and analysis of this wastage may give suitable solutions to reduce the waste.

In a construction site, unproductive and idle labours generate direct waste. Lack of productivity arises due to the dissatisfaction of a skilled or unskilled worker with his/her job. In most construction sites, workers are recruited for particular types of work in which they are often not familiar. The reasons are lack of education and knowledge, experience, motivation, welfare, etc. (Jayawardana and Gunawardena, 1998).

Idle labour is also an important factor in generating labour wastage. It can be divided into two categories. They are 'idle labour with work' and 'idle labour without work'. In Sri Lanka approximately 26% of workers are idle with work and without work (Jayawardena, 1994). In construction, idle labour without work arises due to a lack of proper planning and proper scheduling of works by the site management. When analyzing the 'idle labour with work' a number of reasons have been identified as the origins of this wastage. Some of reasons can be highlighted as follows.

- Dissatisfaction with work.
- Inefficiency of tools and equipment.
- Conflicts with supervisor and/or their superiors.
- Bad opinions on site management.
- Dissatisfaction with the provided facilities.
- Lack of co-operation with other workers.
- Lack of education, knowledge, experience, training, etc.
- Poor health conditions.

2.3 Waste Arises other than Sources of Waste

Other than the sources of waste, there are other factors that can affect the generation of material and labour wastage. In most of the sites, inexperienced persons and trainees are acting as main supervisors. They are reluctant to give correct instructions at the correct time to the correct person in correct way. When considering the attitudes of labourers a small number of construction firms are highly concerned about the issue of labour motivation.

Within the sites, the material transportation is carried out manually or by wheelbarrows. But the efficiency of wheelbarrows is very low because of their high maintenance. Some equipment and tools also generate waste at sites. The firms, with the exception of M1 and M2 grades (graded by the Institute of Construction Training and Development) use hired plant and equipment, which have higher costs than their own plant and equipment (as a percentage). As an average, 40% of hired plant and equipment are used by each firm. Due to lack of proper maintenance and working hours the efficiency of plant is very low and this causes material and labour wastage.

The type of employment given, their experience, job satisfaction, and training needs also affect material wastage. According to the survey it is clear that many construction workers are hired on a project basis and are made redundant on project completion. In Sri Lanka approximately 65% of workers are employed on a temporary basis. Job satisfaction is one of the significant issues of motivation. The survey (Jayawardana and Gunawardena, 1998) has illustrated that approximately 24% of workers are dissatisfied with their work. Additional reasons are low income, lack of job security, poor social status etc. The training needs of workers have been identified from the same survey. Half of the skilled workers are willing to train and 25% of workers like to train in other trades as well. Effective labour (skilled & unskilled) motivation is essential to reduce labour wastage on sites. There are various ways available to reduce labour wastage as well as material wastage through motivation. By

providing opportunities to increase earnings, proper organization of work, improving working conditions, workers can be motivated and this will ultimately lead to the reduction of waste on Sri Lankan construction sites.

3. WASTE EFFECTS ON THE ENVIRONMENT

The rapid development of intellectual and the inherent skills and capabilities of mankind have caused more harm than good to the environment, which by its nature is conducive to the well-being of mankind. Every second the global environment is polluted due to human activity that is not in harmony with nature all over the world. Even though these activities are termed 'development' it does not appear appropriate if it causes an imbalance in nature. The well-being of mankind is totally dependent on the harmonious linkage of man and the environment. Hence both developed and developing countries have made it a point to conduct environmental studies prior to implementation of development programmes with view to maintaining equilibrium between nature and the development process. Various "development" processes undertaken by man have caused extensive damage to the environment.

The population of Sri Lanka doubles every 25 years. Everyone needs to be provided with a home.. If not, they are likely to put up their own abode without reference to any plans. These facts are equally true for the construction industry. The construction industry in Sri Lanka is established in such a way that most of its raw materials are extracted from the natural environment and release considerable amount of site waste back in to the environment.

The environment is the basic foundation of our existence. In fact, humans have to engage in many different development processes to attain their comfort levels. They are altering the natural environment in various ways where it leads to its ultimate deterioration. During their life cycle humans consume natural resources and converts them to a final output through a conversion process. In the meantime the output has resulted in some waste that as a by-product creates negative impact on the environment, as follows:

3.1 Resource Depletion

Resources are generally considered as primary material such as fossil fuels, minerals and timber in that the mineral ores and fossil fuels are the non-renewable materials. Timber is a renewable material and can be re-grown. Timber is diminishing in many countries through poor management and high consumption. Removing them from the rain forests can cause imbalances in the eco system and depletes not only tree but also forest resources and services.

3.2 Physical Depletion

Physical depletion is the interference caused to the environment by the actual construction process, maintenance, refurbishment or demolition work. Loss of productive lands, disturbances due to development and degradation and loss of bio diversity are critical.

3.3 Pollution

Pollution caused through waste disposal at the construction and operation stages of a project development on the natural and built environment is very high. The effect of civil engineering projects can contribute to resource depletion such as water resources and also to

contaminating lands due to the waste disposal in the water reservoirs and their contamination. This, ultimately can cause disease and can lead to the degradation of the aquatic lives.

Therefore minimizing these environmental degradations through reducing construction site waste (in terms of material consumption) will support the achievement of environmental sustainable goals effectively. Further utilization of renewable materials rather than non-renewable materials should be encouraged in the construction procurement process in Sri Lanka.

4. WASTE MANAGEMENT FOR SUSTAINABLE CONSTRUCTION

Implementation of waste minimization and prevention strategies are essential for every construction site when it's driven through sustainability. Minimizing waste at its source, re-use, and recycling are identified as most significant waste minimization strategies.

Minimizing waste at the point of origin depends on the applicability of management strategies and the design responses. With reference to Johnston and Mincks (1995), waste management should be a project wise concern, which can be easily implemented by building contractors. It is evident from the research that current international best practice takes a holistic approach to the development process when considering ways to reduce on site material waste. For the success of on-site waste management, the main contractor should have effective communication with and careful supervision of sub-contractors, skilled and unskilled workers. The implementation of waste management policies within the resource management plan is significant and a role of resource manager is needed to be identified on every construction project in Sri Lanka.

Criminal wastage, which includes pilfering, theft and vandalism, may be totally eliminated through a proper inventory system. Security must be related to the policy of the company, the nature of the project and the value of material involved. Listing of potential losses would help to ensure a sensible balance between security costs and the value of goods likely to be stolen and their effect on work due to delays in replacement. Depending on the requirements, site fencing, employing security persons, a proper lighting system around the site and constructing lockable and much stronger stores etc, should be considered by the site management.

Site accidents cannot be fully eliminated. However, it can be minimized by adopting precautionary procedures. Skilled and unskilled workers and supervisors should be encouraged by site management to adopt these precautionary procedures and reduce the labour waste in sites. Further precautionary measures should be strictly implemented by the site management.

To a certain extent, non-consumable waste is also unavoidable. The designers of material and the merchants are often responsible for much waste. Therefore it is essential for manufacturers to give detailed consideration to the handling, packaging and security of their products (both in transit and for storage before use on site). The consideration may also include the ways in which these products will be used and taking account of every stage of the construction process under a variety of site conditions. The components should be durable, easily handled and suitably packaged and safeguarded against damage for transport to the site. A standardization of packaging the waste is caused by methods of packing. This includes standardization of pallets and pack loads; the ultimate disposal of packaging material and the facility to breakdown the loads into convenient sizes for distribution.

Design responses to reducing on-site material waste range from the design of modular and prefabricated building systems to ensuring adequate documentation and detailing of construction works. The designers must consider the specification of recycled materials or

products and the use of materials or production with recycled content when designing. This could in the long term, improve the cost effectiveness of on-site separation schemes. But in Sri Lanka, there are some limitations to the use of recycled products such as insufficient regulation and standards, and limited knowledge of performance characteristics. Further, designers should adapt a life-cycle perspective and take account of use of industrialized building systems too.

The incorrect documentation of construction works can lead to increased waste on-site due to errors by trades people or an increased incidence in changes to orders or rectifications. Designers should therefore be aware of the need to effectively communicate design and construction requirements.

A small number of construction firms adopt a 're-use' strategy in Sri Lanka. Normally, in large-scale projects, after the completion considerable amounts of each material are given up as waste. However, these materials may be sufficient for small-scale projects. Therefore large-scale contractors should have good relationships with small-scale contractors, as this can facilitate the sales of such materials.

In most countries, there are a number of re-cycling contractors available. However, in Sri Lanka there are no re-cycling contractors. Even though, in some sites, they use 're-cycling techniques' and it is limited to few materials such as sand, aggregate etc.

The contractor should be familiar with incorporating job-site recycling into waste management systems. Achieving effective on-site recycling requires careful planning and consideration of construction sequences and material flows. It must also be stressed that effective on site source separation of waste materials is essential to the success of recycling operations. There are some limitations to implementing the recycling process in Sri Lanka. These are;

- It gives better results on large-scale projects only.
- Initial cost (to buy equipments and machinery) is high.
- Possible need for operation training.

If the contractors adopt the re-cycling techniques, they can benefit form

- Less waste leaving the facility.
- Reduced liability and cost of transporting waste off site
- Reduced pollution.
- In the long term, it may be a source of generating higher profits.

Building and design teams need more encouragement to further 'Reduce, Reuse, and Recycle' construction and demolition waste materials. Since land is a scarce resource it is very difficult to find dumping sites within Colombo metropolitan area. By reducing construction site waste, the economic benefits can be immediately apparent. The builder or contractor saves by not buying excess material and then having to haul it away. These savings can be used to offset rising material prices. Therefore it is a must that action is taken to prevent these hurdles and minimize construction site waste. By minimizing this waste environmental improvements can be obtained.

Other than the waste minimization strategies there are some waste prevention attitudes, which can also be adopted to minimise waste on sites. It was identified that the main reasons for material wastage was the absence of a proper material reconciliation system on Sri Lankan construction sites.

The contractor should have a clear idea of the quantities of materials required for a certain activity and the quantity actually used for the same activity. Further, every attempt should be made by the contractor to have some kind of material reconciliation system. Proper planning, good organization, diligent execution, viable co-ordination and effective control are essential to make an effective and qualitative material reconciliation system.

It is difficult to forecast some of the essential points on control of materials on site at the planning stage. Management, particularly for the larger contract, should initiate a series of formal and informal pre-contract meetings with the appropriate staff. Together they have to discuss the aspects of materials waste relevant to the preparation of the outline planning and other pre-contract procedures.

5. CONCLUSION

The concept of sustainable construction emerged simultaneously with the evolution of the concept of sustainable development. It is a critical issue for the systems and techniques that are employed, to be able to measure progress (Brandon and Lombardi, 2005). The initial focus was on how to deal with the issues of limited resources, especially energy and on how to reduce impacts on the natural environment through minimizing waste and other harmful impacts.

The research paper focused on identifying the significance of construction waste sources, and their effects on the environment and the waste minimization strategies towards sustainability. According to the research it indicates that approximately 38% of construction firms do not have any policies on waste in Sri Lanka. Among them, they are concerned with 'minimizing waste at the source of origin only' and they do not consider the re-cycling or re-using methods during construction, which make high contribution to attain sustainable goals.

According to the analysis of data it was found that design changes, design/detailing errors, inadequate material handling and poor workmanship are the most significant sources of construction site waste during the construction. The first two sources reveal that the timely instructions and communications between the parties are essential and the next two sources point out the importance of training, education of workers and worker motivation.

The trend towards increasing waste reduction is encouraging from both the environmental and economic perspective. Waste prevention has two requirements. First: adaptability to the many constraints reinforced by a realistic materials control, communications and recording procedures concerning materials. Secondly, even for the most experienced firm, an on-going reappraisal is necessary for which a waste committee (or at the least an executive who has to keep waste prevention under review) backed by an on going training (and retraining) policy is desirable. Therefore the recognized institutes should introduce such policies and need to take necessary actions to implement them within Sri Lankan construction sector.

It is a significant issue that environmental impacts due to construction are very much considered, if it is not feasible the project might be abandoned. Pollution caused by waste disposal at the construction stage and operation stage of development project on the natural and built environment is very high. The effect of civil engineering project could be contributed to resource depletion such as water resourses and also to the contamination of lands. Due to the waste disposal on to the water reservoirs the contaminated water can cause disease. Therefore, waste minimization always helps to make a project environmentally sustainable.

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