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Development of Framework with Circular Economic Approach for Sustainable Construction and Demolition Waste Management for Residential Building

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ABSTRACT

Despite its vital position in the global economy, the construction sector has an undeniable impact on the environment. This scholarly article explores the profound impact that a circular economy methodology has on the construction and demolition (C&D) industry, with a particular focus on the sustainable utilisation of resources. The research study employs a questionnaire survey as its principal research instrument in order to collect perspectives from experts, stakeholders, and professionals in the field. The importance of data collection, material segregation, and sustainable practices in the implementation of circular economy principles is emphasised in the paper. A comprehensive framework is suggested, which combines systematic material classification with efficient data collection using the "5 R's" principle: Reuse, Recycle, Refuse, Reduce, and Rot. Emphasis is placed on essential strategies including the identification of reusable materials, the recycling of metal and concrete, the avoidance of environmentally hazardous products, the reduction of overall resource consumption, and the incorporation of organic waste via decomposition. In addition, the study supports the implementation of a comprehensive sustainability assessment methodology to evaluate the management of Construction and Demolition Waste (CDW), taking into account principles of the circular economy, social impact, and environmental impact. This methodology integrates cost-benefit analysis, multi-criteria decision making, and materials stock approximation. In order to promote circularity, the study suggests that future scenarios employ the average recovery rates observed in Europe. In conclusion, this study aims to contribute to a circular economy paradigm shift in the construction industry through the promotion of circular economy principles, waste reduction, and environmental impact mitigation.

Keywords- Circular Economy, Construction and Demolition, Residential Building, Sustainable Construction, Material Segregation.

INTRODUCTION

The construction industry has long been recognized as one of the largest contributors to environmental degradation, resource depletion, and waste generation globally. Traditional construction practices often follow a linear model, characterized by a 'take-make-dispose' approach, where raw materials are extracted, processed, used in construction, and ultimately disposed of after demolition. However, this linear model is no longer sustainable in the face of growing environmental concerns and resource scarcity. In response to these challenges, there has been a paradigm shift towards embracing the principles of the circular economy within the construction sector. The circular economy is an economic model that aims to keep resources in use for as long as possible, extract the maximum value from them during their use, and then recover and regenerate products and materials at the end of their service life. It promotes a closed-loop system where resources are continuously reused, recycled, or repurposed, minimizing waste generation and reducing environmental impact. The adoption of circular economy principles in construction and demolition (C&D) activities holds immense potential to transform the industry into a more sustainable and resource-efficient sector. This paper explores the concept of the circular economy approach in C&D for building projects, highlighting its benefits, challenges, and implementation strategies.

Firstly, the adoption of circular economy principles in C&D activities can significantly reduce the environmental footprint associated with construction projects. By promoting the reuse and recycling of materials, it minimizes the need for virgin resource extraction, thereby conserving natural resources and reducing energy consumption and greenhouse gas emissions. Additionally, extending the lifespan of building materials through refurbishment and repurposing prolongs their utility, reducing the demand for new materials and the associated environmental impact. Secondly, embracing the circular economy approach in C&D can also generate economic benefits for stakeholders across the construction value chain. By implementing strategies such as deconstruction, salvage, and material recovery, contractors can reduce disposal costs and generate revenue from the sale of salvaged materials. Moreover, the market for recycled and reclaimed materials is growing, creating opportunities for innovation, job creation, and economic growth in the construction sector.

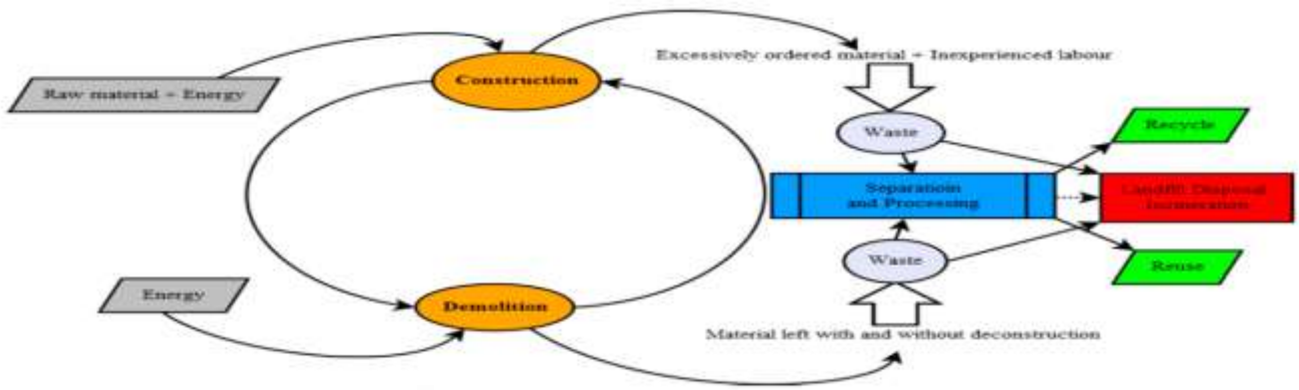


Figure No.1 Construction and Demolition

However, despite its potential benefits, the transition towards a circular economy in C&D is not without challenges. One of the primary challenges is the lack of awareness and understanding among stakeholders about the principles and practices of the circular economy. Many construction professionals may be accustomed to traditional linear approaches and may be hesitant to adopt new methods and technologies. Additionally, there may be regulatory barriers, market constraints, and logistical challenges that hinder the widespread implementation of circular economy practices in C&D activities. The adoption of the circular economy approach in construction and demolition holds immense promise for creating a more sustainable, resource-efficient, and resilient built environment. By rethinking traditional construction practices and embracing innovative solutions, stakeholders can minimize waste, conserve resources, and mitigate environmental impact while simultaneously unlocking economic opportunities. This paper aims to delve deeper into the various aspects of the circular economy approach in C&D for building projects, offering insights into its potential, challenges, and pathways for implementation.

1.1 Circular Economy in C&D Waste Management

Circular economy approach in construction and demolition (C&D) waste management revolves around the idea of reducing waste generation, reusing materials, and recycling resources to create a sustainable building environment. In the context of building projects, implementing a circular economy model entails several key strategies. Firstly, it involves designing buildings for disassembly and adaptability, ensuring that materials used can be easily separated and reused or recycled at the end of a building's lifecycle. This approach encourages the use of modular construction techniques and reversible connections, facilitating easier deconstruction and minimizing waste generation during demolition. Secondly, the emphasis is placed on salvaging and repurposing materials from demolished structures. Salvaged materials such as bricks, timber, metals, and concrete can be reclaimed and reintegrated into new construction projects, reducing the demand for virgin resources and mitigating the environmental impact associated with their extraction and processing. furthermore, adopting innovative recycling technologies plays a crucial role in the circular economy approach. Techniques like concrete crushing to produce aggregate for new concrete mixes, or shredding wood waste to create composite materials, demonstrate how waste materials can be transformed into valuable resources, closing the loop in the construction supply chain. Overall, embracing a circular economy approach in construction and demolition waste management not only reduces landfill disposal but also conserves natural resources, minimizes carbon emissions, and fosters a more sustainable and resilient built environment. Through collaboration among stakeholders, policymakers, and industry players, the construction sector can drive towards a more circular and regenerative future.

RELATED WORK

Masoud Norouzi et.al (2021) The construction industry's environmental impact is significant, driven by resource consumption, energy use, and waste production. Embracing Circular Economy (CE) principles offers promising avenues for enhancing sustainability within this sector. Through quantitative analysis of over 7000 documents from 2005 to 2020, this study identifies emerging trends in CE application within construction. Key clusters include energy efficiency, waste management, and sustainable development, signaling a growing focus on sustainability, renewable energy, and recycling. Moreover, areas like alternative construction materials, circular business models, and the integration of CE with smart cities and Industry 4.0 emerge as promising avenues for future research.

Leonora Charlotte Malabi Eberhardt et.al (2019) The construction sector significantly impacts resource scarcity through resource consumption and waste generation. This study explores implementing circular economy principles in construction, focusing on challenges and potentials. It utilizes a Danish office building case study to quantify environmental and economic benefits of designing for disassembly. While recycling and energy recovery are common practices, reuse offers higher benefits, notably in reducing CO2 emissions. Challenges include short-term focus, complex supply chains, and lack of collaboration. Designing for disassembly improves environmental performance and economic gains, suggesting a shift towards circular economy principles**.**

Mohd Reza Esa et.al (2017) Construction and demolition (C&D) waste poses a significant challenge in Malaysia and globally, extending to developed nations. Effective management throughout the construction cycle is imperative. The emerging concept of circular economy (CE) offers promise in waste reduction. This study evaluates the potential of CE in C&D waste management in Malaysia through a systematic review. A three-layered theoretical framework is proposed, addressing waste minimization strategies across planning, design, procurement, construction, and demolition stages, while identifying stakeholders and their interactions.

Amirreza Mahpour et.al (2018) The pressing concerns surrounding the detrimental impacts of construction and demolition (C&D) waste have spurred public attention. Embracing the principles of a circular economy presents a promising approach to enhance resource efficiency in C&D waste management. However, the transition faces significant barriers across behavioral, technical, and legal domains. This paper identifies 22 key barriers through literature review and expert consultation, prioritizing them using the fuzzy TOPSIS method. The findings underscore the critical need to address issues such as ineffective waste handling processes and regulatory uncertainties to advance towards a circular economy in C&D waste management.

Salman Shooshtarian et.al (2022) Australia's architecture, engineering, and construction (AEC) sector faces challenges with increasing construction and demolition (C&D) waste. Through a systematic literature review, this study explores opportunities and barriers across the C&D waste lifecycle. Findings reveal 58 barriers and 73 opportunities, primarily in design, transport, and landfilling stages. Key stakeholders include project managers, government bodies, and waste operators. Recommendations include enhanced collaboration, waste management system alignment, and stakeholder analysis for improved resource efficiency and circular economy initiatives. Further research should focus on University Industry Engagement, technological impacts, transportation efficiency, and sustainability rating tools in waste reduction.

Jonathan Soto-Paz et.al (2023) The Construction Industry (CI) is a major contributor to global solid waste, with construction and demolition waste (CDW) accounting for approximately 30% of total solid waste. While there is growing research on CDW management strategies, much of it is concentrated in developed nations, leaving a gap in understanding within emerging economies. Through a systematic review and bibliometric analysis of literature from 2010 to 2022, this study highlights the significance of eco-design in CDW reduction and identifies disparities in research focus between developed and emerging economies. Addressing gaps in CDW estimation can greatly benefit construction management practices.

Valeria Superti et.al (2021) The concept of the Circular Economy (CE) has gained traction recently, offering solutions to global challenges like resource scarcity and waste management. This paper aims to categorize CE interventions, analyze their consideration in the Construction and Demolition (C&D) sector, and propose indicators for better assessment tools. Through literature review and expert interviews, we developed a framework with four intervention groups: Research and Realize, Implement, Support, and Enable. Results indicate a focus on implementing strategies, but suggest incorporating other intervention categories for a more comprehensive CE transition assessment.

Valeria Superti et.al (2021) As urbanization grows, innovative strategies like the Circular Economy (CE) are vital to curb resource use. In Switzerland, Construction & Demolition (C&D) waste constitutes a significant portion (84%) of total waste. Recycling C&D waste, particularly through methods like producing recycled concrete (RC) with recycled aggregates, can mitigate landfilling. Despite hurdles, our study investigates the factors influencing architects' adoption of RC, emphasizing the need for a comprehensive approach towards sustainable construction practices.

Lukman A. Akanbi et.al (2020) A successful circular economy hinges on continuous material reuse. Predicting salvage and waste materials from buildings pre-demolition is challenging due to time constraints. This study developed deep learning models using data from 2280 UK building demolition records. The models, with an average R-squared value of 0.97 and Mean Absolute Error between 17.93 and 19.04, accurately predict material recovery. These models aid demolition engineers and waste planners in decision-making.

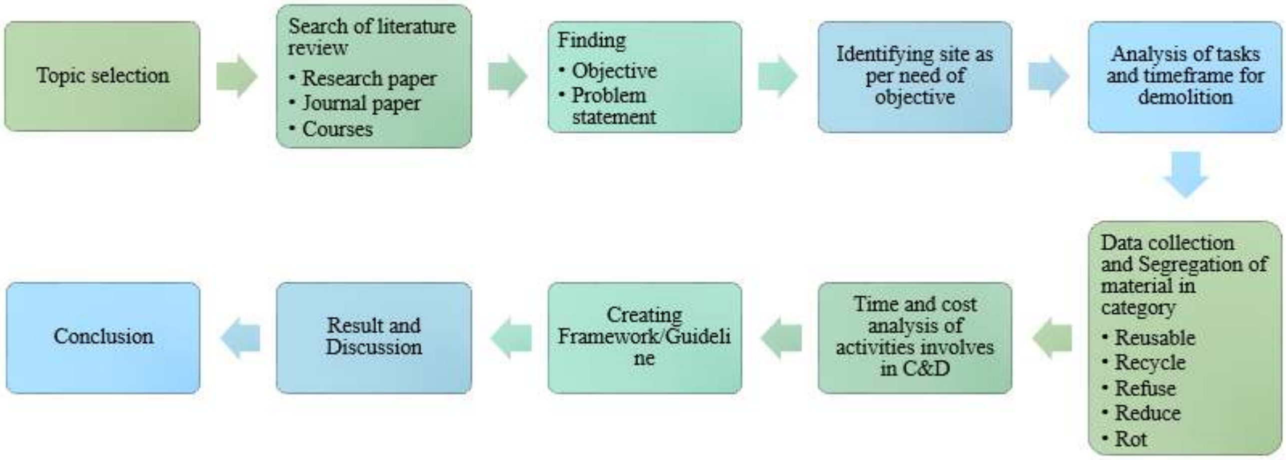
Carmen Díaz-López et.al (2021) The exploration of circular economy (CE) in construction and demolition waste (CDW) is a burgeoning area of study, laden with intricate information. This article endeavors to offer a holistic perspective by scrutinizing existing CE research on CDW through systematic literature review and bibliometric analysis. Utilizing the Science Mapping Analysis Tool (SciMAT), it identifies key authors, subject areas, and trends from 1993 to 2020, shedding light on the evolving landscape of sustainable deconstruction.

Marcos Díaz González et.al (2021) This research investigated the impact of incorporating fine (fMRA) and coarse (cMRA) mixed recycled aggregates, both individually and together, in the production of eco-friendly recycled concrete with reduced natural resource consumption. After characterizing the recycled materials, their effects on fresh and hardened concrete were analyzed. Results indicate that adding fMRA and/or cMRA maintains workability without compromising compressive strength, which can increase by up to 12.4%. Tensile strength varies with aggregate type, with fMRA mitigating the negative effects of cMRA. All concrete mixes exhibit adequate water resistance, supporting their use in structures with a characteristic strength of 25 MPa, with 25% replacement of fMRA deemed optimal.

Md. Uzzal Hossain et.al (2020) The circular economy (CE) concept is gaining traction across various sectors, particularly in construction, due to concerns over resource depletion. Transitioning from a linear economy to a CE model is seen as crucial for conserving resources and enhancing efficiency. Despite being in its early stages within construction, scientific contributions to CE are growing. This review aims to assess the implications, contributions, and challenges of CE in construction, identifying key areas such as design, supply chain, and policy integration. While full-scale evaluations and comprehensive frameworks are lacking, proposed integrated frameworks aim to propel sustainable construction forward.

Thomas Budde Christensen et.al (2022) The passage delves into the establishment of a closed-loop system for production and consumption on Bornholm, Denmark, focusing on recycling construction and demolition waste. It details various initiatives undertaken, such as resource mapping, selective demolition, and assessing CO_2 reduction potentials and business models. The article scrutinizes economic and practical challenges and potentials for integrating recycled materials into new construction. It also explores the transferability of lessons from Bornholm to other islands and remote regions embracing circular economies in construction and demolition.

METHODOLOGY



To explore the implementation of a circular economy approach within the construction and demolition (C&D) sector for building projects, a robust research methodology was employed. The methodology was devised to gather primary data through a questionnaire-based survey, targeting stakeholders engaged in the C&D industry. A comprehensive questionnaire was formulated to elicit insights from various stakeholders involved in construction and demolition endeavors. These stakeholders included engineers, workers, contractors, and other pertinent professionals associated with C&D activities. The survey instrument was structured to delve into the feasibility, obstacles, and prospects related to the integration of circular economy principles within the C&D sector.

A sample size of 50 participants was chosen to ensure a diverse representation of stakeholders within the industry. This sample encompassed individuals directly engaged in C&D projects, facilitating a holistic understanding of the challenges and opportunities from different vantage points. The primary data collection phase entailed the distribution of the questionnaire to the selected sample of stakeholders. The survey was conducted through both online platforms and face-to face interactions, thereby accommodating participants' preferences and ensuring accessibility.

Following the culmination of the data collection phase, a combination of quantitative and qualitative analysis techniques was employed to scrutinize the survey responses. Quantitative data underwent statistical analysis using SPSS software, enabling the identification of trends, patterns, and correlations. Concurrently, qualitative data underwent thematic analysis to extract key themes and insights, offering a nuanced understanding of stakeholders' perspectives and experiences. Through this rigorous research methodology, a comprehensive exploration of the feasibility and implications of integrating circular economy principles within the C&D sector for building projects was conducted. The amalgamation of quantitative and qualitative analyses facilitated the derivation of actionable recommendations and insights conducive to fostering sustainability and efficiency within the construction industry

Site Visit (SV) Method

This methodology requires investigators to visit the construction or demolition sites for a realistic survey. Direct or indirect approaches can be utilized to collect C&D waste generation data.

1. Direct Measurement

Direct measurement requires to weigh the waste produced or to measure its volume on site. Before implementing direct measurement, some assumptions have to be made. Four assumptions were made depending on how C&D waste was stockpiled, gathered, scattered or stacked. For stockpiled waste, a rectangular based pyramid was assumed, and the volume was calculated by Eq. $V_s = 1/3 * (L*B*H)$

2. Indirect Measurement

As direct measurement requires a substantial amount of time and labour, indirect measurement is more frequently used for practical estimation. Employed truck load records to estimate the volume of C&D waste generated on site. The investigators recorded the number of trucks for waste collecting, together with the container's volume of each. Based on this information, the total waste volume at a project level was derived. For the purpose of indirect quantification at a regional level, obtained truck load records from landfills.

➢ The Circular Economy Through MSP Software

1. Project Planning and Design
2. Procurement and Supply Chain Management
3. Construction Phase
4. Demolition and Disassembly
5. Post-Construction
6. Monitoring and Reporting

SPSS SOFTWARE

SPSS Methodology for Circular Economy Analysis

Circular Economy Approach in Construction and Demolition for Construction, SPSS (Statistical Package for the Social Sciences) software plays a crucial role in analysing data gathered through various methodologies. The research design incorporates a multifaceted approach, combining interviews, questionnaire surveys, and comprehensive reports. Interviews with key stakeholders in the construction industry provide qualitative insights, while a structured questionnaire survey

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collects quantitative data. SPSS is employed to analyse survey responses, enabling the extraction of meaningful patterns and correlations.

➢ **Data Collection:** Construction and Demolition Waste Metrics
➢ **Variable Identification:** Key factors impacting circularity
➢ **Data Analysis with SPSS:** Descriptive and Inferential Statistics

DETAILS ABOUT SITE 1 AND 2: Pune, MH, India

Table 1. Details of the Building Analyzed

Activity	Type of waste site 1	Type of waste site 2
Type of structure	Concrete waste	Concrete waste
Partitions	Broken bricks and mortar	Broken bricks and mortar
Flooring	Broken tiles and marble	Broken tiles and marble
Outside finishing	Broken marbles and Styrofoam	Broken marbles and Styrofoam
Wall finishing	Cement and gypsum	Cement and gypsum
Plumbing and water	PVC pipes	PVC pipes
Electrical network	Copper and PVC insulation	Copper and PVC insulation
Roofing	Broken concrete tiles	Broken marble concrete tiles
Finishing	Plastic false ceiling	Plastic false ceiling
Doors	PVC and Aluminum	PVC and Aluminum and woodrn
Windows	Aluminum	Aluminum

Construction, an inventory was made to account for the volume and mass of waste generated during the following stages: foundations excavation, concrete structure work, masonry, plastering, floor and roof tiles, covering the outside of buildings, and MEP (mechanical, electrical and plumbing) work. Datasheets were developed to register the mass of CDW generated. The volumes of the different types of waste (sand, concrete, brick, steel, etc...) were determined, and using their density, their mass was calculated.

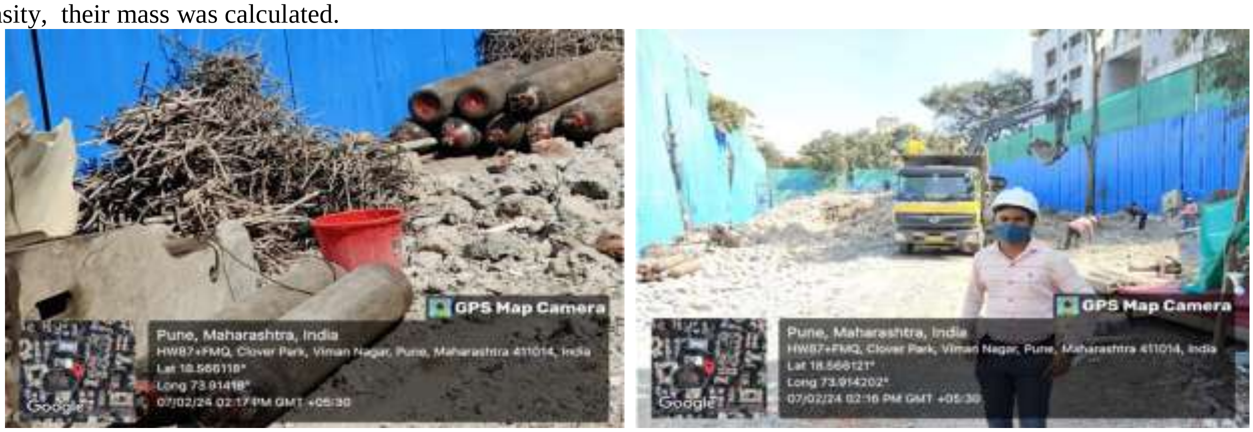

Figure No.3 Site Visit and Data Collection

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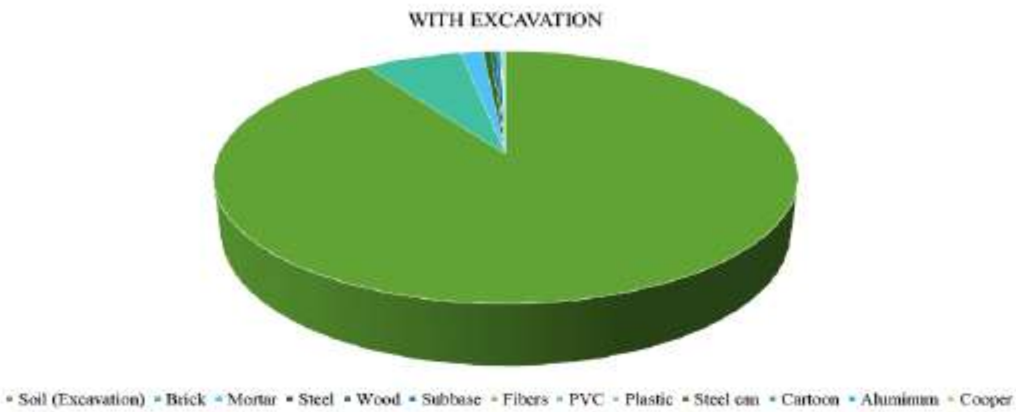


Figure No.5 CDW Generated During the Construction of the Building with Excavation.

Table. 2 Amounts of The Cdw Generated Without Excavation

Waste Material	Quantity, kg	Waste Material	Quantity, Kg
Brick	24,650.0	Plastic	304.6
Mortar	5,584.0	Steel can	295.0
Steel	1,992.0	Cartoon	225.0
Wood	1,240.0	Aluminum	160.0
Subbase	1,058.4	Fibers	37.2
PVC	342.0	Cooper	70.0
Total	35957.8		

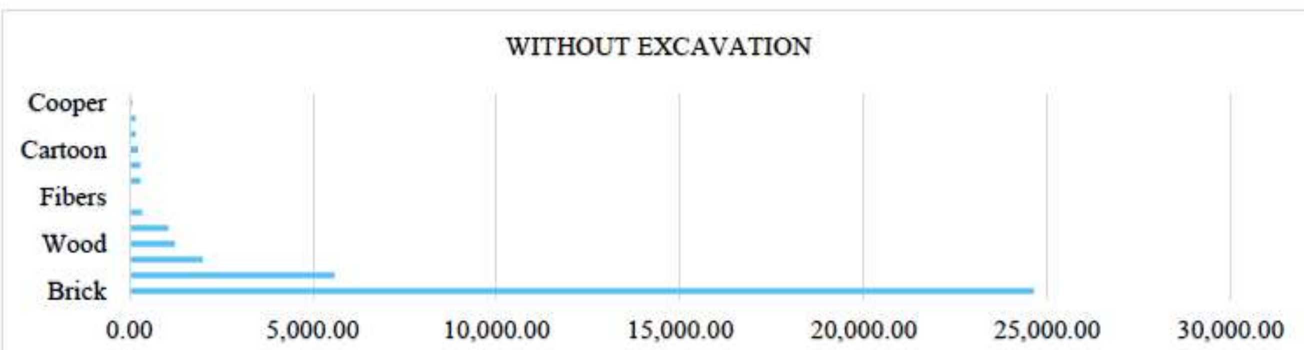


Figure No.6 CDW Generated During the Building Construction Without Excavation

Table.10 Material Name, Total Quantity, Reuse and Scrap and Demolition Quantity

Material Name	Total Quantity	Reuse Quantity	Demolition and Scrap Quantity
Brick	24,650.0	7395	17255
Concrete	10,100.0	3030	7070

Mortar	5,584.0	1954	3630
Ceramic and marble	3,500.0	1470	2030
Gypsum	2,558.0	844	1714
Steel	1,992.0	1035	957
Wood	1,240.0	682	558
PVC	342.0	290	52
Window	114	45	69
Door	105	55	50
Window Frame	114	45	69
Basin	75	33	42

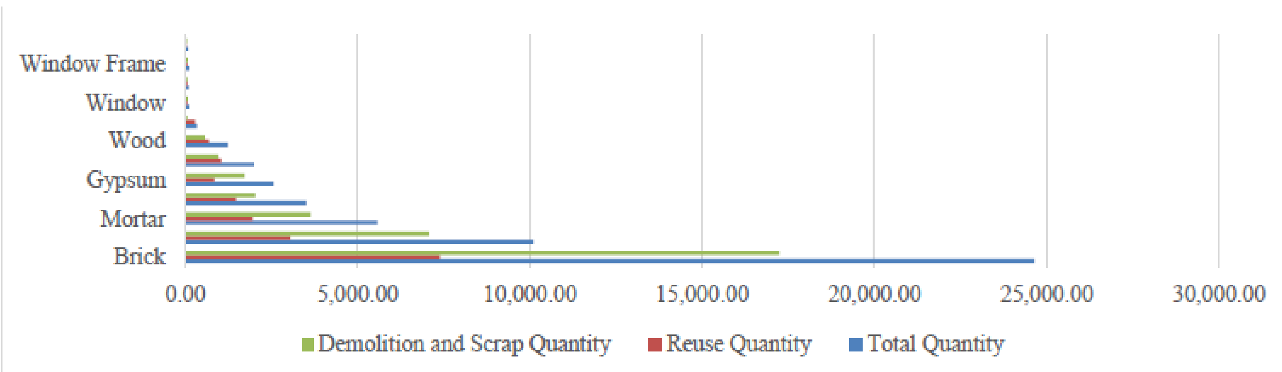


Figure No.13 Material Name, Total Quantity, Reuse and Scrap and Demolition Quantity

Table. 4 Amounts of The Cdw Generated With Excavation Site 2

Waste Material	**Quantity, kg**	**Waste Material**	**Quantity, kg**
Soil (Excavation)	243,142.8	Steel can	385.0
Brick	34,650.0	Cartoon	325.0
Mortar	6,584.0	Aluminum	100.0
Steel	2,992.0	Styrofoam	229.2
Wood	2,240.0	Cooper	80.0
PVC	242.0	Fibers	47.2
Plastic	404.6	-	-

Total	291421.8

Figure No.8 With Excavation

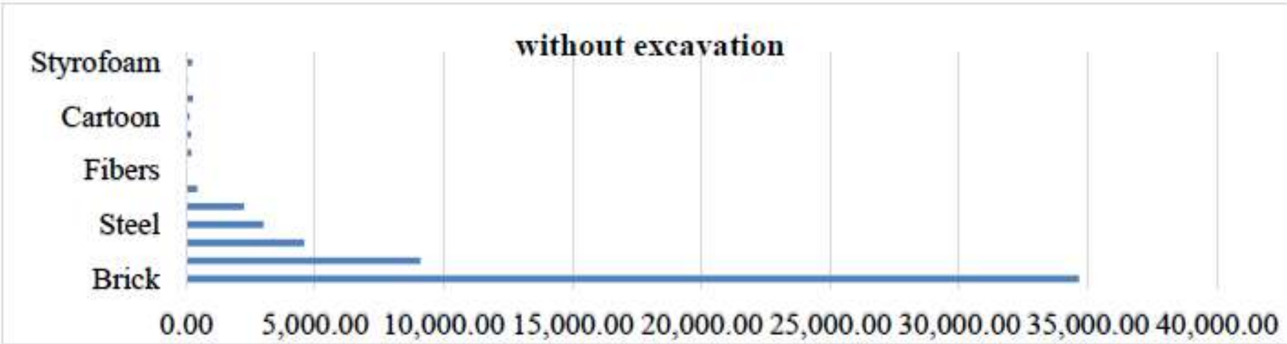


Figure No.9 Without Excavation

Table.6 Material Name, Total Quantity, Reuse and Scrap and Demolition Quantity

Material Name	Total Quantity	Reuse Quantity	Demolition and Scrap Quantity
Brick	14,650.0	6395	7255
Mortar	6,584.0	2954	4630
Steel	2,992.0	2035	1057
Wood	2,240.0	782	658
PVC	242.0	190	62
Window	214	35	79
Door	125	57	52
Window Frame	214	55	79
Basin	65	23	32

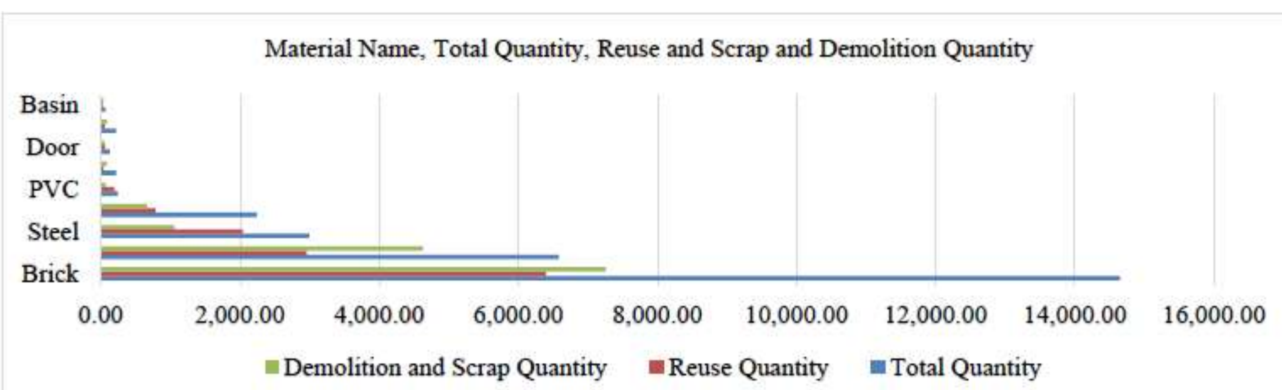


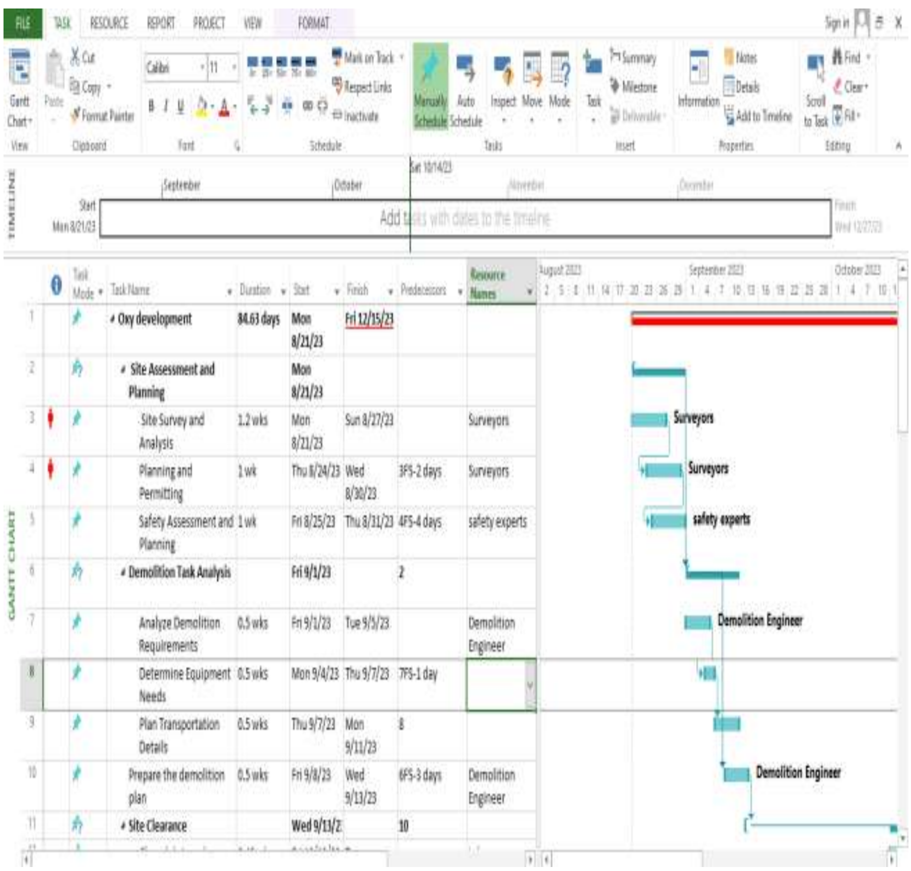
Figure No.10 Material Name, Total Quantity, Reuse and Scrap and Demolition Quantity

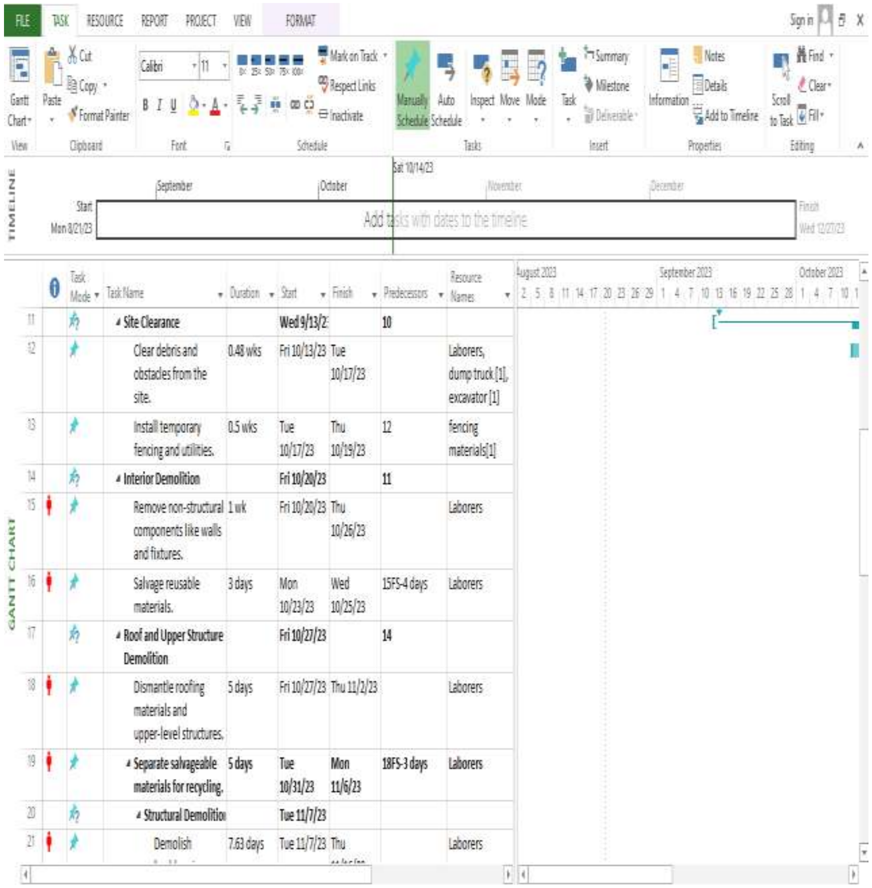
Material Name	Activity (Recycling/Reuse)	No. of Days	Labour	Cost of Labour Per Day	Description
Soil (Excavation)	Reuse	3	4	350	Reusing soil for landscaping or backfilling
Brick	Reuse	5	6	500	Cleaning and stacking bricks for reuse
Mortar	Recycling	4	5	250	Crushing and processing mortar for reuse
Steel	Recycling	7	8	450	Melting and reshaping steel for reuse
Wood	Reuse	6	7	250	Sorting and treating wood for reuse
Subbase	Reuse	3	4	450	Reprocessing subbase material for reuse
Plastic	Recycling	5	6	200	Melting and reshaping plastic for reuse
Steel Can	Recycling	4	5	500	Melting and reshaping steel cans for reuse
Fibers	Recycling	2	3	200	Processing fibers for reuse
Cardboard	Recycling	3	4	200	Processing cardboard for reuse

Material Name	Activity (Recycling/Reuse)	Total Material Quantity (kg)	Material Quantity For Reuse (kg)	Material Quantity For Recycling (kg)	No. of Days	Description
Soil (Excavation)	Reuse	343,142.80	100,000	243,142.80	30	Reuse for filling purposes
Brick	Reuse	24,650.00	15,000	9,650.00	20	Reuse for new construction
Mortar	Recycling	5,584.00	0	5,584.00	15	Crushed & used as aggregate for new mortar
Steel	Recycling	1,992.00	0	1,992.00	10	Melted down & recycled for new steel products
Wood	Reuse	1,240.00	800	440	5	Reuse for carpentry or furniture making
Subbase	Reuse	1,058.40	500	558.4	8	Reuse for new subbase construction
Fibers	Recycling	37.2	0	37.2	3	Recycled into new fiber products
PVC	Recycling	342	0	342	2	Recycled into new PVC products

Plastic	Recycling	304.6	0	304.6	2	Recycled into new plastic products
Steel can	Recycling	295	0	295	2	Melted down & recycled for new steel products
Cartoon	Recycling	225	0	225	1	Recycled into new cardboard products
Aluminum	Recycling	160	0	160	1	Melted down & recycled for new products
Cooper	Recycling	70	0	70	1	Melted down and recycled for new copper products

MSP SOFTWARE WORK

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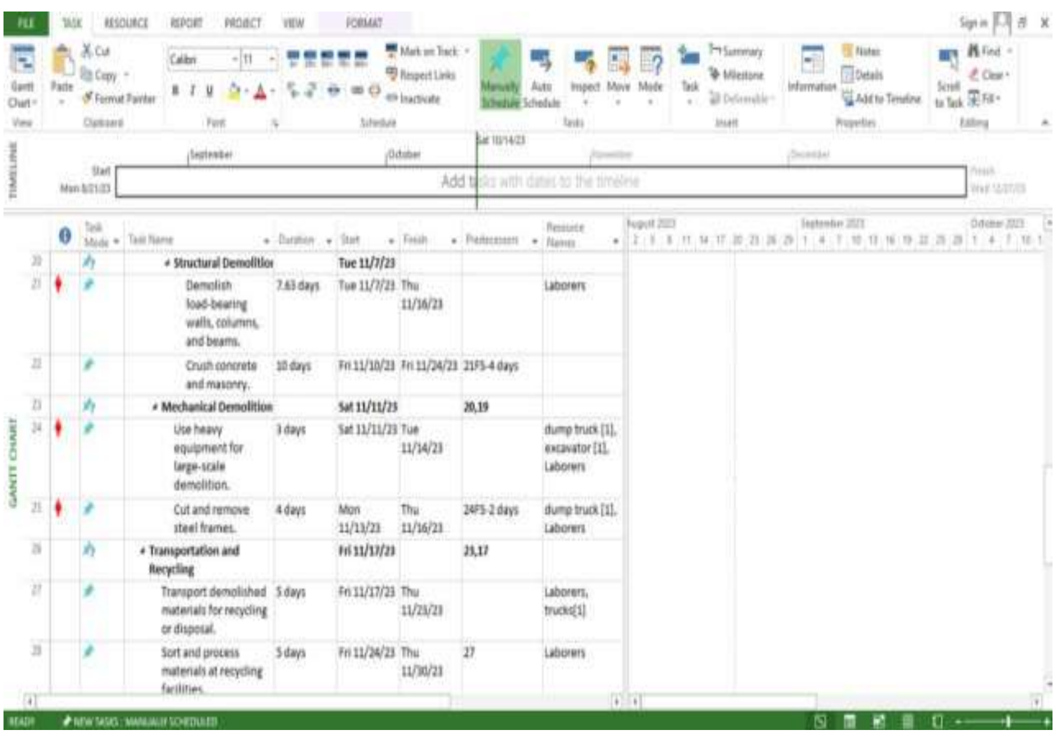
Respect Links
Inactivate
Manually Schedule
Auto Schedule
Inspect
Move
Mode
Task
Summary
Milestone
Deliverable
Information
Notes
Details
Add to Timeline
Scroll to Task
Find
Clear
Fill
View
Clipboard
Font
Schedule
Tasks
Insert
Properties
Editing
TIMELINE
Sat 10/14/23
September
October
November
December
Start
Mon 8/21/23
Add tasks with dates to the timeline
Finish
Wed 12/27/23
Task Mode
Task Name
Duration
Start
Finish
Predecessors
Resource Names
August 2023
September 2023
October 2023
11 Site Clearance Wed 9/13/2 10
12 Clear debris and obstacles from the site. 0.48 wks Fri 10/13/23 Tue 10/17/23 Laborers, dump truck [1], excavator [1]
13 Install temporary fencing and utilities. 0.5 wks Tue 10/17/23 Thu 10/19/23 12 fencing materials[1]
14 Interior Demolition Fri 10/20/23 11
15 Remove non-structural components like walls and fixtures. 1 wk Fri 10/20/23 Thu 10/26/23 Laborers
16 Salvage reusable materials. 3 days Mon 10/23/23 Wed 10/25/23 15FS-4 days Laborers
17 Roof and Upper Structure Demolition Fri 10/27/23 14
18 Dismantle roofing materials and upper-level structures. 5 days Fri 10/27/23 Thu 11/2/23 Laborers
19 Separate salvageable materials for recycling. 5 days Tue 10/31/23 Mon 11/6/23 18FS-3 days Laborers
20 Structural Demolition Tue 11/7/23
21 Demolish 7.63 days Tue 11/7/23 Thu Laborers
GANTT CHART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Sign in
TIMELINE
Sat 10/14/23
September
October
Start
Mon 8/21/23
Add tasks with dates to the timeline
Task Mode
Task Name
Duration
Start
Finish
Predecessors
Resource Names
20 Structural Demolition Tue 11/7/23
21 Demolish load-bearing walls, columns, and beams. 7.63 days Tue 11/7/23 Thu 11/16/23 Laborers
22 Crush concrete and masonry. 10 days Fri 11/10/23 Fri 11/24/23 21FS-4 days
23 Mechanical Demolition Sat 11/11/23 20,19
24 Use heavy equipment for large-scale demolition. 3 days Sat 11/11/23 Tue 11/14/23 dump truck [1], excavator [1], Laborers
25 Cut and remove steel frames. 4 days Mon 11/13/23 Thu 11/16/23 24FS-2 days dump truck [1], Laborers
26 Transportation and Recycling Fri 11/17/23 23,17
27 Transport demolished materials for recycling or disposal. 5 days Fri 11/17/23 Thu 11/23/23 Laborers, trucks[1]
28 Sort and process materials at recycling facilities. 5 days Fri 11/24/23 Thu 11/30/23 27 Laborers
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READY
NEW TASKS : MANUALLY SCHEDULED

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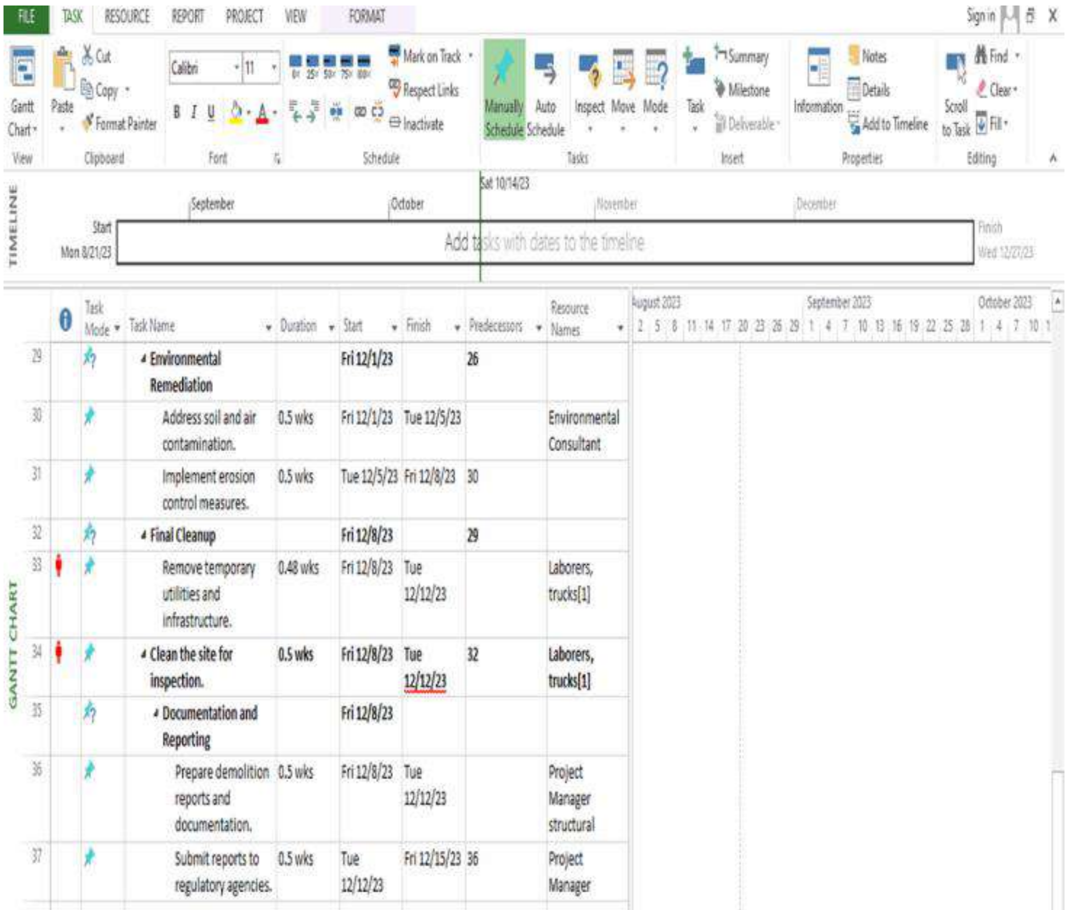


RESULTS AND DISCUSSION

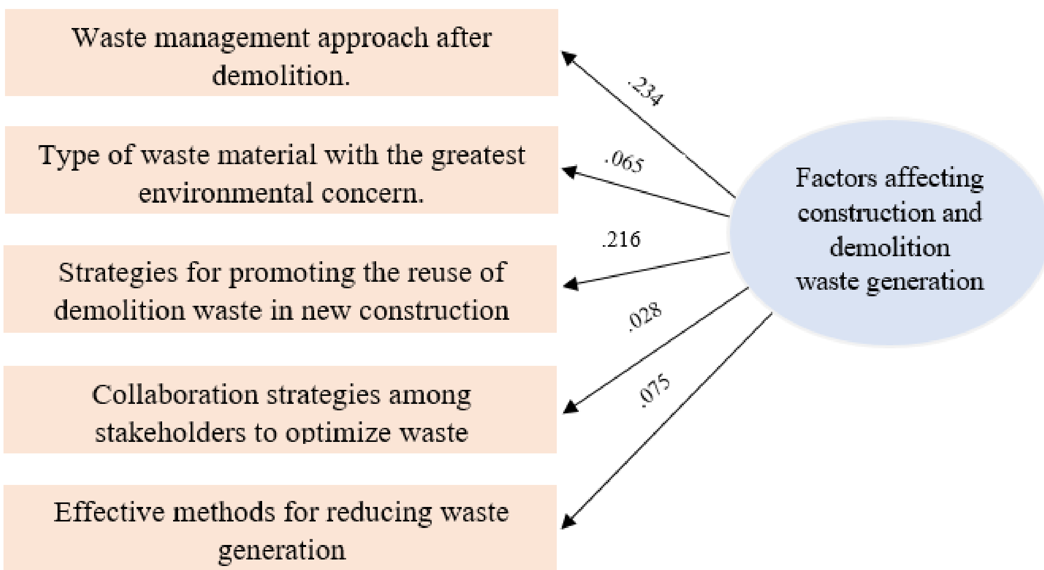
Table.8 Amounts & percentages of the CDW generated during construction of the building withexcavation

Waste Material	Quantity, kg	Percentage %	Waste Material	Quantity, kg	Percentage %
Soil (Excavation)	343,142.8	86.75	PVC	342.0	0.09
Brick	24,650.0	6.23	Plastic	304.6	0.08
Concrete	10,100.0	2.55	Steel can	295.0	0.07
Mortar	5,584.0	1.41	Cartoon	225.0	0.06
Ceramic and marble	3,500.0	0.88	Aluminum	160.0	0.04
Gypsum	2,558.0	0.65	Paint	165.0	0.04
Steel	1,992.0	0.50	Styrofoam	129.2	0.03
Wood	1,240.0	0.31	Cooper	70.0	0.02
Subbase	1,058.4	0.27	Fibers	37.2	0.01
Total Quantity, kg	**395,553.15**				

Table.9 Amounts and percentages of the CDW generated during the building construction without excavation

Waste Material	Quantity, kg	Percentage %	Waste Material	Quantity, kg	Percentage %
Brick	24,650.0	47.03%	Plastic	304.6	0.58%
Concrete	10,100.0	19.27%	Steel can	295.0	0.56%
Mortar	5,584.0	10.65%	Cartoon	225.0	0.43%
Ceramic and marble	3,500.0	6.68%	Aluminum	160.0	0.31%
Gypsum	2,558.0	4.88%	Paint	165.0	0.31%
Steel	1,992.0	3.80%	Styrofoam	129.2	0.25%
Wood	1,240.0	2.37%	Cooper	70.0	0.13%
Subbase	1,058.4	2.02%	Fibers	37.2	0.07%
PVC	342.0	0.65%	-	-	-
Total Quantity, kg	**52,410.35**				

Conceptual Framework for Factors affecting construction and demolition waste generation.



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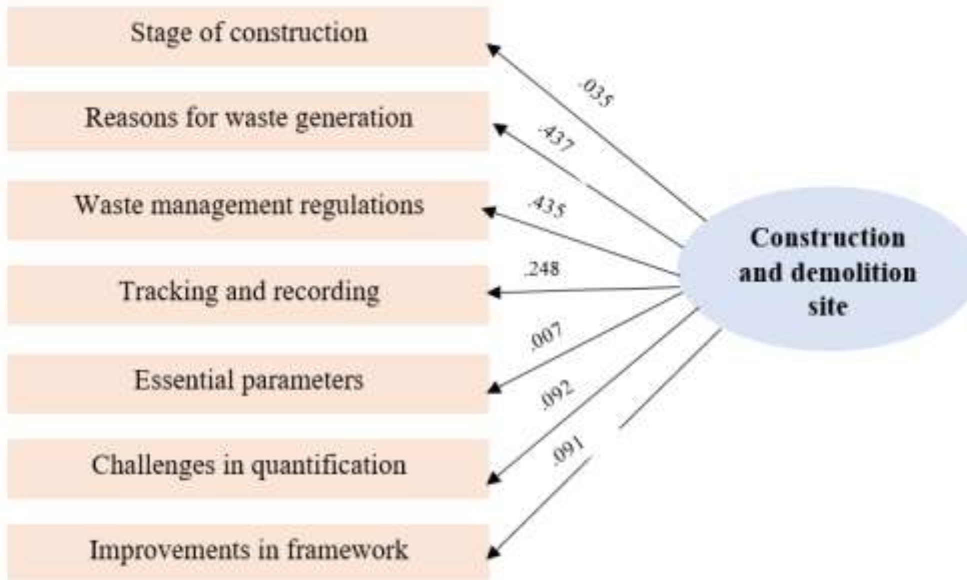
Conceptual framework for quantification of construction and demolition waste during lifecycle of a construction project.



CONCLUSION

Embracing a circular economy approach within the construction and demolition sector is imperative for sustainable development and environmental preservation. By shifting from the traditional linear model of 'take-make-dispose' to one that prioritizes resource efficiency, recycling, and reuse, we can significantly reduce waste generation, conserve natural resources, and mitigate the environmental footprint of building projects. Through the implementation of innovative techniques such as material recovery, modular construction, and design for disassembly, we can prolong the lifespan of building materials and components, thus promoting a more sustainable and resilient built environment. Moreover, fostering collaboration among stakeholders including architects, engineers, contractors, policymakers, and waste management professionals is crucial for driving systemic change and fostering a culture of circularity within the industry. Furthermore, the adoption of circular economy principles not only presents environmental benefits but also offers economic opportunities, such as cost savings through reduced material procurement and waste management expenses, as well as the creation of new markets for recycled materials and green technologies. In essence, by embracing a circular economy approach in construction and demolition, we can pave the way for a more sustainable and prosperous future, where resource efficiency, environmental stewardship, and economic viability go hand in hand. It's imperative that stakeholders across the construction industry unite to champion this transformative shift towards a circular paradigm, thereby building a better world for current and future generations. This paradigm shift requires a collective effort from all stakeholders involved in the construction and demolition process. Governments play a crucial role in setting regulatory frameworks and providing incentives to encourage the adoption of circular economy practices. Additionally, industry associations and organizations can facilitate knowledge sharing, research, and development of innovative technologies and practices. Investment in education and training programs is also vital to equip professionals with the skills and knowledge necessary to implement circular economy principles effectively. By raising awareness and promoting best practices, we can create a culture of sustainability within the industry and inspire widespread adoption of circular approaches.

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