REENVISIONING CONSTRUCTION WASTE INTO VALUE: A MULTIFACTED REVIEW

Tasnimul Alam Khan*[1], Dhrubo Biswas Toy[2]

[1] *Undergraduate Student, Khulna University of Engineering & Technology, Khulna, Bangladesh, e-mail: alam2023038@gmail.com*

[2] *Undergraduate Student, Khulna University of Engineering & Technology, Khulna, Bangladesh, e-mail: toy2023005@stud.kuet.ac.bd*

ABSTRACT

The construction and infrastructure industries generate a vast quantity of scraps, posing critical environmental, economic and social challenges. As Bangladesh undergoes rapid urban expansion and galloping development in the housing sector, the issue of construction and demolition (C&D) waste is becoming increasingly pressing—but it also presents a significant opportunity. This multifaceted review delves into how we can rethink recyclable construction waste as a valuable asset within a circular economy by analyzing and studying different aspects, involving efforts to provide waste generation rates (WGR) for various C&D waste materials and examine the economic and ecological advantages of recycling C&D waste on a nationwide scale. These aspects include how waste is classified, current recycling practices, behavioral analysis, the roles of various stakeholders, and the environmental consequences, while also pinpointing challenges like weak regulations, technological feasibility, and a lack of public awareness in relation to concurrent timeframes. The study shows how linked supply chains can cut down on the need for raw materials, lower carbon footprints, and create new sources of income. It suggests a strategy that combines digital technologies, incentive programs and collaborative planning by incorporating the concept of the 3R (reduce, reuse, and recycle) in waste management. By viewing construction waste as a driver for sustainable progress instead of just waste, this review offers a rudimentary projection for industry leaders, and researchers working towards a closed-loop system in construction.

Keywords: *Construction and demolition (C&D) waste, Circular economy, 3R principles (reduce, reuse, recycle), Waste generation rates (WGR)*

1. INTRODUCTION

Construction waste, formally known as Construction and Demolition (C&D) waste, stands out as a special kind of solid waste, which occurs as unwanted, assorted materials left after construction, demolitions, excavations, and site clearance. (Haque et al., 2024). It includes mainly wood, tiles, ceramics, bricks, concrete and other non-biodegradable materials. Besides, there are bituminous mixes, coal tar, and tarred products. Metals and their alloys form a separate one. Plastic and glass make up another group. Earth waste includes dirt dug up from dredge debris, stones, and spots with pollution. Insulating materials come next, along with any construction items that have asbestos in them. Bangladesh has set a goal of reaching the status of emerging economy country by 2031, and as a result, has been conducting significant development and building efforts. At present, about 85 to 90% of the total construction and demolition waste (CDW) produced is disposed improperly like in some unauthorized places or open landfills due to bad management practices (Islam et al., 2019). Bangladesh's waste disposal space is scarce and the landfills are located in the outskirts of the urban areas. Therefore, CDW is usually found stacked up along the roads of building and dismantling location or in unsanctioned places and often it is dumped in the neighboring rivers. Recycling and reuse of waste through on-site construction and renovation are very little and some informally scrap dealers in the big cities are salvaging and supplying the waste. The recycling and reuse of waste through construction and renovation on-site are very small, whereas some debris is collected and informal scrap dealers rescue it in the big cities. Municipal solid waste (MSW) generation rates in the six major urban areas, i.e., Dhaka, Chattogram, Khulna, Barisal, Sylhet, and Rajshahi fluctuates from 0.25 to 0.56 kg per person per day (M.S.Haque, 2019). To stress the point made (Hasan et al., 2022), the improper and unmonitored disposal of construction and demolition waste (CDW) has in turn resulted in the infiltration of heavy metals plus other hazardous materials into unauthorized landfilling areas. Besides, it is the case where at most of the local construction sites, the waste materials are often burnt in open spots to get rid of such CDW products.

The difficulties in getting the resources, the scarce availability of those, the expensive price of technological primary products, and the formation of hazardous landfills resulted in an alteration of conventional waste management practices and makeover this field into a business that could not just better the environmental condition, but also earn money thereby increasing the public utility of goods produced. The aim of this multifacted review is to systematically evaluate rate in terms of C&D refuse grows in Bangladesh. The evaluation will include an in-depth investigation of the possibility of managing C&D waste from the perspective of a circular economy model.The review will open up the circular economy and come up with possible ways for waste reduction and resource recovery. The study will also look at the 3R model—Reduce, Reuse, and Recycle—as a crucial factor in dealing with C&D waste in Bangladesh. The review will include analysis of previously collected data so as to assess the historical trends in waste generation. Using visualized predictions, the review will be able to discuss the future of C&D waste management under the proposed models. The review will point out the critical role of stakeholder involvement in developing practices for the management of waste in an environmentally-friendly manner.In the long run, this analysis will help Bangladesh move toward a more sustainable future by making eco-friendly C&D waste management options more available.

2. METHODOLOGY

The framework of this review starts with a thorough literature review of relevant data that will form a foundation of already existing knowledge and situational understanding.
The paper discusses the waste management on four levels: waste sorting, which differentiates between the municipal, industrial, hazardous, and biodegradable wastes; environmental impacts associated with poor waste management, such as pollution and emissions; contemporary recycling methods, which have potentials and constraints; and the existing systems, which are evaluated against policy, economic considerations, and social acceptability. Those areas create a comprehensive overview that adds the knowledge of pro-environmental, feasible, and socially aware approaches.

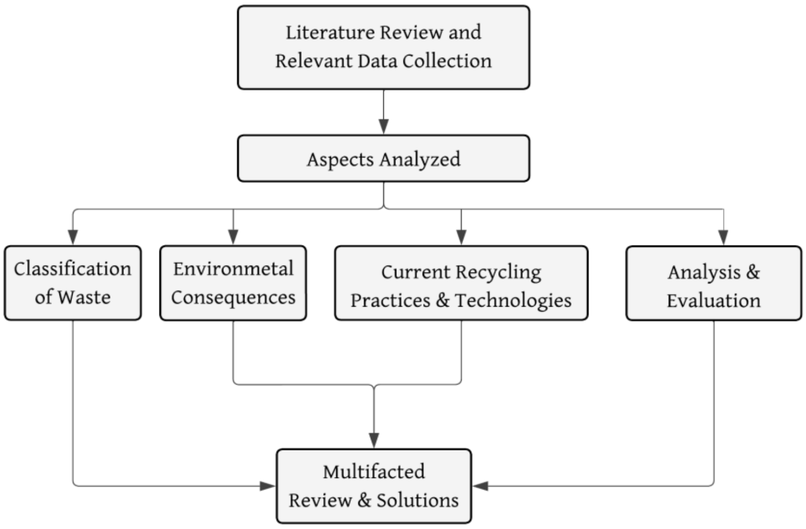

Figure 1 : Process flow diagram of methodology.

2.1 Classification of Waste

CDW is mainly produced by two activities: construction and demolition. No matter if the construction project involves building, renovation, or infrastructure development resource waste is through excess materials, off-cuts, and unused resources. When existing structures are dismantled, on the other hand, demolition activities produce large amounts of waste, often mixed materials that require precise segregation and disposal which is quite challenging too. After generation, CDW can be separated into two types: inert and non-inert. Inert mainly consists of brick, concrete, and mortar which, besides being unstable chemically, do not undergo biological or chemical changes significantly. Non-inert is made of metals, glass, timber, and plastics, which may provide recycling opportunities but also pose environmental hazards if not managed properly. Wastes disposal methods are different for each type of waste. Inert CDW is usually sent to landfills, although this practice leads to a pressure on land usage. It may also be disposed of illegally in unauthorized places, thereby creating ecological and regulatory problems, or managed onsite through reuse and controlled storage to reduce dependence on landfills. Non-inert CDW is mostly directed towards informal sellers, where materials are sold for reuse or recycling. Although this helps in resource recovery, it also brings up issues related to safety, quality control, and the absence of formal regulation in waste management practices. The whole process is discussed in Figure 2.

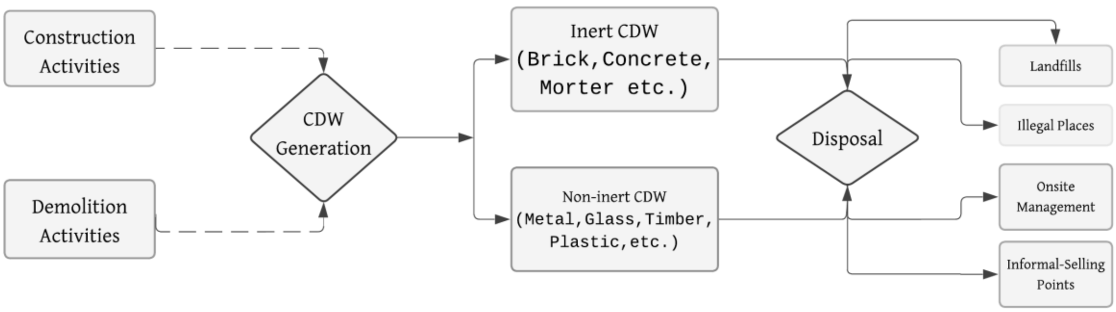

Figure 2: Existing CDW management in Bangladesh (Hasan et al., 2022).

Another study focused on developed countries such as Australia and the UK. It basically confirmed that small business owner-managers have real potential for handling construction and demolition waste in effective ways. The results Table 1 highlighted a clear need for involvement from employers, employees, government bodies, and even local communities to strengthen overall engagement. Still, interest in this area turns out to be pretty negligible in underdeveloped or developing countries.

Offering further education on the business benefits of using recycled construction waste materials could shift practices in the workplace. That kind of change might help lower internal barriers that keep people from participating.

Table 1: Categorization of root causes of C&D Waste (Islam et al., 2019)

Group	Factors of C&D Waste
Design and contract documents	Defects in contract documents; Design detailing errors and complexity; Frequent changes of design; Selection of below standard materials.
Procurement	Supplier's and/or shipping errors; Ordering errors; Over allowances
Handling and Storage	Damage during transportation (off site and on site); Supply and storage in loose form
Site management and supervision	Worker's lack of knowledge and mistakes; Unused/leftover materials; Scarcity and malfunction of equipment
External	Weather condition; Theft and/or vandalism
Residual	Waste from application process; Packaging

2.2 Environmental Consequences

Bangladesh while contributing a slice of global CO_2 emissions ranks among the world's most climate-vulnerable nations wrestling with ever-escalating floods and cyclones. Recycling construction and demolition waste (bricks and metal—offers a remedy shaving off roughly 0.45 million tons of CO_2 each year preserving scarce inputs such, as clay, iron ore, coal, limestone and wood and slashing the need, for energy-intensive, polluting mining operations expressed in Figure 3. Diverting CDW from landfills also shields soil and water from contamination curbs heavy-metal leaching and trims emissions tied to transport. The nation's brick-kiln sector has swelled dramatically now cranking out about 27 billion bricks each year. That boom has come with a price: 6,000 premature deaths are linked to the industry annually and the kilns generate around 58 % of the fine-particulate haze that hangs over Dhaka. Bringing brick recycling into the construction-and-demolition-waste (CDW) stream offers a way to ease those health and environmental burdens. With construction-and-demolition waste hovering, around 3.71 million tons a year and the building sector spewing 35.28 million tons of CO_2, a shift, toward recycling and a gradual phase-out of bricks could steer Bangladesh toward its COP21 pledge-cutting emissions by 20 % by 2030-while also nudging sustainability and public health in the right direction.

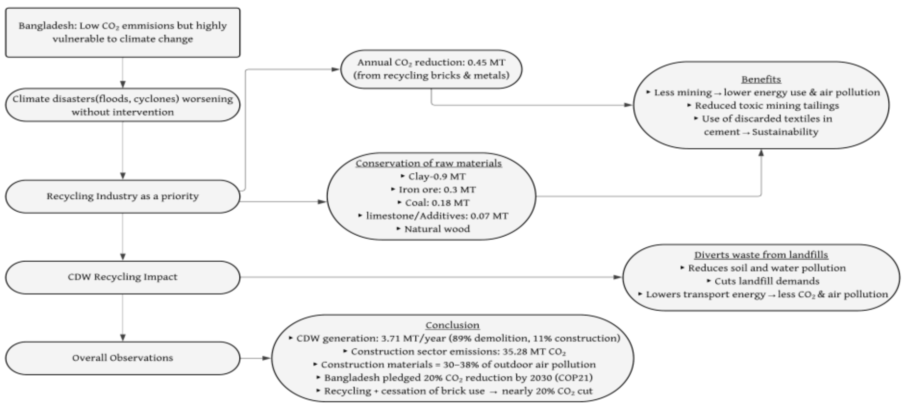

Figure 3: A schematic diagram of environmental consequences of

2.2.1 Waste Generation Rates (WGR)

To determine the WGR for the CDW, a combination of measurement techniques were employed which were direct and indirect. The direct measurements included calculations made on-site to determine the mass, assuming the waste had a pyramid shape according to equation (1) and then a cuboid shape according to equation (2) , afterwards getting the weight through volume and density. Regarding indirect measurements, we based our findings on the logs of waste-collecting truck loads, which provided an understanding of the amount of CDW generated at the site (Rafiq et al., 2024).

$$V_S = \frac{1}{3}\, x\, (X\, x\, Y\, x\, Z) \quad (1)$$

In this equation, V_s signifies the spatial quantity of the accumulated CDW, x indicates the distance of the pyramid's foundation, y represents width of the base, and z denotes its height.

$$V_G = (X\, x\, Y\, x\, Z) \quad (2)$$

In this context, V_G refers to the spatial quantity of collected waste, where x signifies the length, y denotes the breadth, and z represents the elevation of the presumed cuboid. To summarize, the mean WGR for building and dismantling activities was calculated using the equation 3.

$$Q = \sum_{k=i}^{n} \sum_{j=i}^{m} A_{(i)} X WGR_{(jk)} \quad (3)$$

Where, Q= Total quantity of CDW emerged from a specific area, A_i = Total building and dismantling operations measured in m^2 , WGR_{jk} = the rate of waste Generationnnat which waste is generated for the specific waste material type (j) in the particular building type (k), kg/m^2 . The variables m and n depict the number of fundamental materials and the number of individual building types respectively.

2.2.2 Estimating The Recycling Potential

Equation (4), which was modified (Islam et al., 2019), was used to compute the amount of particular waste that was recycled.

$$M_Q = CDW_{MC}\, X\, C \quad (4)$$

Here, Q= Quantity referred to the refuse flow in million tons (MT), CDW_{MC}= Total quantity of refuse in the important urban areas in MT, and C= The waste composition ratio in the refuse flow/100.

$$R_Q = C_W\, X\, P_R \quad (5)$$

Here, R_Q = Quantity reprocessed in MT, C_w= CDW in MT, and P_R = Reprocessing percentage/100

2.3 Current Recycling Practices & Technologies

Over the last several decades there has been a dramatic increase in the solid waste that is discarded in Bangladesh—a 1.10 million tons in 1970 to 5.20 million tons in 2015, with an annual increase of approximately 0.134 million tons. When it comes to urban areas, even if they only account for a small part of the whole population, they are the ones that generate the most waste. Thus, if in 2017 daily waste per urban resident was around 0.32-0.35kg, then the major cities had waste generation of 0.25-0.56kg per person. According to the projections, by 2025 waste generation will be around 57,718 tons every day which translates to 0.60 kg per head, stressing out even more the already existing problem of waste management in a sustainable manner. With a territory of roughly 3,060km² and an 18 million people strong population Dhaka is literally at the center of the waste problem in Bangladesh. The governance of the city has been in a constant change through time until it finally took the form of division into two entities: Dhaka North (DNCC) and Dhaka South (DSCC) starting in the year 2011. The collection of waste is mostly performed by informal local workers transport waste from people's homes to the secondary transfer stations by means of cycle vans and later on, the larger trucks will take it from there to the two main dumping sites: Matuail and Amin Bazar. They usually do their job without any protective gear on and also do the sorting of the waste to get the recyclable materials which they sell to the dealers. Yet, even after this entire process, it is still the case that around 17-20%

of the total waste produced in Dhaka is not collected and is being thrown in places like drains or open areas. Apart from the growing urban population, Bangladesh's changing consumption patterns, and better living conditions have also brought a change in the composition of waste and an increase in waste quantity. Although various policy measures such as the Dhaka City Corporation Ordinance (1983) and National 3R Strategy (2010) have attempted to make the waste management sector more efficient, the overall system is still lacking in efficiency and remains far from being compliant with international standards in waste reduction, recycling and disposal.

Table 2 **:** The existing policies for CDW management in Bangladesh (Haque et al., 2024)

Domestic policies, regulations, and initiative plans	**Liable / Executing Officials**	**Year Implemented**
Constitution of Bangladesh	Government of the People's Republic of Bangladesh	1972
Dhaka City Corporation Ordinance	Government of the People's Republic of Bangladesh, Local Government (City Corporations), NGOs, INGOs, and private companies	1983
National Environment Policy	Ministry of Environment, Forest and Climate Change	1992
National Environmental Management Action Plan	Ministry of Environment, Forest and Climate Change, Local Governments, and NGOs	1995
Environment Conservation Rule	Department of Environment, Local Government and Rural Development, private sector, and NGOs	1997
National 3R Strategy	Ministry of Local Government, Rural Development and Co-operatives, Ministry of Environment, Forest and Climate Change, Ministry of Information, and Ministry of Health	2010
The Bangladesh Environment Conservation Act	Government of the People's Republic of Bangladesh, NGOs, and Private Sector	2010
Solid Waste Management Rules	Department of Environment, Local Government, NGOs, and Private Sector	2021

2.4 Demographic Status and Reliability Analysis

In a study (Datta et al., 2022) the overall information regarding the respondents and their demographic analysis is presented. Participants in this research were drawn from all divisions of Bangladesh, with a significant majority being male (74.34%). Furthermore, most respondents fell within the age range of 30 to 35 years and possessed a minimum of 5 to 10 years in the development sector. The capital city Dhaka was selected as the focal point of the survey due to the concentration of development projects located there. The volume of affirmative responses received from participants in this city was notably high.

Table 3: Demographic Status (Datta et al., 2022)

General Information	Demographic Properties	Frequency	Percentage (%)
Age	20–25	19	16.81
	25–30	31	27.43
	30–35	35	30.97
	>35	28	24.78
Gender	Man	84	74.34
	Woman	29	25.66
Role	Engineer	37	32.74
	Employer	28	24.78
	Site Engineer	21	18.58
	Contractor	27	23.89
Site Spot	Dhaka	29	25.66
	Barishal	9	7.96
	Chittagong	11	9.73
	Mymensingh	10	8.85
	Khulna	22	19.47
	Rajshahi	15	13.27
	Rangpur	8	7.08
	Sylhet	9	7.96

To check the internal consistency of the Likert Scale data, this research (Datta et al., 2022) also employed two different reliability analysis methods: the Kruskal-Wallis test and Cronbach's Alpha. The function of the Cronbach's alpha coefficient starts at 0 and ends at 1, meaning a value close to 0 poor consistency and a number close to 1 strong consistency; because it reflects the data's internal consistency. The description of the Cronbach's alpha coefficient values is presented in Table 4. The Kruskal-Wallis test is a nonparametric statistical technique that assesses the differences among three or more independently sampled groups with respect to a single, non-normally distributed continuous variable.

Table 4: Cronbach's Alpha Interpretation (Datta et al., 2022)

Cronbach's Alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Table 5: Relation Between RII and Importance Levels (Datta et al., 2022)

RII Values	Importance Level
$1.0 \geq RII \geq 0.8$	High (H)
$0.8 \geq RII \geq 0.6$	High-Medium (H-M)
$0.6 \geq RII \geq 0.4$	Medium (M)
$0.4 \geq RII \geq 0.2$	Medium-Low (M-L)
$0.2 \geq RII \geq 0.0$	Low (L)

The waste generation variables were ranked using the Relative Importance Index method after checking the internal consistency of the questionnaire survey data. The Relative Importance Index (RII) is calculated using Equation (5) which provides a numerical representation of the different components' relative importance.

$$\text{RII} = \frac{\Sigma W}{A * N} \tag{5}$$

Here N= total number of participants, A= highest weight on scale (5 in this case), W= participants' weighting assigned to each element on a scale from 1 to 5. The equation (5) was used to evaluate the impact of each factor on the production of construction waste and to rank the factors according to the respondents' views on the importance of each factor. The RII values were limited to a range of 0 to 1. Activities with a high RII value mostly influence the site with regard to construction waste generation. The process of converting RII values into five levels of significance is found in Table (5).

3. RESULTS & DISCUSSION

Table 6: Amount of CDW Generated in Fiscal Year 2022–23 in Major Cities of Bangladesh

City	Volume of CDW, MT
Dhaka	2.590
Chittagong	0.635
Khulna	0.249
Rajshahi	0.082
Barisal	0.059
Sylhet	0.100
Total	3.710

Table 7: Amount, Recycling Percentage, Amount Recycled and Demand of CDW in FY 2022–23

CDW	Amount in Waste, MT $M_Q = CDW_{MC} \times C$	Recycling Percentage	Amount Recycled, MT $R_Q = C_W \times P_R$	Demand in FY 2022–23
Concrete	2.077	75	1.558	Aggregate = 70 MT, Cement = 33 MT
Brick	0.556	75	0.417	Brick = 23 Billion (67.85 MT)
Mortar	0.333	5	0.017	-
Metals	0.222	100	0.222	7.4 MT
Ceramics	0.185	3.5	0.065	26 crore m²
Timber	0.111	3	0.033	-

Table 6 and Table 7 are estimated representation (Datta et al., 2022) of generated quantity of CDW in cities of Bangladesh as well as recycling amount, and demands. Furthermore, The Table 8 (Haque et. al., 2024) outlines the expected volume of recyclable CDW materials and corresponding financial benefits of recycling in Dhaka City for the period 2021-2030. The volumes of recycled CDW materials were ascertained via on-site interviews with the respective contractors and scrap dealers. The gradual rise in construction and demolition activities has led to the forecast that by the year 2025 the incorporation of concrete waste as aggregates in the construction and demolition (C&D) activities of Dhaka will bring about the financial benefits of 32,245 Bangladeshi Taka (BDT) and 11,666 BDT, respectively. For the year 2022, the reclamation of bricks from demolition projects in Dhaka yielded a benefit of around 39,562 BDT, whereas the incorporation of brick waste in construction activities might lead to a saving of roughly 13,236 BDT.

Table 8: Calculated Recycled Amount, Recycling Value, and Economic Return

CDW	T	R	R	R	R	R	B	B	B	B

Items	ype	2021	2022	2025	2030	Value (BDT/t)	2021	2022	2025	2030
Concrete	D	126,072	136,157.49	171,519.23	252,018.01	188.00	23,701.49	25,597.61	32,245.61	47,379.39
	C	45,614	49,263.02	62,057.21	91,182.41		8575.41	9261.45	11,666.76	17,142.29
Brick	D	20,127.10	21,737.27	27,382.69	91,672.55	1820.00	36,631.32	39,561.82	49,836.50	166,844.05
	C	6734.13	7272.86	9161.71	13,461.56		12,256.12	13,236.61	16,674.32	24,500.04
Mortar	D	6721.03	7258.71	9143.89	13,435.37	188.00	1263.55	1364.64	1719.05	2525.85
	C	1119.67	1209.25	1523.31	2238.24		210.50	227.34	286.38	420.79
Metal	D	292.21	315.58	397.54	584.12	50,000.00	14,610.36	15,779.19	19,877.23	29,206.17
	C	547.87	591.70	745.38	1095.20		27,393.71	29,585.20	37,268.83	54,760.15
Timber	D	358.13	386.78	487.24	715.91	2700.00	966.96	1044.31	1315.53	1932.95
	C	154.24	166.58	209.84	308.33		416.45	449.77	566.58	832.49
Plastic	D	42.29	45.68	57.54	84.56	10,000.00	422.94	456.77	575.40	845.45
	C	18.22	19.67	24.78	36.41		182.15	196.72	247.82	364.12

*1 USD = 120.00 BDT, R= Recycled, B= Benefit, D= Demolition, C= Construction

Table 9: Ranking and Statistical inspection of the elements leading to the emergence of building and development site waste

Factors category	ID	Waste generation factors	Mean	Standard deviation	Co-efficient of variance	RII	Category rank	Overall rank
Design	F1	Change in design by employer on current construction	3.381	1.0633	0.315	0.676	1	6
	F2	Change in design by Architect/Engineer	3.133	1.1379	0.363	0.627	2	15
	F3	Inaccuracies in design	3.009	1.3059	0.434	0.602	3	19
	F4	Over and under ordering	2.637	1.0182	0.386	0.527	4	26
Management	F5	Formwork management	3.381	0.9192	0.272	0.676	1	7
	F6	Negative attitude of higher management	3.239	1.2194	0.376	0.648	2	12

	F7	Lack of safety precautions	3.23	1.2248	0.379	0.646	3	11
	F8	Improper handling during transportation	3.159	1.0314	0.326	0.632	4	14
	F9	Cutting the reinforcement	3.133	0.8814	0.281	0.627	5	15
	F10	Unpacked supply	2.885	0.9613	0.333	0.577	6	22
	F11	Default packaging	2.814	1.0819	0.384	0.563	7	25
Manpower	F12	improper training of workers	3.549	1.1572	0.326	0.709	1	3
	F13	Lack of proper guidelines for worker	3.398	1.2645	0.372	0.679	2	5
	F14	Reduced incentive to the employee	2.69	1.1579	0.439	0.527	3	27
Materials	F15	Leaving material in public place	3.894	1.1049	0.284	0.779	1	1
	F16	Improper equipment storage	3.619	1.1442	0.316	0.724	2	2
	F17	Hard refuses (concrete, cement)	3.522	1.1108	0.315	0.704	3	4
	F18	Closing works	3.336	1.1308	0.339	0.667	4	8
	F19	Plastic works (PVC pipes, fittings)	3.319	1.0545	0.318	0.664	5	9
	F20	Tile works	3.292	1.0912	0.331	0.658	6	10
	F21	Packaging waste	3.23	1.102	0.341	0.646	7	12
	F22	Wood works (Doors frames)	3.062	1.2122	0.396	0.612	8	17
	F23	Metal works (Cladding, railing,)	2.965	1.0685	0.360	0.593	9	20
	F24	Chemical waste (Admixtures, oil)	2.876	1.1962	0.416	0.575	10	23
	F25	Glass works (Insulation, windows)	2.832	0.9902	0.349	0.566	11	24
	F26	Organic materials	2.566	1.0596	0.413	0.513	12	28
External	F27	Unforeseen situations (act of God)	3.027	1.271	0.419	0.605	1	18
	F28	Theft and vandalism	2.894	1.2419	0.429	0.579	2	21

Table 9 (Datta et al., 2022) discusses the explicit breakdown of the construction waste and its contribution factors in different aspects. To tackle the problems related with waste, some strategies at Table 10(Mohammed et al., 2021) and technologies at Figure (4) (Mikhno et al., 2023) are discussed regarding these issues.

Table 10: Ranking for waste minimization strategies.

Waste Minimization Strategies	**Mean**	**Rank**
Reusing or recycling some of	0.908	1

the waste materials on site		
Proper storage and handling of materials on-site	0.874	2
Prepare a list of each waste material to be salvaged, reduce, reused, or recycled	0.857	3
Issuing guidelines for waste segregation	0.829	4
Minimizing design changes	0.752	5
Analyzing site waste to be generated	0.749	6
Minimizing Waste at the source of origin	0.728	7
Organizing waste management meetings	0.723	8
Training of construction personnel	0.723	9
Designating waste disposal operators	0.689	10

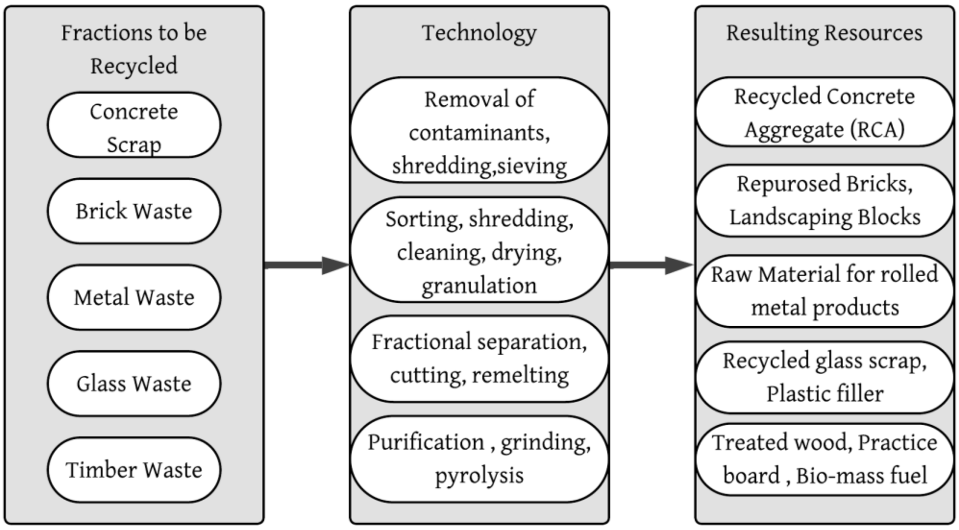

Figure 4 : Key Components of CDW for Recycling and Resources

4. CONCLUSION

Through the observation of different statistical analysis and results from different studies, the following decisions are made-

- The maximum efficient management of CDW is possible through reusing or recycling of the waste materials on site.
- The most impctful factors that contribute to the production of construction waste is under “Material” category which is deposited material in public place.
- The highest waste generating element among CDW is “Concrete” and most recyclable waste is “Metal” which can be considered as the most valuable asset under 3R principles. Moreover, brick and concrete are the second most recyclable and reusable material that can reduce the production and dependency on primary derivatives of these materials.
- All the stakeholders, from the industrial experts to the workers, should be concerned about the evaluation and management of these huge CDW by eliminating the loss of waste and recycling. Thus, it will dwindle global environmental impact.

- Through the stakeholders, Bangladesh can surely develop a circular economy model consisting the principle of 3R for each and every CDW generated.

DECLARTION OF USE OF AI

The authors agree to the fact that all elements of this paper were completed without the assistance of any type of AI. All aspects of this research were conducted entirely by the authors, from study design and data analysis, collection from sources to manuscript writing and editing.

REFERENCES

Datta, S. D., Rana, M. J., Assafi, M. N., Mim, N. J., & Ahmed, S. (2022). Investigation on the generation of construction wastes in Bangladesh. *International Journal of Construction Management*, *23*(13), 2260–2269. https://doi.org/10.1080/15623599.2022.2050977

Haque, M. S. (2019). Sustainable use of plastic brick from waste PET plastic bottle as building block in Rohingya refugee camp: a review. *Environmental Science and Pollution Research*, *26*(36), 36163–36183. https://doi.org/10.1007/s11356-019-06843-y

Haque, S. E., Nahar, N., & Haque, M. S. (2024). A study on the waste generation rates and recycling potential for the construction and demolition waste in Dhaka, Bangladesh. *Environmental Monitoring and Assessment*, *196*(2), 183. https://doi.org/10.1007/s10661-024-12329-3

Hasan, M. R., Sagar, M. S. I., & Ray, B. C. (2022). Barriers to improving construction and demolition waste management in Bangladesh. *International Journal of Construction Management*, *23*(14), 2333–2347. https://doi.org/10.1080/15623599.2022.2056804

Islam, R., Nazifa, T. H., Yuniarto, A., Uddin, A. S., Salmiati, S., & Shahid, S. (2019). An empirical study of construction and demolition waste generation and implication of recycling. *Waste Management*, *95*, 10–21. https://doi.org/10.1016/j.wasman.2019.05.049

Mikhno, I., Ihnatenko, N., Cherniaiev, O., Vynogradnya, V., Atstaja, D., & Koval, V. (2023). Construction waste recycling in the circular economy model. *IOP Conference Series Earth and Environmental Science*, *1126*(1), 012003. https://doi.org/10.1088/1755-1315/1126/1/012003

Mohammed, M., Shafiq, N., Elmansoury, A., Al-Mekhlafi, A. A., Rached, E. F., Zawawi, N. A., Haruna, A., Rafindadi, A. D., & Ibrahim, M. B. (2021). Modeling of 3R (Reduce, Reuse and Recycle) for Sustainable construction Waste reduction: a Partial Least squares Structural Equation Modeling (PLS-SEM). *Sustainability*, *13*(19), 10660. https://doi.org/10.3390/su131910660

Rafiq, M. S., Sultana, R., Apurba, M. S. H., & Khandaker, N. R. (2024). Sustainable management of construction and demolition waste in Bangladesh to promote resource recycling. *Sustainable and Resilient Infrastructure*, *10*(4), 336–350. https://doi.org/10.1080/23789689.2024.2413339