The Thesis on

PROSPECTING THE BARRICADES FOR ADMINISTERING CONSTRUCTION WASTE TRADING PRACTICES IN THE CONSTRUCTION INDUSTRY

Submitted in the partial fulfillment of the award of

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CONSTRUCTION TECHNOLOGY &MANAGEMENT

By

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Department of Civil

DECLARATION

I declare that the research thesis entitled **"PROSPECTING THE BARRICADES FOR ADMINISTERING CONSTRUCTION WASTE TRADING PRACTICES IN THE CONSTRUCTION INDUSTRY "** is the bonafide research work carried out by me, under the guidance of **Mr. Mohd Asim, Assistant Professor, Department of Civil Engineering, Integral University, Lucknow.** Further I declare that this has not previously formed the basis of award of any degree, diploma, associate-ship or other similar degrees or diplomas, and has not been submitted anywhere else**.**

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CERTIFICATE

*Certified that the thesis entitled "***PROSPECTING THE BARRICADES FOR ADMINISTERING CONSTRUCTION WASTE TRADING PRACTICES IN THE CONSTRUCTION INDUSTRY "** *is being submitted by* ***Mr. Imran Abbas Naqvi (Roll no: 2001103001)*** *in partial fulfillment of the requirement for the award of degree of Master of Technology (Construction Technology And Management) of Integral University, Lucknow , is a record of candidate's own work carried out by him under my supervision and guidance.*

The results presented in this thesis have not been submitted to any other university or institute for the award of any other degree or diploma.

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ABSTRACT

Conventionally, in a linear economy, C&D (Construction and Demolition) waste was considered as zero value materials, and, as a result of that, most C&D waste materials ended up in landfills.

In recent years, with the increase in the awareness around sustainability and resource management, various countries have started to explore new models to minimize the use of limited resources which are currently overused, mismanaged, or quickly depleting . Reviewing of the literature revealed that the barriers in implementing C&D waste trading fall in five main domains, namely legal, technical, social, behavioral, and economic aspects.

In this context, it was found that policy and governance, permits and specifications, technological limitation, quality and performance, knowledge and information, and, finally, the costs associated with the implementation of CE model at the early stage are the main barriers. In addition to these, from the contractors' perspective, C&D waste dismantling, segregation, and on-site sorting, transportation, and local recovery processes are the main challenges at the start point for small-scale companies. PESTAL analysis has been done to conclude to identified barriers in waste trading.

CHAPTER-1

1.1 INTRODUCTION

The construction industry is increasingly concerned with improving its environmental performance and reducing environmental degradation, which often results from carbon emission and high volume of waste generated from new construction, renovation or refurbishment and demolition activities including site clearance and excavation associated with these activities as well as from natural disasters. The consumption of natural resources by the construction industry continues to rise more likely in the range of 50–75% compared to the increase in overall resource consumption. The depletion in natural resources, increased global warming and pollution are stimulating the construction industry stakeholders to pay more attention to the issues related to environmental, economic and social sustainability. The future reputation of the industry, therefore, depends on how the industry is being accountable for minimizing waste and thus, waste footprint through the careful use of finite resources and their conservation. The construction industry in UP India contributes to around 27 Mt (44% of the total) of construction and demolition (C&D) waste out of total core waste streams across all industries. During the last 13 years (2006-2019), waste generation by the C&D waste stream has been raised by 32% per capita, showing a different trend in waste generation compared with the other core waste streams: Municipal Solid Waste (MSW) and Commercial & Industrial (C&I). Most of the Waste Trading in the past years resulted from the unprecedented levels of development associated with urbanization and industrialization due to rapid population grow Waste Trading, predominantly in the major cities of UP India. Consequently, management of C&D waste has become a challenging task for both industry and government, from the perspective of engineering, technology, management, policies, and legislation. Whereas waste management (WM) is considered as an inter-disciplinary theme that is escalating the connection with economic, environmental, institutional, social, and political aspects. The major goals of WM, therefore, should focus on waste avoidance and minimization through recycling/reusing, waste to energy options and safe disposal of residual waste, which is the least preferred final option while simultaneously promoting the institutional, economic, environmental and social performance of C&D

WM at project, industry and national levels. Though the C&D sector in UP India has great potential in averting the waste materials from landfills, the recovery rate is still at 77% which is less than the target rate, ranging in between 75- 90% across the jurisdictions. With a target to optimize each state's potential to utilize the waste at its maximum level, Uttar Pradesh state and territory governments continue to encourage best WM and resource recovery practices in the C&D sector based on the strategies stipulated in the waste hierarchy. The key three '3Rs'(Reduction, Re-use and Recycling) strategies are being promoted in WM practices as they offer benefits through conserving natural resources, minimizing the burden of C&D waste reaching landfill (Suthar et al., 2016) and creating economic benefits. Perceive waste trading (waste trading) as an innovative approach to achieve cleaner production and sustainability through diverting the waste from landfills by the means of reuse or recycling of waste materials in the construction industry. Waste Tradingis a well-recognized method that increases resource efficiency and minimizes the environmental impact associated with the waste streams arising from major industrial and consumer activities while contributing to economic benefits. Having reviewed the barriers for reuse of waste, emphasized the need for a strategy to escalate the effectiveness of reusable and recycled materials which can replace the raw materials used in new construction and renovation activities. Waste Trading can be advocated as a strategic solution to construction waste which includes both raw inert construction waste and recycled products made from construction and demolition waste. However, the notion of Waste Trading has not much been assessed and little attention has been paid to waste diversion through Waste Trading practices in the C&D waste sector in UP India. Despite the barriers for Waste Trading have been recognized, in the long run, it is important to identify the factors, which drive the Waste Trading practices in order to boost and expand the Waste Trading in the C&D sector. This study, therefore, is an attempt to address this research gap and aims to identify the potential drivers for implementing effective Waste Trading practices from different perspectives in the context of the construction industry which is the highest generator of C&D waste among other jurisdictions. This study is intended to be accomplished by exploring Waste Trading as a sustainable waste minimization approach through the maximum diversion from landfills and saving transport and disposal costs. The comprehensive literature review assisted to identify the existing drivers to WM and their related

perspectives and the research gaps in the area of Waste Trading. The expert forum and validation process ensure the validity of the outcome and provides more insight to the drivers to Waste Trading in the context of the C&D sector.

1.2 Theoretical Background

Reflecting on past urban contexts, waste management has generally been focused on eliminating hazardous substances that pose a risk to humans . However, with such unsustainable management approaches, social and financial implications have become a major challenge for many communities, prompting a major shift to more sustainable and holistic management of waste. Within C&D waste management there is more emphasis on the premise that 'waste' can be considered as a 'resource' and that material can have second or a third life, enabling resources to be in the loop for a longer period of time . The well-known waste hierarchy describes the order of preference for options—from avoiding, to reusing, recovering, treating, and disposing of waste.

Within this hierarchical framework, the authors have turned to the key concepts of cleaner production, construction and demolition waste management, and circular economy to use as a theoretical foundation for the review . With increasing attention on sustainable construction, the use of eco-material and innovative technologies have emerged as targeted practices to lower production of byproduct waste. Cleaner production methodologies also describe efforts to prevent and minimise C&D waste generation. While the authors acknowledge these upstream strategies, this review focuses on the residual C&D waste (waste that cannot be avoided) that arises from the industry. This residual waste can be treated and re-integrated to industrial processes through internal recycling and external recycling . Many industries have also been prompted to engage in sustainable business processes with the use of the European Waste Catalogue (EWC). This has enabled the discovery of industrial symbiosis opportunities for many business entities.

While humans are typically engaged in linear economic practices (take-use-dispose) there is an increasing scope on circular economy to longer product usage through reuse, repair, recondition, and upgrade, or a combination of those . Specifically, two key strategies have been established for resource cycling. These include slowing resource loops and closing resource loops . Slowing resource loops is defined as "product planning and design aim at a long product lifetime; this extension of product use results in the deceleration of resource flow". Closing resource loops is defined as

“the periods of production and post-use stand as a closed loop, supporting circular resource flows” . Creating a marketplace for reusing and recycling C&D waste will require a substantial amount of time and experience to fully develop into a reliable, skilful, marketable, and sustainable industry .While there are difficulties identified in commercializing waste materials there are many global efforts to venture into the reuse and recycling market and contribute to a circular economy system. Building on this previous research, the authors carry out a systematic literature review on creating a marketplace for construction and demolition waste while appreciating the theoretical foundations elicited from circular economic principles.

1.3 Materials & Methods

The strategy used in this study comprised two main stages. In the first stage, a systematic review has been conducted to identify and synthesize research evidence in order to make a generic source of information. This strategy ensures that all relevant, research-based evidence has been collected. For the systematic review of literature, relevant literature was fetched from the largest scientific database, known as Science Direct. To maintain relevancy, the keywords included “construction and demolition”, “waste”, “construction”, “circular economy”, “framework”, “climate change”, “carbon emissions”, etc. The Boolean operators (AND) and (OR) were used separately and in combination for retrieval of relevant publications. Examples of search inputs include: “circular economy” OR “construction and demolition waste” AND “framework”, “construction and demolition” AND “waste”, and “construction waste” OR “demolition waste”, AND “framework”, OR “strategies” OR “management”, etc. The period of search was limited to 2005–2021, with the majority of the publications obtained for this review being from the last five years. This was to ensure that relevancy, novelty, and innovative retrieval of novel ideas and research concepts was maintained. The advantage of this paper to the previously published papers is that the state-of-the-art research in this area is discussed from a new angle of considering the importance of environmental impacts based on C&D waste.

1.4 Waste trading

According to Hyder (2012), defining waste appropriately enables to determine whether a material is “waste”, a “product” or a “resource”. This differentiation can have significant impacts on regulations, environment and finance required for the entire WM system which involves different stakeholders such as waste generators, collectors, transporters, processors, disposal operators, landfill owners and traders from the waste generation phase to the final destination phase. Besides, WM is always a challenging task as it is influenced by community demand, government policies and programmes, technological development and market circumstances (Pickin et al., 2018). The Environment Protection and Heritage Council (2010, p. 361) define waste as: “Any discarded, rejected, unwanted, surplus or abandoned matter intended for recycling, reprocessing, recovery, re-use, or purification by a separate operation from that which produced the matter, or for sale, whether of any value or not.” The recognition of waste as a potential resource has been further acknowledged by Edge Environment (2012), specifying that C&D waste is a general term for a diverse range of materials which can include high-value materials and resources for new construction after segregation. According to Braungart (2013), industrialisation has made industries practice cradle-to-grave patterns of material flow with less attention to the impact on the environment caused by industrial waste. These practices are opposed to the cradle-to-cradle approach in which zero waste is produced as it is based on the closed-loop nutrient cycle of nature (McDonough and Braungart, 2003). This approach is further recognized by the circular economy concept in which waste is kept within the economy by productively circulating it through repeated usage, thus evading landfills. The circular economy aims to convert waste into a valuable resource through reusing, recycling, repairing and reprocessing waste materials and products, unlike the linear economic concept which is based on a “take-make consume-throw away” pattern (Bourguignon, 2014). These practices have been further promoted by the zero WM strategies that recognize waste as the transformation of resources while the traditional WM system treats waste as an “end-of-life” product (Zaman, 2013). In alignment with these concepts, waste generated from the construction industry has a high potential to yield valuable resources into economy by either reusing, recycling, repairing, reprocessing or re-manufacturing. Consequently, there is a pressing need to

integrate more sustainable strategies into WM processes that enable the transformation of waste into resources by creating end value to waste. Integrating WT strategies into holistic WM could substantially increase the competitiveness of C&D waste materials and contribute to the return of a significant volume of waste into economy. WT is a well-recognized methodology that increases resource efficiency and minimizes the environmental impact associated with the waste streams arising from major industrial and consumer activities while contributing to economic benefits (Corder et al., 2014). Hence, it can be considered as an alternative WM method to the disposal method as it diverts most of the waste from landfills, thus greatly contributing to environmental, economic and social sustainability development (GDRC, 2016; Pun et al., 2007). Caldera et al. (2020) perceive WT as a targeted intervention that opens up an opportunity for second life to waste that can be used for its original purpose or new purpose. WT can be considered as a strategy that enables efficient use of waste materials (reusable residual waste and recyclable waste materials/products) and/or recovered energy from waste through buying, selling and/or exchanging options while accomplishing the compliances with relevant waste regulations. Hence, it prompts the circularity of waste from where the waste is generated/stored/recycled to where it is to be consumed to gain economic benefits. Adopting a WT strategy in C&D WM could simultaneously improve the economic, environmental and social performance. In the context, international solid WT has been well established over the past years. However, local markets for the trading of solid waste have not been well established yet, while the market for C&D WT is comparatively limited in balancing the demand and supply. A survey carried out in the Indian C&D waste sector revealed that sustainable material procurement, the imposition of landfill levies and investment in technology and infrastructure are the major factors that influence the establishment of marketplaces for C&D waste (Shooshtarian et al., 2020). Several other factors which influence the construction material supply chain include material procurement, recycling process, plant management, market promotions and government intervention through market-based policy instruments (Caldera et al., 2020; Villoria Saez and Osmani, 2019). Although the trading of reusable/recyclable C&D waste materials is relatively not a new approach in the global solid WM system, limited studies have been focused on managing the C&D waste through WT strategies in the construction sector. Barriers to assess the effectiveness of this strategy were not well attended by

past studies as different aspects and challenges associated with WM have not been taken into account. This study can be taken as an example of a study that intends to draw insight into the barriers to the effectiveness of the WT approach in the C&D sector and, hence, an attempt to accelerate the industry moving towards the circular economy in C&D WM.

1.5 Scope of study

i. Properties of C&D waste and targeted waste management methods

ii. Waste composition and points of generation

iii. Benefits of C&D waste management through waste trading

iv. Models for creating an online marketplace for connecting sellers and buyers

v. Enablers and barriers for creating a marketplace for C&D waste.

CHAPTER-2

2.1 LITERATURE REVIEW

This presents the review on importance of soft skills .It also introduces to the reader a comprehensive detail is stipulated work of various researches has been incorporated in this

S.NO.	AUTHOR	NAME OF THE STUDY	YEAR	OBSERVATION
1	Serena Giorgi	Drivers and barriers towards circular economy in the building sector: Stakeholder interviews and analysis of five European countries policies and practices	2022	The paper objective is to analyse the present level of application of circularity strategies, identifying the related barriers and drivers, through interviews with building stakeholders across five European countries
2	Benjamin I.Oluleye	Circular economy research on building construction and demolition waste: A review of current trends and future research directions	2022	It is believed that the analysed critical issues for CE adoption in BCDW management and identified future research directions would further help the development of CE research and help stakeholders and policymakers in advancing and adopting CE in the construction industry at large.
3	Zainab	Management	2022	This study was

	Toyin Jagun, Dzurllkanian Daud, Ajit Bhoslay, Satish Kumar Palniappan & Ramesh Murlidhar Bhatawdekar	Strategy for Indian Housing Development Waste		conducted to determine the necessity of recycling factories that produce aggregates and sand from demolished concrete from housing development trash. Therefore, providing tools to accelerate the development of waste recycling.
4	Zezhou Wu	Major barriers to information sharing in reverse logistics of construction and demolition waste	2022	This study aims to identify the major barriers systematically and to analyze their hierarchical relationships by using interpretive structural modeling (ISM)
5	Mina Salman & Mehdi Chougan	The Circular Construction Industry	2022	Reduce, reuse, recycle and recover are essential interventions for a circular construction, with a systemic shift in the culture and mindsets of stakeholders.
6	T.Ilango E.Meenakshi M.J.Rajesh kumar	Minimization of construction waste in Chennai construction industry	2022	This article scrutinizes various factors affecting waste generation at all stages and gives remedial measures to be taken to curb this.
7	AbrahamZhang Jason X.Wang	Overcoming barriers to circular product design	2022	The most influential stakeholder classes for overcoming the barriers are consumers, industry leaders, and governments. Circumventing measures lie in

				sustainable end-of-life product and waste management, resource circularity, modularity and standardization in design, and supply chain collaboration.
8	Christopher Amoah, Jeanne Smith	Barriers to the green retrofitting of existing residential buildings	2022	This study aims to examine the challenges for green retrofitting implementation in existing residential buildings to lower the running cost and achieve a better energy-efficient system.
9	Amma Kyewaa Agyekum, Frank Desmond Kofi Fugar	Barriers to stakeholder engagement in sustainable procurement of public works	2022	The absence of effective stakeholder engagement at the early planning and implementation stages impact projects negatively.
10	Sultan Çetin Vincent Gruis	Towards Circular Social Housing: An Exploration of Practices, Barriers, and Enablers	2021	Building on the panel input, this study suggests potential enablers to overcome these barriers, such as CE legislation, best practice case studies, commitment and support from the top management, and the creation of a clear business case.
11	Rabia Charef [1], Jean-Claude Morel [2,*] and Kambiz Rakhshan [3]	Barriers to Implementing the Circular Economy in the Construction Industry: A Critical Review	2021	The study gives a detailed map of the barriers that would help stakeholders from the AEC sector develop strategies to overcome the current obstacles in the shift to a CE

12	Geraldo Cardoso de Oliveira Neto; Roberto Rodrigues Leite; and Dirceu da Silva	Plan to Overcome Barriers to Reverse Logistics in Construction and Demolition Waste: Survey of the Construction Industry	2021	The findings contribute to the literature and organizational practice because understanding these barriers is necessary to address the barriers that negatively influence the implementation of RL in the CI.
13	Wassim Al balkhy, Rateb Sweis	Barriers to adopting lean construction in the construction industry: a literature review	2021	The purpose of this paper is to identify and theoretically explain the general barriers to adopting lean construction practices in the construction industry regardless of the country or the company size or specialization, and to suggest future research studies in this field.
14	Stephen Emmitt[b]	Uses of building information modelling for overcoming barriers to a circular economy	2021	The current linear economy approach of the construction industry is partly responsible for the environmental impact of the sector.
15	Tahir Noor , Syed Makhdoom Hussain	Types of sources & mangement of urban waste	2020	In this study l The amount of CDW in urban areas is still unknown.An old saying ‘you cannot improve what you cannot measure’ is the case with CDW
16	Andrea Di Maria	Use of LCA and LCC to help decision-making between downcycling versus recycling of construction and demolition waste	2020	In this study the Advances in Construction and Demolition Waste Recycling

17	Paola Villoria-SáezCésar Porras-AmoresMercedes del Río Merino	Estimation of construction & demolish waste	2020	This study concludes that These indicators can be easily used to plan in advance the best practices for C&DW management and determine the size of the waste containers and how often they need to be replaced
18	Julia A. Stegemann	From Waste Management to Component Management in the Construction Industry	2018	The construction industry uses more resources and produces more waste than any other industrial sector; sustainable development depends on the reduction of both, while providing for a growing global population.
19	Saheed O.Ajayi[a]Lukumon O.Oyedele	Waste effectiveness of the construction industry: Understanding the impediments and requisites for improvements	2015	The proposed strategies are not only important for achieving low waste construction projects, they are important for reducing waste intensiveness of the construction. Implementation of the suggested measures would drive waste management practices within the construction industry.
20	Susan Dzifa Djokoto1 , John Dadzie1 & Eric Ohemeng-Ababio	Barriers to Sustainable Construction in the Ghanaian Construction Industry: Consultants Perspectives	2014	The results show that key barriers to sustainable construction are lack of demand for sustainable buildings, lack of strategy to promote sustainable construction, higher initial cost, lack of public awareness and

				lack of government support
21	Mohamed Osmani	Construction Waste Composition and Quantification	2011	This paper contributes significantly to It is difficult to give exact figures of construction waste produced on a typical construction site, but it is estimated that it is as much as 30% of the total weight of building materials delivered to a building site
22	Koskela, Lauri	An exploration towards a production theory and its application to construction	2000	The answer to the research questions can thus be summarized shortly. It is possible to formulate a theory of production, which also provides a new theoretical foundation for construction.

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2.2 The Hierarchy of Waste Management

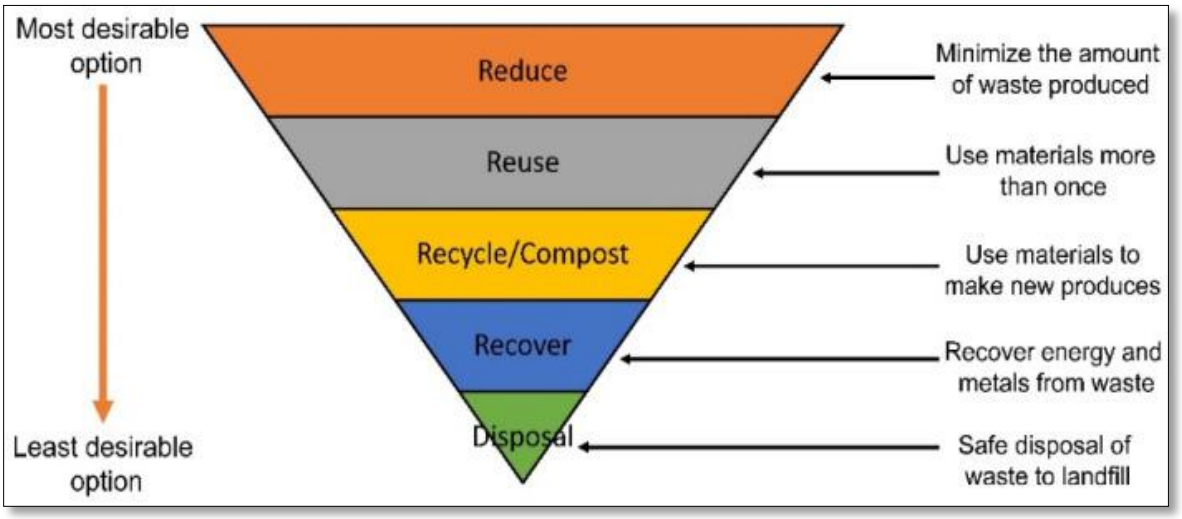


Figure 1. The global waste management hierarchy (Waste hierarchy Wikipedia)

This globally-used hierarchy (Figure 1) begins with the most desirable waste minimization technique; to reduce waste at the source. This simply entails the reduction of excess waste, whether its material packaging or more efficient uses for materials on building sites. The responsibility of the problem falls on companies who create these products or designs buildings or other infrastructure. The second option in the hierarchy is to reuse products/materials once they reach the end of their lifespan. Again, this involves various inputs from different organizations and business, whether its designing for deconstruction on a building site or manufacturing materials which have a long lifespan. The next option is to recycle or compost the materials. Recycling involves finding use for materials which cannot be reused, generally achieved by altering the form of materials to make them desirable for use in other applications or materials. Composting is just recycling that occurs in organic matter, where the materials breakdown and become nutrient rich soil which has many applications. The fourth option is to recover which involves the processing of the waste, in some manner, to produce a valuable outcome. This can include combusting municipal solid waste for energy or recovering precious metals from electronics. The final option, disposal, is the least attractive option on the hierarchy. This is where waste that has no current value is disposed of in a safe manner.

2.3 OBJECTIVE

i. This study aims to assess global efforts for creating a marketplace for C&D waste, and to examine enablers and barriers for developing a marketplace.

ii. It will help establish a cross-jurisdictional waste material trading market in the Greater Bay Area. It also provides useful references to other regions in searching solutions for waste trading/sharing.

iii. This study seeks Waste Trading can be considered as a strategy that enables efficient use of waste materials (reusable residual waste and recyclable waste materials/products) and/or recovered energy from waste through buying, selling and/or exchanging options while accomplishing the compliances with relevant waste regulations. Hence, it prompts the circularity of waste from where the waste is generated/stored/recycled to where it is to be consumed to gain economic benefits. Adopting a WT strategy in C&D WM could simultaneously improve the economic, environmental and social performance.

CHAPTER -3

3.1 METHODOLOGY

This study adopted a systematic literature review (SLR) method, which is a comprehensive and reproducible scientific approach to evaluate existing evidence, identify research gaps and create new knowledge . This research comprised a review of papers discussing marketplace for construction and demolition waste that were published in three databases of Scopus, Web of Science & ProQuest from 1999 to 2019. The review process consists of five steps:

1) Define the research question,

2) Select sources and locate studies,

3) Select articles and evaluate,

4) Analysis and synthesis of results,

5) Interpret and report the results.

Table 1 presents these steps along with supporting methods and tools.

Table 1. Detailed systematic literature review protocol adopted in five phases

Literature review phase	**Methods**	**Tools**
1. Define research question	Derive a research question; Analyse highly cited journal articles and identifying gaps	Backward and forward review
2. Select sources and locate studies	Define the relevant databases	Scopus, Web of Science & ProQuest
3. Select articles and evaluate	Define the time span of research papers	1999-2019
	Define criteria and search strings	*Inclusion criteria*- • "Construction waste" & "demolition waste", "Trading" & "market place" (or"marketplace". Full-text, peer-reviewed academic journal articles Exclusion criteria: Conference papers, dissertations, Book reviews, non- English publications and grey literature
	Select relevant articles	Backward and forward review, peer-reviewed journal papers where full text is available
4. Analysis and synthesis of results	Select a method to analyse the qualitative data	Thematic analysis
	Code and synthesise data	NVivo software
5. Interpret and report the results	Critically analyse and synthesise key literature	The information gathered through selected publication were entered into a database in excel spreadsheet. Qualitative and quantitative analysis were carried out to generate themes and summary tables on enablers and barriers .

This approach to create an evidence-based literature review has been established in similar research areas, including construction and demolition waste and market feasibility.

a. Defining the research question and source selection (Phases 1&2)

Firstly, the purpose of the literature review was clearly defined, and the aims and objectives developed to align with the overall purpose. The review protocol was created with all necessary review steps and details including time frame, databases, key search terms and inclusion and exclusion criteria. Databases including Scopus, Web of Science & ProQuest were searched within the timeframe of 1999-2019. The search terms of "construction waste" & "demolition waste", and "trading" & "market place" (or "marketplace") were used to develop the search strings. Only full text, peer-reviewed journal articles were considered as they are the most useful evidence of all primary and secondary literature sources . As articles were reviewed, other cited articles were added (i.e. snowball sampling).

b. Article selection and evaluation (Phase 3)

Inclusion and exclusion criteria were established using the C-I-M-O (context-intervention- mechanism-outcome) framework . This criteria guided the research team to deliberately select the most relevant articles . In selecting relevant articles, backward and forward reviews were carried out to capture an extensive range of literature. The title and abstract were reviewed to ensure the articles were relevant to the study scope. After the initial meta search 3,201 articles were identified. Then all duplicated articles were removed, and papers only aligned with C&D waste trading or marketplace for C&D waste were stored. Of the total 76 articles, 52 articles met the inclusion and exclusion criteria of this study as illustrated in Figure 1. Considering the study scope, some of the collected articles were excluded if it was beyond the scope or irrelevant (e.g. if the market just referred to external environment not a trading platform to C&D waste). Full papers were then reviewed using an Excel database to code the key information.

c. Extraction, synthesis and documenting the review (Phase 4 &5)

Descriptive and thematic analysis was used as to categories and synthesize the distribution and patterns of the reviewed literature. The descriptive analysis describes the research context, research distribution, types of data, methods, journal outlets and geographic distribution. Thematic analysis highlights four key emergent themes in the construction and demolition waste trading landscape, as well as the knowledge gaps .

3.2 CASE STUDY

A survey was appropriated to specialists who went to an industry-scholarly discussion to assess and rate the significance of each boundary through the poll review. Following the study, five semi-organized interviews have been directed with specialists to approve the consequences of the poll review and to add the discoveries of this review. The interviewees included high-level administrators who were approached to give their perspectives and remarks on the distinguished boundaries. The interviewees were likewise approached to add any hindrances that they thought were vital to insert the utilization of waste trading in the construction and demolition area. Three of the interviewees were from construction projects, which have a high potential for trading/exchanging waste materials, and two interviewees were from waste management administrations. The new boundaries recognized from the poll overview and meetings are talked about under the applicable classes in the conversation segment. Table 1 shows the profile of the respondents associated with both the quantitative and subjective investigations.

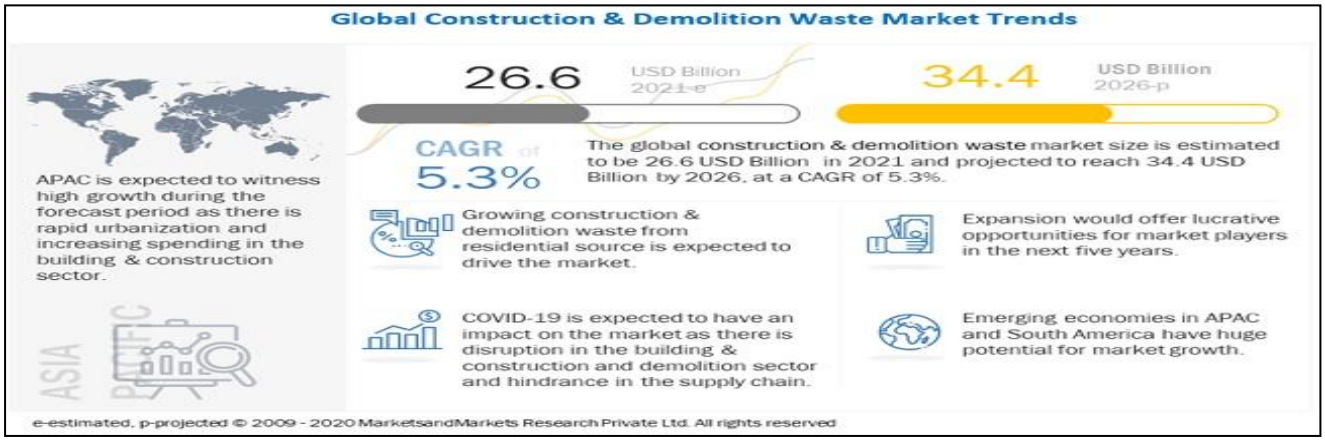


Figure 1. Global trends for construction and demolition waste

This study primarily adopts a quantitative method approach combining a questionnaire survey conducted during an expert forum and a validation process by industry experts to ensure the reliability and validity of the drivers. Initially, a comprehensive literature review has been carried out to identify the drivers to the reuse/recycling of C&D waste, as well as the drivers for implementing effective waste trading practices and creating marketplaces in the C&D sector. Subsequently, a questionnaire that was used to collect the data from an

expert forum was distributed to experts who attended an industry-academic forum to evaluate and rate the importance of each driver through the questionnaire survey.

The evaluated and newly identified drivers from the expert forum went through a validation process for ranking the drivers again by six industry experts to provide more insight into the findings. Table 1 shows the profile of the respondents involved in the expert forum and the validation of drivers derived from the expert forum.This study adapted the six aspects of the PESTEL (Political, Economic, Social, Technical, Environmental, and Legal) model as the initial coding categories to classify the drivers. The drivers identified from the literature have been categorized under six main perspectives: Economic, Environmental, Institutional/Organizational, Socio-Cultural, Legal/Political, and Technical. Since C&D waste management is recognized as an inter-disciplinary theme,involving different aspectsand issues

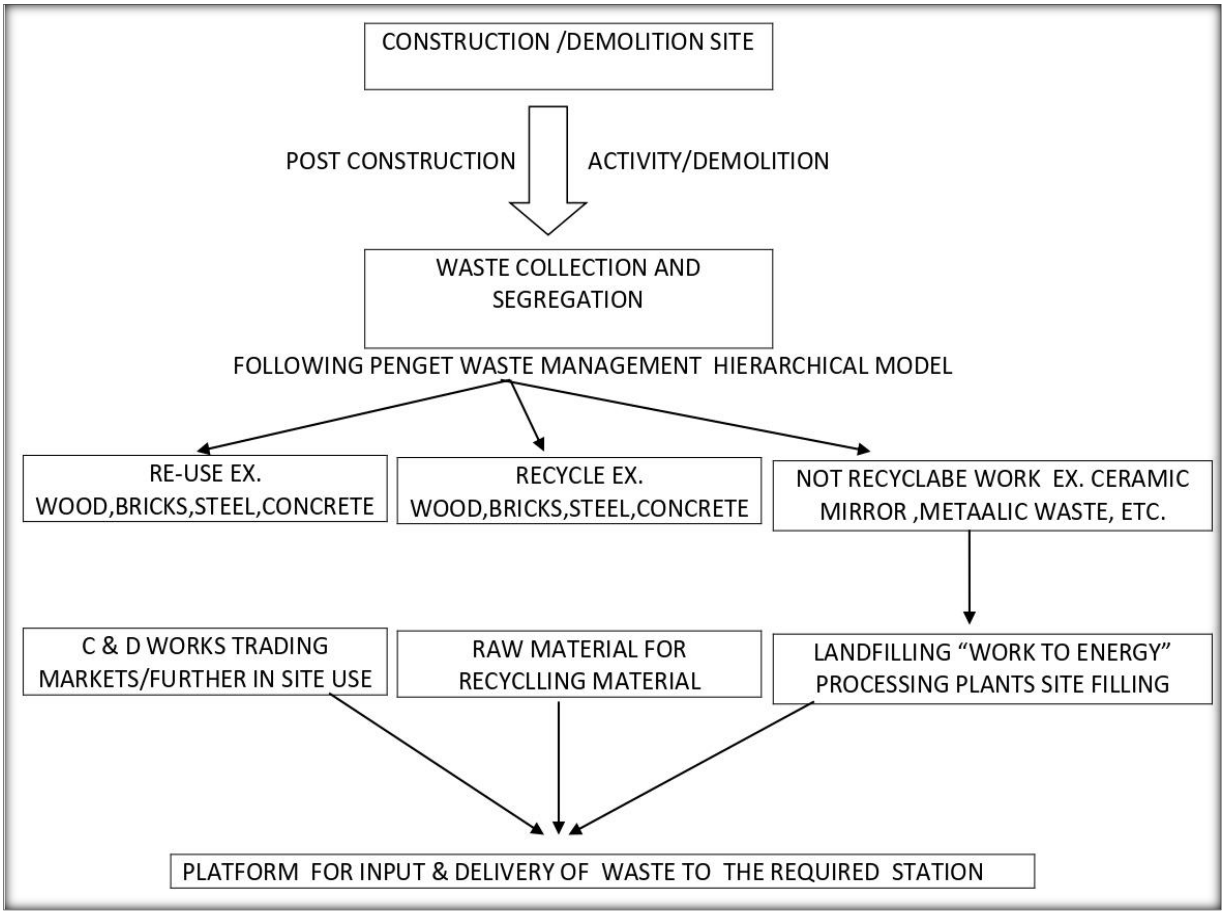


Figure 2. A Flow Chart showing the initiation of waste trading practices the construction industry (Author made)

such as engineering, technology, management, policies, and legislation (Jin et al., 2017, Arshad et al., 2017, John and Itodo, 2013), this study includes the "Institutional/Organizational" category as an additional category that is considered as essential in recognizing the drivers.

Based on the feedback received from the academics, the questionnaire has been improved to attain content validity and clarity. After the questionnaire was pre-tested, the questionnaire has been circulated among a group of experts who have participated in an expert forum conducted at an industry-academic roundtable. The roundtable event has attracted over 40 experts comprising contractors, consultants, architects, clients, manufacturers/suppliers, and academics. This study has used a purposive sampling method by targeting professionals in the forum based on their experience and knowledge in the field of managing construction projects.

Out of the total number of distributed questionnaires, 35 responses have been considered for the analysis as 5 responses were incomplete. All the academics who have participated in the expert forum possess relevant experience in academia and industry in the construction management discipline. The inclusion of academic perspectives is appropriate to enrich the result of this study as Waste Trading is still not commonly practiced in the industry. Industry-academic participation is essential particularly in cultivating the need for sustainable building construction through research and transferring knowledge to the industry.

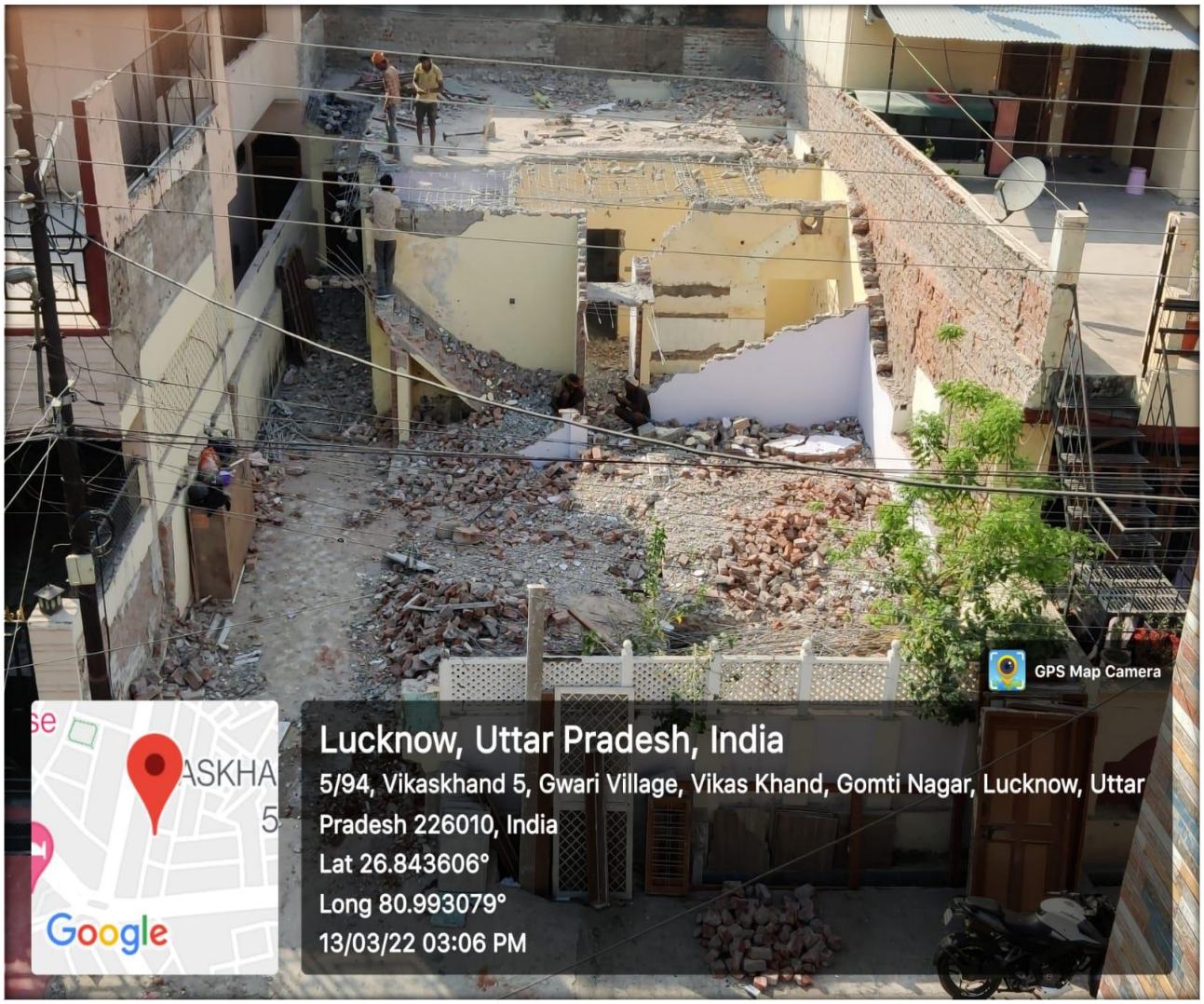


Figure 3. Generation of demolished waste for trading practices

3.3 SURVEY FORMAT

Please enter the suitable information requested in the form below. Your details will be kept confidential. Summaries and statistical analysis of responses will be presented to the University for Study Purpose only. (M.Tech. thesis work)

Objective of the study: **To assess global efforts for creating a marketplace for C&D waste, and to examine enablers and barriers for developing a marketplace**

As the next step, the articles were coded and categorised into four key themes which are described in detail below. The thematic findings of the structured literature review were categorised under key themes of:

1) Properties of C&D waste and targeted waste management methods [What],

2) Waste composition and points of generation [Who],

3) Benefits of C&D waste management through waste trading [Why]

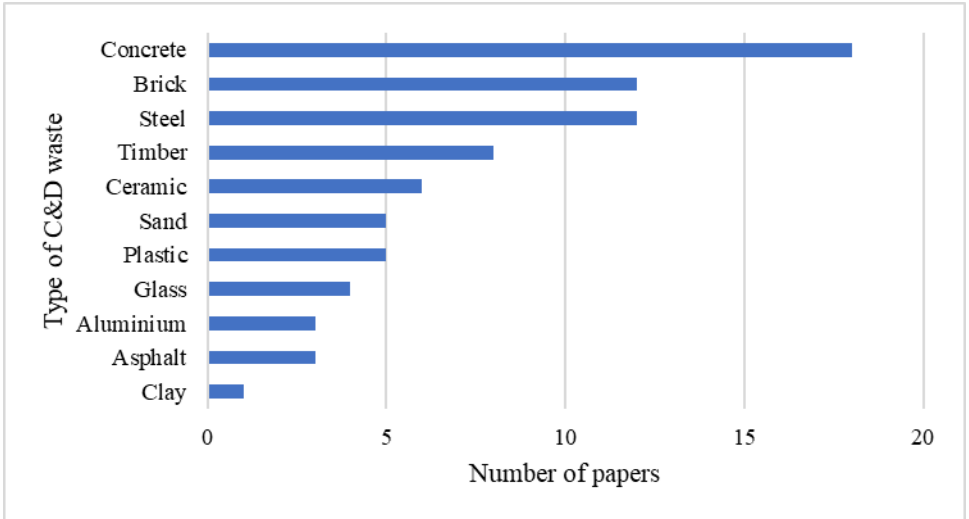
4) Closing the loop through recycled waste trading, Barriers and challenges for C&D waste management [How].

3.4 SURVEY RESPONSE

Respondents	Experience (Years)			Total Number
	5-10	10-20	over 20	
Questionnaire Survey				
Contractors/Developers	2	9	2	13
Consultants		2	2	4
Clients/Architects		1	1	2
Manufacturers/Suppliers	1	1		2
Academics	6	3	5	14
Total				**35**
Validation Survey				
Project Manager (Residential & Commercial Development)		1		1
Sustainability and Research Managers (Land and PropertyDevelopment)	1	1		2
Head of Sustainability Management (Waste Management Service)			1	1
Operation Manager (Waste Collection and Management Service)		1		1
Sales Manager (Waste Recycling Service)		1		1
Total				**6**

Figure 1 shows that most papers specifically discussed concrete (n=18), brick (n=12) and steel(n=12), as these materials have the most demand for a secondary life. It is important to note that these waste types are not mutually exclusive as some publication focussed on more than one type of C&D waste. Of the 52 papers, 17 papers addressed C&D waste in general and therefore were not included in Figure 1.

Figure 1: Types of C&D waste



3.5 What are the Benefits of C&D waste management through waste trading?

With the increasing volumes of C&D waste going into landfills, there are urgent calls for industrial practitioners to take immediate measures to divert waste from the landfill. The creation of markets for recycled C&D waste is thus seen as a solution which benefits both society and industry including. These benefits include lower disposal costs for the waste producer, the aggregate user and lower environmental costs for the society. The market for trading recycled construction material is still in its infancy and creating an industrial chain requires deliberate consideration of economic parameters and market conditions . This is due to its requirement of a high level of planning, investments and resources . Therefore, it is critical to assess the economic feasibility as a first step and the cost benefit analysis is generally considered as the standard method for this purpose. Previous research provides evidence for recycle markets' ability to rapidly grow with increasing supply of C&D waste material. This could reduce the cost of recycling due to economies of scale. The more waste also means a need for more infrastructure for waste processing. These market conditions could also be further influenced by post- disaster phases. For example, during the earthquake in Gujrat , the demand for waste concrete went from a cost negative (1000 Rs. per tonne disposal fee for waste concrete) to a cost positive (100 Rs. per tonne payment for waste concrete) . Therefore, the geographical spread of the damage (and waste) will also affect the feasibility of recycling.

As mentioned above, cost minimisation is critical factor that could enable the formation of markets for recycled C&DW. However, it is important to note that the quality requirements need to be fulfilled to attract buyers who were originally purchasing natural raw material. Furthermore, it is important to make the clients more aware of the recycled C&DW and encourage them to choose recycling aggregates. Within this context, transport and additional cost for using the material

are also key considerations for buyers. Subsidies play a significant role in making recycled C&DW more economically viable as it reduces the cost of using the recycling centre and the cost of use of recycled aggregates. This gives more market power to the recycling centres to make a profit by charging a price to C&D waste makers and to users of aggregates in additional to the cost of recycling.

3.6 Closing the loop through recycled waste trading: Enablers and barriers

Closing the loop through waste recycling has been recognised as a practical approach to obtain maximum value from resources and minimizing waste and pollution. It helps the industries to move from the traditional liner, 'take-make-use-dispose' economic system, to a circular economic system and reuse/recycle C&D waste within the construction industry. Creating a marketplace for C&D waste trading would create a secondary life for waste material and connect producers and buyers who would benefit from lowering their disposal and purchasing costs. In order to create a viable marketplace, there are several factors influencing the supply chain including the material procurement, recycling process, plant management and market promotions.

It is critical to have government intervention through market-based policy instruments to encourage uptake of the circular economy by boosting CDW recovery and management . It is also important to establish institutions to prevent corruption and opportunistic behaviours that could take place during negotiating, contracting and operating . "Walking the talk" is akey highlight of inducing positive behaviour in the market and claims that when the government provides providing adequate information about its quality and benefits of C&D recycled material and use these in their own projects more efforts will be made to take up this practice. Within this context Table 1 provides a summary of enablers under the three key themes of governance, operations and market enablers. Enablers were elicited from key literature on measures for implementing supportive legislation and policies, critical success factors on-site sorting, factors affecting the management of supply chain, requirements for material recycling and strategies for engaging key stakeholders.

Table 1. A summary of key enablers for effective C&D waste management and market creation elicited from literature

Types of enablers	**Enabler description and sub-enablers**
Governance enablers	Governance enablers comprise of all processes including laws, norms and rules to facilitate C&D waste trading. Five key sub-enablers comprise of: 1) increased targeting of design stages in policies and extension of sustainable design appraisal systems, 2) increased stringency of legislative measures, fiscal policies, 3) corroboration of policy requirements with enablers and facilitators [28], 4) taxing virgin aggregates, recyclable materials that are landfilled [4], 5) subsidising CDW recycling businesses [23, 29,30].
Operational enablers	Operational enablers comprise of all technical processes and necessary human resources to manage material supply chains, sorting facilities, waste segregation and recycling operations. Five sub-enablers consist of: 1) reliable recycling technology, and infrastructure [31], 2) continuous supply of contamination free material, [32], 3) organized transportation [33], 4) responsible workforce, 4) effective communication and stakeholder engagement [4].
Market enablers	Market enablers comprise of creating conducive market conditions to sustain the demand C&D waste and supply of material. Five sub-enablers are: 1) Increasing client awareness of the short- and long-term benefits of reusing, 2) Presence of a market for different types of products from demolition 32, 31, 3) standardisation for the quality of recycled material, 3) supportive insurance, legal advice and accounting services, 4) commercial/marketing expenses, 5) creation of ongoing demand for recycled material [23, 34]

This section analyses barriers and challenges for C&D waste management, particularly focusing on C&D waste recycling and creating a marketplace for secondary material. Barriers related to availability, economics, acceptability were considered as three overarching categories. These categories were then divided into three themes of governance.

Table 2: A summary of key barriers affecting the update of C&D waste management practices

Types of barriers	**Barrier description and sub-barriers**
Governan cebarriers	Governance barriers comprise of all limitations in structures, policies and legislations that hinders the C&D waste trading efforts. Five key sub-barriers comprise of: 1) lacking enforceable law for C&D waste generators, 2) immature strategic policies for effective C&D management and recycling [21, 35, 36], 3) limited coordination among C&D regulators and generators, 4) lack of institution collaboration, 5) intricate coordination is required between provider and users [35]
Operation albarriers	Operational barriers comprise of all limitations technical processes and human resources that obstructs the management of material supply chains, sorting facilities, waste segregation and recycling operations. Five sub-barriers consists of: 1)improper infrastructure for disposal of landfills and absence of treatment facilities, 2) lack of a well-developed waste recycling market, 3) possibility of raw materials to be contaminated with hazardous material such as heavy metals and other pollutants, including asbestos, originate in building products [21, 37] , 4) lack of motives, awareness and incentives to manage C&D waste, 5) lack of culture for saving the resource and/or optimum use [21, 35].
Market barriers	Market barriers comprise of market, environmental and financial conditions impeding the supply and demand C&D waste material. Five sub-barriers are: 1) lack of an established market for reused construction materials, 2) limited demand for second-hand building materials, 3) negative attitudes and behaviours of stakeholders [4], 4) higher costs compared to alternative disposal methods [37], 5)contractors, who pay less attention to C & D waste reduction which result in irresponsible behaviour [4].

If the waste producers and buyers are to engage in effective C&D waste management practice, it is critical that they understand what enables such practice and possible barriers that might arise. The authors present the three key barrier types supported by 15 sub-barriers and three key enabler types. This is supported by 15 sub-enablers for developing a marketplace for C&D waste. Industrial practitioners could use these aspects as a guide to engagement in C&D waste trading practices within the construction industry and contribute to the circular economy.

3.7 EMERGENT FRAMEWORK ON ENABLING A MARKETPLACE FOR C&DWASTE

Based on these findings the authors present an emergent framework of enablers and barriers that would guide practitioners, government policymakers in creating waste trading platforms. Figure 1 presents these six key categories of enablers and barriers along with sub-categories derived..

Through this analysis it was evident that market-based policy instruments could be developed through taxes, subsidies and other incentives, to encourage waste diversion from landfills, recycle and create a secondary life for waste material. To market the recycled material as a substitute for natural raw materials it is important to increase awareness and carry out promotional activities. Then a continuous supply of clean waste streams is necessary to produce high-quality recycled material that satisfy the given technical specifications and be economically competitive.

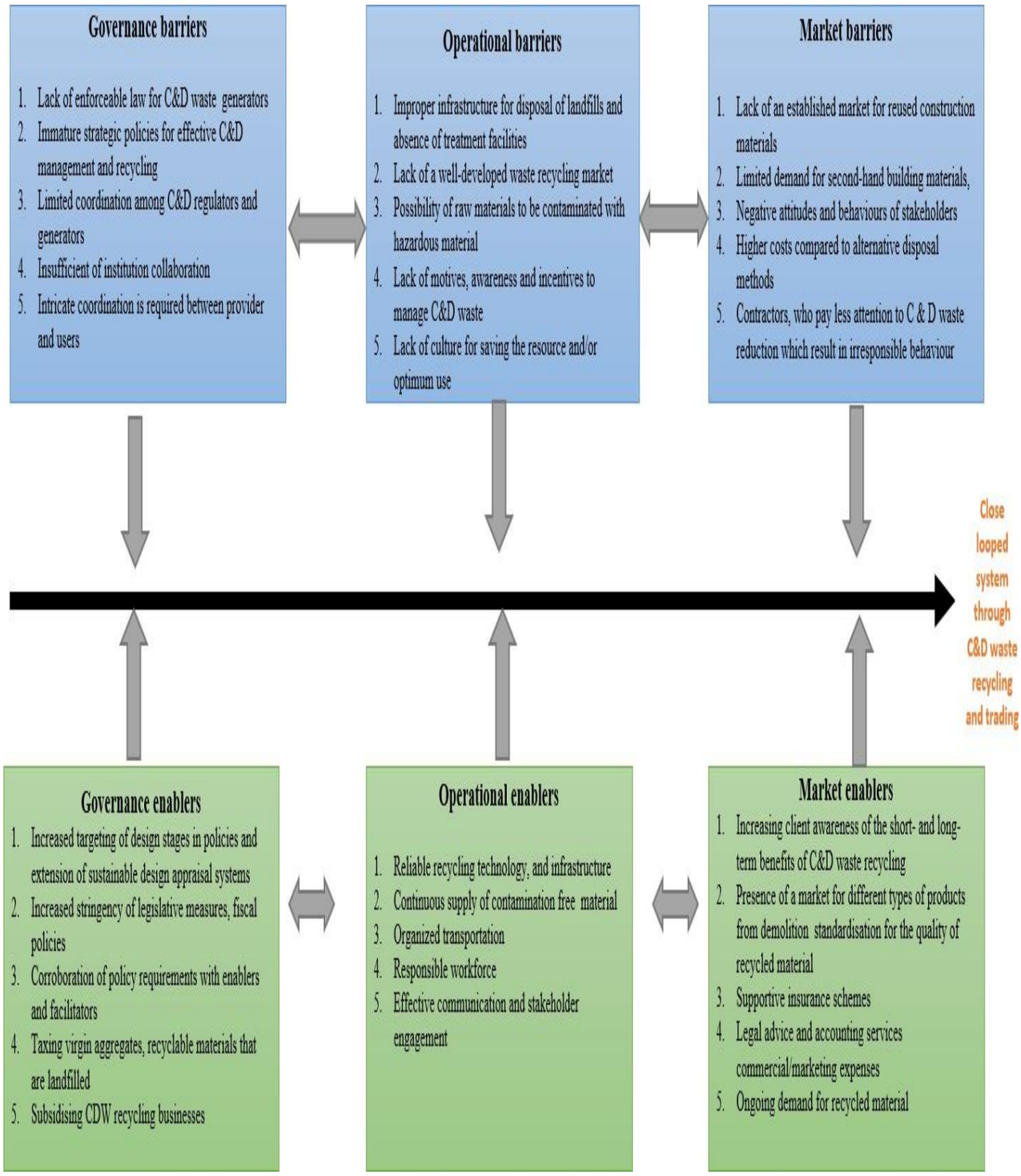


Figure 1: Emergent framework on enablers and barriers for developing a marketplace for C&D waste

Finally, an appropriate market is required to connect sellers and buyers through easily accessible user-friendly platforms. Online platforms have been identified as a potential marketplace due to versatility and accessibility.

3.8 Barriers and opportunities for deconstruction Waste materials

There are a number of areas where the authorities may influence design and planning strategies at an early stage. These include fiscal incentives such as the maintenance of a fixed price for recovered products or increased costs for waste disposal through the landfill tax. Incorporation of deconstruction techniques into material specifications and design codes on both a National and European level would focus the minds of designers and manufacturers. Education of the long-term benefits of deconstruction techniques for regulators and major clients would provide the necessary incentive for the initial feasibility stage. Design for deconstruction is not, however, solely an issue for the designers of buildings. The development of suitable tools for the safe and economic removal of structural elements is an essential pre-requisite of the more widespread adoption of deconstruction (Couto & Couto, 2007).

A study carried out by BRE (Building Research Establishment) (Hurley et al., 2001) has shown what the industry has known for decades; that there are keys factors that affect the choice of the demolition method and particular barriers to reuse and recycling of components and materials of the structures. The most factors are physical in terms of the nature and design of the building along with external factors such as time and safety. Future factors to consider should well include the fate of the components, the culture of the demolition contractor and the ‘true cost’ of the process. For the latter, barriers to uptake include the perception of planners and developers, time and money, availability of quality information about the structure, prohibitively expensive health and safety measures, infrastructure, markets quality of components, codes and standards, location, client perception and risk.

The main barriers in UP to the increased use of deconstruction methods within construction include:Lack of information, skills and tools on how to deconstruct.

i. Lack of information, skills and tools on how to design for deconstruction;
ii. Lack of information, skills and tools on how to deconstruct;
i. Lack of a large enough established market for deconstructed products;
ii. Lack of design. Products are not designed with deconstruction in mind;
iii. Reluctance of manufactures, which always prefer to purchase a new product

rather than to reuse an existing one;

iv. Composite products. Many modern products are composites which can lead to contamination if not properly deconstructed or handled; and

v. Joints between components are often designed to be hidden (and therefore inaccessible) and permanent

Although the market for products from deconstruction to be poorly developed in Portugal can be noted that the interest in low volume, high value, rare, unique or antique architectural components it's much higher than the interest in materials that have high volume, low value, such as concrete.

Even though there are significant advantages to deconstruction as an option for building removal, there are still more challenges faced by this alternative:

i. Deconstruction requires additional time. Time constraints and financial pressure to clear the site quickly, due to lost time resulting from delays in getting a demolition, or removal permit, may detract from the viability of deconstruction as a business alternative;

ii. Deconstruction is a labor-intensive effort, using standard hand tools in the majority of cases. Specialized tools designed for deconstructing buildings often do not exist;

iii. The proper removal of asbestos-containing materials and lead-based paints, often encountered in older buildings that are candidates for deconstruction, requires special training, handling, and equipment; and

iv. Re-certification of used materials is not always possible, and building codes often do not address the reuse of building components.

The main opportunities which require development include:

i. The design of joints to facilitate deconstruction;

ii. The development of methodologies to assess, test and certify deconstructed elements for strength and durability, etc.;

iii. The development of techniques for reusing such elements; and

iv. The identification of demonstration projects to illustrate the potential of the different methods.

Modern materials such plywood and composite boards are difficult to remove from structures. Moreover, new building techniques such as gluing floorboards and usage of high-tech fasteners inhibit deconstruction. Thus, buildings constructed before 1950 should be ideally targeted for deconstruction (Moussiopoulos et al., 2007). In Portugal, it is expected a substantial increase in investment in rehabilitation of buildings. The deconstruction should have a

relevant contribution in this process.

The greatest benefit will be achieved by incorporating deconstruction issues into the design and feasibility stage for all new construction. Each case can then be judged on its merits in terms of the potential cost of recovery and recycling or reclamation and reuse of construction materials.

The following in table 2 is an attempt to systematize the main barriers in the implementation of deconstruction in Potugal from the analysis of the barriers identified in the international literature (Storey & Pedersen, 2003):

Barrier	**How this relates to PT**	**Solutions**
Legislation		
Current standard specifications.	Standards give the impression that new materials must be specified.	- Development of standard specifications etc, which incorporate reused/recycled components. - Document and publish examples of the successful use of reused and recycled components. - Government and local council as examples in new development.
Markets		
The high cost of transport and storage of recycled components and materials.		- Market networking. - Direct sales from site.
Uses for some salvaged materials are undeveloped.	Finding uses for some recycled or salvaged materials is difficult.	- Increased research focusing on problem materials.

Designer/public/builder attitude: “new is better” and new buildings are permanent.	The majority of building materials specified and used in PT are new. Design for deconstruction is uncommon.	- Education for architects in life cycle considerations and holistic design principles. - General education of public, designers and builders. - Easy to use guides in the use of salvaged materials/design for deconstruction. - Publishing and compilation of research into quality aspects of reused goods.
The lack of a grading system for reused components.		- Development of a grading system. - Training in the grading of reused materials. - Liability issue addressed.
Guaranteed quality /quantities of reused materials are difficult.		- Increased networking of salvage. - Increased deconstruction.
Lack of information and tools to implement deconstruction.	There is a lack of PT specific documents or information kits for the implementation of deconstruction and specific feasibility studies or clear PT examples cases.	- Compilation of guides, development of implementation ideas. - Clear ways to implement PT Waste Strategy targets are needed. - Increased pilot studies and test cases. - Strategic planning to address barriers.
C+D Industry		
Lack of communication and networking in the C&D industry.		Greater communication, networking and collaboration. Increased conferences, email discussion groups, networking, professional articles publications, etc.

Lack of design for deconstruction.	International research is not always applicable to PT. There is a lack of example cases built in PT. Design for deconstruction is	- Education of architects and designers through conferences/exhibitions/case studies etc. - Education at architecture
	not taught at architecture schools.	schools. - Development and sharing of teaching resources and case study examples.
Difficulty in securing funding for research.	Science and Innovation Policy.	- Governments and funding agencies need to make waste minimisation a priority.
Economics Factors		
The benefits of deconstruction are long term and collective.		-Increased education on environmental building impacts for developers.
Lack of financial incentive for deconstruction.		- Implementation of economic incentives and deterrents to encourage deconstruction.

Market pressures – the current climate of "as fast as possible".	Limited time to salvage maximum materials in the demolition stage. Deconstruction takes longer.	- Salvage operations to work along side but independently of demolition contractors. - Share of environmental responsibility to developers.
It is difficult to access or apply economic assessment tools for deconstruction or LCA in some cases.	There are no PT specific deconstruction evaluation tools or national feasibility studies.	- Collection of existing tools in one place. Possibly website. - Development of non region-specific tools or more flexible parameters.
Deconstruction needs a more skilled workforce than demolition.	Unregulated demolition industry. Lack of case jobs to train on.	- Increased opportunities for training and transition from traditional demolition to deconstruction. - Cooperative between the construction and demolition sectors.
Technical Issues		
Lack of documentation.	Records of materials used in construction are not kept.	- Better recording of materialsused. - Storage of records in the actualbuilding.
Increased use of in situ technology, chemical bonds and plastic sealants, etc.	Commonly used in new buildings in PT. Most concrete structures have in situ components.	- Research viable alternatives to these techniques. - Development of ways toseparate these bonds
Most existing buildingsare not designed to be deconstructed.	This is true in PT.	- Research and development tofind ways to effectively deconstruct these buildings. - Implementation of design for deconstruction techniques into learning establishments a priority.

Table . Main barriers to deconstruction in Adapted from (Storey & Pedersen, 2003)

3.9 Waste Trading as a Sustainable Approach

According to the Oxford learner's dictionary, trading is defined as '*the activity of buying and selling or of exchanging (one thing) for another, goods or services between people, firms or countries*'. The Environment Protection and Heritage Council (2010) define waste as "*any discarded, rejected, unwanted, surplus or abandoned matter which is intended for recycling, reprocessing, recovery, reuse, or purification by a separate operation from that which produced the matter, or for sale, whether of any value or not*". At the same time, determining material whether it is 'waste', a 'product' or a 'resource' is substantially influenced by some key factors such as regulations, environment, and economy which are essential for managing the waste efficiently from the generation phase to final destination (Hyder, 2012). The C&D waste has been recognised as a potential resource to include a diverse range of high-value materials and resources, which can be used for new construction and renovation once sophistically sorted (Edge Environment, 2012). This study attempts to develop a definition forWT in the context of the C&D sector as follows. "WT is a process of buying and selling (or exchanging) reusable raw inert construction waste, recycled materials, products that contain recycled contents and energy recovered from C&D waste and/or services between people, organizations, interstates, or countries.

The circular economy recognises the closed-loop material cycle concept in which the waste istransformed into a resource for sustainable use and kept within the economy by productively circulating materials by repeated usage (Smol et al., 2015). Through this concept, the maximumeconomic value of the material is preserved by circulation within the economy through the process of reusing (or re-purposing), recycling, repairing, remanufacturing and remarketing. The circulation process enables to change the linear economy models to substitute 'throwing' waste with 'making use' of waste and bring similar or diverse industries to collaborate throughexchanging of resources and sharing WM infrastructure, resulting in reducing disposable wasteand lower production cost (Wu et al., 2019). WT, therefore, turns into a promising sustainablesolution as it enables the efficient use of waste materials through the 3R principles of the circular economy while contributing to economic growth and complying with relevant waste regulations/legislation (Ratnasabapathy et al., 2021). According to Lu et al. (2020), the

major goal of WT in the construction industry is to manage the C&D waste by balancing the demandand supply of waste materials and succeed with a win-win solution for both sides; waste suppliers (generators, recyclers) and consumers. Trading C&D waste between construction sites, to be specific, transporting waste directly from a project's site where it is generated and/or temporarily stockpiled to another site where that waste is required to be consumed is an ideal means of cost-saving for waste generators as it reduces the disposal cost.

Intrinsically, the integration of the WT process into an integrated WM system would be highly effective in the perspective of a circular economy and enable the construction industry to transition to the circular economy through innovative collaborations. Being an alternative process to landfill disposal, WT promotes sustainability through resource efficiency, minimising environmental impact by stimulating innovations in the reuse of waste materials.

The WT approach in an integrated WM system provides waste an opportunity for a second life with multiple uses. Simultaneously, the concept of the closed-loop material cycle combines the goal of zero waste through exchange/trading is connected to the principles of IS.

Despite most of the previous studies have focused on the barriers to WM, some research studies have examined the key indicators and enablers for the effectiveness of C&D WM. Ajayi et al. (2015), suggested some key factors as requisites to reduce waste intensiveness of the C&D industry which include tackling waste at the design stage, whole life waste consideration, compliance of WM solutions with Building Information Modelling (BIM), cheaper cost of WMpractice, increased stringency of WM legislation and fiscal policies, and research and enlightenment. Yuan (2013) identified the key performance indicators related to the four majoraspects which include waste generation, economy, environment, and society that affect the effectiveness of WM. Abarca-Guerrero et al. (2017) observed the motivations for more efficient and effective use of materials in the construction sector. Similarly, Caldera et al. (2020) identified the enablers for effective WM and the establishment of marketplaces for C&Dwaste in terms of market, operational, and governance-related factors.

Though the trading of reusable/recyclable waste is relatively not a new approach in the industrial WM system, limited studies have been focused on managing waste through WT approaches in the C&D sector (Caldera et al., 2020, Lu et al., 2020, Bao et al., 2020). The previous studies discussed the drivers to WM and few on market development for waste but overlooked the drivers of WT practices in terms of different aspects of WM in particular. Hence, this study aims to explore the potential drivers to WT in the context of the C&D sectorof Australia. This study can be taken as an example to draw insight into the potential drivers for the wider application of the WT approach in the C&D industry and hence an attempt to accelerate the industry moving towards the circular economy in C&D WM.

CHAPTER 04

CONCLUSION

The findings of this systematic literature review provide theoretical and practical insights into closing the loop through C&D waste recycling. The authors propose an emergent framework on enablers and barriers for developing a marketplace for C&D waste. A key finding is to highlight the effectiveness of market-based policy instruments to encourage practitioners to engage in C&D waste trading. Market conditions such as sufficient demand for recycled C&D material and continues supply of C&D waste are critical for s sustainable market system. Within this context technology-based market applications have emerged as targeted interventions to facilitate online trading providing more accessible, user-friendly marketplaces for sellers and buyers. In addition, the authors have provided commentary on key measures for implementing supportive legislation and policies, critical success factors on-site sorting, factors affecting the management of supply chain, requirements for material recycling and strategies for engaging key stakeholders. The identified barriers related to availability, economics and acceptability should be managed if the C&D waste trading are to be embedded to the existing waste industry. Our findings are useful for industry practitioners, government policymakers addressing circular economy opportunities at a firm level, and governance leaders in bridging the gap between ideas and action for scaling up C&D waste management practices.

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PROSPECTING THE BARRICADES FOR ADMINISTERING CONSTRUCTION WASTE

TRADING PRACTICES IN THE CONSTRUCTION INDUSTRY UP INDIA

during the "2nd International Conference on Civil Engineering, Architecture and Sustainable Infrastructure (ICCEASI - 22)" Organized by Babu Banarasi Das University, Lucknow held on 09th & 10th February 2022 at Virtual Conference.

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Prospecting the barricades for administering construction waste trading practices in the construction industry of U.P, India

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***Abstract*— The construction industry is a significant generator of waste, which has a high potential to yield a generous measure of waste into the economy as an important asset. Squander exchanging is a manageable procedure for further developing asset usage and changing the construction industry towards the round economy. This study aims to determine the barriers for implementing effective waste trading practices in the UP India (construction and demolition (C&D) sector).**

Index Terms—*Barricades, Construction and Demolition waste, Waste materials cycle, Waste management trade*.

I. INTRODUCTION

Waste trading can be considered as a system that empowers proficient utilization of waste materials (reusable leftover waste and recyclable waste materials/items) and additionally recuperated energy from squandering through purchasing, selling, and additionally trading choices while achieving the compliances with significant waste guidelines. (Caldera et al., 2020) Consequently, it prompts the circularity of waste from where the squander is created/put away/reused to where it is to be burned-through to acquire monetary advantages.

Embracing a construction and demolition waste trading procedure could at the same time work on the financial, natural and social execution. (CIB, 2014)

Nonetheless, local markets for the exchanging of strong waste have not been grounded at this point, while the market for construction and demolition waste trading is similarly restricted in adjusting the interest and supply.

The exchanging of reusable/recyclable construction and demolition squander materials is somewhat not a new approach, restricted examinations have been centered around dealing with the demolition squander through waste exchanging systems in the construction area. (Arshad et al., 2017; Jin et al., 2019). Boundaries to surveying the viability of this technique were not all around went to by past investigations as various angles and difficulties related with squander the board have not been considered.

This review can be taken to act as an illustration of a review that plans to bring understanding into the boundaries to the adequacy of the waste exchanging approach the construction and destruction squander area and, consequently, an endeavor to speed up the business moving towards the round economy in development and destruction squander the executives.

II. DESIGN CRITERIA

To acquire the focus of this study, a triangulation conjecture of quantitative and qualitative course of action has been cast-off. This mixed-method course of action integrates an extensive literature review, survey from practitioners and semi-structured interviews with construction industry experts.

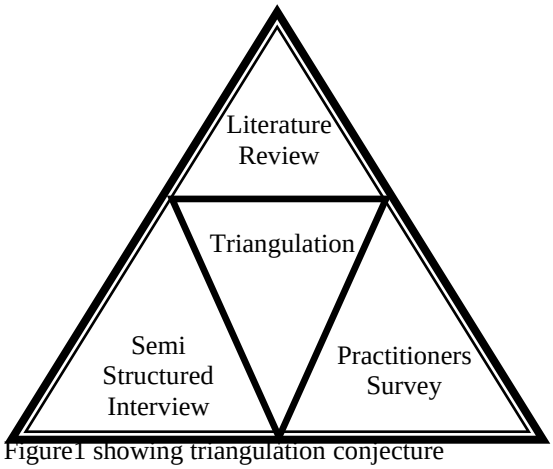

Figure1 showing triangulation conjecture

III. IMPLICATION

The consequences of this study are based on the data collected in the Lucknow district of state Uttar Pradesh (India) which is regarded as the limitation of the study. This study has explored a wide range of barricades to the practices of waste trading in the construction and demolition sector.

IV. CONSTRUCTION AND DEMOLITION WASTE MARKET (SUPPLY)

It is assessed that 25–30 million ton of construction and demolition waste is produced yearly in India. It has been further assessed that 40–60 kilogram for each cubic meter (kg/m3) of construction and demolition waste is created during development and minor fix or redesign. During destruction of appropriate cement and workmanship structures (locally called pucca working), around 500 kg/m3 of C&D squander is created though 300 kg/m3 is produced for structures with fractional cementing also workmanship. (https://www.marketsandmarkets.com/Market-Reports/construction-demolition-waste-market-225127553.html) Presence of unearthed soil and residue might change this creation. Indeed, even in metro urban areas like Delhi and Mumbai, where construction and demolition waste are gathered independently, squander is blended containing around half of soil and residue. Figure 2 highlights global construction and demolition waste market trends.

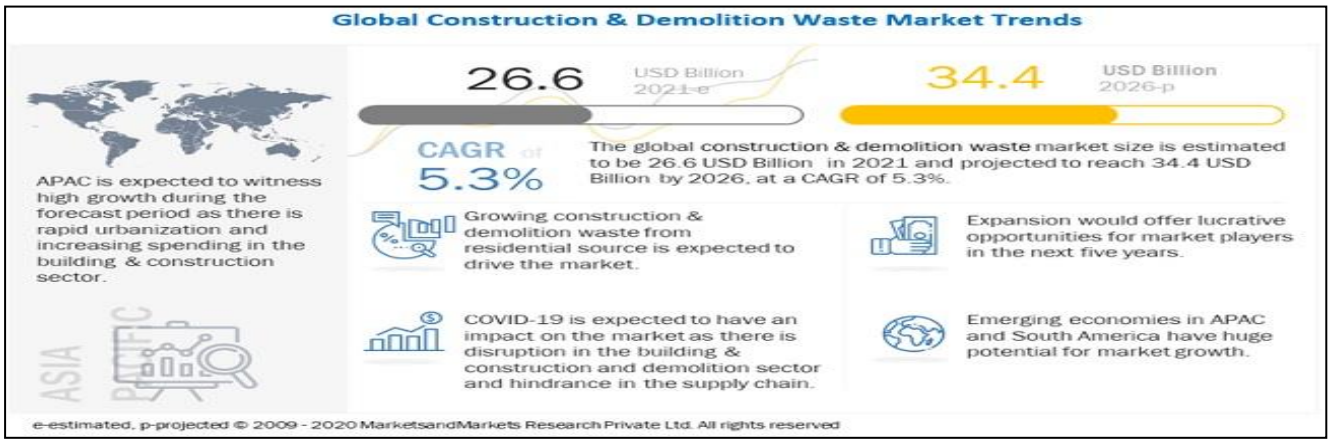

FIGURE 2

V. IDENTIFIED BARRICADES FOR CONSTRUCTION WASTES TRADING PRACTICES

Some previous examination studies have researched a few hindrances that impede the viability of waste management practices, including the boundaries for lessening, reusing, and reusing waste materials. For case, the CIB Working Commission W115 in 2014 zeroed in on the boundaries for deconstruction and reuse/reusing of development materials in some evolved nations across the world (CIB, 2014). Intermittent boundaries for most squandered materials like brickwork, concrete, wood, metal, and black-top have been researched in Canada, Germany, Japan, the Netherlands, Norway, Singapore, the USA, and New Zealand (CIB, 2014). Caldera et. al (2020) assessed the hindrances to fostering a commercial center for C&D squander as far as market, operational and administration related elements. Mahpour (2018) distinguished possible boundaries from social, specialized and lawful points of view, meaning to change the business moving towards the round economy in development and destruction squander the board. Table 1 presents the synopsis of stratified barricades recognized from the literature survey. These barriers can be considered as potential for further developing waste trading rehearses in the construction and demolition area.

VI. RESEARCH METHODOLOGY

A survey was appropriated to specialists who went to an industry-scholarly discussion to assess and rate the significance of each boundary through the poll review. Following the study, five semi-organized interviews have been directed with specialists to approve the consequences of the poll review and to add the discoveries of this review. The interviewees included high-level administrators who were approached to give their perspectives and remarks on the distinguished boundaries. The interviewees were likewise approached to add any hindrances that they thought were vital to insert the utilization of waste trading in the construction and demolition area. Three of the interviewees were from construction projects, which have a high potential for trading/exchanging waste materials, and two interviewees were from waste management administrations. The new boundaries recognized from the poll overview and meetings are talked about under the applicable classes in the conversation segment. Table 2 shows the profile of the respondents associated with both the quantitative and subjective investigations.

VII. FINDINGS AND COMMENTS

Multiple barricades were discovered post quantitative and qualitative survey to implement construction waste trading practices. PESTEL Analysis is used to assess the outer climate of a construction waste business by separating the chances and dangers into Political, Economic, Social, Technological, Environmental, and Legal elements. PESTEL Analysis proves to be a compelling structure to be incorporated in waste trading strategy planning and for distinguishing the upsides and downsides of a waste trading. The worldwide Construction and destruction squander market is relied upon to observe a diminishing in its development rate in 2020-2021, as the structure and development industry is seriously hit by the Coronavirus pandemic. The pandemic has impacted both material, work, and key expense parts of development projects. The pandemic has prompted stoppage in a few development and destruction projects under lockdown. This large number of elements have prompted disturbance in the store network of the Construction and destruction squander market as tasks have dialed back in many help-giving units.

Respondent	**Experience**			**Total**
	0-5	**5-10**	**10-15**	
Contractors	**3**	**2**	**-**	**5**
Engineers	**1**	**3**	**1**	**5**
Academics	**3**	**1**	**1**	**5**
	Total			**15**
Interview				
Site Engineer	**1**	**1**		**2**
Operation Manager	**1**	**1**		**2**
Project Manager	**2**	**1**	**1**	**4**
	Total			**8**

Table 2. showing profile of respondents (Lucknow city)

Identified Barriers	References
Significant expense associated with in general administration (arranging and handling) and examining of construction waste	Caldera, S., Ryley, T. and Zatyko, N. (2020)
Restricted monetary and political motivating forces to advance successfully squander the executives' practices and waste exchanging	Bao et al. (2020), Caldera et al. (2020)
Unorganised market structure for reusable and recycled waste materials and limited market information and access to such markets	Caldera et al. (2020), Huang et al. (2018)
Inadequate knowledge and insight into the circular economy in construction and demolition waste management	Ranta et al. (2018), Ritzen and Sandstrom (2017)
Absence of functional proficiency and aloof nature of existing squander trade frameworks	Nasaruddin et al. (2008), Chen et al. (2006), Huang et al. (2018), Corder et al. (2014
Absence of correspondence, doubt and straightforwardness in squander announcing by partners	Hardie et al. (2012), Park and Tucker (2017), Lim (2016
Limited demand for secondary building materials	Caldera et al. (2020
Absence of set up squander information base to give open data on quality, accessibility and advantages of auxiliary materials	jayi and Oyedele (2017), Huang et al. (2018), Mahpour (2018), Veleva et al. (2017), Bao et al. (2020), Yuan (2017)
Absence of checking and following of waste stream in waste management trade	Gangolells et al. (2014), Hardie et al. (2012), Lu and Yuan (2011)
Absence of complex coordination between squander supplier, client also administrative bodies	Mahpour (2018), Park and Tucker (2017), Yuan et al. (2011)
Nonattendance of a methodical and predictable construction and demolition squander information the executives framework	Zaman and Swapan (2016), Hardie et al. (2012), Li et al. (2016)

Table 1. Outline of potential barricades for waste trading practices

This investigation has discovered that the specialized obstructions essentially impact the execution of powerful waste trading rehearses in the construction and demolition area. Specialized boundaries are for the most part connected with the absence of instruction, experience, abilities, preparing, and a mix of brilliant advances in making due squander data and materials. The absence of easy-to-understand and dynamic online waste trade frameworks is profoundly thwarting the adequacy of waste trading in the construction and demolition area. Absence of information, techniques, and innovation to change over squander into significant materials, that is the absence of information on what and how to squander materials can be reused utilizing various strategies furthermore how to carry out trend-setting innovation to reuse and reuse, just as absence of waste data stream, effectively available and dynamic market stages for optional materials are all observed to be significant hindrances for reuse of waste materials.

A few approaches concerning ecological supportability and procedures for market advancement has been created to build the reuse and reusing of development squander, the absence of principles/authentications that guarantee the nature of auxiliary materials to satisfy the specialized details and building regulations for feasible development rehearses are the major hindrances that prevent the overall acknowledgment and utilization of reused materials. Besides, the absence of a particular administering body for construction and demolition squander at the central government level, conflicting landfill demand across various states, absence of explicit guidelines for diminishing landfills of construction and demolition squander, the non-obligatory status of reusing across the states, and absence of a broadened maker obligation driven lawful instruments for construction and demolition to squander are a portion of the other legitimate obstructions.

Absence of interest for manageable development from customers and inadequate mindfulness and consideration of the partners on the effect on the climate. Climate-related variables are for the most part connected with the garbage removal process at the landfills, which brings about a circuitous expense for treatment, cost of work, and high tension on landfill limit. Expanding the duty charge for removal of construction and demolition waste would bring about redirecting more waste from landfills, accordingly improving the possible utilization of the loss as a significant asset and hence, diminishing the effect on the climate.

The institutional hindrances are connected with squander information, correspondence among partners, the administrative obligation to waste management, squander the board plan, modern standards/principles, and benchmark for waste management, among others. Absence of steady waste information and announcing at project, industry. Steady and convenient waste information is fundamental not just for assessing and observing the advancement of waste management towards the asset recuperation targets yet in addition for the turn of events and execution of powerful waste approaches what's more public guidelines, which mean to animate asset proficiency and the extension of markets for reusable and reused squander materials.

VIII. Conclusion and Recommendation

This study has determined the barricades to implement waste trading practices in Lucknow (U.P).

The discoveries of this review add to the collection of information on construction and demolition waste management by featuring the obstructions of waste trading and ways forward to carry out this imaginative methodology in practice. The discoveries are helpful to waste management specialists/organizations and government bodies in helping to build up new roundabout plans of action. The public authority or administrative bodies can propose approaches and foster maintainable procedures and start motivating forces that expect to further, develop asset proficiency and manageability by advancing waste trading rehearses in the development area.

Further author is continuously working to perform statistical analysis to rank the identified barricades and generating new distinguished results.

This review has restrictions as far as the sort and size of the example used to gather the information. The information assortment has been directed in Lucknow which is the quickest developing economy in Uttar Pradesh and the most elevated generator of construction and demolition squander among different urban areas being the capital city of U.P.

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[24]

AUTHORS PROFILE

Mohd Asim (Gold medalist) is an Assistant Professor in the Department of Civil Engineering, Integral University, Lucknow and is PhD research scholar in NIT Patna. He has published 12 research papers and 1 book in various journals. He has 4 years of teaching experience and 1-year industrial experience. He has organized various STCs, and Workshop at Rajkiya Engineering College Ambedkar Nagar. His area of research is construction delays and their analysis, and is deeply interested in Vastu shastra science.

Imran Abbas Naqvi is research scholar, pursuing M.Tech in Construction ,Technology & Management from Integral University and had completed B.Tech from Civil Engineering in 2013 from Uttar Pradesh Technical University. My research work is under Mr. Mohd Asim and research area is construction and demolition waste and its trading. Construction waste management is the area of my core interest.
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Author-3 Photo

Syed Aqeel Ahmad is the Professor and Head, Department of Civil Engineering, Integral University, Lucknow. He has guided various thesis at post graduate level and doctorate level. He is the head of Human Resource Development Center, Integral University, Lucknow.

Exploring the barriers for implementing construction waste trading practices in the construction industry of U.P, India

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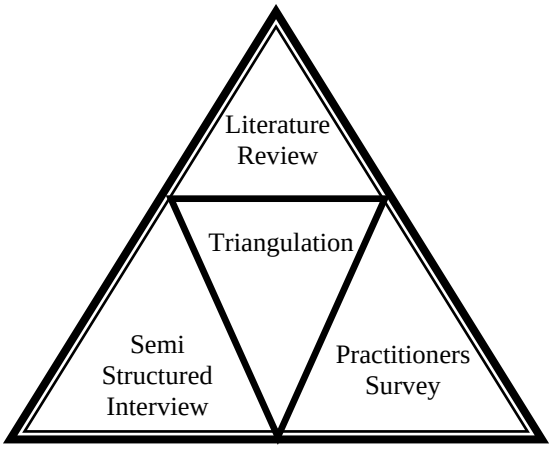

Figure1. Triangulation conjecture

3. IMPLICATION

The consequences of this study are based on the data collected in the Lucknow district of state Uttar Pradesh (India) which is regarded as the limitation of the study. This study has explored a wide range of barricades to the practices of waste trading in the construction and demolition sector.

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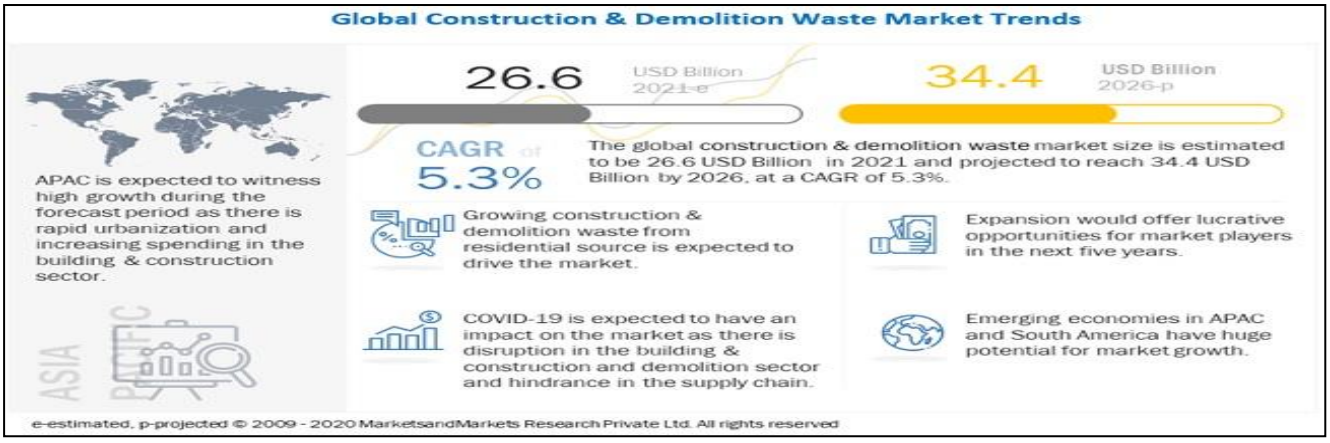

FIGURE 2. GLOBAL TRENDS FOR CONSTRUCTION AND DEMOLITION WASTE

Mahpour (2018) distinguished possible boundaries from social, specialized and lawful points of view, meaning to change the business moving towards the round economy in development and destruction squander the board. Table 1 presents the synopsis of stratified barricades recognized from the literature survey. These barriers can be considered as potential for further developing waste trading rehearses in the construction and demolition area.

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Table 2. showing profile of respondents (Lucknow city)

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Contractors	3	2	-	5
Engineers	1	3	1	5
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Project Manager	2	1	1	4
Total				8

This investigation has discovered that the specialized obstructions essentially impact the execution of powerful waste trading rehearses in the construction and demolition area. Specialized boundaries are for the most part connected with the absence of instruction, experience, abilities, preparing, and a mix of brilliant advances in making due squander data and materials. The absence of easy-to-understand and dynamic online waste trade frameworks is profoundly thwarting the adequacy of waste trading in the construction and demolition area. Absence of information, techniques, and innovation to change over squander into significant materials, that is the absence of information on what and how to squander materials can be reused utilizing various strategies furthermore how to carry out trend-setting innovation to reuse and reuse, just as absence of waste data stream, effectively available and dynamic market stages for optional materials are all observed to be significant hindrances for reuse of waste materials.

A few approaches concerning ecological supportability and procedures for market advancement has been created to build the reuse and reusing of development squander, the absence of principles/authentications that guarantee the nature of auxiliary materials to satisfy the specialized details and building regulations for feasible development rehearses are the major hindrances that prevent the overall acknowledgment and utilization of reused materials. Besides, the absence of a particular administering body for construction and demolition squander at the central government level, conflicting landfill demand across various states,

absence of explicit guidelines for diminishing landfills of construction and demolition squander, the non-obligatory status of reusing across the states, and absence of a broadened maker obligation driven lawful instruments for construction and demolition to squander are a portion of the other legitimate obstructions. Absence of interest for manageable development from customers and inadequate mindfulness and consideration of the partners on the effect on the climate. Climate-related variables are for the most part connected with the garbage removal process at the landfills, which brings about a circuitous expense for treatment, cost of work, and high tension on landfill limit. Expanding the duty charge for removal of construction and demolition waste would bring about redirecting more waste from landfills, accordingly improving the possible utilization of the loss as a significant asset and hence, diminishing the effect on the climate. The institutional hindrances are connected with squander information, correspondence among partners, the administrative obligation to waste management, squander the board plan, modern standards/principles, and benchmark for waste management, among others. Absence of steady waste information and announcing at project, industry. Steady and convenient waste information is fundamental not just for assessing and observing the advancement of waste management towards the asset recuperation targets yet in addition for the turn of events and execution of powerful waste approaches what's more public guidelines, which mean to animate asset proficiency and the extension of markets for reusable and reused squander materials.

8. CONCLUSION AND RECOMMENDATION

This study has determined the barricades to implement waste trading practices in Lucknow (U.P). The discoveries of this review add to the collection of information on construction and demolition waste management by featuring the obstructions of waste trading and ways forward to carry out this imaginative methodology in practice. The discoveries are helpful to waste management specialists/organizations and government bodies in helping to build up new roundabout plans of action. The public authority or administrative bodies can propose approaches and foster maintainable procedures and start motivating forces that expect to further, develop asset proficiency and manageability by advancing waste trading rehearses in the development area. Further author is continuously working to perform statistical analysis to rank the identified barricades and generating new distinguished results.

This review has restrictions as far as the sort and size of the example used to gather the information. The information assortment has been directed in Lucknow which is the quickest developing economy in Uttar Pradesh and the most elevated generator of construction and demolition squander among different urban areas being the capital city of U.P.

Identified Barriers	References

Significant expense associated with in general administration (arranging and handling) and examining of construction waste	Caldera, S., Ryley, T. and Zatyko, N. (2020)
Restricted monetary and political motivating forces to advance successfully squander the executives' practices and waste exchanging	Bao et al. (2020), Caldera et al. (2020)
Unorganised market structure for reusable and recycled waste materials and limited market information and access to such markets	Caldera et al. (2020), Huang et al. (2018)
Inadequate knowledge and insight into the circular economy in construction and demolition waste management	Ranta et al. (2018), Ritzen and Sandstrom (2017)
Absence of functional proficiency and aloof nature of existing squander trade frameworks	Nasaruddin et al. (2008), Chen et al. (2006), Huang et al. (2018), Corder et al. (2014
Absence of correspondence, doubt and straightforwardness in squander announcing by partners	Hardie et al. (2012), Park and Tucker (2017), Lim (2016
Limited demand for secondary building materials	Caldera et al. (2020
Absence of set up squander information base to give open data on quality, accessibility and advantages of auxiliary materials	jayi and Oyedele (2017), Huang et al. (2018), Mahpour (2018), Veleva et al. (2017), Bao et al. (2020), Yuan (2017)
Absence of checking and following of waste stream in waste management trade	Gangolells et al. (2014), Hardie et al. (2012), Lu and Yuan (2011)
Absence of complex coordination between squander supplier, client also, administrative bodies	Mahpour (2018), Park and Tucker (2017), Yuan et al. (2011)
Nonattendance of a methodical and predictable construction and demolition squander information the executive's framework	Zaman and Swapan (2016), Hardie et al. (2012), Li et al. (2016)

Table 1. Outline of potential barricades for waste trading practices

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