Sood, T. and Gurmu. A., 2022. Reusing and repurposing of glass waste: A literature review. In: Sandanayake, Y.G., Gunatilake, S. and Waidyasekara, K.G.A.S. (eds). *Proceedings of the 10th World Construction Symposium*, 24-26 June 2022, Sri Lanka. [Online]. pp. 695-706. DOI: https://doi.org/10.31705/WCS.2022.56. Available from: https://ciobwcs.com/2022-papers/

REUSING AND REPURPOSING OF GLASS WASTE: A LITERATURE REVIEW

Tushar Sood[1] and Argaw Gurmu[2]

ABSTRACT

An increase in demolition activities has led to the generation of large amounts of glass waste. Due to its non-biodegradable nature, glass can stay in landfills for longer periods without decomposition; thus, it occupies a large volume of landfills. This study aimed to analyze the potential reuses and repurposing of glass waste in the construction industry. A systematic review of the literature was conducted, and secondary data were extracted. The data were analyzed qualitatively to achieve the objective of the study. The generation of glass waste in four different parts of the world, namely: Hong Kong, Australia, Europe and the USA has been studied to get an estimate for the increase in glass waste trends. The generation of glass waste saw a downfall from 2006 to 2010, was then steady from 2011 to 2016 and then slightly rose. A high volume of glass waste in landfills and its non-biodegradable nature has made it essential for the discovery of new methods of reuse and recycling of glass waste. Some of the potential reuse and repurposing options include Aggregate for Concrete, Filtration Media, Glass Fibres, Blast Abrasive, Roof Coating, Ceramic Based Products, Burnt Bricks, Low-Temperature Stoneware Tiles, Insulation, and Decorative Materials. The paper provides useful information to various stakeholders in the construction industry to understand how and where glass waste can be reused.

Keywords: *Construction Industry; Glass Waste; Repurposing; Reusing.*

1. INTRODUCTION

According to Ofori (2000), sustainable construction can be defined as the creation of construction items via efficient resources and best practices with clean techniques from the extraction of raw materials to the demolition and disposal of its components. Sustainable construction also aims at producing competitive as well as profitable industry-built assets, enhancing the quality of life, offering customer satisfaction, achieving higher growth, maximizing the efficient use of resources, reducing pollution, and providing support to both social and natural environments. According to Lu and Lai (2020), global carbon emissions saw a rise from 24.69 billion tons in 2000 to 36.14 billion tons in 2014. International Energy Agency (2020) stated that the building and building construction sectors are responsible for over one-third of global energy consumption and nearly 40% of the total direct and indirect CO_2 emissions.

As with so many materials in the construction industry, a series of technological breakthroughs in the glass industry has led to its extensive use in construction. Furthermore, its translucent ability made it a more versatile and popular material in the

[1] School of Architecture and Built Environment, Deakin University, Australia, tusharsood5@gmail.com
[2] School of Architecture and Built Environment, Deakin University, Australia, argaw.gurmu@deakin.edu.au

building industry. The uses of the material extended from doors, windows, skylights, and display shelves to glazing panels, greenhouses as well as crystal palaces making it an integral part of the architecture of the building industry. A wide variety of users suggests a large-scale use of the material and hence the problem of managing the waste generated due to its huge consumption. Kazmi (2017) highlighted that recycling the old waste products shall reduce the demand for new raw materials by reducing the costs of energy and transportation. Due to the non-biodegradable nature of glass, it occupies a larger share of landfill spaces. Recycling glass further helps in reducing these stresses on the land as well as reducing carbon footprint.

According to the national waste report published in 2018 (Pickin, et al., 2021), about 1.1 million tonnes of glass waste was generated in 2016-17 in Australia. The report further confirms the recycling rate of glass waste remains between 54% to 61%. And yet the alternative glass recycling markets such as using glass as aggregate in concrete, foam panels and others are still underdeveloped. A few studies have been conducted to comprehensively explore the potential areas for reusing and recycling glass waste. This research is thus conducted to fill that gap and find out how recycling glass waste can benefit such markets. Therefore, the objective of the study is to identify potential reusing and repurposing options for glass waste in the construction industry. In this research, repurposing can be defined as the use of a material for a use other than for its initial requirement (Rose, 2019).

2. RESEARCH METHODOLOGY

This research was conducted by adopting the qualitative analysis of data through a Systematic Literature Review (SLR). The steps followed in collecting and analysing data are shown in Figure 1.

2.1 DATA COLLECTION

With researchers collecting and storing data all over the world, the present age makes it more viable to analyze secondary data to draw more accurate results with limited resources and time (Andrews et al., 2012). Moreover, due to academic limitations, the process of collection of primary data becomes quite complex and time-consuming. The main advantage of using secondary data lies in the convenience and cost-effectiveness it provides since it allows access to high-quality data (Smith et al., 2011). To gather relevant data, an online search was conducted and relevant journal articles, government reports and conference proceedings were collected using databases such as the library of Deakin University and Google Scholar. The databases also provided access to esteemed databases such as the American Society of Civil Engineering, Emerald Insight, Science Direct, Semantic Scholar, Academia, Taylor and Francis and Elsevier. The first searches for the research included keywords such as “glass waste analysis”, “generation of glass waste”, “recycling glass waste”, “reusing glass waste”, and “repurposing glass waste”.

This was then followed by more comprehensive research in the same areas to gather specific knowledge. The timeframe selected for this research was 20 years (i.e. 2001-2021). The first step to comprehensive research involved the generation of a selection criterion which helped in the selection of the most relevant articles for the research study. The criteria consisted of comparability of the title, keywords and abstracts. After conducting SLR, data pertaining to glass waste generation, reusing options, repurposing the glass waste and the amount of waste generated by different industries were collected. The data also included information regarding study type and title, journal, author as well as methodology.

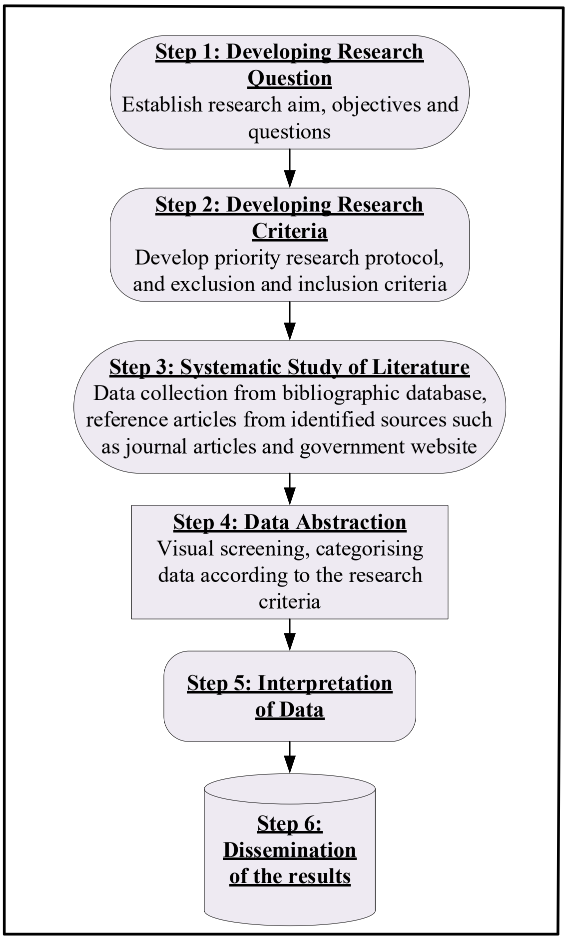

Figure 1: Overview of research methodology adapted from Schweizer and Nair (2017)

2.2 DATA ANALYSIS

Due to the methodological rigor of SLR, it is found to be one of the famous methods for synthesizing data. The two common ways in SLR to synthesize data involve narrative synthesis and meta-analysis (Seidler, 2020). Meta-analysis can be described as the use of statistical techniques to summarize and combine the results of various studies which may be contained within a systematic review. The method aims at providing more precise estimates than those derived from individual studies (Moher, et al., 2015). On the other hand, since the research does not study the statistics of the previous research, narrative synthesis was chosen as the best method for analyzing the data. Narrative synthesis is a form of storytelling, where we are a part of a storytelling culture describing in a convincing manner what needs to be done or stopped and why it is so. It also helps in understanding the impacts of various long-established policies or practices by researching the gaps so that the policies and practices can be bridged. The method involves the synthesis of findings from multiple studies to explain and summarize the findings via text and words. Furthermore, the method allows for focusing on a wide variety of questions and not only those relating to the effectiveness of a particular intervention (Van, et al., 2019).

3. FINDINGS

After applying visual scanning and applying selection criteria, 31 articles were selected for a comprehensive review to achieve the study's objective. Figure 2 presents the information regarding the various papers selected for SLR and the year in which they were published. As shown in the figure, most of the papers chosen for the study were published in the year 2020 followed by 2019. However, two of the sources have been published in the years 1974 and 1998 have also been taken into consideration due to the usefulness of the information they contain.

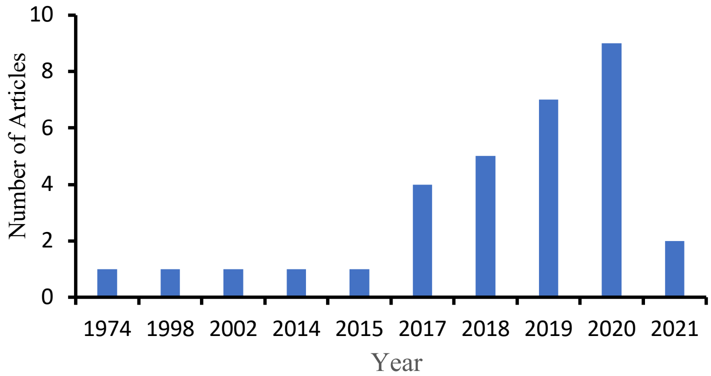

Figure 2: Breakdown of papers according to year

Table 1 depicts the information regarding the number of articles selected and the name of the journal from which they were selected to achieve the objective of the study. The highest number of articles were selected from the Journal of Cleaner Production followed by the Journal of Building Engineering.

Table 1: Sources of Secondary Data for Systematic Literature Review

Item	Name of Journal	No. of Articles
1	Journal of Materials in Civil Engineering	3
2	Journal of Cleaner Production	6
3	Journal of Building Engineering	4
4	Construction and Building Materials	2
5	Reference Module in Materials Science and Materials Engineering	1
6	Journal of environmental chemical engineering	1
7	Materials	1
8	Case Studies in Construction Materials	1
9	Environmental Science and Pollution Research	1
10	Materialia	1
11	SN Applied Sciences	1
12	Cement and Concrete Research	1
13	Journal of environmental management	2
14	Journal of Industrial Textiles	1
15	Composites	1
16	Composites Part A: Applied Science and Manufacturing	1

Item	Name of Journal	No. of Articles
17	Biomaterials	1
18	Ceramics International	1
19	Civil and Environmental Engineering	1
20	Journal of Non-Crystalline Solids	1
	Total	31

3.1 POTENTIAL REUSING AND REPURPOSING OPTIONS FOR GLASS WASTE IN CONSTRUCTION INDUSTRY

Glass waste has a lot of reusing potential which can be utilized as Aggregate for Concrete, Filtration Media, Glass Fibres, Blast Abrasive, Roof Coating, Ceramic Based Products, Burnt Bricks, Low-Temperature Stoneware Tiles, Insulation and Decorative Materials (Polley, et al., 1998; Jani and Hogland, 2014; Silva, et al., 2017; Gualtieri, et al., 2018; Al-Fakih, et al., 2019). This section shall present findings on how effective and practical these uses are and their potential for reusing in the construction industry.

The following functions will form the criteria against which different options for glass waste shall be analysed for the sake of this study. These criteria have been looked up in the various secondary sources to find evidence of the reusing potential.

1. Cost-Efficient - Allows for a reasonable cost for production (i.e. provides optimum results for least possible expenditure). The criteria have been chosen to make it more practical for the construction industry to become more sustainable.
2. Mass Production - It can be defined as the production of large quantities of standardized products using automation technology or assembly lines and facilitates the efficient production of a large number of similar products (Banton, 2021). This criterion has been chosen as it would lead to the reuse of large volumes of glass waste thereby moving it faster from the landfills.
3. Feasible Production - The criteria can be defined as the analysis of the production process to determine if it is technically feasible to manufacture to meet the customer requirements. It is not limited to necessary resources, estimated costs, required software, capacity, and skills including support functions (Mangla, 2021). The criterion is chosen to ensure that the production process is not overly complicated and can be easily adopted.
4. High-Quality Product - The criteria ensure that the glass waste has been reused to produce a product that is fit for the desired use or purpose, provides value for money as well as free from defects (Akrani, 2021).

The above functions have been chosen since they not only encourage utilizing large amounts of waste but also help the process become more practical. Table 2 presents information collected from papers regarding the presence of primary functions required for the reuse of glass waste. After going through 17 research papers, is quite evident that reusing options show great potential in terms of cost-efficiency, mass production, feasible production, and high-quality products.

The reusing option of glass as waste aggregates requires high energy and a long period of time to crush the glass waste. The glass waste may not be suitable for use as fine aggregate or part of the binder. The main reasons include the unsuitability of glass to participate in pozzolanic reaction, wide ranges of shapes and sizes, presence of high amounts of impurities and sharp edges (Khan, et al., 2020). Though using glass waste as aggregates can be a bit expensive but it offers a great resolution to move large volumes of glass waste from the landfills and thus helps in preserving the virgin material for future use. Due to the increase in durability compressive strength, freezing and thawing strength and permeability resistance (Kim, et al., 2018), the glass waste offers a high-quality product and thus makes it a popular choice of reuse in the cement industry thereby allowing for mass production. The process of production is not overly complicated and can be easily adapted and thus qualifies for feasible production.

Table 2: Functional requirements finding checklist

Reusing Option	Function 1 Cost efficient	Function 2 Mass production	Function 3 Feasible production	Function 4 High quality product	References
Aggregate for concrete	x	✔	✔	✔	(Kim, et al., 2018)
Filtration Media	✔	✔	✔	✔	(Jeong, et al., 2019
Glass Fibres	✔	✔	✔	✔	(Pegoretti, et al., 2002)
Ceramic Based Products	✔	x	✔	✔	(Gol, et al., 2021)
Burnt Bricks	✔	✔	✔	✔	(Saraswathy, et al., 2019)
Insulation	✔	✔	✔	✔	(Shafi et al., 2019)

The other reusing option which failed to satisfy one of the primary functions was ceramic-based products. This is mainly due to the poor shock resistance, weak in tension and may crack when hit with heavy items (TheKacasSite, 2021). This makes mass production of the reusing option a bit difficult as there is not much demand for the same. On the other hand, it offers a cost-efficient, high-quality product with a feasible production, giving it a very good potential in the construction industry. In Section 4, four alternatives (Filtration Media, Glass Fibres, Burnt Bricks and Insulation) and their reusing potential is discussed.

3.2 GLASS WASTE GENERATION TRENDS

The disposal of glass waste has become one of the major environmental concerns due to the increasing demand for natural resources and landfill space. In the early years of glass production, its uses were limited to beads, bowls and jars (Glass, 2021) but now it has found a plethora of uses. The increase in consumption has further led to an increase in the waste generation of the material. Upon studying the trends for glass waste generation, it was found the USA and Europe were producing a higher amount of glass waste than other countries (refer Figure 3).

According to Environmental Protection Agency (EPA) (2015), 10.37 million tonnes of glass waste was generated in the USA which consisted mainly of food and drinks containers. It was also understood that only about 27% of the glass was recovered for recycling and the rest was discarded in landfills. On the other hand, 1.5 million tonnes of glass waste was produced in Europe due to construction activities and about 15.9 million tonnes from glass packaging industries (Hestin, et al., 2016; Eurostat, 2021).

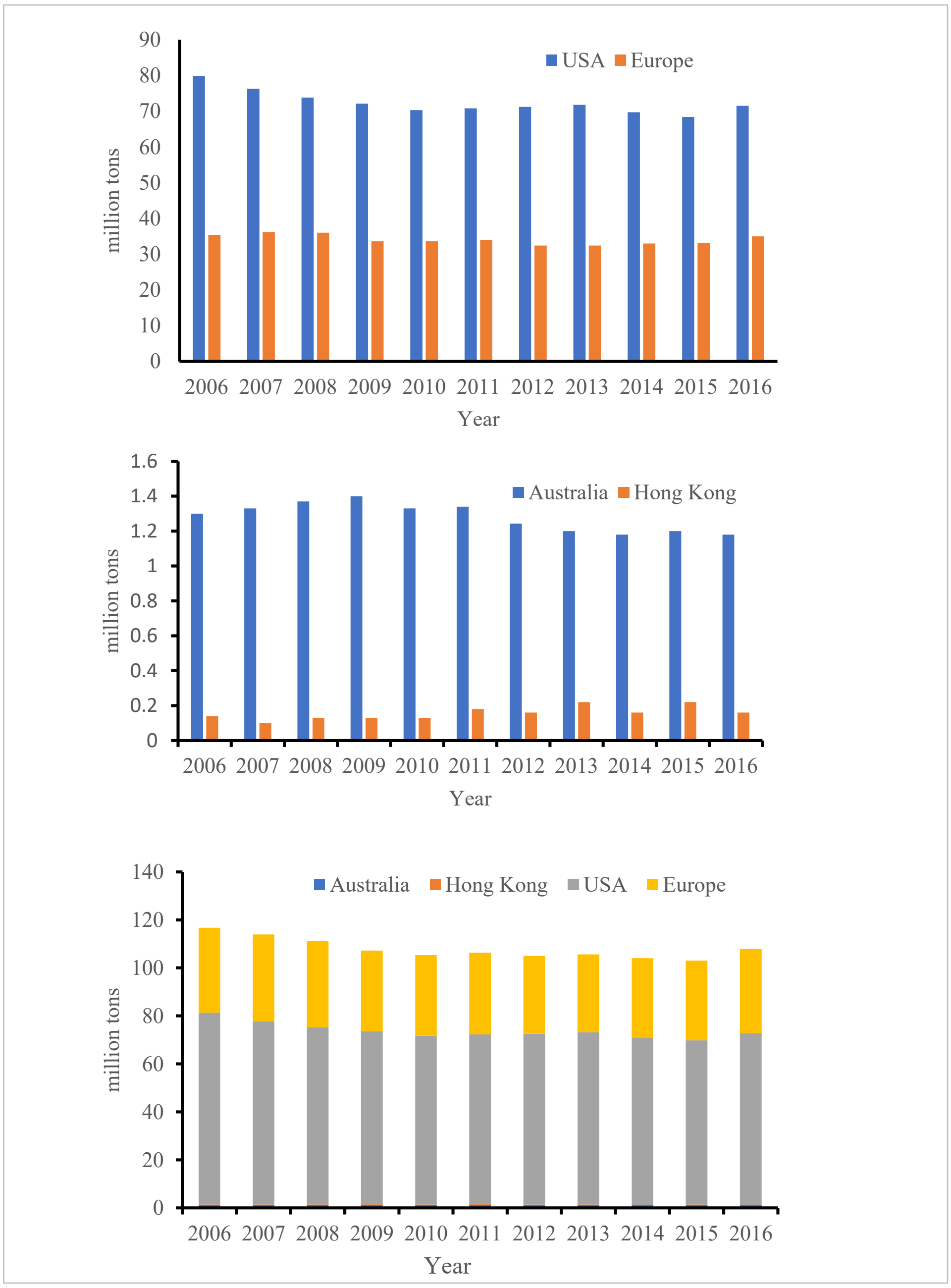

Figure 3: Glass waste generation trends

Though in Australia, an average of 1.25 million tonnes of glass waste have been produced every year it was able to stabilise the glass waste production and eventually reduce it due to its high recycling percentage which is about 57% (Pickin et al., 2021). On the other hand, Hong Kong seems to be volatile. This can also be the result of production over many years as it is one of the countries delivering the highest dollar value glass and glassware (Workman, 2021). It can also be related to its recycling rates which too were volatile ranging between 35% to 45% of the total waste generated. The combined waste generation trends for the USA, Australia Hongkong and Europe showed that the generation of glass waste indicated a downfall from 2006 up till 2010, was then steady for a couple of years until 2016 and then slightly rose (refer Figure 3).

4. DISCUSSION

4.1 UTILIZATION OF GLASS WASTE THROUGH REPURPOSING

To achieve more sustainability in the construction industry, it is crucial to preserve new or virgin natural materials and at the same time use materials which have low embodied energy. It is also essential that the work carried out produces high-quality work and with the least possible cost. When the materials are repurposed or reused, the total cost of the material is highly affected thereby affecting the lifecycle cost of the building. Since the materials have already been manufactured the cost of manufacturing is reduced to nil when the materials are repurposed and may form a small portion of its initial manufacturing cost when they are reused. These costs generally include cleaning, repainting, or repairing the material to be reused. This certainly makes reusing and repurposing more popular since they not only help in improving sustainability in the construction industry but also allow for financial incentives to the consumers by helping them save on the initial cost of materials.

If the material is highly durable and has a life of more than the life cycle of the current building, the quality of the material shouldn't cost as much. But if an extended life is expected of the material, the quality cost may be quite variable. Where some of the materials may require more cost for maintenance, others might just need a bit of repair work to be working as brand new. Quality costs can be significantly reduced provided proper planning is done regarding the implementation of the material and may thus help in saving the total cost for the material. The maintenance cost is an integral part of the total cost for any material as it is crucial to keep them working in the best possible condition. Though the cost of maintenance cannot be reduced; however, if the materials used are naturally maintenance-free due to certain properties it helps in reducing the overall cost. Repurposing materials helps in opening several possibilities in this regard. Though a material may not be naturally maintenance-free for a certain use, its repurposed use opens it to a limitless possibility due to its various characteristics.

Through repurposing new ways can be found to use glass and thus move tons of the glass waste accumulated in the landfills thereby saving space. This shall further reduce the pressure on land which can be used for other uses. The concept of repurposing can be seen in effect by using glass waste as aggregates for concrete. This not only helps in saving virgin materials but also saves costs on the whole project.

4.2 ADVANTAGES AND DISADVANTAGES OF THE REUSING OPTIONS

In this section, a brief overview of the advantages and disadvantages of the various reusing options for glass waste is presented (refer Table 3). This has been done to gain more insight into the options and help make a more efficient decision. The following table entails the information gathered through various journal articles for better understanding of reusing options and their potential.

5. CONCLUSION

This research delves deeper into glass waste generation to find out practical and achievable methods of reusing and repurposing glass waste. Through literature review, many uses of glass waste were found namely aggregate for concrete, filtration media, glass fibres, blast abrasives, roof coating, ceramic-based products, burnt bricks, low-temperature stoneware tiles, insulation as well as decorative materials. Of all the potential options, insulation, filtration media, burnt bricks and glass fibres satisfied all the four primary functions. Though all the options have great potential and bring sustainability to the construction industry, based on the findings of this study, insulation material was found to be the best material among all four due to its superior insulation quality as well as cost-efficiency. The product also offers to move large amounts of glass waste into a good quality product and like other potential options preserve virgin material for future use. The research not only provides many options for reusing and repurposing glass waste but also increases awareness regarding the amounts of glass waste generated in different parts of the world and its impact on our environment. Consequently, more and more glass waste shall be moved from the landfills, not only freeing up space but at the same time helping in reduction of carbon footprint in our environment making the construction industry more sustainable.

Table 3: Advantages and disadvantages of potential reusing option of glass waste

Material	Advantages	Disadvantages	References
Filtration Media	High porosity; Simple technology for production; Sustainable material and Method of production; Higher compressive strength at higher sintering temperatures; Improved efficiency; Cost-efficient	Requires high Firing temperatures; Low glass milling efficiency and thus Low sorption ability	(Shishkin, et al., 2021, Silva, et al., 2017)
Insulation	Production does not require High temperature; Absence of toxic gasses and chemical pollutants; Low carbon footprint; Recyclable product; Available in different sizes and colours; Both thermal and Acoustic insulation properties; Sustainable; Low conductivity; High mechanical strength		Assefi, et al., 2021)
Glass fibres	Resistance to chemical attack; Hardness; Flexibility; Strength; Low thermal conductivity; Low Density; Ability to float on water; Ultra-Light Weight	Long term performance still needs to be tested	(Silva, et al., 2017, Mohajerani, et al., 2017)
Burnt Bricks	Increased porosity and good water absorption rate of less than 20%; Increased flexural and compressive strength; High structural efficiency; Lighter in weight offering reduction in labour and transportation costs; Severe weather resistance; Sustainable and eco-friendly	Large amount of energy is required for production	(Akinyele, et al., 2020, Kazmi, et al., 2017, Hasan, et al., 2021, Al-Fakih, et al., 2019)

This research shall help the stakeholders in the construction industry to decide which reuse of glass is the best value for them according to the scope of their project and at the same time encourage them to use waste glass in their construction projects. The government can also use the research to find the best reuse of glass waste sitting in the landfills and thus control the problem of waste management as well as free up space accumulated with glass waste. Though much insightful information has been gathered, some limitations were faced while conducting this research. The research only analyses secondary data to come up with potential reusing and repurposing options. The concept of repurposing would have drawn more alternative potential options had there been a chance of collecting primary data through interviews and questionnaires. Further research can be carried out on different primary functions for use of glass waste in order to determine the best use of glass waste for different scopes for different projects thereby making it easier for the stakeholder to make a decision on how they can incorporate the use of glass waste for saving resources and at the same time providing a high-quality product. Research regarding the comparison of glass waste to other waste generated in the construction such as concrete, roof tiles, packaging, mortar, sand-lime bricks and elements, piles and stone tablets could also benefit the future study.

6. REFERENCES

Akinyele, J., Igba, U., Ayorinde, T. and Jimoh, P., 2020. Structural efficiency of burnt clay bricks containing waste crushed glass and polypropylene granules. *Case Studies in Construction Materials,* 13, p. e00404.

Akrani, G., 2021. What is product quality? definition meaning importance. [Online]. Available from: https://kalyan-city.blogspot.com/2013/05/what-is-product-quality-definition.html. [Accessed 5 May 2021].

Al-Fakih, A., Mohammed, B.S., Liew, M.S. and Nikbakht, E., 2019. Incorporation of waste materials in the manufacture of masonry bricks: An update review. *Journal of Building Engineering,* 21**,** pp. 37-54.

Andrews, L., Higgins, A., Andrews, M.W. and Lalor, J.G., 2012. Classic grounded theory to analyse secondary data: Reality and reflections. *Grounded Theory Review,* 11(1), pp. 12-24.

Assefi, M., Maroufi, S., Mansuri, I. and Sahajwalla, V., 2021. High strength glass foams recycled from LCD waste screens for insulation application. *Journal of Cleaner Production,* 280**,** p. 124311.

Banton, C., 2021. *Mass Production* [Online]. Available from: https://www.investopedia.com/terms/m/mass-production.asp#:~:text=Mass%20production%20is%20the%20manufacturing%20of%20large%20quantities,production%20of%20a%20large%20number%20of%20similar%20products. [Accessed 5 May 2021].

EPA, U., 2015. Advancing sustainable materials management: 2014 fact sheet. [Online]. Available from: https://www.epa.gov/sites/default/files/2016-11/documents/2014_smmfactsheet_508.pdf. [Accessed 25 May 2021].

EUROSTAT., 2021. *Packaging waste statistics* [Online]. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Packaging_waste_statistics [Accessed 16 May 2021].

Glass, H. O., 2021. *History of glass* [Online]. Available from: http://www.historyofglass.com/ [Accessed 15 May 2021].

Gol, F., Yilmaz, A., Kacar, E., Simsek, S., Sarıtas, Z. G., Ture, C., Arslan, M., Bekmezci, M., Burhan, H. and Sen, F., 2021. Reuse of Glass Waste in the Manufacture of Ceramic Tableware Glazes. *Ceramics International*, 47(15), pp.21061-21068.

Gualtieri, M. L., Mugoni, C., Guandalini, S., Cattini, A., Mazzini, D., Alboni, C. and Siligardi, C., 2018. Glass recycling in the production of low-temperature stoneware tiles. *Journal of Cleaner Production,* 197**,** pp. 1531-1539.

Hasan, M.R., Siddika, A., Akanda, M.P.A. and Islam, M.R., 2021. Effects of waste glass addition on the physical and mechanical properties of brick. I*nnovative Infrastructure Solutions,* 6(1), pp. 1-13.

Hestin, M., De Veron, S. and Burgos, S., 2016. Economic study on recycling of building glass in Europe. *Deloitte. Viitattu,* 20**,** pp. 1-141.

International Energy Agency., 2020. *Buildings: A source of enormous untapped efficiency potential* [Online]. Available: https://www.iea.org/topics/buildings [Accessed August 24 2021].

Jani, Y. and Hogland, W., 2014. Waste glass in the production of cement and concrete - A review. *Journal of Environmental Chemical Engineering,* 2(3), pp. 1767-1775.

Jeong, T.U., Chu, K.H., Kim, S.J., Lee, J., Chae, K.J. and Hwang, M.H., 2019. Evaluation of foam-glass media in a high-rate filtration process for the removal of particulate matter containing phosphorus in municipal wastewater. *Journal of Environmental Management* 239**,** pp. 159-166.

Kazmi, S.M., Abbas, S., Nehdi, M.L., Saleem, M.A. and Munir, M., 2017. Feasibility of using waste glass sludge in production of eco-friendly clay bricks. *Journal of Materials in Civil Engineering,* 29**,** pp. 04017056.

Khan, M.N.N., Saha, A.K. and Sarker, P.K., 2020. Reuse of waste glass as a supplementary binder and aggregate for sustainable cement-based construction materials: A review. *Journal of Building Engineering*, 28, p. 101052.

Kim, I.S., Choi, S. . and Yang, E.I., 2018. Evaluation of durability of concrete substituted heavyweight waste glass as fine aggregate. *Construction and Building Materials,* 184**,** pp. 269-277.

Lu, M. and Lai, J., 2020. Review on carbon emissions of commercial buildings. *Renewable and Sustainable Energy Reviews*, 119**,** p. 109545.

Mangla, B., 2021. *What is manufacturing feasibility?* [Online]. Available from: https://www.linkedin.com/pulse/what-manufacturing-feasibility-bhavya-mangla/ [Accessed 5 May 2021].

Mohajerani, A., Vajna, J., Cheung, T.H.H., Kurmus, H., Arulrajah, A. and Horpibulsuk, S., 2017. Practical recycling applications of crushed waste glass in construction materials: A review. *Construction Building Materials,* 156, pp. 443-467.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P. and Stewart, L. A., 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews,* 4(1)**,** pp. 1-9.

International Energy Agency., 2020. *Buildings: A source of enormous untapped efficiency potential* [Online]. Available from: https://www.vba.vic.gov.au/about/data [Accessed 31 March 2021].

Ofori, G., 2000. Greening the construction supply chain in Singapore. *European Journal of Purchasing and Supply Management*, 6(3-4), pp. 195-206.

Pegoretti, A., Fambri, L., Zappini, G. and Bianchetti, M.J.B., 2002. Finite element analysis of a glass fibre reinforced composite endodontic post. *Biomaterials,* 23**,** pp. 2667-2682.

Pickin, J., Randell, P., Trinh, J. and Grant, B., 2021. *National waste report 2018* [Online]. Available from: https://www.environment.gov.au/system/files/resources/7381c1de-31d0-429b-912c-91a6dbc83af7/files/national-waste-report-2018.pdf [Accessed 18 April 2021].

Polley, C., Cramer, S.M. and Cruz, R.V.D.L., 1998. Potential for using waste glass in Portland cement concrete. *Journal of materials in Civil Engineering,* 10**,** pp. 210-219.

Rose, C., 2019. *Systems for reuse, repurposing and upcycling of existing building components.* UCL (University College London).

Saraswathy, R., James, J., Pandian, P.K., Sriram, G., Sundar, J., Kumar, G.S. and Kumar, A.S., 2019. Valorization of crushed glass as a potential replacement for sand in cement stabilized fly ash bricks. *Civil Environmental Engineering,* 15(1), pp. 48-57.

Schweizer, M.L. and Nair, R., 2017. A practical guide to systematic literature reviews and meta-analyses in infection prevention: Planning, challenges, and execution. *American Journal of Infection Control,* 45(11)**,** pp. 1292-1294.

Seidler, M., 2020. *Sink or SWiM? When and how to use narrative synthesis in lieu of meta-analysis* [Online]. Available from: https://usblog.gradeworkinggroup.org/2020/05/sink-or-swim-when-and-how-to-use.html#:~:text=Whereas%20a%20meta-analysis%20is%20useful%20in%20that%20it,and%20the%20potential%20moderators%20that%20define%20these%20relationships. [Accessed 21 April 2021].

Shafi, S., Navik, R., Ding, X. and Zhao, Y., 2019. Improved heat insulation and mechanical properties of silica aerogel/glass fiber composite by impregnating silica gel. *Journal of Non-Crystalline Solids,* 503**,** pp. 78-83.

Shishkin, A., Aguedal, H., Goel, G., Peculevica, J., Newport, D. and Ozolins, J., 2021. Influence of waste glass in the foaming process of open cell porous ceramic as filtration media for industrial wastewater. *Journal of Cleaner Production,* 282**,** p. 124546.

Silva, R., De Brito, J., Lye, C. and Dhir, R., 2017. The role of glass waste in the production of ceramic-based products and other applications: A review. *Journal of Cleaner Production,* 167**,** pp. 346-364.

Smith, A.K., Ayanian, J.Z., Covinsky, K.E., Landon, B.E., Mccarthy, E.P., Wee, C.C. and Steinman, M.A., 2011. Conducting high-value secondary dataset analysis: An introductory guide and resources. *Journal of General Internal Medicine,* 26**,** pp. 920-929.

Statistics Unit and Department, E. P., 2021. *Environment protection department* [Online]. Available from: https://www.wastereduction.gov.hk/en/assistancewizard/waste_red_sat.htm [Accessed 30 April 2021].

Thekacassite., 2021. *What are the advantages and disadvantages of ceramic?* [Online]. Available from: https://sites.google.com/site/thekacassite/ceramic/what-are-the-advantages-and-disadvantages-of-ceramic [Accessed 8 May 2021].

Van Niekerk, L., Weaver-Pirie, B. and Matthewson, M., 2019. Psychological interventions for endometriosis-related symptoms: a systematic review with narrative data synthesis. *Archives of Women's Mental Health,* 22(6), pp. 723-735.

Workman, D., 2021. *Top glass and glassware exports by country* [Online]. Available from: https://www.worldstopexports.com/top-glass-and-glassware-exports-by-country/ [Accessed 15 May 2021].