Library Progress International
Vol.44 No. 3, July-December 2024: P 24093-24103

Print version ISSN 0970 1052
Online version ISSN 2320 317X

Original Article

Available online at www.bpasjournals.com

Formulation of a Circular Business Model for the Construction Industry in India

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How to cite this article: Pallavi Rallan, Anish Nair, Tarun Bansal (2024). Formulation of a Circular Business Model for the Construction Industry in India. *Library Progress International,* 44(3), 24093-24103.

Abstract

The construction sector in India is expected to reach a $1.4 trillion by 2025 according to the report by Mordor Intelligence. This growth is supported by a major boost from new investments, growing population as well as the policies and schemes of the Indian Government such as Make in India, Smart Cities mission, and Pradhan Mantri Awas Yojna. But, with the growth in the sector there comes a huge underlying disadvantage i.e. the pollution the sector generates. The linear model of the industry i.e. "take, make, and waste" utilizes a ton of non-renewable resources to manufacture Portland cement concrete (PCC), the raw material used in the construction, leading to adverse effects on the environment with the waste and carbon emissions produced. Therefore, the literature was investigated by the researchers to identify the impediments to the long-term sustainability in the Indian construction industry. Considering the concept of a circular economy which rests on the premise that Earth operates as a circular or closed system with limited resources. The research paper aims to formulate a circular business model which overcomes the shortcomings of the linear model. This is done by adopting geopolymer concrete as the main material for construction rather than PCC which is made using waste materials from construction & demolition wastes (CDWs) as well as waste materials of other industries and can also be recycled. Thus, reducing the amount of waste generated by the businesses as well as promoting circularity in the overall economy by utilizing waste generated by other sectors. This also has an additional benefit of releasing significantly less carbon compared to the production of PCC. Lastly, the paper adapts a framework of a circular business model canvas to highlight the key features of the findings.

Keywords: Circular Economy, Circular Business Model, India, Construction Industry, Sustainability, Geopolymer

1. Introduction

Construction is referred to as an economic activity that involves the whole process from producing raw material to manufacturing materials and components to making design and project management (Pheng and Hou, 2019). Currently, the market size of construction industry in India is $639 Billion and is growing at an exponential rate with its value estimated to reach $1.4 trillion till 2025 (Mordor Intelligence). In India, the gross value added from the industry has reached 9% in year 2023. The compounded annual growth rate of construction industry was 6% since past five years and expected to increase to 8% soon (Statista Research Department, 2024). The growth of the construction industry is vital for a country's gross domestic product (GDP), capital formation and employment (Hillebrandt, 2000). Currently, the sector is the second largest employer and sixth largest recipient of FDIs in India (Loganathan, Srinath, Kumaraswamy, Kalidindi, and Varghese, 2017). Population density and new investments are some major factors contributing to the boom of the industry. The Indian government has allowed 100% foreign direct investment in infrastructure and real estate projects (Harris, 2011) as well as the planning commission of India has proposed an investment of around US$ 1 trillion for the period 2012-2018, doubled since the last plan (Invest India Scheme). The population of India is expected to beat China till 2050

and reach a massive amount of approx. 1.7 billion (UN population bureau, 2012). Schemes such as 'Make in India' and 'Smart Cities mission' are expected to give a further boost to the industry.

It is expected that the construction industry in India will continue to grow at an unprecedented rate and the construction sector will become the 3rd largest market in the next 2-3 years. According to the Investment India Scheme, an estimated 600 million people are likely to live in the urban areas by the year 2030, creating a demand for 25 million additional units in housing, commercial, industrial and infrastructure sectors (Make in India, 2014). Many schemes such as Smart City Mission will be crucial for the development of the sector by improving the quality of life for residents presently and in the future (India Smart Cities Challenge, 2016). The government of India is also heavily focusing on the sector, which can also be seen by the 33% increase in investment in construction sector in the Union budget.

'The Make in India' scheme was launched in September 2014 with the aim to increase India's economy. As a result, the construction industry is expected to grow even more. The scheme focuses on major driving forces, including infrastructure. The government plans to partner with industry sector to boost its working. The concept of smart cities mission is to adapt technology in states to leverage greater efficiency and sustainability. Since the industry will be getting a major boost, there is a major need for sustainable business models.

While an economy benefits greatly due to the development in this industry, there are several problems associated with the boom in the construction industry. The construction sector utilizes many non-renewable materials which leads to a few environmental issues. The sector contributes to one-sixth of the total gas emissions in the country (World Resources Institute, 2023). The construction industry currently is one of the most polluting industries in the world because the sector accounts for 35% of global carbon emissions, generates around 55% of landfill waste (Ahmed, Majava and Aaltonen, 2023). In addition, the construction sector emits about 30% of greenhouse gases with its associated activities included and 18% of which is caused by transportation and processing of raw material (Zea Escamilla et al., 2016). Furthermore, the linear business model of this industry believes in extracting virgin raw materials at a pace so fast that they cannot be replenished. If this pace keeps up, then the global waste generation is expected to rise to 75% by the year 2050 (European Investment Bank). Additionally, non-renewable resources are a major ingredient in this industry, which has a major impact on the environment. The current use of material resources combined with population growth will likely result in the scarcity of certain materials, such as steel and copper, which are widely used in the construction sector (Rios and Grau, 2019).

Analysing the adverse effects of the linear business model of construction industry, it becomes important to keep sustainability in mind. Sustainability means measures taken to meet the needs of present and future generations. Therefore, the concept of circular economy has emerged to counteract these adverse effects. It is believed that circular economy has the potential to tackle the above issues to an extent.

As the construction industry is a major contributor to environmental problems, there is a need to include environmental impact as one of the success criteria in construction projects to ensure sustainable development (Aarseth et al., 2017; Eriksson and Westerberg, 2011). Hence, circular model can be used for the construction sector. The successful implementation of circular economy is highly dependent on the business model of the organization. This paper develops a business model in the construction industry that can help in fostering sustainability.

2. Literature Review

2.1. Business Model

Business models (BMs) are considered the base of any business/organization. BM can be defined as the network of interconnected and independent activities that shape the working of any organization (Foss and Saebi, 2017). The concept of business models has emerged from previous research in the field of strategy on concepts like business idea and theory of business (Normann, 1975; Normann, 2001; Porter, 1998; Drucker, 1979; Drucker, 1994). The right choice of interconnected activities determines the performance of an organization. A suitable business model helps to create value by exploitation of opportunities by designing the content, structure and governance of transactions (Amit & Zott, 2001). A study analysed that business models influence both the firm performance and first mover advantage (Markides & Sosa, 2013). To conclude, business models provide stability, build the foundation, and help organizations gain first mover advantage, all of which ultimately results in exponential success of organizations.

2.2. Linear Business Model in the Construction Industry

Over the years the construction industry has followed the linear model of business i.e. 'take, make, waste.' Many businesses conventionally use this model, where products are purchased, used and ultimately thrown away. It does not take into consideration the recycling or reuse of the materials. The linear model of the construction industry relates to adverse pollution causing environmental degradation. The construction industry produces 35% of waste to landfill (Ghaffar et al., 2020) and consumes 32% of natural resources (Purchase et al., 2022). According to the linear model, acquiring raw materials is an important activity and most of the hazards are caused by concrete and steel (Gervasio and Dimova, 2018). This model is obsolete and will lead to overloading of earth's vital resources (Antikainen and Valkokari, 2016).

Thus, focus to apply this model should be related to raw material and waste generation, mainly from demolition activities (Gorecki, 2019). This switch from the current linear model will not only bring savings of hundreds of billions of USD dollars but also reduce the overall negative impact (Lewandowski, 2016).

2.3. Circular Business Model

Since 1990, many definitions of circular business model have been formed and studied. Different researchers have highlighted various principles of circular business models as seen in Figure 1, but the most relevant is 'waste does not exist' (Ogunmakinde et al., 2021). The basic explanation is that the business activity should not cause any wastage or environmental pollution. (Jama & Kapoor, 2022) adopted the circular business model in the Indian fashion industry because of the adverse effects the industry has on the environment, the paper concluded that to achieve the goal of long-term sustainability in the fashion industry, the circular business model will play a key role. Circular business model in the fashion industry focuses on longer product life, reuse of materials and disposing correctly the finished products in the fashion industry. The model primarily focuses on using materials that will help in extending the use of product and can be reused and recycled in the future. Following the model materials such as nylon and polyester are being adopted as they can be recovered and recycled, hence reducing the pollution in the fashion sector (Murray and Jackson, 2022). After procuring these are utilized by deploying upcycling techniques.

Figure 1: Principles of circular business models

Principle	Source
Increasing the productivity of materials by doing the same or more with less	Fuller (1973), Hawken *et al*. (1999), Lund (1955), Stahel (2010), Womack *et al*. (1990)
Eliminating waste by defining materials as either technical or biological nutrients enabling them to be within closed material loops; 'waste as food'	EMF (2013a, 2013b), Lyle (1994), McDonough and Braungart (2002)
Maintaining or increasing the value of materials, environmentally and economically	EMF (2013a, 2013b), Weizsäcker *et al*. (1997)
Thinking in systems by studying the flows of material and energy through industrialised systems, understanding the links, how they influence each other and the consequences, enabling closed-loop processes where waste serves as an input	Graedel and Allenby (1995), Meadows and Wright (2008), Pauli (2010)

Source: Adams et al., 2016

Throughout the years, the industry neither focused on circular economy (CE) nor on applying newer models to maintain high residual values (Afshari and Gorecki, 2019). Therefore, to bridge this gap, this paper intends to apply circular economy model in the construction sector to reduce the environmental hazards associated with the linear model and proposes newer materials that can be used in production. Applying circular economy model can be considered revolutionary in this industry given the abundance of untapped natural resource reservoirs.

As the old linear model is criticized and novel models are studied, the concept of sustainability is gaining prominence. Sustainability is defined as development that meets the requirements of present while also saving for the future generations. Figure 1 alludes how the circular economy can be applied in the construction industry to achieve sustainability. However, since sustainability is not solely adequate for the growth of a business, this paper explores another concept of Triple Bottom Line (TBL), which was coined by Elkington in 1997. The term states economic, social and environmental dimensions as three main drivers of a business. TBL places equal significance on all these three dimensions to achieve balance and coherence in business activities (Elkington, 1997; Epstein, 2008; Harmon et al., 2009; Russell et al., 2009; Savitz & Weber, 2006). This research paper, thus, analyses the process and plan to implement circular business model in the construction industry in India.

3. Research Problem

The research problem for this article has been defined as the formulation of a circular business model for the construction industry in India.

4. Research Methodology

This article utilises an Exploratory research design as the objective is to formulate a novel business model by

exploring and studying the literature available on the subject. Articles have been extracted from databases such as Ebsco, Proquest, and Google Scholar etc. and the extant literature available on the topic has been studied in order to formulate a business model for the Indian construction industry which overcomes the shortcomings of the traditional linear model.

5. Discussion

The study by Jang et al., 2019point to the importance of formulating a design for the business strategy and product in advance. Therefore, the researchers conceptualise a business model and product design for the construction industry which is done with circularity as the focus. There exist a lot of different ways to design for a circular economy and two general methods are slowing loops or closing resource loops. Slowing resource loops refers to the extension of the life and utilisation period of a product which results in the slowdown of the flow of resources while closing resource loops refers to the closure between post-use and production of a product by utilisation of recycling leading to a circular flow of resources. In this study the design has been made to close loops (Wells & Seitz, 2005) and both micro as well as macro strategies have been utilised. Further, Industrial Symbiosis has been chosen as the main strategy under closed loop business model strategy while disassembly and reassembly (Bocken et al., 2016) has been chosen as the main strategy for Product design. All these strategies are crafted while keeping in consideration the Value Retention Options (ROs) which was a framework proposed by (Reike et al., 2018). ROs have been applied to the Traditional Linear model to transform it and craft a Circular Business Model from it. The traditional business model usually consists of 'take, make and waste' and for the Construction Industry it can be divided into 4 phases which has been adapted from (Maury-Ramírez et al., 2022). The first stage including extraction of raw materials and their processing which leads to rapid depletion of natural resources like limestone and the release of copious amounts of carbon emissions. This stage is followed by the construction of the project which results in a lot of noise, particulate matter and gases along with heavy consumption of water and embodied energy. The next phase is about the use and operation of the buildings/infrastructure which could stand to benefit from better management of solid waste as well as efficient use of water and energy. The last stage talks about the end of the lifecycle of a project where the main activity is demolition of the building/infrastructure and leads to the generation of a lot of CDW. The demolition or partial demolition process is also more damaging to the environment than the construction itself. These limitations point to the requirement for an alternative approach. Therefore, in order to make the business model more sustainable, the researchers have proposed a circular business model. The key features of the business model have been mapped out the with the help of a business model canvas, the framework for which was highlighted in (Jayakodi et al., 2024).

Figure 2: Circular Business Model Canvas

<table>
<tr><td colspan="3">Problem/Challenge: Environmental Damage from Linear Construction Business Model</td><td colspan="4">Solution: Circular Construction Business Model</td></tr>
<tr><td>Key Stakeholders: Consumers, Employees, Shareholders, Suppliers, Clients, Governments/Municipal Corporations</td><td>Key Resources: Waste materials for Geopolymer Concrete such as Fly Ash, CDW, Brick waste, etc.</td><td>Key Activities: Processing Materials, collecting CDWs, transport of materials, etc.</td><td>Client Relationship: Form vision for the product as well as of the collective process with the clients.</td><td>Value Added Circular Economy Services: Extending the life of certain type of construction products.</td><td>Value Chain Partner Segments: Thermal Power Companies, Industries, technology partners, etc.</td><td>Communication and Collaboration: Digital networks, ESG reports, LCA reports, GRI report, Carbon accounting, etc.</td></tr>
<tr><td colspan="3">Circular Cost Structure: Machinery, Raw Materials, Labour, transportation, etc.</td><td colspan="4">Circular Revenue Stream: Sale of buildings, plants, railway sleeps, sewer pipes, roads, etc.</td></tr>
<tr><td colspan="2">Technology Adoption: Industry 4.0 technology integration such as IoT, 3D printing, BIM, etc.</td><td colspan="2">Circular Economy Research and Innovation: Innovation in further development and efficiency boost of geopolymer concrete production and technology.</td><td colspan="3">Circular Design and Construction Methods: Closed Loop Business Model design, disassembly and reassembly product design, Value Retention Options integrated.</td></tr>
<tr><td colspan="7">External Adoption Factors: Favourable Government Initiatives, Increased Economic growth in the industry, higher relevance of ESG and Green Business practices, Technology Advancements in 3D printing, etc.</td></tr>
</table>

Source: Author's Primary Analysis

Problem: The main issue faced by the linear model currently followed in the construction industry is the huge strain which it puts on the natural resources while emitting a lot of carbon and sending a lot of waste to landfills. This issue becomes bigger and bigger as the industry in India is growing at a fast pace in recent years and will continue to do so in the years to come because it is in essential for the growth of India as a country therefore, there is a need to mitigate its negative effects while still letting the industry grow.

Solution: This business model aims to contribute to mitigating this problem by applying a Circular Economy based business model which will be a closed loop and integrate value retention options to add circularity in all 4 phases of the traditional linear business model followed by the Indian construction industry.

Key Resources: The primary issue in the construction industry begins with the raw materials, as constitute the main sources of environmental degradation. The PCC (Portland Cement Concrete) is recognised as the most important raw material, and it is also related with many environmental concerns. For usability, PCC is melted at high temperatures with fossil fuels, leading to their degradation. In addition to this degradation, high amounts of carbon is released during the process. Therefore, the paper intends to use Geopolymer Concrete (GPC), the substitute of PCC.

The geopolymer concrete (GPC) has various benefits as compared to the normal concrete. The research concludes that GPC has lower global warming potential by 26-45% (Stengel, Reger and Heinz, 2011). Geopolymer uses waste materials, reducing the cost significantly while also providing high durability and mechanical characteristics. All of this helps in cost reduction and waste recycling. Using geopolymers as a OPC substitute can also reduce the overall CO2 footprint compared to traditional concrete. Moreover, GPCs can be a great step to achieve the CE as the material can be recycled and reused to offer a sustainable solution. The utilisation of Geopolymer concrete instead of Portland Cement Concrete is a big transformation which leads to a lot of sustainable outcomes, it reduces the amount of initial embodied energy that is consumed in the construction process (Jamieson et al., 2015). The benefits also include reduce of strain on natural resources such as limestone which is the main material for cement production. Additionally, the waste that would normally go to landfills such as Brick waste (Pasupathy et al., 2023), Concrete Demolition Waste (Vásquez et al., 2016), sewage sludge ash (Smol et al., 2015), etc. also gets utilised in the production of geopolymer concrete.

Key Stakeholders: Some of the main stakeholders would be employees who would share the vision of the founders and work towards the success of the organisation along with advancements in their own career and providing benefit to society; the customers who come to the organisation for a sustainable form of construction; the investors who would be interested in investing in green companies while constructing a ESG themed portfolio, etc. Other important partnerships would also be required to obtain the waste materials for making Geopolymer concrete such as from other Industries, Thermal power Companies, Construction Companies, etc

which produce that type of waste. For example, a primarily fly ash based geopolymer concrete would benefit from having partnerships with Thermal power companies which produce fly ash in bulk. Construction and Demolition Waste (CDW) based Geopolymer concrete would benefit from partnerships with other construction companies while Bayer liquor based Geopolymer concrete would benefit from partnerships with companies that refine alumina from bauxite. Similarly, other types of partnerships would be required based on which type of geopolymer is being utilised. Technology Providers are also essential since 3D printing machines would be required to 3D print the geopolymer concrete. Cultivating a partnership with the government or local municipalities would prove to be beneficial as well since participation in the various programs of the government which were stated earlier are a tremendous opportunity to capitalise on.

Client Relationships and Value Chain Partner Segments: A review by Hossain et al., (2020) stated that a couple of the main challenges faced when implementing Circular Economy in the Construction Industry are 'Collaborations among actors' and 'Knowledge among stakeholders'. The researchers have clubbed client relationships and value chain partner segments together because of both issues can be tackled utilising the collaboration tool implemented by Leising et al., 2018 which provides a framework with 5 phases of the project cycle, starting at preparation and vision development and ending at Usage and preparation for next use. Essentially, it recommends alternative strategies and thinking systems compared to traditional processes from the inception of the project cycle till the end and therefore suggests the involvement of clients and the organisation to come together and create a vision for both the product as well as the collective process rather than just discussing specified requirements for building a project. Another recommendation was the utilisation of Building Integrated Modelling (BIM) in the third phase of 'process design and collaboration' which would provide technical support in the collaboration within the organisation and with the suppliers.

Communication and Collaboration: This section deals with communication of the company's vision, mission and direction to the customers as well as the targets, progress and reports to the shareholders. The communication to consumers can take place through the company's website and advertisements on social media utilising digital channels and avoiding waste of materials with things like banners, posters, etc. Shareholders would need empirical evidence for the direction and claims of the organisation with respect to sustainability therefore tools such as Lifecycle Assessment (LCA) can be used to calculate and report the presence of circularity in the business model as well as other forms of ESG and greenhouse gas reporting such as GRI, etc. which would help invoke confidence in the investors about the organisations claims and believe it to be not just greenwashing, aiding in their decision to invest in the company if they support green construction.

Circular Economy Research and Innovation: There needs to be extensive research carried out to find more efficient ways to produce geopolymer concrete to save time and reduce its cost of production since the cost is significantly higher than Portland cement concrete and one of the main barriers to the application of this business model. Additionally, research can also be directed towards utilising more forms of waste in the production of geopolymer as the business scales more and starts to run short of materials like fly ash.

Circular Design and Construction Methods: This section talks about the way that the business model has been designed. This business model is one which is designed to close resource loops since tertiary recycling has been utilised and the waste from its end product as well as waste from the end products of other industries has been used for another process of production while the construction products of the business have been adapted using a disassembly and reassembly design. The following value retention options have also been applied which creates Medium Long Loops:

(a) Refurbish- refers to when a large multi-component product maintains its overall structure, while many components are repaired or replaced. In this case, the overall construction of the building, road, house etc would remain intact while parts which have cracks or other faults can be repaired or replaced by using 3D printed Geopolymer Concrete.
(b) Remanufacture- refers to disassembling or repairing a multi-component product, when necessary, through an industrial process while ensuring that the materials are brought up to par with a new product, although it may lead to a shorter life span because of using recycled components. For example, part of a road constructed could be taken apart and then the CDW could be recycled to produce Geopolymer Concrete which would be utilised to repair the road.

(c) Repurpose- refers to when discarded goods or components are adapted for another function and the material gets a new life cycle. The following can be utilised when a house, building road, etc. is demolished, the CDW from it can be utilised to produce geopolymer concrete for a different type of construction product.

All these concepts are similar in nature but essentially point different ways in which the circularity can be integrated into the business model. Most of these points transform the 'End of lifecycle' and 'Use and Operation' phases of the linear business model.

Circular cost structure: This describes the costs or expenses that are incurred to operate a model (Osterwalder, and Pigneur, 2010). These costs can be further distinguished into direct and indirect costs. The major direct costs being cost of machinery, cost of raw materials and transportation of the materials to the site. The indirect costs that can be considered are costs of marketing the building or any other construction unit for further uses by customers, and any costs of maintenance and improvements that are needed. The geopolymer concrete will be used instead of PCC, the geopolymer concrete will be procured by CDWs and waste from other industries and brought to the site for further procurement. After full wear and tear of the product, the demolition of the building will be done, and the waste will again be collected and turned to geopolymer leading to sustainability. Thus, the direct cost of the business includes procurement, processing and transportation. This helps in reducing the overall waste in the economy and tackling the negative effects of PCC attaining sustainability in the business model.

Circular revenue streams: The revenue streams represent the cash generated by the operations of the business. The geopolymer concrete can be used to produce units/projects such as railway sleeps, sewer piper (Almutairi et al., 2021), GPC can be used for repair applications of highway infrastructures (Yun & Choi, 2014) among others. Infrastructural projects such as buildings and plants can be taken up as large-scale projects. There are various ways in which CBM in the construction industry generate revenues i.e. asset sale, lending, renting and leasing of the above projects. After demolition of these assets, the waste can be utilized to help produce more geopolymer concrete for newer projects, hence creating a circular loop.

Value added circular economy services: These are the added benefits of the final product which gives competitive advantage to the organisation. With increasing awareness about sustainability, circular business model provides the perfect framework for the business as it utilizes the strategies such as reuse, recycle and remanufacture. Furthermore, the final product can be used for various other revenues such as usage fee. The model also helps in reducing the cost significantly by using the demolition waste as a component of raw material to manufacture the concrete used for construction. The geopolymer concrete further has better chemical characteristics as it is more resistant to heat and chemicals, making geopolymer concrete very durable as compared to other concretes (Karayannis & Moustakas, 2018). These advantages have proved to be crucial towards construction of industries and factories where a lot of heat and chemicals are produced.

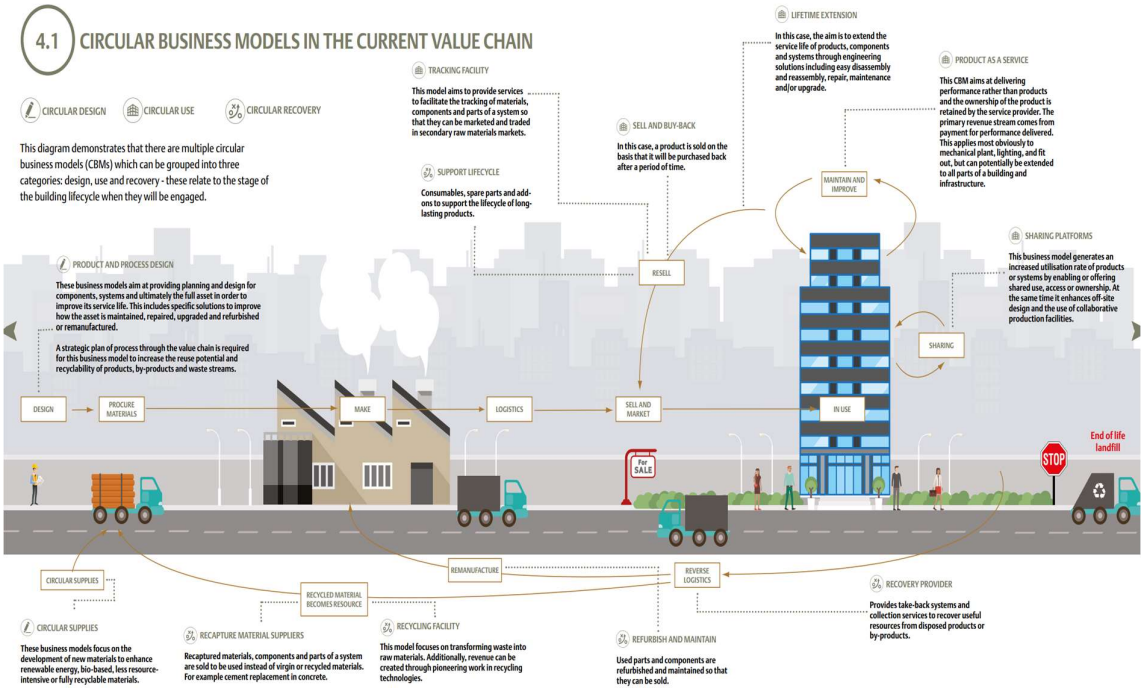
Technology adoption: It focuses on the technology adopted to achieve circularity in the business model. The technology utilized shall be complementing the business activities such as 3D Printing that allows quick and cost-efficient creation of prototypes, construction site control via IoT (Internet of Things) that provides efficiency and increased automation in the work process, building information modelling (BIM) that generates digital representation of functional characteristics, digital collaboration and smart devices for staff and other activities (Jayakodi et al., 2024).

External adoption factors: These factors are considered external factors which affect the organisation's activities. These factors can be studied through PESTLE i.e. political, economic, social, technological, legal and environmental. Under the reign of current government, many schemes and policy are construction sector focused giving it a political boost with the market size expected to reach $1.4 Trillion till 2025 (Mordor Intelligence). Analysing the economic factor, a large chuck of the union budget i.e. 33% more than the last year will be reserved for the manufacturing sector (Make in India, 2014), hence increase in the demand soon with many new projects coming up. The model will get a further boost from the social aspect due to increase in the sustainability awareness. Many companies are forced to incorporate or increase their ESG (Economic social governance) indicators. New technology is being adopted to uplift the circular businesses such as 3D printing, BIM, and IoT. Along with technology, policies such as Make in India and Smart Cities Mission are complimenting the industry. Other major policies/schemes recently launched by the government are The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) which had the objective of providing basic civic amenities while developing green spaces and promoting Urban development; Pradhan Mantri Awas

Yojana (PMAY) which aimed at addressing Urban housing shortages while providing Pakka houses with basic amenities in the rural areas; Deendayal Antyodaya Yojana-National Urban Livelihoods Mission (DAY-NULM) was launched in September 2013 and aims at providing employment as well as shelter with amenities to the urban poor households in order to reduce their poverty and vulnerabilities. All these programs looked at together point to the trend that the government is looking to increase the development of infrastructure and houses for both Urban as well as Rural areas. The Global Housing Technology Challenge (GHTC) which was launched in January 2019 and encourages Technological suppliers, researchers, start-ups, developers and academics to participate so that the most cutting-edge construction technology at minimum cost can be found and utilised in a sustainable manner. Adopting the circular model is beneficial for the environment as it helps reduce pollution from the industry substantially.

Key Activity: The key activity describes the most important activities a company must do to run the business model (Osterwalder and Pigneur, 2010). Therefore, the activities that can be considered crucial can be processing the materials, adopting relevant technologies and techniques, collecting CDWs, transporting the materials and construction of the project. The various key activities can be seen in Figure 3. Another major step in the process is collecting and processing the CDWs for further processing geopolymer concrete.

Figure 3: Key Activities



Source: https://circulareconomy.europa.eu/platform/sites/default/files/knowledge_-_circular_business-models-for_the_environment.pdf

6. Conclusion and Recommendations

This paper aims to formulate a business model based on the concept of circularity to overcome the limitations of the linear business model in the construction industry which is responsible for the disposal of a lot of waste to landfills as well as release of a lot of carbon emissions. Studying the literature, geopolymer concrete was found as an exemplary substitute to the PCC which could mitigate the negative impact of construction. It was also found that geopolymer can be made from waste generated by other industries which made it ideal to promote circularity in the wider economy of India. Further, research was conducted to study the applications of geopolymer concrete in the market and 3D printed geopolymer concrete was found among the results which can be adapted as the main material for constructions undertaken by the business. Studies suggest that the cost of 3D printing geopolymer is significantly higher than using PCC which would serve as a barrier to entry for a lot of businessmen and therefore further research needs to be undertaken initially with the objective to reduce the cost of production and later attain economies of scale to further decrease cost. This study identifies the different

types of costs involved in the business as well as various revenue streams and holds the opinion that the qualitative advantages outweigh the cost due to the opportunity at present in the Indian market. There is a push for sustainable construction by the government of India which can be seen by all the polices that have been highlighted in the paper and this business model capitalises on that trend. Further, the demand for sustainability by the people will only increase over the years as can be seen by the past trend of growth around the subject leading to more conscious end consumers who ultimately commission the construction.

It is crucial that partnerships need to be formed with various industries that produce the waste which is used to make geopolymer and are geographically closer to the business to reduce the cost needed to transport the waste. The researchers suggest that the entrepreneurs focus on the market share rather than the margins initially due to the opportunity to disrupt a huge market in India and later focus on turning over a profit which can be achieved in a variety of different ways, one of which could be the loss leadership strategy. The intent behind this is similar to what companies like Zomato have adopted in India.

7. Limitations

The study acknowledges the limitations that framework is theoretical in nature and therefore it cannot capture all the elements of the market. The concept of geopolymer along with the technology is in its initial stages and therefore can be risky for the businesses to adopt it. Therefore, there is a need for further exploration in the long-term sustainability of adopting this business. The framework tries to capture every aspect of the circular business model but fails to consider significant financial barriers in adoption of geopolymer instead of PCC. The regulatory framework in India is very complex and therefore can act as a hindrance in the process of adopting the circular business model. Furthermore, adoption of technologies like 3D Printing, IoT and BIM can be very technical and difficult to adopt in the Indian market.

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