

¹Carmela C. Quizana,

²Serge T. Chua Jr.

Developing Building Information Modeling(BIM) integrated in Construction Waste Management Strategies



Abstract: - The boost in building projects in the Philippines has transformed attitudes in the construction sector toward construction waste management and environmental conservation. This paper includes a discussion of the emerging technology of BIM or Building Information Modelling at the threshold of its development and integration as strategies in Construction Waste Management. It is proposed to build a specific center that can achieve accurate material coordination and information data using BIM to track and coordinate the whole construction waste series from the points of origin to the disposal and materials points that can be recycled.

This study will look into the growth of construction waste management among Philippine construction industry, with the goal of determining their views on the benefits of waste management, stakeholders' ability to reduce waste, and the value of waste disposal strategy.

Keywords: BIM(Building Informatin Modelling), AEC (Architecture Engineering and Construction), Construction, Demolition, WasteManagement, Implementation, Strategies

I. INTRODUCTION

The construction sector particularly the current government administration Build, Build, Build Project is currently developing actively. With the continual rise in the number of structures under construction counting together with demolition, the quantity of construction waste is increasing.

According to A.Backchan *et al.*, [1] construction and demolition waste (CDW) is a type of solid waste came from a construction site. Common construction waste is due to excessive purchased materials and mishandling caused by unskilled laborers. Demolition can be dismantling outdated and inoperable structures to replace new ones and can also a source of construction waste. Construction waste can also be produced after an unforeseen event such as natural calamity. since the turn of the late 20TH century, CDW research studies have been carried out and problems related to construction waste are generally made of a huge volume of waste.

As with other forms of waste, CDW management approaches are best taken into account utilizing the globally recognized "waste hierarchy" paradigm. ted in legislation such as the EU Waste Framework Directive (2008), which aims in improving sustainable waste management operations by implementing the following waste management hierarchy, as illustrated in *Figure 1*.



Figure 1: The Waste Management Hierarchy

¹ Doctor in Engineering Management ,Polytechnic University of the Philippines Open University System,Manila Philippines

¹College of Architecture,National University-Manila,Manila Philippines

²College of Industrial Education, Doctor of Philosophy Program in Technology Management, Technological University of the Philippines, Manila Philippines

²School of Architecture,National University-Mall of Asia,Pasay City Philippines

[1]ccquizana@pup.edu.ph,[2] serge.chua@tup.edu.ph

* Corresponding Author: Carmela C. Quizana , ccquizana@pup.edu.ph

The lack of awareness of many who handle CDW's composition and characteristics features leads to discard enormous amounts of potentially recyclable material, as an alternative to their natural equivalent [2]. Construction and demolition waste minimization performance of contractors is still dull, largely motivated not by the environmental and resource efficiency concerns, but by short-sighted commercial and practical factors. The collection, recycling, and disposal of construction waste in many nations are not yet directed in the law.

This study aims to understand and provide the current construction waste management and the possible but realistic routes for the construction industry towards the adoption, strategy, and methods for the Architecture, Engineering, and Consultation (AEC) professional using BIM (Building Information Technology).

II. METHODOLOGY

The gathering of data and research materials was accomplished by the use of search engines. Hits returned from search engines and browsers such as Google Scholar, Science Direct, Researchgate, Elsevier, and Academia were filtered based on their relevancy and relation. Due to the nature and purpose of the research (stated in the Abstract), repetition and reuse of previous literature gathered were avoided wherever possible. The results restrict the research to papers published between 2016 and 2020 to examine contemporary studies in the area so that outdated studies are not reviewed.

From the 50-research literature, the abstracts and sections of the full article are reviewed manually and the following criteria are taken into account:

- Construction waste types and quantities
- Benefits and Barriers
- Current construction waste management
- Use of BIM to enhance the Construction and Demolition Waste Management

The filtering resulted in fifty (50) research literature containing discussions across various geographic locations, such as the Philippines, China, Japan, United States, Australia, Hong Kong, Iceland, United Kingdom, Oman, and other Middle East countries. The literature review was undertaken on twenty-eight (28) journal publications, eight (8) book chapters, seven (7) conference papers, five (5) annual reports, and two (2) webpage articles.

Articles qualified for at least one of the above criteria were not redundant to other publications, and have been critiqued which is exclusively on Construction and Demolition Waste (CDW), reuse, and recycling of CDW's with a total of 36 documents. This review study also includes early investigations and published publications that showed CDW was done as far back as the twentieth century. An evaluation of the research papers was undertaken to analyze existing Construction waste management, legislation policies, material recovery and to assess the current CDW reuse/recycling strategies.

III. RESEARCH AND DISCUSSIONS

A. Construction Waste Composition and Quantification

While the exact statistics for building trash generated on a normal building site are impossible to establish, the estimated value of construction materials supplied on a building site is up to thirty percent of their overall weight [3]. During 2003 according to R. Emanuel United States, has over 170 million tons of generated construction and demolition waste, and forty-eight percent (48%) of which were projected to be recovered [4].

According to Chun Li *et al.* [5] generation of building, waste was linked to the floor areas of the designed building by stating typical structures that can create 20-30 kg m² of waste. The highest generated waste stream in Europe is around 450 million tons that makes the major waste stream every year, excluding mining and farm waste [6]. Currently, seventy-five percent (75%) of European building and demolition waste is delivered to landfills. While in Netherlands and Germany more than eighty percent (80%) of the recycling rate has been reached [3].

In the United Kingdom landfill volume is more than fifty percent (50%) composed of construction waste [7] It is also estimated that ten percent (10%) comes from excessive purchasing and damage materials are become construction waste [7] However, Fishbein [8] calculated that the overall mass of the building supplies and materials as high as thirty percent (30%).

In addition, 38% of Hong Kong's solid waste is coming from the construction industry. In 2006, the use of landfills as a solution in handling construction waste was approximated at forty percent (40%) [9] . Furthermore, as reported by Bossink *et al.* [3] shown every building material creates one to ten percent (1-10%) of the quantity purchased which results in a total average of nine percent (9%) of the materials purchased being waste. In addition, based on Pinto and Agopyan [10] reported that, in Brazil, twenty to thirty percent (20-30%) of the mass of the entire building materials used are can become construction waste during the construction process.

Brick and concrete have by far the greatest recyclability potential in the building industry in terms of weight based on the results of extensive studies done in the United States, United Kingdom, Brazil, Korea, Hong Kong, and China. The report compares the types and quantities of construction wastes in various nations [9] , [11]. However, according to the building techniques used, the types and the composition of waste on-site are maybe varied. For instance, if precast concrete is used, pieces of formworks of concrete and timber waste are very minimal [12].

Hongping Yuan *et.al* [7]- [12] categorized construction and demolition as follows:

1. Materials with potential value and readily recycled in construction including bricks, tiles, steel, PVC pipes, asphalt, and soil;
2. Materials can recycle in some way thru processing; involving wood, glass, paper, plastic, metal, and oils;
3. and materials cannot easily be recycled with specific disposal problems such as chemicals (paints and solvents), asbestos, and plasters.

As stated in the book of Coventry et al. [13] stated seven main categories of waste: bricks, ChB, and mortar at thirty-three percent (33%); wood having twenty-seven percent (27%); packaging and other plastic and carton materials at eighteen percent (18%), metals at three percent (3%); special waste e.g., toxic waste at one percent (1%) and (10%) miscellaneous waste.

In **Table1** construction waste was categorized. The quantity of construction waste was generated from 2010 to 2015 shows the major categories of concrete and mixed waste. As the waste production rate in various types and quantities of building materials is demonstrated, construction waste is inevitable.

Waste Classification		2010	2011	2012	2013	2014	2015
Construction waste materials	Concrete	114,302	121,181	117,754	111,653	114,908	124,451
	Asphalt concrete	32,535	35,245	35,738	35,398	33,725	35,509
	Others ¹	2132	2339	2957	3280	2393	3230
	Sub total	148,969	158,765	156,448	150,331	151,026	163,190
Combustibility wastes	Wood	636	592	683	704	866	923
	Synthetic resin	839	1096	1261	1695	1586	1654
	Others ²	98	20	21	19	67	11
	Sub total	1573	1708	1964	2418	2519	2588
Non-combustibility wastes	Construction sludge	645	1403	644	1052	707	995
	Others ³	9	4	7	6	170	41
	Sub total	654	1407	651	1058	877	1036
Construction soil debris		5347	4838	5094	5067	5863	7659
Mixed construction wastes ⁴		21,577	19,699	22,471	24,664	25,097	23,787
Total		178,120	186,417	186,629	183,538	185,382	198,260

¹ Construction waste materials: waste brick, waste block, and waste roofing tile. ² Combustible wastes: waste fiber and waste wallpaper. ³ Non-combustible wastes: waste metal, waste glass, waste tile, and waste ceramics.

⁴ Mixed construction wastes: mixed construction waste, waste board, and waste panel.

Table 1: Quantities and Waste Classification (Unit: ton per day)

Concerning methods for disposal and management, waste produced in the construction phase, collection and transport firms gather the waste from storage yards and sort it mostly on their premises by type of waste. The intermediary companies specific for waste are hired to process recyclable waste which is mostly low-value roadbed materials [14]

The construction waste that cannot be recycled will be directly burned and buried in the landfills. Through the material properties waste generated during construction will be more distinctive and identified that can easily be sorted for recycling or reuse instead of directly dumping to the landfill without sorting [15] [16].

The small range of waste classifications is not adequate for sorting and reducing it. The combustible and non-combustible waste might be combined and stored then collected boxes or sacks and delivered to landfill areas for burial without any explicit separation [17] [18].

The identification of the major waste created during the construction phase will help to develop a construction system that is environmentally friendly and can help to minimize and optimize the recycling rate.

B. Benefits and Barriers

Due to BIM's demands in architecture, engineering, and construction (AEC), BIM has been starting to incorporate in most firms. Gallaher (2004) said the absence of software interoperability loss almost \$ 15.8 billion per year. Therefore, users deal with the various software demands and competence by efficient collaboration and adoption of BIM in the AEC industry. [19]

Conceptual Boundaries / Information Services. Methods and languages for reasoning-based and algorithm approaches are research focus areas that result in the interoperability of BIM applications. Research and development in the areas further enhance the interoperability of data exchanges formulated from BIM schema standards. [20] [21]

Adoption. Cultural changes from CAD to BIM presented the greatest challenge due to the philosophical difference in data management. The occurrence of BIM adoption is dictated by the phase of the project life cycle, such as the 1) Pre-design 2) Schematic 3) Design development.

Industry-wide Adoption. Present conditions and future expectations of a firm contribute to its competitive position in the industry affecting BIM adoption in target disciplines or for the entire set. The 3P's 1) People, 2) Processes, and 3) Policy of BIM [22] remain to be the main factors for industry-wide adoption decisions. [20]

The development of the Industry Foundation Class (IFCs), allowed software-independent work on models due to its vendor-neutrality. [23]

Lean Construction and Green BIM. The headways made by BIM into green and lean design and construction are anchored on BIM's informative and intelligent design models, project database and management, as well as its simulation capabilities for solar and comfort analysis, structural design analysis among others and can help in minimizing construction waste.

This restriction is laid down by Akinade *et al.* (2016) [24] and is a huge problem that consequently needs to be tackled. BIM and CDW practitioners who are trying to adopt the BIM software are tackling interoperability challenges. Once it is solved the use of BIM functionalities can explore the possible use as CDW analysis tools.

C. Current Construction Waste Management

In keeping with the journal article of K. Kabirifar *et al.* in 2019, the average waste from construction and demolition activities disposed at landfills by the construction industry [25] will be over 4000 tons or twenty-five percent of total disposal each day. Most mixed construction wastes are disposed of without sorting at sorting facilities or landfills. The present trend of waste management overloaded our landfills and public fill capacity in the year 2020 [25] [26].

The government is looking into how building waste may be reduced. The public and private sectors have different plans, strategies, and actions to manage construction waste. Seven effective best practices have been identified by

Poon & Pun et al. these are the following: a) Construction Waste Disposal Charging Scheme (CWDCS,) b) Construction Site Waste Management Plans, c) Proper Design, d) Deconstruction, Prefabrication, and Modular Construction, e) Waste Sorting (Reduce, Re-use and Recycle) and lastly f) On-Site and Off-Site (See sections C.1-C.6) [25] [26] [27] which should be incorporated in the construction waste management program in urbanized or highly populated cities.

C.1 Site Waste Management Plan. The Site Waste Management Plan (SWMP), [25] has become an increasingly attractive and helpful strategy to help stakeholders and contractors predict C&D waste including sorting of materials that will assess the amount of construction waste [28]. For all public projects, a waste management strategy is needed and has shown that reuse and recycling using construction materials may be improved [29]. However, site restrictions and overhead expenses are limiting SWMP's efficacy [30]. Most construction projects do not have sufficient spaces for on-site labor-intensive sorting. In private sector projects, the implementation of SWMP is not frequently used. Supplementary sorting facilities are needed and ways how to decrease overhead expenses are to be explored.

C.2 Proper Design. A suitable design can prevent waste generation in the early stages of construction [26] [31], which comprises the coordination and standardization of dimensions, a) the minimization of temporary facilities, b) a recycled materials inclusive design, c) avoidance of late design modifications, d) the application of low waste building technology and e) building information modeling for the design concerning the article written by Zhang et al. and Baldwin et al. [32] [33]. However, during the design stage, thinking the construction waste is not extensively studied [34]. For the future study, the question needed to answer is how waste will be minimized during the design stage?

C.3 Deconstruction. By reversing construction, deconstruction is carried out to prevent contamination of materials recyclables, such as concrete aggregates, metal, wood, paper, cardboard, and plastics [35], [36] that requires systematic classification of the materials into their categories.

C.4 Prefabrication and Modular Construction. Prefabrication may minimize building waste by about fifty-two percent (52%) by limiting site wet trade on the premises as well as increasing buildability and performing in environmental, economic, social aspects and conventional construction methods [29] [27] [37] [38] [39] the developer in housing prefabrication is the Hong Kong's Housing Authority. In the private sector, however, prefabrication is not widespread. In addition, prefabrication has several drawbacks, including modular design plans, limitations on transferring pre-fabrication materials on-site [40].

C.5 Waste Sorting: On-Site and Off-site [14] . The on-site sorting of construction waste has proven to be beneficial in lessening construction waste. We can already segregate and recover the material that can reuse and recycling materials to reduce the cost of disposal [40].

In the article written by Ann T. W. Yu, et al, contractors are hesitant to perform on-site sorting despite positive effects on the economics. Contractors are more conscious of site conditions that will be overfilled, tight construction schedule, different labor people for sorting waste, and lack of material recovery facilities [41]. Sorting on-site can be a way to encourage reuse and recycling and might lessen the cost of transporting waste to landfills. More tailored recycling technology and off-site recycling must be developed on-site [42]. This can be a significant aspect for suitable selections for off-site waste sorting plants to decrease transport costs.

C.6 Reduce, Reuse, and Recycling. The main focus of the research is the application of the "three Rs" approach, which is known as the "waste hierarchy" (reduction, reuse, and recycling) [28] [43]. According to the research of T.C. Ling et. al has been undertaken on the reuse of "discarded glass as an aggregate in concrete or additive in mortar or cement paste" [44] [45] [46]. Despite the development of recycling technology in recent years, the promotion of recycled products remains a problem that has to be resolved. Further, it is of the greatest significance for "Sustainable Construction and Demolition Waste Management", to change the recycling attitude and behavior [47].

D. Use of BIM to enhance the Construction and Demolition Waste Management

Despite the popularity and increasing adoption of BIM in building design, BIM is not compatible with most current waste management tools [48]. This is because the adoption and collaboration of the BIM program restrict the full potential of the software. This indicates a major gap as literature research suggests that efficient waste reduction should be initiated as early as the design stage.

Adoption of waste management thru BIM will have the advantage to evaluate and develop the current practice of the project team. This notion contributes to and duties of the philosophy of “shared risk and rewards”. [49]. Cai and Waldmann [50] described that the key companies suggested construction materi bank will include an assessment on the following: a) condition of recovered materials b) storage c) components obtained from demounted structures. In the line with this a thorough database on construction materials and components through BIM design tools, the software can introduce that is compatible with the existing software that could extend the functionalities.

Detailed knowledge of construction materials and their components will help calculate and promote construction waste management. This was started the idea of a Material and Component (M&C) bank, that will act as management that can handle multiple companies in the construction industry [50]. The database will include all the materials and components information in a project which can help to identify a strategy to minimize construction waste. The M&C bank role is illustrated in *Figure 2* which Cai and Waldmann [50] provide further insights.

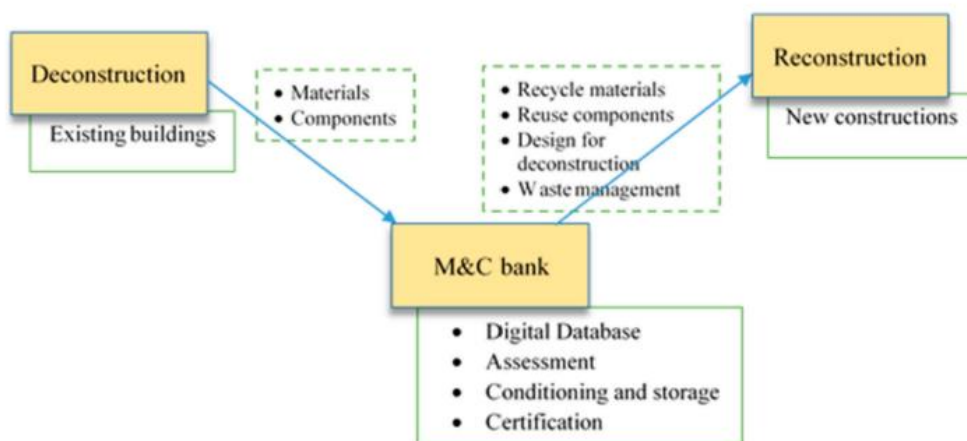


Figure 2 Material and Component Bank Role Framework [50]

In comparison with the current literature, the proposed software database will provide all kinds of information regarding the most construction materials used on-site for example concrete, steel, and wood that allows a circular economy through material recycling and re-use components and provides a central database as a further BIM software for the calculation of the waste during the design phase. Accordingly, the purpose of this study is to design a methodology for an existing system braced by BIM to guarantee that the construction history is completely recorded, secured and can predict over stockpiling of used and used materials.

D1. BIM Based software tool as construction materials database bank

Hundreds of thousands of construction materials and components are included in a typical structure. It means a considerable quantity of information has to be saved for thorough materials and components which can be a baseline in evaluating potential recycling and re-use. [51]. BIM has been able to manage a great deal of storing information that the proposed software needed. It has become a vital tool for designing a new structure, as it can specify all the functional and physical features that can determine the possible wastage [52]. It is suggested to have a centralized database that will offer all sorts of materials and components pieces of information. The data will come from gathered information from BIM existing and/or new structures. In this research, a software application will be developed using the help of computer programmers that will have a rational database

management system for storing and accessing an enormous amount of information that will be used in identifying the possible amount of waste as early as in the design stage. The required information will be extracted from a BIM model using the BIM software REVIT as illustrated in **Figure 3**.

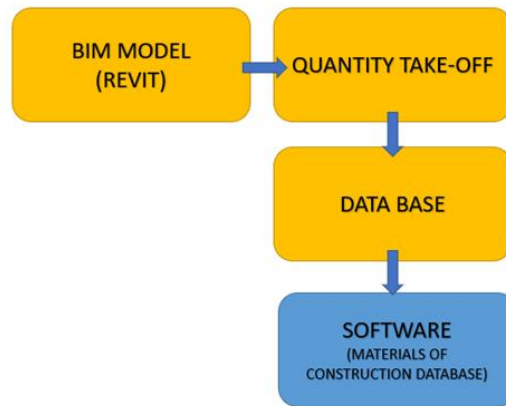


Figure 3: Database collection framework.

The data from Revit using “quantity take-off” in the design and construction process will be saved in the database. The database will be focusing on basic construction materials such as concrete, steel, and wood. The Revit quantity takeoff will extract all material and geometrical parameters that can help to avoid ordering unnecessary materials and the results will be filtered out in a form of a list.

Finally, the developed software (materials of construction database will include the following: a) Project Profile b) Item(materials) c) Description d) Quantity e) Unit f) evaluation sheet.

D2. System Layout and Discussion

The main page of the proposed software appears as shown in **figure 4**. The user must register and download the software to access the system bank. The users can input the project type and materials that will be used in the project by clicking the button or importing the excel file to the software.

The description of the item and the amount utilized in a project are shown in material properties page, as shown in **figure 5**.Material properties will be described in items, descriptions, and quantity. Each material will be required a piece of detailed information for the identification and assessment of environmental risk.

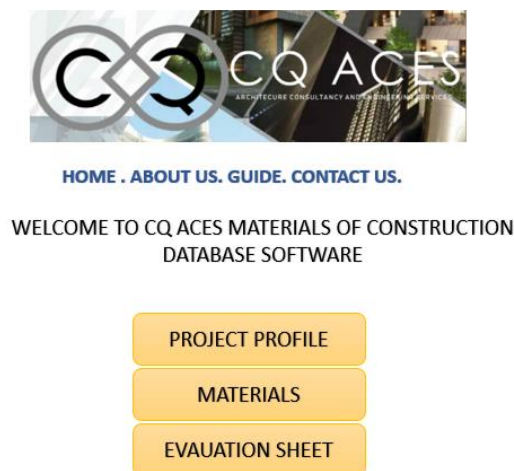


Figure 3: CQ ACES Main Page



MATERIALS

DESCRIPTION	DATA			UNIT
1.0.0 CONCRETE WORKS				
Cement				Bag
Sand				Cu. M
Gravel				Cu. M
2.0.0 Concrete Mixtures				
	CLASS			
	AA	12	bags/cum	Cu. M
	A	10	bags/cum	Cu. M
	B	9	bags/cum	Cu. M
	C	8	bags/cum	Cu. M
3.0.0 RE-BARS				
	GRADE			
	20			Kg.
	40			Kg.
GI TIE WIRE				P/KG
				KG/ROLL
				ROLL
4.0.0 PLASTER				
Cement	16			230.00
Sand	0.9			750.00

Figure 4 Material Properties

On the assessment page the re-use and recycle will be categorized and from here the users can calculate the volume amount of construction and demolition waste.

IV. CONCLUSIONS AND FUTURE WORK

Construction waste management is a huge and difficult undertaking that requires consistency and effectiveness in contact between regional, municipal, and waste management officials, construction companies as well as the stakeholders in this activity. This study confirmed that most construction projects produce a large amount of waste. It can be lessened through the use of intelligent engineering, standard dimensions, and the recycling of material.

To expand the effectiveness of any construction & demolition waste management practices, developmental standards for a construction waste management plan mainly be focusing on developing material construction software. It will coordinate specific materials, information resources and track the waste's life cycle. Including this proposed software in a construction waste management plan in every project will eliminate or at least reduce waste on-site.

It will be custom prepared for the use of the contractor to be submitted to the municipality or other regulatory agencies for supervision of implementation.

The suggested construction waste management plan will provide the complete spectrum of building waste management includes:

- Statement of goal for objectives for waste management.
- List of personnel for implementation
- Waste material and planned disposal list
- Estimate of Architects in building materials and quantities using the proposed software
- Actual construction waste material report
- A report in segregation of construction waste (materials and quantities)

The integration of Building Information Modeling (BIM) during the design phase and adaptation to resource-saving activities provide a reserve to increase the efficiency of construction waste flow management. To achieve economic and environmental advantages, the development of suggested research will enhance construction & demolition waste management.

BIBLIOGRAPHY

- [1] Akhtar and A. Y. G. Sarmah, "Developing a quantitative construction waste estimation model for building construction projects," in *Construction and demolition waste generation and properties of recycled aggregate*, 2018, pp. 262-281.
- [2] R. Silva and J. D. R. de Brito, "Availability and processing of recycled aggregates within construction and demolition chain," pp. 598-614, 2017.
- [3] H. B. B.A.G. Bossink, "Construction Waste: quantification and source evaluation. *Journal of Construction Engineering and Management*," vol. ASCEC 122, pp. 55-60, 1996.
- [4] R. Emanuel, "Estimating the environmental suitability of wall materials: preliminary results from Sri Lanka, *Building and Environment* 39," 2004, pp. 1253-126.
- [5] D. S. C. K. Chun-li, "Strategies for successful construction and demolition waste recycling operations, *Construction Management and Economics* 15, 1997.
- [6] J. G. G. M. Osmani, "An Investigation Into Impact of Procurement System on Waste Generation: The Contractors' Perspective, *Association of Research in Construction Management*," in *Waste*, Nottingham UK, September 2009, pp. 103-104.
- [7] L. S. , J. W. Hongping Yuan, "China's construction industry," no. Article publication date: 5 April 2011 , 2011.
- [8] B.K. Fishbein, *Building for the Future Strategies to Reduce Construction and Demolition Waste in Municipal Projects*, New York: INFORM Publications, 1998.
- [9] J. G. A. P. M. Osmani, "Architect and Contractors attitudes towards waste minimisation,," in *Waste and Resource Management* , 2006, pp. 65-72.
- [10] V. A. T.P. Pinto, "Construction Waste as Raw Materials for Low Cost Construction,," in *Sustainable Construction*, Tampa, FL, pp. 335-342.
- [11] H. L. C. W. Z. Chen, "An Application of barcode system reducing construction waste,," in *Automation in Construction* , 2002, pp. 521-533.
- [12] A. Y. L. N. C. S. Poon, "Onsite sorting of construction and demolition waste in Hongkong," in *Resources, Conservation and Recycling*, 2001, pp. 152-172.
- [13] S. M. K. S. Coventry, "Demonstrating waste Minimisation Benefits in Construction," Ciria, London, 2001.
- [14] M. Bovea and J. Powell, "Developments in life cycle assessment applied to evaluate the environmental,," in *Waste Management* , 2016, pp. 151-172.
- [15] R. Kim, "Current State of Carbon Dioxide Emission in Cement Industry and Proposal for the Environment,," *Korean Recycled Constr. Resour. Inst*, 2013, p. 22-28.
- [16] Baek, S. Park, M. Suzuki and S. Lee, "Life cycle carbon dioxide assessment tool for buildings in the schematic,," in *Energy Building* , 2013, pp. 611, 75-87..
- [17] Yi and K. Seo, Seoul, Korea,., 2010.
- [18] T. Song and J. Seong, "Comparison of the Construction Waste Generated by the Project and the Estimation of the Waste Generation Unit,," 2017, pp. 427-435.
- [19] S. O. L. K. K. A. O. B. M. O. H. Ajayi, "Competency-based measures for designing out construction waste: task and contextual attributes. *Eng. Construct. Architect. Manag*," pp. 464-490, 2016.
- [20] J. I. U. Underwood, *Handbook of Research on Building Information Modelling and*, Hershey: IGI Global, 2010.
- [21] U. Isikdag, "The Future of Building Information Modelling: BIM 2.0,," in *Enhanced Building Information Models*, Springer, 2015, pp. 13-25.
- [22] G. Trivedi, "BIMTODAY,," 09 May 2017. [Online]. Available: <https://www.pbctoday.co.uk/news/bim-news/3-ps-of-bim/33019/>. [Accessed 2 June 2021].
- [23] P. Smith, "BIM implementation - global strategies,," in *Creative Construction Conference*, 2014.
- [24] O. O. L. M. K. B. M. A. S. O. H. Akinade, "Evaluation criteria for construction waste management tools towards a holistic BIM,," pp. 3-21, 2016.
- [25] M. W. Kamyar Kabirifar, "Introduction to Construction Waste (2020),," *Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review*, August 2020.
- [26] C. Poon, "Management of construction and demolition waste,," 2009, pp. 159-160.
- [27] C. a. I. C. (CIC), "Report on Strategy for Management and Reduction of Construction and Demolition,," 2017 August.
- [28] K. Kabirifar, M. Mojtahedi, C. Wang and V. Tam, *Construction and demolition waste management contributing factors coupled with reduced , reuse, and recycle strategies for effective waste management: A review,.*, 2020.

- [29] V. Tam, "On the effectiveness in implementing a waste-management-plan method in construction.," in *Waste Management*, 2008, p. 1072–1080.
- [30] 1072–1080, "E. Management of construction waste in public housing projects in Hong Kong," in *Constr. Manag. Econ*, 2004, pp. 22,675-689.
- [31] Z. Wu, A. Yu, L. Shen and G. Liu, "Quantifying construction and demolition waste: An analytical review. *Waste Management*," p. 2973–2979., 2014.
- [32] X. Zhang, Y. Wu and L. Shen, "Application of low waste technologies for design and construction," *Renew. Sustain. Energy Rev.*, p. 2973–2979, 2012.
- [33] Baldwin, C.-S. Poon, L.-Y. Shen, S. Austin and I. Wong, "Designing out waste in high-rise residential buildings: Analysis of precasting methods and traditional construction.," in *Renew. Energy*, 2009, p. 2067–2073..
- [34] "Construction and Industry Council (CIC). Report on Strategy for Management and Reduction of Construction and Demolition," August 2017.
- [35] C. Poon, "Management and recycling of demolition waste in Hong Kong.," in *Waste Manag. Res*, 1997, p. 561–572..
- [36] Lauritzen and N. Hahn, "Building waste generation and recycling. In *International Solid Waste Management Association Year*," Union of International Associations, Vols. Union of International Associations: Cambridge, UK, p. 48–58, 1991–1992.
- [37] Z. Li, Q. Shen and X. Xue, "Critical review of the research on the management of prefabricated construction. *Habitat Int.*," pp. 240-249, 2014.
- [38] T. W. Yu, I. Wong, Z. Wu and C.-S. Poon, "Strategies for Effective Waste Reduction and Management of Building Construction Projects in Highly Urbanized Cities—A Case Study of Hong Kong," *Constr. Manag. Econ*, 2021.
- [39] Y.-H. Chiang, E.-W. Chan and L.-L. J. Lok, "Prefabrication and barriers to entry—A case study of public housing and institutional buildings in Hong Kong," *Critical factors in effective construction waste minimization at the design stage: A Shenzhen case study, China*, p. 482–499., 2006.
- [40] V. Tam and C. Tam, "Evaluations of existing waste recycling methods: A Hong Kong study," *Build. Environ.*, p. 1649–1660., 2006.
- [41] Y. L. N. C.S. Poon, "On-site sorting of Construction and demolition waste in Hongkong," in *Resources, CO nservation and Recycling* , 2001, pp. 157-172.
- [42] Z. Bao, W. Lee and W. Lu, "Implementing on-site construction waste recycling in Hong Kong: Barriers and facilitators.," *Sci. Total. Environ*, pp. 2020.,
- [43] M. Osmani and P. Villoria-Sáez, "Current and emerging construction waste management status, trends and approaches," in *Waste*, 2019, p. 365–380.
- [44] T.-C. Ling, C.-S. Poon and H.-W. Wong, "Management and recycling of waste glass in concrete products: Current situations in HongKong.," *Resour. Conserv. Recycl.*, pp. 25-31, 2013.
- [45] Z. Duan and C. Poon, "Properties of recycled aggregate concrete made with recycled aggregates with different amounts of old adhered mortars," *Mater. Des.*, p. 19–29, 2014.
- [46] J.-X. Lu, Z.-H. Duan and C. Poon, "Fresh properties of cement pastes or mortars incorporating waste glass powder and cullet," *Constr. Build. Mater.*, p. 793–799, 2017.
- [47] T. Mak, K. Iris, L. Wang, S. Hsu, D. Tsang, C. Li and C. Poon, "Extended theory of planned behaviour for pro-moting construction waste recycling in Hong Kong.," in *Waste Management*, 2019, pp. 161-170.
- [48] J. M. L. Cheng, "A BIM-based system for demolition and renovation waste estimation and planning," 2013, pp. 1539-1551..
- [49] R. B. M. O. H. M. C. M. S. Eadie, "BIM Implementation throughout the UK construction project life cycle," 2013b, pp. 145-151.
- [50] Cai and D. Waldmann, "A material and component bank to facilitate material recycling and component reuse for a sustainable construction: Concept and preliminary study," 2019, pp. 2015-2032.
- [51] Akbarnezhad, K. Ong and L. Chandra, "Economic and environmental assessment of deconstruction strategies using building information modeling.," 2014, pp. 131-144.
- [52] R. Eadie, M. Browne, H. Odeyinka, C. Mckeown and M. S., "BIM implementation throughout the UK Project lifecycle.," 2013, pp. 145-151.
- [53] R. K. Aries Roda D. Romallosa, *Feasibility of Biomass Briquette Production from Municipal Waste Streams by Integrating the Informal Sector in the Philippines*, 2017.
- [54] S. O. Alicia L. Castillo1), "Solid Waste Management," 2013. [Online]. Available: https://www.jstage.jst.go.jp/article/jsmcwm/24/0/24_677/_pdf.
- [55] Alicia L. Castillo, "Environmental Resources System," 2013.
- [56] "JICA Waste Characterization Study," 1997.
- [57] J. Barritt, *An overview on recycling and waste in construction. Proceedings of the Institute of Civil Engineers.*, 2015.
- [58] Q. Y.B., "Research on promotion of CDW management approaches and relevant legislation," *University of Nanjing Forestry*, 2009.

- [59] C. H., "Introduction of construction waste recycling," 2014.
- [60] L. R. B. R. V. S. Zhao W, "Evaluation of the economic feasibility for the recycling of construction and demolition waste in the PRC—The case of Chongqing," in *Resources Conservation & Recycling*, 2010, pp. 377-389.
- [61] G. W. Reporting, 2013. [Online]. Available: <https://www.environment.gov.au/topics/environment-protection/nwp/reporting/national-waste-generation>.