International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 06 | June 2021 www.irjet.net p-ISSN: 2395-0072

# Linkages between Urban Growth and Construction Waste: A Step Towards Sustainability

**Aditi Parihar**

*Department of Architecture and Planning, Maulana Azad National Institute of Technology, Bhopal, India*

---

**Abstract -** *In many nations throughout the world, construction waste is becoming a severe environmental issue. Because of the large quantity of waste caused by construction, demolition, remodeling, as well as related operations, the construction sector is long been recognized amongst the biggest drivers causing harmful environmental effect. Cities are growing dramatically around the world, posing evident environmental and socioeconomic issues. Construction waste management is a worldwide problem, but a few nations have reliable stats on generation and use. This paper aims to link Urban Growth and Construction waste providing a step towards sustainability for the Kolkata Metropolitan Area (KMA), West Bengal, India. Reduce, reuse, and recycle has been given as a recommendation regarding decreasing construction waste. The construction industry's product, which includes a wide range of waste generated at every stage of building operations and practices on site, must be addressed seriously since it has a notable influence on the natural environment. To promote development and a sustainable future, it is critical to dispose of construction waste responsibly.*

***Key Words***: Construction waste, Sustainability, Urban Growth, Urbanization, Waste Management

## 1.INTRODUCTION

Accelerated urbanization is a major concern around the world, particularly in India and other developing countries [1]. At turn of the millennium, urban sprawl emerged as one of the most pressing concerns confronting most communities. Areas that were earlier agricultural lands, meadows, marshes, water bodies, or woods are being encroached upon by housing infrastructures and rise in impermeable floorings [2]. Rising levels of waste output, owing to growing urbanization, and a large number of illicit dumping have become important challenges in many countries [3]. The advancement in environmental management along with the objective of sustainable development has placed strain on all sectors, such as construction, to embrace suitable environmental protection techniques [4]. Despite how serious the problem of building waste is, less is known regarding the origins of construction waste [5]. There is no comprehensive database on construction debris in India, according to the Union Ministry of Forests and Environment (MoEF) [6].

Although environmental preservation has become increasingly important around the world, pollution generated by construction work appears to be challenging to regulate [4]. During the construction, modification, as well as demolition stages of a project life, waste is generated. In many nations, construction debris has become a severe environmental issue [7]. Construction activities produce approximately 6408 tonnes of garbage every year, accounting for 38% of all waste generated [4]. A large variety of environmental policies and strategies have been implemented in order to maintain the environment while ensuring growth. The majority of these rules are aimed at reducing and controlling construction waste [3]. As a result, in order to effectively and efficiently reduce waste, although required for waste reduction produced by those materials.

**Table -1:** Related Works

| S. No. | Citation | City/ Country | Work |
|---|---|---|---|
| 1 | [8] | | Attempts for the usage of a system dynamics (SD) method to construct a plan for quantitatively analysing Construction Waste Management's social performance. |
| 2 | [9] | Europe | a methodology that allows specialists to evaluate C&D waste in the design process, promoting prevention and recovery |
| 3 | [7] | Turkey | Make recommendations for preventing/reducing waste generated by renovations in Turkish homes. |
| 4 | [10] | Shenzhen city in south China | The study aims to conduct a SWOT analysis for evaluating current state of construction waste management for Shenzhen, China. |
| 5 | [11] | Canada | provides a theoretical C&D waste management methodology for maximising 3Rs (reduce, reuse, and recycle) as well as minimising construction waste disposal through executing a long-term, comprehensive approach across the duration of construction projects. |

| | | | |
|---|---|---|---|
| 6 | [12] | UK | Examines earlier research related to architects' approaches to construction waste minimisation, especially explored: the causes of waste; waste reduction design practises in the UK, using a postal questionnaire. |
| 7 | [13] | Sri Lanka | exposes impact regarding construction workers' attitudes and views regarding waste management software, which will aid construction managers by creating as well as executing improved waste management methods. |
| 8 | [14] | Dutch | focuses on reduction of construction waste produced. |
| 9 | [15] | Japan | offers views and experiences with immediate construction as well as demolition (C&D) waste management, aftermath by big Hanshin-Awaji earthquake |
| 10 | [16] | University of Massachusetts – Amherst | combining construction sectors into the notion of sustainable building, which is primarily concerned with resource and waste management. |
| 11 | [17] | Thailand | investigates Thailand's construction waste generation as well as management. |
| 12 | [18] | Thailand | determine the variables that contribute to construction waste in construction sector |
| 13 | [5] | Australia | reports on the findings of a survey related to techniques on construction project sites undertaken with project on construction waste minimization. |
| 14 | [19] | Calgary, Alberta | proposes an innovative way of grouping components, hence lowering the factors for analysis, which necessitates the establishment by correlations between waste quantity and a variety of parameters. |
| 15 | [20] | | Explores circular economy (CE) concepts, focusing on material recovery and manufacturing, with a focus on CDW reuse and recycling, as well as recycling into new construction uses. |

In terms of sustainability, the theme of preventing the formation of construction waste could be considered a priority that concentrates on the threat of exhaustion of construction materials [14].

In C&D waste management, quantitative measurement along assessment for sustainability is difficult task. In order to assist decision-makers, composite indicators are increasingly being utilized to summarize complicated or multi-dimensional issues [11]

This paper aims to link Urban Growth and Construction waste providing a step towards sustainability for the Kolkata Metropolitan Area (KMA), West Bengal, India. Further, provide recommendations for combating the construction waste in order to make the area more sustainable. This research was conducted because construction industrial waste is becoming one of the most significant environmental issues. It has an influence on the environment, which we may mitigate through construction management and waste minimization on the job site.

Prior to 2016, the Solid Waste Management Rules contained these responsibilities. The Construction & Demolition Waste Disposal Rules, 2016 were passed to control the processing and management of C&D waste created, putting a spotlight this problem. Various relevant stakeholders are usually allocated specific obligations under the new laws. Local government institutions have been assigned a primary role in organizing C&D waste management for their jurisdiction, performance targets and timetables specified.

## 2. METHODOLOGY

### 2.1 Study Area, Kolkata

Kolkata, formerly known as Calcutta, was originally the administrative capital during British India, along with its expansion as well as land usage are still heavily affected by colonial rule today [21]. It stretches from 22°24'39" N to 22°46'37" N latitude and 88°11'19" E to 88°34'25" E longitude along the banks of the River Hooghly (the primary tributary of the River Ganga, India's national river) [22].

Due to the extreme geometric increase (Figure 1), there is a significant need for land to build neighborhoods. Therefore, land alteration from undeveloped to developed occurs, as well as urbanization. The Kolkata Metropolitan Development Authority (KMDA) has implemented rigorous planning and spatial transformation to prevent unplanned and rapid urban growth, yet urban growth is still uneven across the city [21].

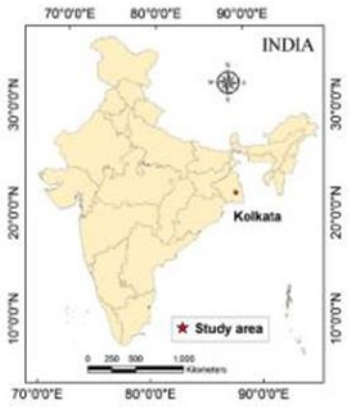


**Fig -1**: Location map of Kolkata, India Source: [22]

It has been determined that the majority of the places in Kolkata's outskirts are completely planned. In Kolkata, population pressure is also a significant issue. Population pressure should be kept to a minimum for long-term strategy and management of the area. In Kolkata, a lack of open spaces is also a big issue, resulting degradation of vegetation as a factor of urban expansion and growth [23].

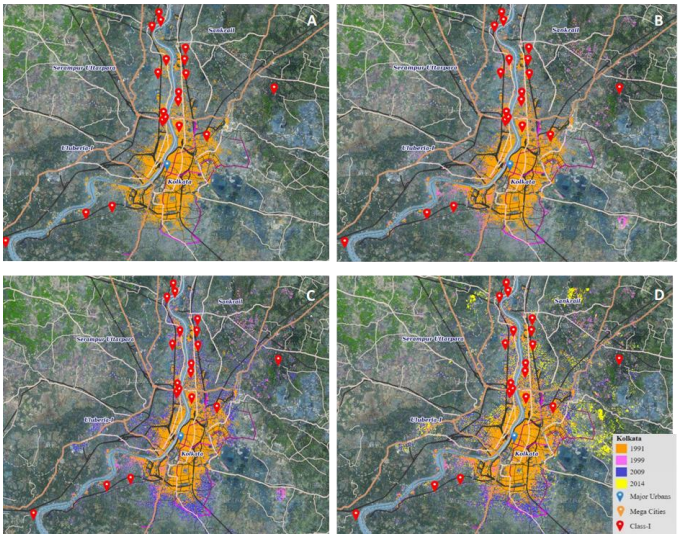


**Fig -2**: Urban Growth in Kolkata A. 1991, B. 1999, C. 2009, D. 2014 Source: Bhuvan

## 2.2 Data collection and calculations

The data is collected from West Bengal Housing Industry Regulatory Authority (Government of West Bengal, 2021). There are a total of 153 projects in 2018 and 201 projects in 2019 which comprises of residential, commercial and mixed land use. Within the house, the carpet area is the area which can be used to extend a carpet. It is the apartment's net useable space. The thickness of the inside wall is included; however, the balcony or terrace is not. The carpet area is the distance between the inner walls in specific language. Technically, the distance between inner walls is carpet area. The carpet area for each project in 2018 and 2019 was noted.

Various frameworks have been used in the research to evaluate C&D waste production. TIFAC (Technology Information, Forecasting, and Assessment Council) suggested different estimates on C&D waste production that understand that the production is performance oriented as mentioned below [24]:

a. new construction- 40-60 kg per sq.m,
b. Building repair- 40-50 kg per sq.m,
c. Demolition of buildings- 300-500 kg per sq.m

Construction waste= Range 40-60 kg per sq.m *carpet area (1)

The total carpet area for the year 2018 and 2019 is 3260986 sq. m and 9840160 sq. m respectively. The construction waste calculated as per Equation (1) for 2018 is 163049300 kg (163049 tons) while for 2019 is 492008000kg (492008 tons).

**Table -2:** Calculations of Construction waste

| Year | Carpet area (sq. m) | Construction waste (kg) | Construction waste (tons) |
|---|---|---|---|
| **2018** | 3260986 | 163049300 | 163049 |
| **2019** | 9840160 | 492008000 | 492008 |

With linear regression, the FORECAST function in Excel has been used to estimate a future value. As per the current trends in construction waste, in 2022 the construction waste is forecasted to be 147884 tons approximately (estimated).

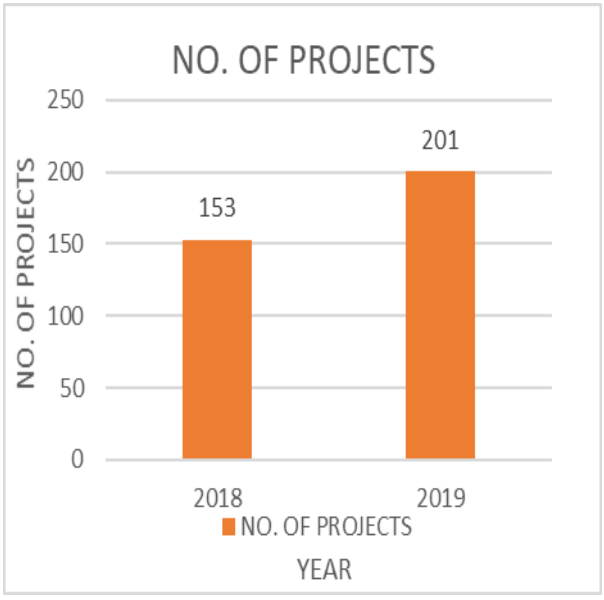


**Fig -3**: No. of Projects

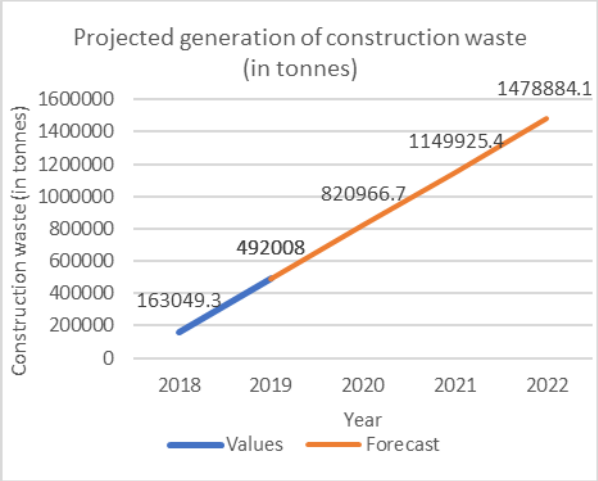


**Fig -3**: Forecasting of construction waste

## 3. DISCUSSIONS AND RECOMMENDATIONS

Every construction site requires a thorough construction waste management system. After analyzing the impact of construction waste, it is critical to devise strategies for reducing it being the most cost-effective way towards any waste challenges. Furthermore, every construction company must be required to implement a construction waste management plan customized to be specific mode of operation, as a result all employees, from management to operational, are working towards a common goal of construction waste management. Aside from these techniques, construction waste management economic considerations such as recycling and contractual consequences are also important [4].

For construction waste management strategy, it is critical to anticipate construction waste proportions. Estimates as per a unique framework called activity-based waste production could be deemed more reliable than other methods in the literature. Better projections might be made if the reasons of waste generation were taken into account, as it explores every probable cause in the complete duration of the project [19].

The strengthening of environmental management was indeed the mission of developing sustainably has put a lot of pressure on all industries, such as construction, to adopt suitable environmental protection techniques. Spontaneous construction is not an environmentally beneficial practice. Reduce, reuse, recycle, compost, incinerate, and landfill are six degrees of disposal alternatives that categorize from low towards high the environmental impacts [25]. The "3Rs" refers for three key trash minimization strategies: reuse, recycle, and reduce. Synchronization for all those engaged in the designing as well as construction processes has to be critical for reducing construction waste created [4].

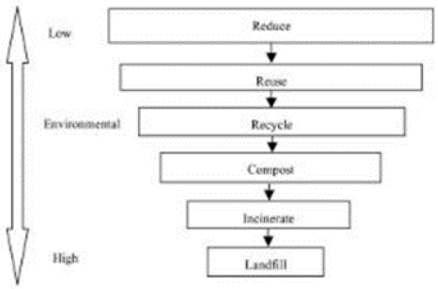


**Fig -4**: Hierarchy of Construction waste materials disposals [25]

Although materials used in a specific project are among the most crucial parameters in calculating construction waste, they also serve as a limitation to the research. As a result, an exploratory study was conducted, and subsequent work on this project will be an add-on to the research.

## 4. CONCLUSIONS

Solid waste (SW) management that is both safe and cost-effective is a key environmental problem for contemporary society. Solid waste management is evolving, localized concern for a ubiquitous social and environmental challenge that are threats to people's health and the natural environment due to rapid urbanization. Inefficient waste management has the possibility to harm people's health as well as the environment. Waste management must embrace waste minimization as well as recycling strategies and aim toward a unified processing and disposal infrastructure that would be both sustainable and effective. Solid waste management is necessary throughout phases of waste creation process, from production to final disposal. This paper has successfully calculated the construction waste for the Kolkata Metropolitan Area (KMA), West Bengal, India along with linking urban growth and Construction waste providing a step towards sustainability for the Kolkata Metropolitan Area (KMA), West Bengal, India. Finally, recommendations for controlling construction waste are presented in addition to making the area increasingly sustainable. SDG 12 (accountable consumption and production) comprises aims for waste reduction (targets 12.4 and 12.5). With India's growing urban population, it's more critical than ever to battle construction waste using sustainable methods. Sustainable waste management fosters the formation significantly lower waste, reuse of consumables, and the recycle and recovery of trash generated, all of which contribute to long-term development.

## ACKNOWLEDGEMENT

The author would like to acknowledge all the people associated for the successful completion of the research.

## REFERENCES

[1] J. A. V. Kumar, S. K. Pathan, and R. J. Bhanderi, "Spatio-temporal analysis for monitoring urban growth - a case study of Indore City," J. Indian Soc. Remote Sens., vol. 35, no. 1, pp. 11–20, 2007, doi: 10.1007/BF02991829.

[2] B. Bhatta, "Analysis of urban growth pattern using remote sensing and GIS: A case study of Kolkata, India," Int. J. Remote Sens., vol. 30, no. 18, pp. 4733–4746, 2009, doi: 10.1080/01431160802651967.

[3] J. Solís-Guzmán, M. Marrero, M. V. Montes-Delgado, and A. Ramírez-de-Arellano, "A Spanish model for quantification and management of construction waste," Waste Manag., vol. 29, no. 9, pp. 2542–2548, 2009, doi: 10.1016/j.wasman.2009.05.009.

[4] V. W. Y. Tam and C. M. Tam, "A review on the viable technology for construction waste recycling," Resour. Conserv. Recycl., vol. 47, no. 3, pp. 209–221, 2006, doi: 10.1016/j.resconrec.2005.12.002.

[5] O. O. Faniran and G. Caban, "Minimizing waste on construction project sites," Eng. Constr. Archit. Manag., vol. 5, no. 2, pp. 182–188, 1998, doi: 10.1108/eb021073.

[6] S. C. U. Oboi, "Development of scientific landfill site at Bettahalasur Quarry site for 250 TPD of C&D Waste and Inerts," pp. 7–8, 2013.

[7] T. Esin and N. Cosgun, "A study conducted to reduce construction waste generation in Turkey," Build. Environ., vol. 42, no. 4, pp. 1667–1674, 2007, doi: 10.1016/j.buildenv.2006.02.008.

[8] H. Yuan, "A model for evaluating the social performance of construction waste management," Waste Manag., vol. 32, no. 6, pp. 1218–1228, 2012, doi: 10.1016/j.wasman.2012.01.028.

[9] C. Llatas, "A model for quantifying construction waste in projects according to the European waste list," Waste Manag., vol. 31, no. 6, pp. 1261–1276, 2011, doi: 10.1016/j.wasman.2011.01.023.

[10] H. Yuan, "A SWOT analysis of successful construction waste management," J. Clean. Prod., vol. 39, pp. 1–8, 2013, doi: 10.1016/j.jclepro.2012.08.016.

[11] M. Yeheyis, K. Hewage, M. S. Alam, C. Eskicioglu, and R. Sadiq, "An overview of construction and demolition waste management in Canada: A lifecycle analysis approach to sustainability," Clean Technol. Environ. Policy, vol. 15, no. 1, pp. 81–91, 2013, doi: 10.1007/s10098-012-0481-6.

[12] M. Osmani, J. Glass, and A. D. F. Price, "Architects' perspectives on construction waste reduction by design," Waste Manag., vol. 28, no. 7, pp. 1147–1158, 2008, doi: 10.1016/j.wasman.2007.05.011.

[13] U. Kulatunga, D. Amaratunga, R. Haigh, and R. Rameezdeen, "Attitudes and perceptions of construction workforce on construction waste in Sri Lanka," Manag. Environ. Qual. An Int. J., vol. 17, no. 1, pp. 57–72, 2006, doi: 10.1108/14777830610639440.

[14] B. A. G. Bossink and H. J. H. Brouwers, "Construction Waste: Quantification and Source Evaluation," J. Constr. Eng. Manag., vol. 122, no. 1, pp. 55–60, 1996, doi: 10.1061/(asce)0733-9364(1996)122:1(55).

[15] E. K. Lauritzen, "Emergency construction waste management," Saf. Sci., vol. 30, no. 1–2, pp. 45–53, 1998, doi: 10.1016/S0925-7535(98)00032-0.

[16] M. Ibrahim, "Estimating the sustainability returns of recycling construction waste from building projects," Sustain. Cities Soc., vol. 23, pp. 78–93, 2016, doi: 10.1016/j.scs.2016.03.005.

[17] O. F. Kofoworola and S. H. Gheewala, "Estimation of construction waste generation and management in Thailand," Waste Manag., vol. 29, no. 2, pp. 731–738, 2009, doi: 10.1016/j.wasman.2008.07.004.

[18] C. Luangcharoenrat, S. Intrachooto, V. Peansupap, and W. Sutthinarakorn, "Factors influencing construction waste generation in building construction: Thailand's perspective," Sustain., vol. 11, no. 13, 2019, doi: 10.3390/su11133638.

[19] J. P. . Wimalasena, B.A.D.S., Ruwanpura, J.Y., Hettiaratchi, "Modeling Construction Waste Generation towards Sustainability," J. Min. Inst. Japan, vol. 83, no. 947, pp. 421–423, 1967, doi: 10.2473/shigentosozai1953.83.947_421.

[20] C. P. Ginga, J. M. C. Ongpeng, and M. K. M. Daly, "Circular economy on construction and demolition waste: A literature review on material recovery and production," Materials (Basel)., vol. 13, no. 13, pp. 1–18, 2020, doi: 10.3390/ma13132970.

[21] M. Mukherjee, "Urban Growth and Spatial Transformation of Kolkata Metropolis: A Continuation of Colonial Legacy," ARPN J. Sci. Technol., vol. 2, pp. 365–380, 2012, [Online]. Available: https://www.academia.edu/34068508/URBAN_GROWTH_AND_SPATIAL_TRANSFORMATION_OF_KOLKATA_METROPOLIS_A_CONTINUATION_OF_COLONIAL_LEGACY.

[22] J. Mandal, N. Ghosh, and A. Mukhopadhyay, "Urban Growth Dynamics and Changing Land-Use Land-Cover of Megacity Kolkata and Its Environs," J. Indian Soc. Remote

Sens., vol. 47, no. 10, pp. 1707–1725, 2019, doi: 10.1007/s12524-019-01020-7.

[23] S. Majumdar and U. Chatterjee, "Modelling urban growth using Urban growth deterministic model in Kolkata Metropolitan Area: a geo-statistical approach," Model. Earth Syst. Environ., no. 0123456789, 2020, doi: 10.1007/s40808-020-00985-6.

[24] CENTRAL POLLUTION CONTROL BOARD, "Guidelines on Environmental Management of C&D Waste Management in India," 2017.

[25] C. L. Peng, D. E. Scorpio, and C. J. Kibert, "Strategies for successful construction and demolition waste recycling operations," Constr. Manag. Econ., vol. 15, no. 1, pp. 49–58, 1997, doi: 10.1080/014461997373105.