

# “Waste Minimization and Environmental Sustainability during the Construction of High Rise Building”

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Submitted: 10-05-2022

Revised: 15-05-2022

Accepted: 18-05-2022

**ABSTRACT**— new construction projects are planned and implemented globally. Construction of the project may put pressure on natural resources, especially soil, noise and air pollution. These are normally at their peak in cities just before such projects are completed. Highways, bridges, flyovers, subways, and refurbishment generate waste. It's mostly made of inert materials like concrete and plaster. This garbage gets sucked up. Because of their size and weight, they are difficult to transport or store. Massive heaps of this heavy material litter roads, causing traffic bottlenecks.

**Keywords**— Waste, Recycle, Reuse, Quality, Recycling, Renewable, Sustainable, High-rise Structure, Environmental Impact

## I. INTRODUCTION

### Definition of Waste

According to Koskela, waste can be defined as “any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered as necessary in the construction of a building”. Waste can be classified as unavoidable waste (or natural waste), in which the investment necessary for its reduction is higher than the economy produced, and avoidable waste, in which the cost of waste is higher than the cost to prevent it. The percentage of unavoidable waste depends on the technological development level of the company. Waste can also be categorized according to its source; namely the stage in which the root causes of waste occurs. Waste may result from the processes preceding construction, such as materials manufacturing, design, materials supply, and planning, as well as the construction stage.

- Design
- Procurement
- Materials Handling
- Operation
- Residual

Small generator waste clogs municipal bins, rendering it unsuitable for composting or energy recovery. Drains clog. It is 10-20% of municipal solid trash (excluding large construction projects). India produces 10-12 million tons of construction trash. Global housing demand forecasts a 55,000 million cu.m. Shortfall Aggregates are required for the 750 m3 road segment. In the short term, building and demolition waste recycling may help. The study report emphasizes trash management and recycling methods.

### Direct Waste

According to waste that can be prevented and which involves the actual loss or removal and replacement of material is called direct waste. Most of the times, the cost of direct waste do not end up in the cost of material, but followed with the cost of removing and disposing. Thus, by preventing direct waste straightforward financial benefits can be obtained. Direct waste can occur at any stage of the construction process before the delivery of material to the site and after incorporating the materials at the building.

### Indirect Waste

Indirect waste occurs when materials are not physically lost; causing only a monetary loss. Waste due to concrete slab thickness larger than that specified by the structural design. Indirect waste arises principally from substitution of materials, waste caused by over allocation, where materials are applied in superior quantity of those indicated or not clearly defined in contract documents, from errors. Waste caused by negligence, where materials are used in addition to the amount required by the contract due to the construction contractor's own negligence.

### Cost-benefit analysis

Cost-benefit analysis is used to help people make decisions. Depending on when the analysis is

undertaken (before, during or after an activity), cost-benefit analysis can provide information to help assess:

- ✦ Whether a project or activity will be or is worthwhile;
- ✦ Should we invest in this project?
- ✦ Which of these two projects should we support?
- ✦ Which project will give us the best pay off per dollar invested?
- ✦ Which project will generate the highest value to society once we have paid for it?
- ✦ Whether a project or activity has been worthwhile. In the process of conducting a cost-benefit analysis, the information generated may also inform
- ✦ What it would take to make the potential benefits of an activity actually materialize (what the pre-conditions for success in the activity are); and
- ✦ The progress of an activity and how it should proceed/be revised based on the benefits and costs identified.

#### Components of the cost benefit analysis

The benefits of recycling are estimated from:

- ✦ Savings in landfill costs which are made up of the financial costs of landfill and externalities (environmental costs);
- ✦ The saved costs of collection for disposal;
- ✦ Possible other benefits amongst other things, we examine possible direct consumer benefits that are expressed as the difference between a willingness to pay to recycle and the actual cost.

#### 5R's of waste Management

- ✦ Refuse – to blindly adopt international trends, materials, technologies, products, etc. especially in areas where local substitutes/equivalents are available
- ✦ Reduce – the dependence on high energy products, systems, processes, etc.
- ✦ Reuse – materials, products, traditional technologies, so as to reduce the costs incurred in designing buildings as well as in operating them
- ✦ Recycle –all possible wastes generated from the building site, during construction, operation and demolition
- ✦ Reinvent – engineering systems, designs, and practices such that India creates global

The data are analyzed to build up cost and benefit curves for individual materials. The analysis takes a marginal perspective, it measures the costs and benefits of additional levels of recycling; this allows an assessment of the optimal quantity of recycling. A key requirement for such an analysis is to build up a sloping curve rather than a horizontal line based on a single cost or benefit estimate. The slope or steps on the marginal cost and benefit curves are built up

through assessing costs and benefits for separate geographical locations Territorial Local Authority areas.

Cost benefit analysis brings a set of assumptions, some of which are usefully outlined in more detail. The starting point for cost benefit analysis of government policies is the assumed objective: policy should result in an improvement in the overall welfare or well-being of society. To assess this, cost benefit analysis measures total costs and benefits wherever they fall in society and compares one with another; wellbeing-improving projects or policies are those for which the total benefits exceed the total costs. In doing this, analysis is not concerned with whether projects or policies have effects that differ across society, for example, if a decision has a net benefit for the nation but results in net negative impacts on some people and net positive impacts on others. The theory is that aggregate distributional effects of many individual policies (or the absence of policy) are addressed in aggregate, rather than for each individual policy.

Cost benefit analysis uses money as a way of aggregating overall impacts on wellbeing. It assumes that the way that people spend their time and money reflects their underlying preferences and that all individuals are seeking to maximize their wellbeing. Thus decisions to recycle or not are based on a weighing up of the personal costs and benefits of those decisions. Within this, individuals will state their preferences for living in a less wasteful society or for other outcomes that might result in a willingness to recycle.

This process should pay particular attention to vulnerable groups where impacts may be concentrated and coping capacity may be low. This prioritization could consider the following criteria:

Costs and benefits that may have an absolute economic value that is high enough to influence the overall result.

Costs and benefits with a perceived high value from certain stakeholder groups, particularly vulnerable communities

The environment is treated in the same way as other resources, i.e. no consideration is given to any differences between the impacts on natural and physical capital. Rather it is assumed that people's preferences for attributes of the environment.

Cost benefit analysis assumes that people and firms act consistently and rationally with the objective of maximizing wellbeing and that we can use money as a convenient way of measuring the aggregate effects.

Waste minimisation processes to minimize the quantity of material that requires final disposal is encouraged in through policies and programmes at

national, regional and local levels. This has included the establishment of targets for recycling of individual materials.

Government intervention to encourage waste minimisation is justified on the basis of market failure. In the national waste strategy, examples of market failure are used to define the waste problem; these include the environmental effects of landfill and inefficient resource use; we combine these impacts with other costs and benefits of recycling to address the following questions:

- ❖ What are the economic costs and benefits of diverting a number of waste streams from current disposal practices?
- ❖ What is the net economic effect of given levels of recovery of each of these wastes? i.e. how do the costs and benefits compare?
- ❖ Are there opportunities for net economic benefits from increased levels of diversion of individual waste streams?

As the construction industry is time and cost driven, developers and construction project managers typically favour demolition over deconstruction as they perceive it is the quickest and cheapest way to take down old buildings. Depicts the current perceptions associated with deconstruction. These are mainly concerned with the complexity of deconstruction in terms of project management, site planning, commitment, skills required for the task and onsite waste sorting. Also, the uncertainty about demand for deconstruction materials often leads to developers to question the profitability of deconstruction.

### Cost Generation in On-Site C&D Waste Management

A typical waste management process in a construction project is comprised of the following main activities.

- ✚ Collection of waste materials,
- ✚ Transport of materials to the storage area located on-site,
- ✚ Sorting of materials to different waste types, and
- ✚ Storage in waste material bins until off-site transport begins.

The sorting of materials to different material bins is required only for the materials types for which the strategies are reuse and/or recycling. All of the other activities are also necessary for the waste management alternative of landfill disposal. Therefore, when evaluating the costs and benefits of reuse and recycling, an additional cost component must be incorporated.

It can be seen that in the overall construction process, resources, materials, manpower and equipment are first invested, and then C&D waste is

produced with time and cost accumulation. Collecting and sorting waste takes time and requires cost. The storage site is required if the waste is collected but not handled in time, therefore cost is generated. Finally, with the transportation of C&D waste to a disposal field or comprehensive treatment place, more cost is generated.

### Costs of Recycling Waste Materials

The recycling process can be identified to comprise of the following four consecutive stages at which costs are incurred:

- a) Collection, transportation and storage of waste on-site,
- b) Sorting into different categories of waste,
- c) Transporting sorted waste to an off-site recycling facility, and Weighing and admission of waste into the recycling facility.

### Costs of Reuse

Reuse of waste materials, which may be a better solution to waste materials generated from demolition projects. However, for the completeness of the model, reuse costs and benefits were also included in the simulation model. The reuse process can be identified as comprised of the following costs:

- a) Collection, transportation and storage of waste on-site,
- b) Sorting into different categories of waste,
- c) Transporting sorted waste to an off-site or on-site location for further processing if required, and
- d) Processing materials for reuse.

### Effect of poor waste management

Waste management at site begins with housekeeping and waste segregation. Housekeeping should be a common practice by all contractors as it is part of all project agreement. According to Saskatchewan Construction Safety Association, housekeeping is the main problem at construction site. Many accidental and near misses occur as a result of poor housekeeping. Efficiency and morale at the worksite can be greatly improved if positive attitude and proper care is taken towards housekeeping. Housekeeping is not just cleaning up waste; it provides a complete basis on which to strengthen overall practices at your construction site. Without a good housekeeping practice, chances for slip, trips, and more serious accident at site are high.

- ✚ Tools not properly stored and are more easily damaged;
- ✚ Time is wasted cleaning up or looking for items in the mess;
- ✚ Emergency exits and access to fire extinguisher can be blocked;

✦ Sharp objects, wires, greases, scrap materials and lumber with protruding nails area among the typical workplace hazards that will affect the workers safety.

Material flow analysis and cost benefit analysis. Two scenarios were elaborated for the cost benefit analysis:

- ✦ Scenario I assumes a waste management system with source separation and separate collection of all types of recyclable materials and that the rest waste flows directly to the landfill;
- ✦ Scenario II differs from Scenario I in that metals are not separated at source, but flows with the rest waste to an incinerator before landfilling, where advanced technologies are applied to control air quality and to recovery energy, ferrous metal and non-ferrous metals.
- ✦ A cost- benefit analysis will illustrate whether the inclusion of a waste incinerator with the advanced bottom ash separation and recovery technology improves the economic efficiency of the waste management system
- ✦ The cost includes investment cost of the equipment and operational and maintenance costs of the incineration plant
- ✦ A cost- benefit analysis is then conducted, where the full range of costs and benefits arising from the subject scenario in comparison with a baseline scenario is analyzed. The Net Present Value as the result of the cost benefit analysis will be presented, together with a sensitivity analysis. Practically, not all costs and benefits can be known, nor can every known impact be measured reliably in economic terms
- ✦ The cost- benefit analysis are defined, where impact parameters are also identified, such as cost of land acquisition, cost of construction, and cost of technology and equipment, operation and maintenance cost, energy sales, revenue from selling recovered metals and the waste treatment fee willing to be paid by the municipal government.

Information is needed in a cost-benefit analysis to assess benefits and costs. In general, the financial costs of a proposed activity are relatively easy to determine. More difficult is the estimation of benefits or intangible costs. This is because the benefits of many activities – especially before a project takes place – are still only hypothetical so their true extent may not be clear.

✦ Waste management project development should be based in the waste hierarchy and waste valorization;

✦ Waste management projects shall promote risk minimization to health and environmental, including sanitary and phyto-sanitary measures;

✦ Waste management projects shall use best technologies available that seek to minimize environmental impact and impact on human health;

✦ Waste management projects shall encourage the establishment of waste management standards.

✦ This responsibility includes the impacts in the selection of technology, the production process, the use of the product as well as the treatment and final disposal of the produce.

### Concept of Waste

#### Material Waste

One of the fundamental themes of sustainable construction is material usage and wastage. Material waste is becoming a serious environmental problem in many large cities in the world. But he believed that there is plenty of scope for improving efficiency and quality simply by taking waste out of construction. The amount of waste construction generates continues to be a major problem for the industry and in many countries.

Material waste should be defined as any negative activities that generates direct and in-direct cost but do not add any value to the project. In a related issue, contemporary research into the problems and solutions of waste in construction projects suggested that waste can occur at any stage of the construction process from conceptualization, through to the design, construction and demolition of the construction infrastructure.

Construction waste can be divided into two main categories, namely, waste generated due to design and specification, and waste generated by construction activities. The above studies have shown that the most significant sources of construction waste are generated during the construction phase usually stemming from Poor storage, protection, and site control; Poor or multiple handling; Poor quality material; Inaccurate or over ordering of materials or leftover; Inefficient use of materials; Bad stock control; Lack of training; Damage to materials during deliveries.

Waste minimisation involves any process, method or activity, which reduces, negates or eradicates waste at its source, or allows recycling to enable re-use. This also takes into consideration materials emitted into water, air and land, including energy consumption. The accepted definition of construction waste minimisation is “the reduction of waste at source, i.e. designing out waste by understanding its root causes and re-engineering current processes and practices to alleviate its

generation". In order to create a practical waste minimisation and management strategy, a comprehensive understanding of the causes of construction waste is needed. This knowledge is an essential part of the strategy as it allows effective methods for dealing with these wastes at their source to be established.

The causes of waste in construction projects indicates that waste can arise at any stage of the construction process from inception, right through the design, construction and operation of the built facility.

### Supply Chain Issues

These challenges have been classified under external and internal supply chain issues and they are discussed below:

- ✦ **Lack of integration in the industry** – The construction industry has been characterized by fragmentation and lack of integration. It was found that significant barriers exist to waste management within the construction sector, which stem from lack of integration within a project team in a construction project. Improving the collaboration between the parties within the construction industry will enhance productivity whilst maximizing efficiency and effectiveness.
- ✦ **The regulation at present are considered as a soft touch** – Under the current regulation, the design team have been able to attain excellence by paying lip service to sustainable design. This goes to prove that the current regulations are not tough enough to implement some of the key issues of waste minimisation;
- ✦ **Lack of knowledge and training in the part of project team** – Evidently, there is serious lack of knowledge of the environmental issues in general in the supply chain as identified in the literature. Consequently there is no formal training mechanism in organization or learning from other industries on how to reduce carbon emission in the supply chain;
- ✦ **High capital cost of reducing or eliminating waste** – because the industry already operates on very low profit margin, it will be difficult to convince the various supply chain members to buy into the idea;
- ✦ **Poor Suppliers' commitment** – Several authors identified poor supplier commitment as a hindrance for waste minimisation practices. They all cited lack of information, confidentiality concerns and fear of poor performance exposure for lack of commitment in addressing waste in construction;
- ✦ **Nature of the clients or customers** – construction industry client desire for lowest price hinder waste management practices. As

documented in many research works on green supply chain, it is argued that selection of tender by clients based on lowest price will impact on any environment strategy requirement; and

- ✦ **Supply chain specify challenges** – it has been established that different organizations in the supply chain have different drivers, barriers and practices and these can influence how reactive or proactive organizations can respond to waste management strategies.

### Waste Generation Rates Estimation

The primary purpose of this study is to propose a less burdensome and more broadly applicable alternative to estimate the WGR of construction and demolition projects. Given that still new and lacking in applicable research, this study focuses on investigating, relative to the construction method employed. This study also investigates the composition of such CDW to identify the percentage of recyclable material.

The projects were selected in accordance with the fulfilment of the following parameters:

- ✦ Project job-site accessibility;
- ✦ Project with available secondary data, such as invoices or reports on waste disposal trips or other waste costs; and
- ✦ Project where a waste sub-contractor handles the construction and demolition waste.
- ✦ Review of existing secondary data, including monthly progress report, waste management plan, contractor claims and invoices, bill of quantities and tender documents indicating waste disposal cost, waste composition, and frequency of disposal;
- ✦ Gathering of primary empirical data through periodic site observations conducted throughout the first half of 2015, including sampling and measurement of waste bin size; and
- ✦ Structured interviews and surveys of related personnel, to supplement and qualitatively improve the above-referenced primary and secondary data obtained.
- ✦ Concrete/ Aggregate (1.26) Cement/ Plaster (0.92) Reinforced concrete (1.44) Dirt/ Soil/ Sand (1.56) Timber/ Plywood (0.39) Brick/ Block (1.40) Scrap metal (0.90) Tile (1.17) Plasterboard (0.33)
- ✦ Concrete, aggregate, reinforced concrete, and cement are the main materials in building construction. Project contractors often do not know the exact quantity of each material required, relying instead on estimation that is prone to waste of concrete. Concrete production is time-sensitive and must match up with daily

work demand, with a tendency to oversupply rather than risk a costly work delay

## II. LITERATURE REVIEW

**Role of Rag Pickers in Solid Waste Management in Nashik City, Pooja Dubey, Prof. Abhay Shelar, International Journal of Engineering Research & Technology (IJERT), May 2019**

The NMC Khat Prkalp plant is designed to degrade biodegradable waste materials generated in kitchens, vegetable markets, slaughterhouses, food and fruit processing companies, as well as agro-waste and biomass. Nasik City is 10 kilometers away.

There is also a proper system for leachate, which is connected to the leachate treatment plant for further processing.

This document summarizes the current state of MSWM in Nasik, as well as essential planning data and planned actions for improvement. As a result, it serves as a planning document for Nasik's long-term Municipal Solid Waste Management. About 70 to 75 percent of recyclables in the country are purchased from families and business entities by the informal sector, sometimes known as the "kabadi system." Individuals, families, groups, and small businesses operate unregistered and unregulated businesses in the informal sector.

**Waste Management Practices in Gadhinglaj (Survey Analysis), Parag S. Dawane , Prof. Sagar M. Gawande, International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03 | June-2015**

We conducted this questionnaire survey in the city based on a study of the general trash concerns that people face. Our volunteers conduct the survey by physically asking these questions to people in various locations of the city during the survey. The information on solid waste generation, collection, disposal methods, storage practices, waste composition, and pollution problems is thoroughly examined, and key remarks are made.

A total of 250 forms were distributed, and people's feedback and recommendations were recorded. In the paper, certain primary observations are documented and interpreted.

**"Analytical Study of Physical Characteristics of Phursungi Dumping Yard in Pune Region," Chetan G. More, Sagar M. Gawande and Gajanan S. More, International Journal For Research In Emerging Science And Technology, Volume-4, Issue-5, MAY-2017**

The urban regeneration and housing act of 2015" aims to boost activity in the housing building sector by giving local governments the capacity to keep a record of lands that are suitable for housing but are not being developed. According to a research conducted by the Central Pollution Control Board (CPCB), India will require approximately 169.6 km<sup>2</sup> of land in 2047 to dump its 300 million tons of solid trash every year. It is past time to consider the dumping ground region as a potential source of regeneration. The physical parameters of the Phursungi dumping yard were investigated in this work for the goal of land regeneration, taking into account accessibility, climatic analysis, and proximity analysis.

**Experimental Study on Ready Mix Concrete Plant Waste Concrete as a Aggregate for Structural Concrete Abhay Shelar (&) , D. Neeraja, and Amit B. Mahindrakar, Springer Nature Singapore Pte Ltd. 2020**

The usage of Arranged blend solid plant abuse concrete is expanding rapidly, regardless of whatever precautions were attempted to limit its use. This results in a lot of waste every day, which is very inconvenient.

A sound and sustainable reuse of Arranged mix solid plant abuse solid offers a diverse range of benefits [1]. The suitability of recycled abuse concrete as a coarse total in bond, as well as its focal concentrations, are discussed. The essential want for bond quality creation and hydration sparkling in Arranged blend solid plant waste solid total was addressed. The attributes of Arranged blend solid plant waste solid total, such as thickness, specific gravity, and total smashing worth, were determined by tests. Because complete substitution of stable coarse total (NCA) with Arranged blend solid plant squander bond coarse total (RMCW) is achievable, insufficient substitution at various rates was investigated [3]. For picking trade qualities such modulus of flexibility, split rigidity, and flexural quality, the rate substitution that generated higher compressive quality was used. With 100 percent NCA supplanted concrete, higher compressive quality with increase bond was discovered.

**Strength and Durability of Concrete Paver Block Bhimaji Dashrath Kanawade1 , Sonali Ratnakar Nawale, Advances in Civil & Structural Engineering, 2017**

Concrete paving blocks are perfect for walkways because they are easier to place and have a superior look and finish. It was discovered that new pavers deteriorated quickly, and the blocks became

unusable within three years. This was a major source of concern, and the issue needed to be identified. The purpose of this study is to discover the qualities of those blocks that degraded quickly vs those that offered long-term satisfactory service, as well as test techniques and requirements that will assure that blocks are durable.

**International Conference on Sustainable Engineering Techniques (ICSET 2019), IOP Conf. Series: Materials Science and Engineering 518 (2019), Impact of the Feasibility Study on the Construction Projects, Sawzan Rasheed Mohammed, Hafeth I. Naji, Rouwaida Hussein Ali**

A Feasibility studies include recognizing and analyzing the power and the flaws of the project, in conjunction, also defining the chance and intimidations external the company within the construction industry. There are a number of problems of the feasibility study as it regards overlooked part in Iraqi construction industry and the problems of feasibility studies abuses. Misinterpretation of study stages and also having incorrect idea of the goal of the feasibility studies, other factors that affect directly and negatively in the Iraqi industry such as delay, cost, and other issues that affect quality of the construction projects The aim of this paper Assess the awareness level of the feasibility study in construction projects and to determine the effects of feasibility study in construction industry and to identify the causes of abuses of feasibility study in construction industry. The methodology of the paper includes survey and formulation of the questionnaire to identify the factor the cause the feasibility study to fail and then use system dynamic to analysis the impact of these factors. The results show that the feasibility study is neglected part in Iraqi construction project due to the fact that its neglected, the were abuse in use the abuse of the feasibility study lead to cost and time over runs, and system dynamic technique approved to be a significant in the analysis of the impact of the.

**J Prakash Arul Jose, P Rajesh Prasanna, Fleming Prakash, "Lean Design Strategy of Waste Minimization in Construction Industries" International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 6 (2018) pp. 4593-4598 ©Research India Publications <http://www.ripublication.com> 4593**

Construction waste minimization is practiced, for the system to be economical and feasible, irrespective of the construction methodology. This paper would be the answer for wastage problems that are common in construction sectors. On reviewing the reliability and accuracy over both the construction and demolition waste, a management scheme is proposed in accordance with lean

construction concept. In lean design, last planner system is implemented to identify the confronting problems, where resource management and scheduling are the key concepts that are focused on. Hence this proves to be an ideal approach in dealing with waste minimization and productivity enhancement by the analysis of the percent of planned complete.

**Economic Viability of Construction and Demolition Waste Management in terms of Cost Savings -A Case of UK Construction Industry Article · Abioye Oyenuga, Rao Bhamidimarri, September 2015,**

The economic viability of managing C&D waste on construction site can be justified by the cost-savings potential in many cases. However, by understanding of proper waste management, the total benefits will continue to exceed cost associated to waste operations as a whole. The paper investigated the problem of C&D waste and management awareness, strategies, and current practice in the UK construction industry, and extended study scope to evaluate the economic viability of applying the 3Rs principle to construction and demolition waste in terms of cost savings. The study found out that net benefit of reusing and recycling of C&D waste is estimated at a significant amount of total project budget. Realistically, the UK construction industry can, in fact, save money by implementing waste minimization practices using 3Rs principles in managing wastes on construction sites.

**Management of Construction Waste Materials: A Review Thangjam Somchand Singh, International Journal of Geology, Agriculture and Environmental Sciences Volume – 3 Issue – Website: [www.woarjournals.org/IJGAES](http://www.woarjournals.org/IJGAES) ISSN: 2348-0254 WOAR Journals, 4 August 2015**

The cost of construction materials may be up to 65% or more of the total cost. Utilization of appropriate construction materials coupled with effective management of these construction materials largely help successful completion of the structure. Due to mushrooming of big construction industries/companies, disposal of construction wastes has become an environmental issue these days, especially in big cities. A large quantity of various types of construction wastes with different characteristics is generated every day. However, this environmental problem may be minimized by introducing a systematic management of construction wastes. Such a system coupled with appropriate construction techniques minimizes generation of waste construction materials and consequently helps in achieving economic and environmental benefits. In

this study, a review on systematic investigation on the management of construction materials and construction wastes is presented.

**Economic Aspects of Construction Waste Materials in terms of cost savings – A case of Indian construction Industry “Mansi Jain” International Journal of Scientific and Research Publications, Volume 2, Issue 10, October 2012 1 ISSN 2250-3153 www.ijsrp.org,**

The excessive wastage of materials, improper management on site and low awareness of the need for waste reduction are common in the local construction sites in India. Today, in most European countries, it is economically feasible to recycle up to 80–90% of the total amount of construction waste and most demolition and recycling technologies are generally easy to implement and control. Considering enormous increase in amount of waste generation owing to the growth in construction industry can lead to wastage of materials which has its economic value. Currently, existence of regional and national policies, laws and regulations governing reuse and recycle principles for C & D waste is minimal in India. Thus the paper aims to focus on the economic feasibility of waste minimisation of construction waste materials in terms of cost savings in India.

**Feasibility and cost-benefit analysis of automated underground waste collection in Tallinn Old Town, January 2019, Tuuli Vreimann Karl Kupits Kadri Mäsak,**

The size of the building that accommodates the collection terminal depends on the number of collected waste types. The building features a control centre, airtight waste containers and separate rooms for pumps. The minimum area of the building is 500 m<sup>2</sup>. Further, the building size depends on installed equipment and requirements to structural design. The building needs an 800A power supply with energy consumption typically ranging between 30 and 50 kWh per ton of waste. The collection terminal consists of four core components: • waste and air separator consisting of a cyclone and rotating screen. Air conveying waste is channeled through a filter that removes dust and smell; • bunkers or containers where the waste mass is compacted plus an overhead crane to change bunkers where necessary; • vacuum device with automation equipment. An important element here is a compressor with ancillary devices which produces compressed air and activates all valves in the system; • filtration system to reduce odours.

**"Evaluation of costs and benefits for the achievement of reuse and recycling targets for the different packaging materials in the frame of the**

**packaging and packaging waste directive 94/62/EC" –Final consolidated report, RDC-Environment & Pira International, March 2016,**

An investigation concerning the possible establishment of reuse targets for the relevant packaging materials by the end of the second five-year phase (30/06/2006) taking into account technical feasibility, costs and environmental benefits, and the development of a methodology for the calculation and monitoring of these targets. Identifying whether landfill, incineration or recycling is preferable implies a number of methodological problems. This will concern both the determination of the environmental, social and economic impacts related to the various options in a life cycle assessment (LCA) and the monetary valuation of these impacts in a cost benefit analysis.

**Construction waste management in India Job Thomas, Wilson P. M. American Journal of Engineering Research (AJER) e-ISSN: 2320-0847 P-ISSN: 2320-0936 Volume-2 pp-06-09 www.ajer.org,**

The management of construction waste is important today. The scarcity in the availability of aggregate for the production of concrete is one of the important problems facing by the construction industry. Appropriate use of the construction waste is a solution to the fast degradation of virgin raw materials in the construction industry. This paper enlightens the importance of reduce, reuse and recycle (3R) concept for managing the construction waste in India. Waste from small generators like individual house construction or demolition; find its way into the nearby municipal bin, waste storage depots, making the municipal waste heavy and unsuitable for further treatment like composting or energy recovery. Sometimes the wastes from small projects are buried in the site itself, forming an impervious layer, which adversely affect the growth of vegetation, prevent the infiltration of surface run off into the ground water table and lead to high level of environmental imbalance. The exploitation of potential resources from construction and demolition (C&D) wastes is yet another opportunity and future profession in the construction industry in India. Waste minimization and waste management programs are in its infancy in India. It is possible to minimize the volume of C&D waste generated by identifying the potential waste early in the design. But even with proper resource-efficient design and by adopting proper construction and deconstruction procedure, some waste may essentially be generated in every project.

**Economic Feasibility of Waste-to-Energy Project in the Philippines Using Real Option Approach, Resy Villanueva, Riza Villanueva, Paul,**



**Johannes G., Joan Arce-Jaque, Neil Ravena, and Salome P. Villamor. "Integration of the informal sector into municipal solid waste management in the Philippines—What does it need?" Waste Management 32, no. 11 (2012): 2019.**

Waste to energy refers to the recovery of the energy from waste materials into usable heat, electricity, or fuel. 18 Different WtE approaches can be categorized into landfill, thermal treatment, and biological treatment. Landfill gas recovery system (LFGRS) can be considered as a WtE technology when it generates biogas (CH<sub>4</sub>) used for energy generation. This suits in municipalities that yield waste which is high in biodegradable content and moisture. Thermal treatment, the most commonly used large-scale WtE technology, employs the traditional incineration and more advanced pyrolysis and gasification.<sup>19</sup> while pyrolysis and gasification involve manual sorting and indirect combustion of MSW to mainly produce syngas, incineration involves a direct combustion of unprepared MSW that yields enough energy to power a steam turbine. Biological treatment on the other hand involves aerobic composting and anaerobic digestions which produces fertilizer or biogas among these treatment technologies, our study focus on thermal treatments in line with the government's WtE projects under evaluation.

**Material waste in the uae construction industry: main causes and minimisation practices A. Al-Hajj, PhD, Heriot-Watt University K. Hamani, MSc, January 2016**

In order to investigate the causes of material waste in construction sites and to assess the current material waste minimisation practices implemented by the UAE contractor's two sets of information were gathered. First, four projects with different locations; sizes, types and at different stages of construction were visited to audit material waste management on construction sites and to find out from project managers about the processes used to minimize construction waste. The results obtained from this stage were analyzed and combined with the literature findings to design and to analyze the questionnaire survey. In the second stage a non-random sampling approach was adopted and only medium and large companies having construction and general contracting as their primary business were targeted.

**A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia Rawshan Ara Beguma,\*, Chamhuri Siwar a, Joy Jacqueline Pereira a, Abdul Hamid Jaafar, © 2016 Elsevier B.V. All rights reserved.**

Construction waste is becoming a serious environmental problem in many large cities in the world. In Malaysia, the construction industry generates lots of construction waste which caused significant impacts on the environment and aroused growing public concern in the local community. Thus, the minimisation of construction wastes has become a pressing issue. This paper is based on a case study which involved construction waste generation and composition as well as reuse and recycling in the site. The case study also analyzed the economic feasibility of waste minimisation such as reusing and recycling of construction waste materials by performing a benefit–cost analysis. This study provides an idea of the amount of waste generation, sources and compositions as well as reuse and recycling of materials on the construction sites taking into account the economic dimension. The study shows that waste minimisation is economically feasible and also plays an important role for the improvement of environmental management. In this view, economic instruments for minimising construction waste can be used to raise revenue for environmental policy, encourage prevention efforts, serve to discourage the least desirable disposal practices, as well as to avoid the negative consequences of environmental unfriendly treatment and disposal practices of construction waste materials.

**Sustainable Building and Integrated Construction Waste Management Challenges and Strategies for China Zixiang Chen, Ping Liu, Yunhui Yang Kunming Metallurgy College, Kunming, China, 3rd International Conference on Humanities and Social Science Research (ICHSSR 2017),**

Punishments Policies and Mechanism on Construction Waste Management It is highly recommended that Chinese government should enforce stronger waste management policies, such as levying heavier construction waste disposal fees at landfills, and levying fines or penalties for extremely poor waste management. Chinese government is taking some actions to tackle the waste problems by establishing a policy which requires all stakeholders of the project to prepare waste management plans for disposal and strictly to minimize the amount of construction and demolition waste entering landfills. The building parties involved should try their best to reduce, reuse and recycle the construction before it disposes to landfills to avoid fines or penalties.

**Economic and Operational Feasibility Analysis of Solid Waste Minimization Projects Matthew J. Franchetti, March 2017,**

The purposes of this chapter are to demonstrate a structured process to evaluate and determine the operational and economic feasibility of solid waste minimization projects that are based on proven financial engineering concepts. Many organizations are concerned with reducing solid waste levels, but few have the tools and necessary resources to evaluate and select among competing projects. These projects can range from fixed equipment purchases, such as balers or digesters, to implementing an office recycling program. This chapter provides a standardized business-based process to evaluate and select among competing solid waste minimization projects to determine which will best meet the organization's goals and maintain compatibility with existing processes. The analysis process involves identifying the benefits, costs, and drawbacks associated with each alternative project. To accomplish this, each alternative is evaluated based on: the impact on the program goal, technical feasibility, operational feasibility, economic feasibility, sustainability, and organizational culture feasibility. In addition, the paper explores the impact of uncertainty in decision making by highlighting economic efficiencies, sensitivity analysis, and changes to the data inputs, specifically inflation, recycling levels, and recycling commodity market shifts. This chapter may serve as an example or model for organizations considering the implementation of competing solid waste minimization projects.

**A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia Resources Conservation and Recycling · July 2018, Joy Jacqueline Pereira, Siwar Chamhuri, Rawshan Ara Begum,**

The case study demonstrates that construction materials contribute to the generation of large quantities of the construction waste. Waste minimisation is common in the project site where 73% of the waste material is reused and recycled. Waste minimisation is economically feasible and also plays an important role for the improvement of environmental management. The net benefit of reusing and recycling of waste materials is estimated at 2.5% of the total project budget. Thus, the construction industry can save money by implementing waste minimisation practices on the site.

**Advances in Social Science, Education and Humanities Research, volume 121, 3rd International Conference on Humanities and Social Science Research (ICHSSR 2017), Sustainable Building and Integrated Construction**

**Waste Management Challenges and Strategies for China Zixiang Chen, Ping Liu, Yunhui Yang,**

China's rapid march toward urbanization makes sustainable building a priority at all levels of governments. Construction industry contributes not only a great portion of economic output, but also contributes a large of portion of solid waste stream which causes the serious negative impacts towards environment and ecosystem in China. Therefore, sustainable development is of paramount importance to China's future. Hence, this paper outlines sustainable building challenges in China currently, and enlightens the importance of Sustainable Building and Integrated Construction Waste Management process through the principle of Life Cycle Design, and the interactions and synergies among BIM, sustainability building technology, which will maximally alleviate construction waste situation by way of reduce, reuse and recycle the construction waste in China.

**Modelling International Project Feasibility of Sustainable Construction Management: Case Study of Tele-Communication Towers Samad M. E. SEPASGOZAR, Gholam Reza SHIRAN, Khalegh BARATI and Renard Y. J. SIEW, ISSN 2562-5438, 2017**

This paper is a result of the initial stages of an on-going study to develop a rigorous model of construction feasibility with sustainability considerations. Two case studies of similar construction projects were selected from two developing countries. The model for project feasibility study proposed in this paper includes economic, social, and environmental performance criteria in addition to traditional project criteria. The paper suggests there is an urgent need for shifting from the traditional approach of project feasibility study to a new approach embracing sustainability principles.

**JOURNAL OF ENVIRONMENTAL ENGINEERING AND LANDSCAPE MANAGEMENT ISSN 1648–6897 / ISSN 1822-4199 2016 Volume 24(03): 185–199 Cost Analysis of MSW Management Scenarios-IASI- ROMANIA CASE STUDY, Cristina GHINEA, Maria GAVRILESCU,**

In this context, the evaluation of economic aspects is imperative since the implementation of a solid waste management system is connected with considerable investment and operating costs. The goal of this study is to assess and report the performance of various waste management scenarios in terms of costs and to determine the most suitable alternative. For this purpose, we analyzed a case study in a typical

Romanian urban area, in terms of the economic impacts of four waste management scenarios. The economic evaluation was performed based on a cost structure, which we have elaborated to analyze the waste management scenarios from a cost perspective. The results indicated that the most suitable alternative for implementation from economic viewpoint in the studied area is scenario which included the following treatment/elimination methods: sorting, composting and landfilling.

**A Review on the Economic Feasibility of Composting for Organic Waste Management in Asian Countries** Mirza Hussein Sabkia , Chew Tin Leea,b, Cassandra P. C. Bonga , Jiří J. Kleměš, VOL. 70, 2018, CHEMICAL ENGINEERING TRANSACTIONS, ISBN 978-88-95608-67-9; ISSN 2283-9216,

This study aims to review the economic feasibility (EF) on two different composting systems, which are the in-vessel and windrow system, implemented in several developed and developing countries. The review considered the cost factors for both composting systems, including the capital cost and operating cost. The return on investment (ROI) is estimated for both composting systems based on the potential cost benefits from the compost sale and the saving of waste tipping fee. This review provides a better insight into the desirability and applicability of both composting systems as an alternative to the landfilling practice. It is expected that the review of the various composting system could be very useful for improving the sustainable composting technology in the developing countries.

**Economic Viability of Construction and Demolition Waste Management in terms of Cost Savings -A Case of UK Construction Industry** Article · September 2015, Abioye A. Oyenuga , Rao Bhamidimarri,

The economic viability of managing C&D waste on construction site can be justified by the cost-savings potential in many cases. However, by understanding of proper waste management, the total benefits will continue to exceed cost associated to waste operations as a whole. The paper investigated the problem of C&D waste and management awareness, strategies, and current practice in the UK construction industry, and extended study scope to evaluate the economic viability of applying the 3Rs principle to construction and demolition waste in terms of cost savings.

**Thangjam Somchand Singh, Management of Construction Waste Materials: A Review** International Journal of Geology, Agriculture and Environmental Sciences Volume – 3 Issues – 4 August 2015,

With the advancement of science and technology, a wide range of new building construction materials has been developed for the construction of civil engineering structures. Depending upon the type of the structure, the cost of construction materials may be up to 65% or more of the total cost. Utilization of appropriate construction materials coupled with effective management of these construction materials largely help successful completion of the structure. Due to mushrooming of big construction industries/companies, disposal of construction wastes has become an environmental issue these days, especially in big cities. A large quantity of various types of construction wastes with different characteristics is generated every day. However, this environmental problem may be minimized by introducing a systematic management of construction wastes.

Such a system coupled with appropriate construction techniques minimizes generation of waste construction materials and consequently helps in achieving economic and environmental benefits. In this study, a review on systematic investigation on the management of construction materials and construction wastes is presented

### III. RESEARCH METHODOLOGY

#### Aim

“This study intended to assess how Sustainable Construction Projects principles could boost project profitability and efficiency. This study also compared and contrasted the construction practices in India, assessing waste reduction”.

#### Problem Statement

“Construction Waste prevention and recycling save money. Waste prevention benefits the environment, society, and your organization as a good neighbor. Designing out waste is a novel idea. Several difficulties and opportunities surround design waste reduction. That's why we started this. It's supposed to inspire waste-free design. the 4R concept—Reduce, Reuse, Recycle, and Recover—are given adequate consideration. It manages waste”.

#### Objectives

- To identify the activities require various resources at each stage of construction.
- To identify and analyze the amount and types of

resources required.

- To analyze the scope of resource optimization at each stage and activity by process/method change and reuse/recycle of the Resources.
- To compare the results with convention practices for resources consumption.

### Research Methodology

Study of literature from various technical papers of both national and international level as well as study of literature from books available in library

- ✓ To find out the various sources of waste generation in terms of material, and time required for recycling and reuse of construction waste and efforts generated in construction activities.
- ✓ For further study in construction wastes take a case study that includes all construction activities. For that particular case study cost-time management will be done.
- ✓ The material wastage generate on site will be measured and maximum amount of material will reuse and recycle to minimize waste. To find cost required to recycle and reuse using cost benefit analysis.
- ✓ To find the factor of construction wastes prepare a survey related to wastages to know current scenario about construction waste management.
- ✓ For finding factor of construction waste use in which factors shows which factor is more concern to wastages generate on site.
- ✓ Apply the technology to minimize the non- value added activity or wastage and increase the productivity of the construction industry.
- ❖ Rework (due to design errors detected during design)
- ❖ Non value-adding activities in information and work flows
- ❖ Waste identification,
- ❖ Source separation and collection;
- ❖ Waste logistics;
- ❖ Waste processing;
- ❖ Quality management;
- ❖ Policy and framework conditions

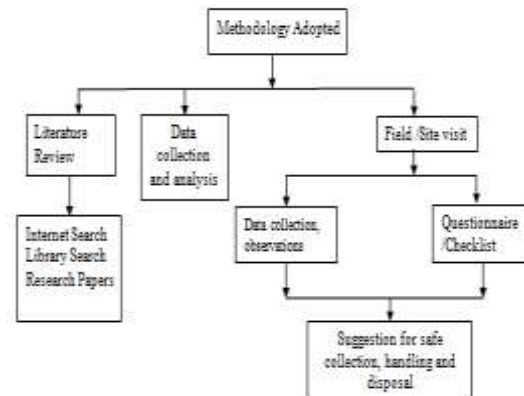


Figure1.1: Methodology Flow

### Guidelines for Improving the Productivity

- Properly training to the labourers
- Motivation to workers towards project completion
- Properly and in advance material procurement and management
- On time payment to the workers
- Systematic flow of work
- Properly, clearly & in time supervision
- Advance site layout
- Maintain work discipline
- Facilities to the labourers
- Clearance of legal documents before starting of work
- Systematic planning of funds in advance
- Pre-monsoon plan to avoid work stop
- Maximum use of machinery and automation system
- Advance equipment planning

### Benefits of Construction

- ✓ Reduce Project Duration
- ✓ Reduction in waste
- ✓ Smooth Workflow
- ✓ Visual Control
- ✓ Improved Safety
- ✓ Improved Project Quality
- ✓ Client's Satisfaction
- ✓ Improved Flexibility
- ✓ Proper Scheduling
- ✓ Defects Reduction
- ✓ Simplifying Work
- ✓ Reduction in Cost
- ✓ Proper Estimation
- ✓ Greater Profit
- ✓ Improved Communication
- ✓ Minimize inventory
- ✓ Control Budget

#### CASE STUDY

- Structure Type: Residential Building Construction
- Construction Type: RCC Construction
- Name of the builder: SiddhiVinayak Group, Pune
- Location: Dhayri, Pune-41
- Total project Cost: 95.45 Crores
- Total Length: 150/90 m
- Date of Commencement: November 2019
- Completion period: 72 Months
- Construction Type: RCC Frame Structure.
- No. of Floor: G+30 Floor
- Total Area of Building: 4, 25000Sq.ft.
- Plinth Area: 10150/- Sq.ft
- RCC Contractor Name: Mr. Swapnil Dhawade
- Authority Engineer: Harshi Chaddha
- Local Authority: Pune Municipal Corporation, Pune
- Walls: 230 mm thick brick masonry walls only at periphery.
- **RCC Design Consultant:** G. A. BHILLARE STRUCTURAL CONSULTANT PVT. LTD.

#### IV. LIMITATION

- Waste minimization techniques can be failed by lack of interest from client side, staff and workers..
- This may impart addition project cost and may create a cost obligation in project.
- Approvals from government development authorities.
- Lacking of trained Engineers to implement i.e. Training must be conducted.
- Availability of the required infrastructure for implementation.

#### V. CONCLUSION

- ✓ From the results it is clear that almost all tools & techniques are used in construction industry, but due to lack of supports from construction organizations and less researches in construction they are not fully implemented as they are functioned.
- ✓ Many respondents using these techniques are not fully aware of their specified functions for that they are made.
- ✓ Although still construction is in its beginning stages so large efforts are required to implement techniques properly.
- ✓ For future recommendations to assess the benefits fully, organizations are suggested to arrange workshops, seminars and meetings to achieve the theoretical functions and benefits of techniques.
- ✓ The study report stresses the importance of recycling construction waste, creating awareness

about the problem of waste management and the availability of technologies for recycling.

#### VI. ACKNOWLEDGEMENT

While working on this paper to its final formation, I would like to thank who contributes in this research. It is a pleasure to convey my gratitude to all of them. I am indebted to my guide Prof. Abhay Shelar and Head of the Department Prof. Sagar M. Gawande who have motivate me to doing his research. It is quite difficult to express my gratitude in few words. Last but not the least; I am thankful to all my Professors and non-teaching staff members in the department whose help provided to be an advantage in completing the project. Also, I would like to acknowledge the moral support of my parents and friends. I am thanks again to all peoples who helped me me during this paper work.

#### REFERENCES

- [1]. Role of Rag Pickers in Solid Waste Management in Nashik City, Pooja Dubey, Prof. Abhay Shelar, International Journal of Engineering Research & Technology (IJERT), May2019
- [2]. Waste Management Practices in Gadhinglaj (Survey Analysis), Parag S. Dawane , Prof. Sagar M. Gawande, International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03 | June-2015
- [3]. "Analytical Study of Physical Characteristics of Phursungi Dumping Yard in Pune Region," Chetan G. More, Sagar M. Gawande and Gajanan S. More, International Journal For Research In Emerging Science And Technology, Volume-4, Issue-5, MAY-2017
- [4]. Experimental Study on Ready Mix Concrete Plant Waste Concrete as a Aggregate for Structural Concrete Abhay Shelar (&) , D. Neeraja, and Amit B. Mahindrakar, Springer Nature Singapore Pte Ltd. 2020
- [5]. Strength and Durability of Concrete Paver Block Bhimaji Dashrath Kanawade1 , Sonali Ratnakar Nawale, Advances in Civil & Structural Engineering, 2017
- [6]. Xin-gang, Z.; Gui-wu, J.; Ang, L.; Yun, L. 2016. Technology, cost, a performance of waste-to-energy incineration industry in China, Renewable and Sustainable Energy Reviews 55: 115– 130
- [7]. World Bank. 2011. Solid waste management in Bulgaria, Croatia, Poland and Romania. A cross-country analysis of sector challenges towards EU harmonization. Reports No.60078–ECA [online], [cited 14 November 2015]. Available from Internet:

- <https://openknowledge.worldbank.org/bitstream/handle/10986/2754/600780ESW0WHIT0and0candidates0FINAL.pdf?sequence=1>
- [8]. Weng, Y.-C.; Fujiwara, T. 2011. Examining the effectiveness of municipal solid waste management systems: An integrated cost-benefit analysis perspective with a financial cost modeling in Taiwan, *Waste Management* 31(6): 1393–1406.
- [9]. Iasi County Council. 2009. Long-term investment plan for the period 2008–2038 on integrated waste management [online], [cited 14 November 2015]. Available from Internet: <http://www.icc.ro/activitate/mediu/MasterP/MasterPlan.pdf> (in Romanian)
- [10]. Hernández-Berriel, M. C.; Mañón-Salas, M. C.; Buenrostro-Delgado, O.; Sánchez-Yáñez, H. M., Márquez-Benavides, L. 2014. Landfill leachate recirculation. Part I: Solid waste degradation and biogas production, *Environmental Engineering and Management Journal* 13(10): 2687–2695.
- [11]. den Boer, E.; den Boer, J.; Jager, J.; Rodrigo, J.; Meneses, M.; Castells, F.; Schanne, L. 2005. The use of life cycle assessment tool for the development of integrated waste management strategies for cities and regions with rapid growing economies LCA–IWM. Deliverable report on D3.1 and D3.2: Environmental sustainability criteria and indicators for waste management (Work Package 3). Technical University of Darmstadt, Darmstadt, Germany, 1–198.
- [12]. Brunner, P. H.; Rechberger H. 2015. Waste to energy – key element for sustainable waste management, *Waste Management* 37: 3–12.
- [13]. Begum, R. A., Satari, S. K. and Pereira, J. J., (2010). Waste Generation and Recycling: Comparison of Conventional and Industrialized Building Systems. *American Journal of Environmental Sciences*, 6(4), 383-388.
- [14]. M. F. a. Goosen, “Environmental management and sustainable development,” *Procedia Engineering*, vol. 33, pp. 6–13, Jan. 2012
- [15]. Somani M., Datta M., Ramana G.V. and Sreekrishnan T.R. (2019). “Leachate Characteristics of Aged Soil-Like Material from MSW Dumps: Sustainability of Landfill Mining.” *Journal of Hazardous, Toxic and Radioactive Waste*, ASCE, 23(4), 04019014.
- [16]. Bučinskis, A., Kriipsalu, M., & Denafas, G. (2018). “Proposal for feasibility assessment model for landfill mining and its implementation for energy generation scenarios.” *Sustainability*, 10(8), 2882.
- [17]. Schneider, P., Anh, L. H., Wagner, J., Reichenbach, J., & Hebner, A. (2017). “Solid waste management in Ho Chi Minh City, Vietnam: moving towards a circular economy?” *Sustainability*, 9(2), 28.
- [18]. Dubey A., Chakrabarti M. and Pandit D. (2016). “Landfill mining as a remediation technique for open dumpsites in India.” *Procedia Environmental Sciences, ELESVIER*, 35, 319-327. [5] MSW Manual, Ministry of Urban Development, 2016.
- [19]. Maheshi D. (2015). “Environmental and economic assessment of ‘open waste dump’ mining in Sri Lanka.” *Resources, Conservation and Recycling, ELESVIER*, 102, 67-79.
- [20]. Gusca J., Fainzilbergs M. and Muizniece I. (2015). “Life cycle assessment of landfill mining project.” *Energy Procedia, ELESVIER*, 72, 322-328.
- [21]. Zhou C., Gong Z., Hu J., Cao A. and Liang H. (2015). “A cost-benefit analysis of landfill mining and material recycling in China.” *Waste Management, ELESVIER*, 35, 191-198.
- [22]. Jeffrey C. (2011) “Construction and Demolition Waste Recycling- A Literature Review” Retrieved from <http://www.dal.ca/content/dam/dalhousie/pdf/sustainability/Final%20C%26D%20literature%20review.pdf> dated 20.11.2013
- [23]. TIFAC (2000). “Utilization of waste from Construction Industry” Department of Science & Technology New Delhi. Retrieved from: [http://www.tifac.org.in/index.php?option=com\\_content&view=article&id=710&Itemid=205](http://www.tifac.org.in/index.php?option=com_content&view=article&id=710&Itemid=205) on 07.11.2013
- [24]. Jain M., (2012) “Economic aspects of construction waste materials in term of cost savings- A case of Indian construction industry”, *International Journal of Scientific Research Publications*, 2(10), 1-7.
- [25]. P.M.Diaz, Analysis of Benefits, Advantages and Challenges of Building Information Modelling in Construction Industry, *Journal of Advances in Civil Engineering*, Vol. 2, No. 2, 2016, pp. 1-11, <http://dx.doi.org/10.18831/djcivil.org/2016021001>
- [26]. Waldo Galle, Mieke Vandenbroucke and Niels De Temmerman, Life Cycle Costing as an Early Stage Feasibility Analysis: The Adaptable Transformation of Willy Van Der Meerens Student Residences, *Procedia: Economics and Finance*, Vol. 21, 2015, pp. 14-22, [http://dx.doi.org/10.1016/S2212-5671\(15\)00145-8](http://dx.doi.org/10.1016/S2212-5671(15)00145-8).

- [27]. J.Prakash Arul Jose and Fleming Prakash, Construction of Reusable Terrace Roof using Blended Paper Pulp and Silica Aerogel, Journal of Advances in Civil Engineering, Vol. 2, No. 3, 2016, pp. 1-8, <http://dx.doi.org/10.18831/djcivil.org/2016031001>.
- [28]. Sadhan K.Ghosh, H.S.Haldar, S.Chatterjee and P.Ghosh, An Optimization Model on Construction and Demolition Waste Quantification from Building, Procedia Environmental Sciences, Vol. 35, 2016, pp. 279-288,
- [29]. Mansi Jain, Economic Aspects of Construction Waste Materials in Terms of Cost Savings – A Case of Indian Construction Industry, International Journal of Scientific and Research Publications, Vol. 2, No. 10, 2012.
- [30]. Paola Villoria Saez, Cesar Porras-Amores and Mercedes del Rio Merino, New Quantification Proposal for Construction Waste Generation in New Residential Constructions, Journal of Cleaner Production, Vol. 102, 2015, pp. 58-65, <http://dx.doi.org/10.1016/j.jclepro.2015.04.029>