

DEMOLITION
COLLECTION
RECYCLE
CONSTRUCTION
GIS PLATFORM
TRANSPORTATION
DATA BASE
SUPPLY
REUSE
MARKET
WASTE
DISPOS
MANAGEMEN

14. Sustainable System for Recycling C & D Waste - A Conceptual Framework.

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Abstract :

The need for recycling Construction & Demolition (C&D) waste is increasing day by day as various government projects and the real estate sector are continuously demolishing buildings to accommodate new infrastructural development. Though the government has come up with the C & D waste management rules in 2016 and Delhi has successfully implemented the country's first recycling plant running on PPP model, there exists a vast gap in the material supply and the market for C & D waste. The recycling plant is capable of segregating and processing C & D waste but there is no market. Surveys with the manufacturers of construction products reveals that they are not getting supply of processed C & D waste and thus they opt for natural building material like natural sand and natural aggregate. There is a decline in the natural resources on one side and a dumping problem of C & D waste on the other. The problem needs to be addressed with sustainable solutions. The gap between the market supply and the demand can be bridged if the information about waste processed and recycled C & D waste end users are shared using the GIS platform.

The proposed conceptual framework will provide a sharing database in GIS where C & D waste processors and processed C & D waste users can find their solutions. The study will thus provide a GIS based viable solution in the form of conceptual framework for C & D waste management

Key words:

Recycling plant, Waste processing, Open dumps, waste management, GIS.

Introduction

An increasing amount of construction & demolition waste (C&DW) has become a major concern of governments and various governing bodies and stakeholders [Jin et. al., 2019, Ferronato et. Al., 2019]. The construction industry is estimated to be accountable for using around two-fifths of the world's energy and materials flow, one-sixth of freshwater reserves and one-quarter of global wood harvest [Horvath, 2004] while contributing to 13–30% to total waste generated worldwide. The exact figures regarding the share of C&D waste in the total Solid Waste stream can be very high and also vary significantly. Referring to waste generated in the process of dismantling, repair, and/or construction of buildings, the conventional preferred way of C&D waste management—in most countries—is disposal to designated landfills. It should be noted that the disposal to landfill is associated with costs, the largest and the most visible ones being transportation costs and landfill tipping fees. Various concerns on environmental pollution and rapid depletion of natural resources as well as sustainability programs being implemented have urged many other countries to find alternative ways for a more efficient waste management. On the contrary, companies are seeking for more efficient ways of waste management most often in terms of economical sustainability than in terms of environmentally and socially sustainable development, leading mainly to cost-cutting strategies.

According to the Technology Information, Forecasting and Assessment Council (TIFAC) (2013), India produced new construction waste of 40- 60kg/sqm. of C & D. Based on this, India produced almost 50 MT of C & D wastes in 2013. The waste generated 300-500 kg per

sqm of destruction is ten times that produced during the construction phase as per TIFAC. It is assumed that annually 5% of the current building assets gets dismantled and reconstructed entirely and therefore, nearly 288 MT more of C & D waste had been produced in the year 2013 itself due to demolition activities.

India requires a paradigm shift from a dumping-based approach to utilizing C&DW efficiently. C&D can be recycled to replace natural building material; this is not only beneficial for the environment, but also results in substantial cost and resource savings (Ministry of Urban Development, Government of India). The study area considered includes the urban precincts of Bengaluru, India. As per survey done by personal communication, the manufacturers are willing to utilize the recycled product as the material availability is economical to them but they are reluctant to use them because there is no continuous supply of utilizable C & D waste to them. The present study sensitizes this problem and addresses the same by providing a conceptual framework that can utilize the GIS capabilities of storing, managing and analyzing huge amounts of data.

Relevance of GIS Based C & D Waste Management System

GIS can be used for C & D waste management as is evident in various studies. (Zainun et. al, 2016) presented a mapping of construction waste illegal dumping in Kluang district, Johor using Geographic Information System (GIS) software. Information of the dumped waste such as coordinate, photos, types of material and quantity of waste were gathered manually through site observation. All information regarding the waste was assigned to the GIS for the mapping process.

The C&D waste recycling industry in India is still to gain impetus in spite of several possible solutions and the ready reckoner for utilization of C & D waste provided by the Building Materials & Technology Promotion Council, Ministry of Housing & Urban Affairs Government of India (Table 1). The current study is an attempt to provide for this need of the Building Materials & Technology Promotion Council by putting forth a conceptual framework of GIS based C & D waste management system.

Literature Review : C & D waste management -National and International Scenario

C & D waste management and processing is now proposed in many cities in India. Various municipal corporations are proposing recycling facilities. Recently a recycling facility in Delhi is operational and utilizing C

& D waste for various construction products. Some cities in India have already proposed C & D waste processing facilities as shown in Table 2.

Considerable research has been carried out in the U.S.A, Japan, U.K, France, Germany, Denmark etc. for recycling concrete, masonry & bricks, bituminous and other constituents of waste from the construction industry. These studies have demonstrated the possibility of using construction waste to substitute new materials for recycling. Even in the USA which is known for its proliferation of landfills, California, the most progressive state, has promulgated an ordinance which requires 50 per cent recycling of C&D waste and 75 per cent diversion of inserts away from landfills. Singapore was recycling 98 per cent of its construction waste by 2007. Hong Kong has been recycling its waste to produce

S.No	Type C & D Waste	Potential use of C & D Waste
1	Concrete	Demolished concrete can easily be recycled as aggregate and used in concrete (As per research carried by Central Building Research Institute - CBRI)
2	Bricks	If deconstructed properly, it can be reused after removal of mortar for refilling or for manufacturing debris paver blocks or debris blocks
3	Stone	Stone can be reused for plinth formation, masonry construction, landscape purpose, ledges, platforms, window sills, coping etc. depending upon the form of available stones
4	Timber	Whole timber arising from construction and demolition works can be utilized easily and directly for reused in other construction projects after cleaning, de-nailing and sizing. Plywood and other timber based boards can be either reused for interior works in new construction or it can be recycled for manufacturing of timber based boards.
5	Gypsum	Phosphor-gypsum and lime sludge can be recycled for manufacture of Portland cement, masonry cement, sand lime bricks, partition walls, flooring tiles, blocks, gypsum plaster, fibrous gypsum boards and super sulphate cement.
6	Steel	Scrap steel is almost totally recyclable and can be reused
7	Debris	Can be recycled to be used in paver blocks

Table1: Potential use of C & D Waste. (Source : Author)

S.No	Name of City	Status of C & D waste recycling facility
1	Nasik	Nasik Municipal Corporation has identified sites for dumping C & D debris. The responsibility for disposing the construction debris is with the waste generators and not with the Corporation. Inert processing unit is of capacity 50 TPD.
2	Ahmedabad	Ahmedabad Municipal Corporation (AMC): m/s DNP Infrastructure Pvt. Ltd. has been awarded operations of a 300 TPD C & D waste processing plant on 5 acres of land on PPP mode for 30 years. It is operational from October, 2013, involved in collection & transportation of such waste from 24 designated locations
3	Indore	Indore Municipal Corporation (IMC) proposes to award 75 TPD C& D waste processing facilities on four acres of land in Devguradia region for a period of 15 years.
4	Bengaluru	Bruhat Bengaluru Mahanagara Palike (BBMP) - proposes to put up the C & D waste processing facilities in PPP mode in three abandoned quarry areas in Kannur, Mallasandra and Anjanapura, each with capacity to process 750 TPD he facility to BBMP
5	Pune	District administration has allocated 2 acres of land at Wagholi for C & D waste processing.
6	Hyderabad	Decentralised C & D waste plants at four identified locations, Fathullaguda, Jeedimetla, Kothwalguda and Mallapur have been identified
7	Mumbai	The Youth for Unity and Voluntary Action (YUVA) and City Industrial Development Corporation (CIDCO) have come up with a decentralized solution for recycling debris into construction material such as bricks and interlocking pavers.
8	Faridabad	The Municipal Corporation has proposed to set up a C & D waste recycling facility near Kachra Chowk on the Gurgaon Faridabad Road.
9	Greater Vishakhapatnam	The state government has accorded permission to the Swachha Andhra Corporation to float request for Proposal for 80 TPD capacity recycling plant near Kapuluppada.

Table 2: Status of recycling facility for C & D waste in some Indian cities (Source : Source: https://kspcb.gov.in/Guidelines_C_and_D_waste.pdf)

Recycled Aggregates (RA) for use in government projects and R&D work. In Taiwan, a comprehensive plan for the management of C&D waste was put in place in 1999 as a response to the challenge posed by the severe earthquake that year, which damaged about 100,000 dwellings (Earth5R, Sustainable Development Goals, 2007) .Figure 1 provides the international scenario of C & D waste generation and Table 3 shows the recycling plants' performance in various countries.

C & D waste generation scenario in the Study area and proposed Conceptual Framework.

The study area of the paper is Bengaluru city, India. Estimates of construction & Demolition Waste(CDW) in the Bengaluru city vary from 2,500 TPD to 3,600 TPD (Vunnam et.al.,2016).The study showed that it has grown from 2,981 TPD in 2012 to 3,540 TPD in 2016, and is likely to reach 4,118 TPD by 2022. Bengaluru, the city generates

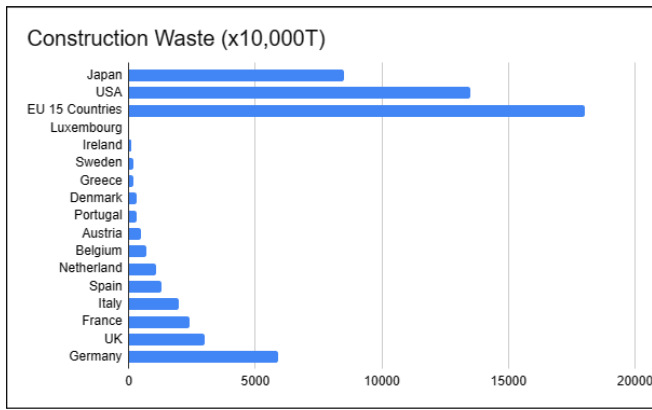


Figure 1: International Scenario of C & D waste generation

S.No	Country	No. of recycling plants
1.	Belgium	60
2.	France	50
3.	Neitherland	70
4.	UK	120
5.	Germany	220
6.	Denmark	20
7.	Italy	43

Table3: Global practice of recycling plants for C & D waste utilization. Source: (Source: Building Materials & Technology Promotion Council, Ministry of Housing & Urban Affairs, Government of India. Utilization of Recycled Produce of Construction & Demolition Waste A Ready Reckoner (http://164.100.228.143:8080/sbm/content/writereaddata/C&D%20Waste_Ready_Reckoner_BMTPCSBM.pdf))

2500-3000 tonnes per day of C & D waste (Construction waste chokes Bengaluru lakebeds, roadsides, 2020). As per study done by Center for Study of Science, Technology & Policy, Bengaluru, (Construction and Demolition Waste Utilisation for Recycled Products in Bengaluru: Challenges and Prospects, 2016) 60-80% of C & D waste is fit to be recycled back into new construction with some pre-processing. However currently a major fraction of the CDW is dumped along roads, highways and next to water-bodies, and most of BBMP's designated CDW disposal sites are either inactive or under-utilized. The monitoring mechanism for CDW disposal is weak and most Demolition and Transportation Contractors (DTCs) are unregulated. The only Stone Crushing Unit (SCU)

utilizing CDW currently is operating at unviable Capacity Utilization (CU) due to lack of demand for its products. Other SCUs have also cited the absence of proper market mechanisms, regulations and standards for CDW-based products. There is a lack of awareness among potential market players regarding CDW utilization. Recently installed processing plant at Kannur named 'Rock Crystal' is being utilized by 10% only as per Construction waste chokes Bengaluru lakebeds, roadsides, (2020) due to lack of continuous supply of C & D waste and meager market of waste products.

The survey in the study area concluded that there are many paver block manufacturing clusters in Bengaluru which can use aggregates processed from C&D waste if there is regular supply at rates lower than natural aggregates. It was also found that price of natural aggregates is directly proportional to distance of stone quarry from paver block manufacturers. Paver block manufacturers situated close to the stone quarry are paying less per unit of aggregate than those situated far from them. The opportunity thus lies for a C&D waste mobile processing unit or standalone processing unit of small capacity in dump sites near to the paver block manufacturers. Designated sites for collection points can be identified for installing decentralized units for processing.

Figure2 below depicts the conceptual Framework for managing C & D waste by preparing a common GIS database after mapping C & D waste generation potential sites, illegal C & D waste dumping sites, encroachment sites (by C & D waste), identified Collection Points (for C & D waste for Recyclers) and manufacturers of Construction Products (which can utilize C & D waste). GIS based information shall help in retrieving waste generation and waste collection information to various C & D waste players which need this data for their required purpose. Table 4 provides some sample data that can be collected and mapped for the C & D waste management system created in the GIS Platform. The Common database can prove to be a common platform where any players who are interested in either C & D waste collection or waste recycling or waste utilization can be benefited in context to their associated data utilization

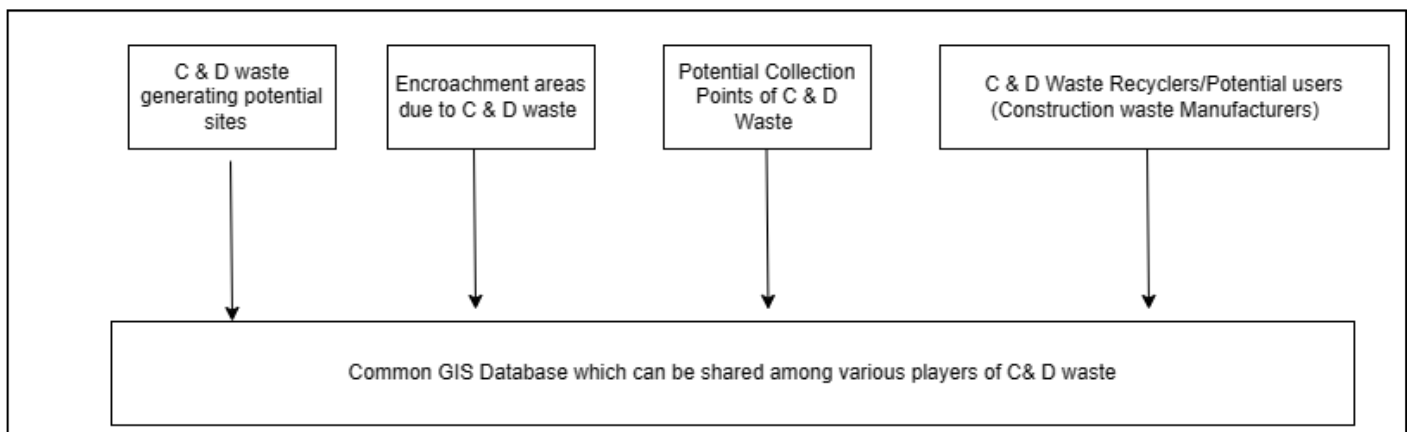


Figure2: Conceptual Framework for GIS based data sharing of C&D waste among various players (Source : Author)

C & D Waste Players	Type of data to be collected and mapped
Location of waste generators in construction or demolition works	1. Amount of waste generated by them
	2. Waste management plan of the waste generator in brief
	3. Whether keeping a record or track of the generation of construction and demolition waste within its jurisdiction and establishing a database and updating once in a year.
	4. Name of service provider or institution consulted for waste management
	5. Image for milestones achieved in waste management
	6. Time frame for various works
	7. Whether incentive received for waste salvation, processing and recycling as given under Construction and Demolition Waste Management Rules, 2016
	8. Whether incentive provided by municipal authority for use of material made out of construction and demolition waste in the construction activity including in non-structural concrete, paving blocks, lower layers of road pavements, colony and rural roads as required under Construction and Demolition Waste Management Rules, 2016
Location of various various construction industries which are potential utilizers of C & D waste	<ol style="list-style-type: none"> Names of product produced by them Amount of various material required by them including amount of cement, concrete, sand etc. Willing to use recycled c & D waste Amount of C & D waste used by them Name of supplier from where they receive C & D waste Difficulties in getting C & D waste in terms of amount and time Cost comparison of product made from recycled C & D waste and natural building material
Mapping of various sites of C & D dumping	<ol style="list-style-type: none"> Site with encroachment on river bank Site with encroachment on wet bodies Site with unauthorized filling of low line areas Mixing with solid waste Sites with encroachment in Parks Sites with encroachment in Footpaths etc.

Table 4: C and D waste Players and information required for Common GIS database (Source : Author)

Conclusions

The study depicts the National and International Scenario of C & D waste management along with C & D waste management scenario in Bengaluru city. The problem of C & D waste management has been addressed by identifying the information gap between C & D waste generators, waste utilizers and waste recyclers and other C & D waste players. The solution has been provided in the form of a GIS based conceptual framework for data sharing so that the information about demand of C & D waste can be provided to its suppliers. The current study

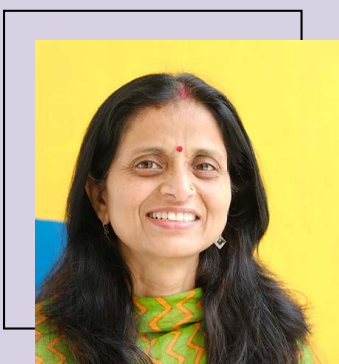
also fulfills the technological intervention through GIS as per requirement of Building Materials & Technology Promotion Council Ministry of Housing & Urban Affairs Government of India .

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