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Economic Aspects of Construction Waste Materials in terms of cost savings – A case of Indian construction Industry

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Abstract- 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 (Lauritzen, 1998). 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.

Index Terms- material waste, Indian construction industry, economic relevance.

I. INTRODUCTION

In most parts of the world, construction industry consumes huge amount of natural resources and often generates large quantities of construction waste. According to US EPA (1998) activities like construction, renovation or demolition of structures generate a mixture of inert and non-inert materials which are particularly defined as construction wastes. Statistical data shows, construction and demolition (C&D) debris frequently makes up 10–30% of the waste received at many landfill sites around the world (Fishbein, 1998).

Indian construction industry is one of the largest in terms of economic expenditure, volume of raw materials/natural resources consumed, volume of materials and products manufactured, employment generated, environmental impacts, etc. Owing to the growth in the construction activity, it is appropriate to link C&D waste generation with the national and global economic growth related issues. Presently there is lack of awareness of resource-efficient construction practices and techniques. Significant portion of Indian construction waste is still disposed off in landfills.

The economic and environmental benefits to be gained from waste minimisation and recycling are enormous (Gutherie, Woolveridge, & Patel, 1999), since it will benefit both the environment and the construction industry in terms of cost savings. Thus this paper aims to focus the problem of construction waste and management awareness, techniques and practices in the Indian construction industry, further evaluating economic feasibility of construction waste management (reduce, reuse and recycle) of projects.

II. OVERVIEW OF CURRENT PRACTICES

Indian construction Industry

According to 11th five year plan, construction industry is the second largest economic activity after agriculture. Based on an analysis of the forward and backward linkages of construction, the multiplier effect for construction on the economy is estimated to be significant (Srivastava & Chini, 2009).

The construction industry sets in motion the process of economical growth in the country. Construction accounts for nearly 65 per cent of the total investment in infrastructure and is expected to be the biggest beneficiary of the surge in infrastructure investment over the next five years. Investment in construction accounts for nearly 11 per cent of India's Gross Domestic Product (GDP) (Market, 2009). This sector is likely to continue to record higher growth in the coming years due to the Government of India's (GOI) recent initiative to allow 100 per cent foreign direct investment in real estate development projects (India(GOI), 2007). Technology Information, Forecasting and Assessment Council (TIFAC) study mentions that total construction work for five years during 2006-2011 is equivalent to $847 billion.

	Materials %	Construction equipment %	Labor %	Finance %	Enabling Expenses %	Admin. Expenses %	Surplus %
Building	58-60	4-5	11-13	7-8	5.5-6.5	3.5-4.5	5-6
Roads	42-45	21-23	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Bridges	46-48	16-18	11-13	7-8	5.5-6.5	3.5-4.5	5-6
Dams, etc	42-46	21-23	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Power	41-43	21-24	10-12	7-8	5.5-6.5	3.5-4.5	5-6
Railway	51-53	6-8	16-18	7-8	5.5-6.5	3.5-4.5	5-6
Mineral plant	41-44	20-22	12-14	7-8	5.5-6.5	3.5-4.5	5-6
Transmission	49-51	5-7	19-21	7-8	5.5-6.5	3.5-4.5	5-6

Table 1: Percentage Cost Distribution In Construction Industry (India(GOI), 2007)

Table 1 shows the distribution of cost among various modes of expenses in Indian construction industry .The importance of materials cost can be seen from the fact that the component of materials cost comprises nearly 40%–60% of the project cost. Therefore material waste generation from construction activity is also huge in monetary terms. Thus economically evaluating cost benefits

Thus cost saving potential for India runs for millions of dollars.

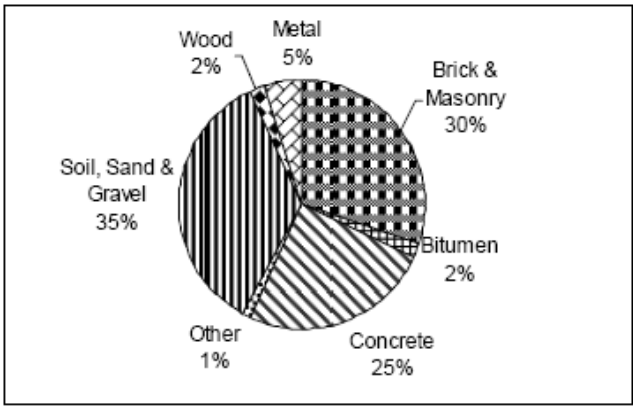

Figure 1 : Various constitutes of construction WASTE (TIFAC, 2000).

Constituent	million tonnes/yr
Soil, Sand and gravel	4.20 to 5.14
Bricks and masonry	3.60 to 4.40
Concrete	2.40 to 3.67
Metals	0.60 to 0.73
Bitumen	0.25 to 0.30
Wood	0.25 to 0.30
Others	0.10 to 0.15

Table 2: Tones of C&D WASTE (TIFAC, 2000)

Figure 1 and Table 2 show the percentage distribution and tonnage of various constituents of C&D waste in India in 2000, respectively (TIFAC, 2000).

Present C & D waste handling in India.

Clients, contractors, architects and the Government should play an important role in improving construction site waste management techniques and approach in India. According to TIFAC (2000) study, following are the present waste handling measures adopted by the industry at various levels.

- Items recovered during construction /demolition is sold in the market at a discount with respect to price of new material.
- Items that cannot be re-used are disposed to landfill site.
- Municipal corporations allow C&D waste in their landfills. No landfill tax is imposed.
- Different constituents of waste are not segregated prior to disposal.
- Builders/ owners bear the cost of transportation, which at present, ranges between US$ 6 to 13/truckload depending on the distance of demolition site from landfill area.
- Municipal authorities incur cost of US$ 1.50 to 2 per tonnes of waste, but presently no charge is levied by them on the owner or builder.
- Though directives exist for disposal of waste to landfill areas, presently penal action against violators is practically not taken.

The above study indicate the attempts made to handle C&D waste in the industry but still majority of it is not implemented in an appropriate manner. This shows lack of awareness in the industry concerning the possibilities of cost savings from proper handling of C&D waste. Managing building material waste can in fact achieve higher construction productivity, save in time and improvement in safety (Chan & Ma, 1998) while disposal of extra waste takes extra time and resources that may slow down the progress of construction.

III. CAUSES OF PROBLEM IN THE INDURTY

Indian industry is unable to take appropriate economic benefits through cost savings particularly because of many reasons that contribute to make this problem appear significantly at the industry level.

*Barriers for widespread adoption of waste management (Reduce, reuse and recycle) system as stated by (*Wildermuth, 2008) *are the following:*

1. *Lack of Awareness in the Industry:* The major barrier in the industry is the lack of awareness among local contractors, construction labor and architects about waste management techniques and approach. Usually most of the waste that is produced during the construction process is the result of poor handling and techniques.
2. *Lack of interest from clients:* Another main reason for an ignorant industry is lack of importance given by clients in imposing waste reduction and management practices into the projects. Clients do not support those activities which do not offer tangible benefits to them. Potential of significant cost saving is not yet voluntarily implemented in projects and timing is given major preference.
3. *Lack of proper training and education:* Lack of contractor's federations and professional institutes in the country which could significantly raise awareness among the clients and contractors about the possible economic benefits and its social consequences.
4. *Lack of skilled labor:* Major portion of construction labor in the industry is unskilled. Due to which proper waste handling methods are not adopted. Thus it is very important that contractors and sub-contractors should develop awareness and skills in labor which is mostly illiterate.
5. *Lack of market competition:* The above mentioned barriers make the industry as a whole to be fragmented and fail to extract benefits from the much evident aspects. This leads to lack of competition among contractors, for e.g. if one contractor makes good cost savings from a project and increases their profit margins. Eventually this should then incentivize other contractors to get involved with waste minimization and management techniques. But mostly from a contractor's viewpoint, taking up waste minimization and management is more of ex *ante* issue where risks are associated with the contractor to bear the cost implications. This will become widespread only after taking project initiative and then benefiting from them.
6. *Lack of Government Interventions*: Government regional, national policies and regulations are limited and are not implemented appropriately. Regulations like landfill tax or tax incentives to incorporate this approach in the project might enforce industry to explore cost savings seriously.
7. *Lack of waste reduction approach by architects:* Usually architects do not give preference to waste minimization approach during design and planning stage. Designing as per standard minimum sizes will eliminate wastage on sites.

According to "India – A building Industry in Transition" many positive and negative points are associated with Indian construction industry. Continuing strong economic growth, foreign investment, cheap & plentiful labour, strong engineering education systems are some of the positive points. On the other hand, inflationary pressures, relatively low skilled and uneducated labours, government bureaucracy, and lack of infrastructure are some of the negative points that make the construction activity more challenging. It also suggests that there is an urgent requirement for a government sponsored 40–50 year holistic infrastructure plan for India to continue on its high growth path towards economic maturity. (Wildermuth, 2008)

Figure 2 shows different routes of waste generation through improper handling and management. It elaborates how clients, designers, contractors, supply chain, procurement contribute to waste production in construction industry.

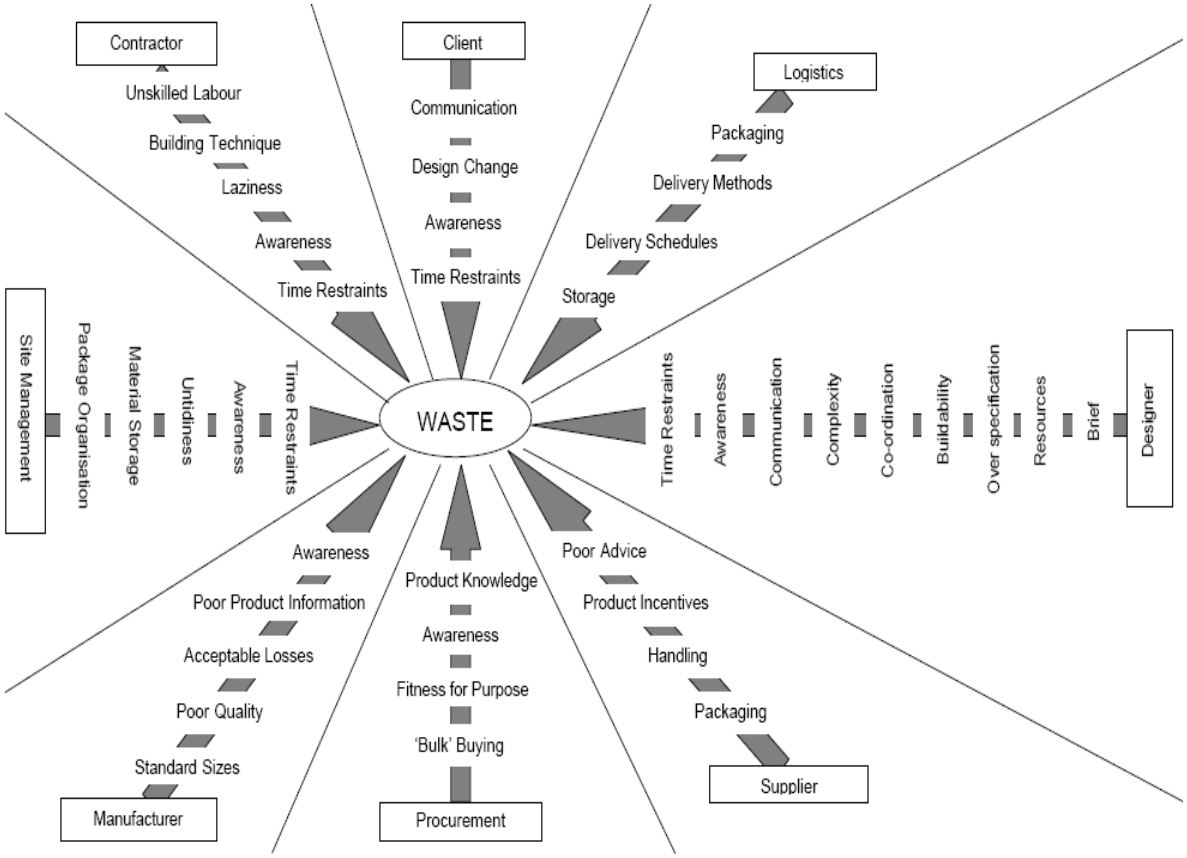

Figure 2 : Waste Generation (Keys, Baldwin, & Austin, 2000)

IV. RELEVANCE TO ECONOMIC THEORY

a. Economic Feasibility in terms of cost savings

This section will evaluate and examine how proper waste handling on construction sites can economically benefit a project and the construction industry by saving millions of dollars to the industry. An attempt has been made to identify possibilities in cost savings in a project.

Generally, economic feasibility is carried out by standard measures of profitability, which is cost –benefit analysis. According to the US EPA (2002), waste management makes good economic and business sense and at the same time it can improve production efficiency, profits, good neighbour image, employee participation, product quality and environmental performance. Therefore benefit–cost analysis (BCA) will be examined to estimate the economic feasibility of construction site waste management in terms of cost savings as adopted by Begum & Siwar (2006). We evaluate project level cost and waste management using a cost function including waste as 'bad output' to estimate overall , input specific, and marginal production cost of waste reduction . It can increase contractor's competitiveness through lower production costs and a better public image.

Net benefits can be expressed by eq (1) which is by subtracting total benefits by total costs.

Net Benefits = Total Benefits – Total Costs**.....**(1)

NB = TB – TC

1. *Total Benefits (TB)* is all the advantages of using of reusing and recycling of construction waste materials. This is the sum of all the direct, indirect and intangible benefits. (*Cost Benefits of reducing waste is not included in monetary terms)*

$TB = P_{SC} + R_{SM} + SC_{CT} + CS_{LC} + A$..... (2)

P_{SC} = Purchasing cost savings by reusing construction waste materials. Company can save money by reusing and buying recycled materials instead of buying virgin materials from the market. (*Cost savings from market price = Average market price /unit x total amount of reused and recycled individual material – Cost of purchasing reused and recycled material at lower cost). This is estimated to be 25% less than virgin materials.* (Begum & Siwar, 2006))

R_{SM} = Revenue from selling of construction waste materials.

SC_{CT} = Waste collection and transportation cost savings from disposing less material to landfill.

CS_{LC} = Cost savings from landfill charges by reusing and recycling of construction waste materials

A = Intangible Benefits

2. The *total Costs (TC)* are all the incremental costs associated with the reusing and recycling of construction waste materials. This is sum of all direct, indirect and intangible costs. So the total costs can be expressed by Eq. (3)

$$TC = CS_C + S_C + T_C + A* \quad \text{..... (3)}$$

CS_C = the collection and separation costs of construction waste materials,

S_C = the storage cost of waste material.

T_C = the transportation cost of disposing waste to landfill

$A*$ = the intangible costs.

Net Benefits = Total Benefits > Total Costs.....(4)

Costs are the key main determinants for decisions and choices for waste management technologies and practices. Financial constraint is the main reason for low priority for waste management. In fact the cost of implementing waste management practices is given more preference than benefits. Quantifying all the associated benefits and the costs in monetary value and also considering the intangible costs and benefits can give a clear picture of the economic benefits of reusing and recycling of construction waste.

Although Begum & Siwar, (2006) suggests that practices that induce waste reduction from the beginning through proper planning, designing etc should be encouraged. This would not only ensure reduced quantity of waste production on site but also less quantity of waste material to be reused and recycled and thereby reducing the cost implications associated with waste management. Following section shall discuss the strategies to mitigate this problem and its economic relevance.

V. STRATEGY TO MITIGATE THE PROBLEM

Examining the lack of practices and its causes in the industry, this section will propose strategies that could be adopted at an industry level to mitigate this problem. Measures to stimulate a widespread adoption of waste minimization and appropriate site waste management practices by extracting benefits from cost savings.

1. Government Initiative - Policy Implications.

Owing to the lack of awareness that makes this problem widespread in the industry. The Indian Government, like other countries should start to legislate and use command and control framework to ensure disposal of waste in landfill sites appropriately by placing liability from 'cradle to the grave' and assigning duties appropriately. Attention can be thus shifted to market – oriented methods to regulate the waste disposal.

Forms of government interventions to stimulate waste reduction are the following:

1. Landfill tax to encourage the reduction of waste thus encouraging movement up the waste hierarchy.
2. Government can impose a subsidy for recycled construction products,
3. Tax credit for the construction that use recycled products.

These changes will encourage reducing, reusing and recycling of material waste in the industry. Such a market mechanism provides incentives for firms to shift attention from end solutions to process solutions for waste minimisation. That is, it underscores the role of production decisions and processes and their likely changes in response to taxes or other forms of the Government intervention to stimulate waste reduction. Such interventions can create awareness among the contractors and clients and direct them towards its economic implications.

2. Create awareness among clients and contractors :

Apart from the Government interventions, voluntary actions by construction firms should be encouraged by setting up of various regional level federations and institutions which readily provide knowledge of economical benefits of waste minimization and management by appropriate techniques. This shall result in location specific 'demand side' characteristics by clients to take up waste minimization and management in their projects and include this from contractual agreement.

However, as material waste management is related to production processes, analysis of waste practices and the potential for – or costs of –waste minimisation requires a supply rather than demand-side approach. And thus will encourage contractors to develop and implement the method appropriately and benefit from cost saving from projects.

3. *Training and Education* :

Construction firms should take the responsibility to provide appropriate training to the unskilled labour about proper techniques to minimize construction waste. This is a step towards waste reduction at source.

4. *Role of an Architect* :

Designers should design buildings with waste minimization into consideration. Use of standard dimensions and sizes can greatly improve waste production on sites. Architects should recommend recycled materials in their specifications and should guide clients in other possible design approach to waste minimization.

VI. EVALUATING PRACTICAL RELEVANCE

Strategies to mitigate the problem at industry level will require government intervention to initiate the waste minimization and management system mainly because of lack of market competition and significance. The high costs of landfill charges and high taxes of using virgin materials along with various institutions and organization initiatives can create a derived demand – supply dynamics in the industry.

Demand from the clients will initiate contractors to develop and experiment various methods of waste minimization and extract possible cost savings from various projects. Benefits from cost savings will encourage more contractors to adopt and compete in the market to outbid the other. This will initiate market competition to evolve in the industry which will soon appear at significant level.

As a result of the Government incentives on using recycled material instead of virgin ones, will increase the demand for recycled materials in the industry. The whole process will also make construction material manufacturing firms to actively participate and change their production process. Waste decisions by manufacturing firms in the context of production costs, and thus in terms of their impacts on input use, output production, and efficiency will be considered. A primary goal of firms is the maximization of output production while minimising private costs. Minimising environmental costs may also be a key target, if there is sufficient market or social incentives (Chapple, Morrison, & Harris, 2005). Reaching these objectives involves making choices about waste generation, in combination with other production decisions.

As a result of this lack of appropriate handling of waste in the industry coupled by waste in economic terms can be dealt with in significantly creating a demand in the industry.

Thus the above strategies will contribute in creating a demand – supply dynamics once its economic implications are widely understood and implemented. Demand from clients will initiate a supply side of system from contractors, which in turn will demand appropriate materials from manufacturers and also provide them with raw materials to recycle from the waste.

Recycle and reuse of construction material waste can also help the economy through the creation of jobs related to salvaging and recycling of construction waste. New products create jobs through the manufacture of recycled content materials.

VII. CONCLUSIONS

Due to least priority given to appropriate site waste minimization and management systems in Indian construction industry leads to generation of huge quantities of material waste every year. This problem is not only detrimental at environmental level as most of the waste is disposed off in landfills but also in economic terms as waste materials have their specific economic values before getting mishandled.

Examining various reasons for the problem, lack of awareness among clients and contractors, lack of skilled labor, lack of proper training and education, minimal Government interventions etc are few of the many reasons that significantly affect the Industry as a whole.

Proper site waste management reveal that it is economically viable to do significant cost savings from the whole process. In which total benefits exceeds totals cost by incorporating appropriate methods. And widespread adoption can significantly save huge amount of money which otherwise goes into landfills in form of waste materials.

First step towards mitigating this problem would be the Government's interventions like Landfill tax, higher tax for using virgin materials, tax credits for recycling etc can act as an initial momentum towards seeking various other cost saving measures through waste minimization at source and appropriately managing it on site. Institutions and local organization can create awareness among clients and contractors which will initiate the demand for material waste minimization from clients and voluntarily from contractors.

These steps can create a market driven mechanism in the industry, with demand and supply factor and market competition which will help to mitigate this problem that will both benefit the economy and the environment.

VIII. RECOMMENDATIONS

However, waste management system may also have its limitations. Proper market for recycling and reusing of waste will require an aggressive marketing effort to locate markets to sell waste material to be recycled and then processed recycled material to be sold at appropriate prices. The current rather low level of market development means that significant time and money must be invested in establishing relationships, keeping track of pricing changes and becoming a reliable supplier of materials, in order to ensure a continuous intake of construction waste materials. The operator also has to locate and develop relationships with demolition and general contractors with projects in the area to market their construction recycling business as the disposal option of choice for the contractors. These aspects in economic terms are although beyond the scope of this study.

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