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Sustainable Business Models for Sustainable Concrete – The Triple Layered Proposition

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ABSTRACT

Addressing the growing need for sustainability, novel concrete solutions become increasingly popular for mitigating the negative environmental impacts found in cement production, such as high CO_2 emissions output and raw materials overuse, providing conventional concrete products alternatives. The industry is lacking a common analytical framework for business models to clearly define sustainable concrete value streams present across economic, environmental, and social layers. Our research utilises the Triple-Layer Business Model Canvas (TL-BMC) to analyse a piloted sustainable concrete product (CIRCLE), describes its multi-layered value, and effectively provides the common framework for sustainable concrete business model adaptation. We conclude that the Triple-Layered Business Model Canvas (TL-BMC) is the most appropriate framework that enables the identification and establishment of successful business models focused on sustainable concrete.

Keywords: business models; triple-layered business model canvas; sustainability; novel concrete solutions; construction

NONMENCLATURE

Abbreviations	
BM	Business Model
BMC	Business Model Canvas
CE	Circular Economy
CIRCLE	Concrete solution dRaining for the CLimate and Environment
EoL	End of Life
FCE	Interreg France (Channel) England (FCE)
TL-BMC	Triple-Layer Business Model Canvas

1. INTRODUCTION

Concrete contributes significantly to humanity's socioeconomic progress toward its aims of expansion and wealth. Because of economic and technical constraints, materials that can replace concrete in all of its applications are not generally accessible [1]. Despite its importance in the construction of a modern and urban civilization, concrete is a major source of global CO_2 emissions produced at various stages of its supply chain. To reduce embodied emissions, sustainable concrete sees the decarbonisation of energy used for clinker production, or change/reduction of use for its various constituent elements (e.g. water, fine & coarse aggregates, admixtures etc.).

To further integrate the use of sustainable concrete in construction, the communication of business plans and ideas becomes crucial in the emerging entrepreneurial ecosystems and communities. People require the communication of formed ideas, innovations, and inventions with one another in order to develop and enhance them. Achieving this in an efficient and standardised manner is a complex process. Issues arise due to the process and areas that require responses including effective communication of concepts that eventually form a business model. Various sections of the model need to be conveyed to explain the essential horizontal coherence between elements while leaving out non-necessary detail. Forming effective business models, useful for decision-making processes [2] ultimately revolve around providing adequate information so that a debate on the idea's potential can be efficiently communicated to any interested individuals and parties.

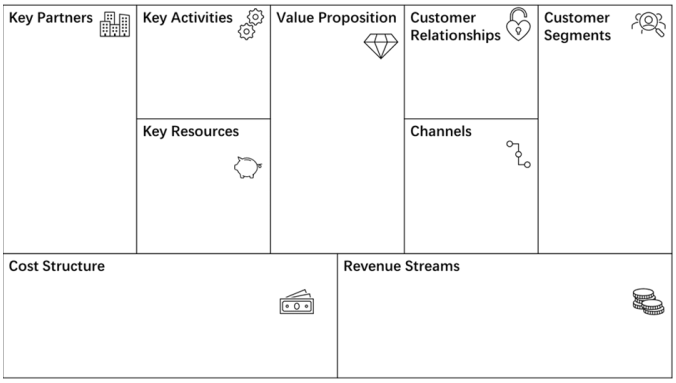

Figure 1. An illustrative example of the Business Model Canvas based on the concept of Osterwalder and Pigneur [3].

Osterwalder and Pigneur [3], providing an effective and simple business model communication to stakeholders, proposed the Business Model Canvas (BMC) model (Figure 1). BMC is made up of nine fundamental components that aim to describe the business model and its intra-model relationships in an economic context. Joyce and Paquin [4] built on the BMC methodology, by adding two additional layers with nine components for each, with the purpose of describing the environmental and social value of the assessed business or product. During the COP26, it was widely accepted by industry leaders that decarbonisation of cement production will bring competitive advantages to the forerunners, therefore it should be an organizing principle for business [5]. However, that value cannot be captured by widely adopted business models such as the BMC, which mainly aim to produce the generated monetary output. The TL-BMC as an analytical framework can capture whole business models in layers that are often neglected when focused exclusively on extracting value output in monetary terms, crucial finding value in CE offerings.

This paper aims to fit the economic, environmental, and social elements found in a sustainable concrete product offering (CIRCLE) to the TL-BMC framework and enable the description of additional existing value streams. We argue that the emphasis on traditional economic value propositions is restrictive, particularly when it comes to the effort of increasing the widescale adoption rates of sustainable concrete as carbon emissions reduction means. We conclude that the Triple-Layered Business Model Canvas (TL-BMC) is the best-fit framework for identifying and establishing viable business models based on sustainable concrete.

2. MATERIALS AND METHODS

The TL-BMC can concentrate on elements that distinguish CE practices in construction, going beyond environmental and social benefits and repercussions to emphasise essential value propositions. The social layer of the concept includes end-user application features such as local communities, workers, users, social culture, scale of outreach, and governance, all of which can act as direct and/or indirect local descriptors. The customer relationship, use phase, and channels serve as descriptors of customer interaction; either one-directional from system services given to the end-user, or bi-directional, with the end-user engaging in system operational choices. The TL-BMC features of channels, activities, resources, and distribution that may be found throughout the layers can be utilised to establish technical competence, whether as technology or customer-centric decision making. Conversely, raw material supply might be integrated into the economic and environmental layers' suppliers and outsourcing, production, materials, distribution, and resources. The social impacts and benefits of all comparative options can be combined. While the TL-BMC framework may capture the entire value that a new building material provides, the three value propositions contained in the TL-BMC layers suggest a significantly higher information input requirement. As a result, that can potentially increase model complexity.

3. RESULTS AND DISCUSSION

The CIRCLE project, which was chosen to fit the TL-BMC framework, intends to investigate unique solutions to permeable urban surfaces by using seashell waste as aggregate and delivering new concrete mixes [6]. This is a very crucial issue for sustainability in the FCE area, which is bordered by water in both nations and has established fishing and seafood processing businesses as a result. It is particularly significant since it connects sustainability to an already robust sector, allowing for circular economic development and regional economic prosperity. More crucially, the cement product has the capacity to filter contaminants in runoff water, therefore improving groundwater quality. As a result, the supply of ideal environmental conditions may benefit all downstream species, making this a genuinely sustainable invention. The current pilot project information is supplied in the following specified subsections to enable its fitting across the economic, environmental, and social layers of the chosen business model framework.

3.1 The TL-BMC Economic Layer

To initiate the analysis of the business model for sustainable concrete, the economic layer of the TL-BMC is presented in a horizontal cohesive approach (Figure 2). The value proposition is presented as the initial point of analysis and debate in this technique. Following that, the left side of the canvas is displayed and discussed, including essential partners, activities, and resources, as well as the corresponding cost structure. The economic layer study finishes with the right side of the canvas, which discusses client categories and connections, channels, and the associated income/revenue streams. This approach in describing the analysis will additionally be utilised for the remaining two layers of the TL-BMC, environmental (Figure 3) and social (Figure 4).

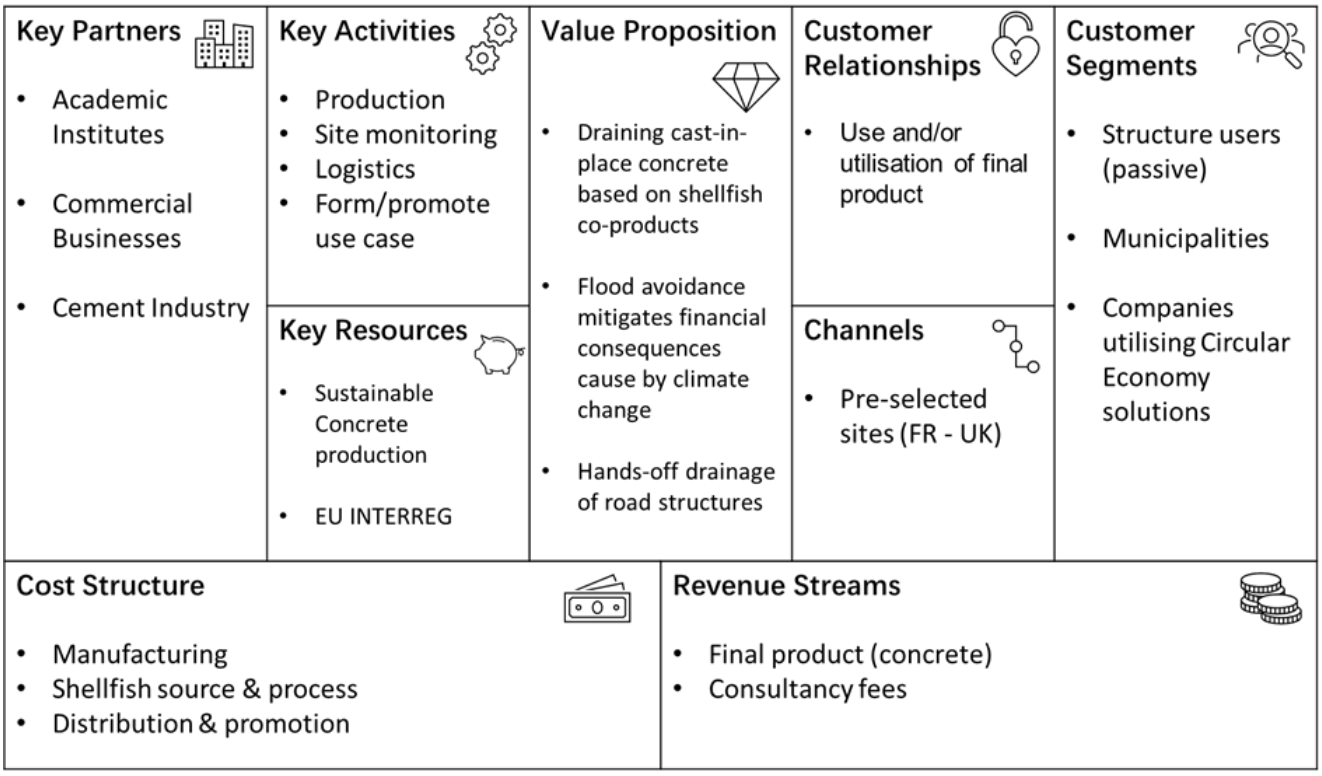

Figure 2. The economic layer of the TL-BMC, adjusted for CIRCLE and its sustainable concrete offering.

Most projects focusing on built environment materials have value propositions that span from delivering one-dimensional value to creating benefit from many streams, improving the projects' long-term economic resilience [7,8]. Furthermore, the majority of the generated monetary value provides more than one revenue source to balance costs [9]. The value proposition incorporates several unique propositions, including the finished product's drain-water concrete property, flood avoidance, and hands-off drainage of road constructions where the final product is employed. The value proposition emphasises the benefits of the final concrete product and how this reduces any associated monetary costs linked with the use phase.

The CIRCLE project is diverse in terms of key partners, with collaborations between research organisations, including academics, and private efforts, including commercial or industrial firms. This applies in its current pilot test state among academic partners, organisations with administrative divisions, and interested commercial-industrial partners as users or in cement manufacturing. Figure 2 depicts essential project operations such as cement and subsequent concrete manufacture, monitoring of the location where the product is laid-used, and, following an evaluation, the formulation and marketing of the product use-case. The canvas's cost structure aspect describes the associated costs, such as the cement-concrete manufacturing stage, the source of shellfish, which is a significant end product property, and the product's distribution and advertising. The horizontal coherence found in the TL-BMC layer extends to the key resources required, which are sustainable concrete production and funds provided by the INTERREG FCE programme, to finance any associated costs and enable the partners to execute the project and realise the full research, applicability, and, ultimately, commercialisation potential.

The right side of the canvas (Figure 2) takes a straightforward approach to establishing revenue streams through horizontal consistency. Because of the properties of the final product, which do not allow, by default, applications that extends further than other products on the market, that technique employs a simplified description. However, there is some variation due to novel traits that are currently being piloted and tested. As a result, the TL-BMC customer segment includes end-users who use the product passively, such as on the road or pavement, municipalities who are willing to test and/or pay for the final product, and companies active in the built environment space who want to use or test circular economy solutions. That property extends to the customer relationship, identifying customers who are willing to use or employ the final product. The channels are, due to the pilot-

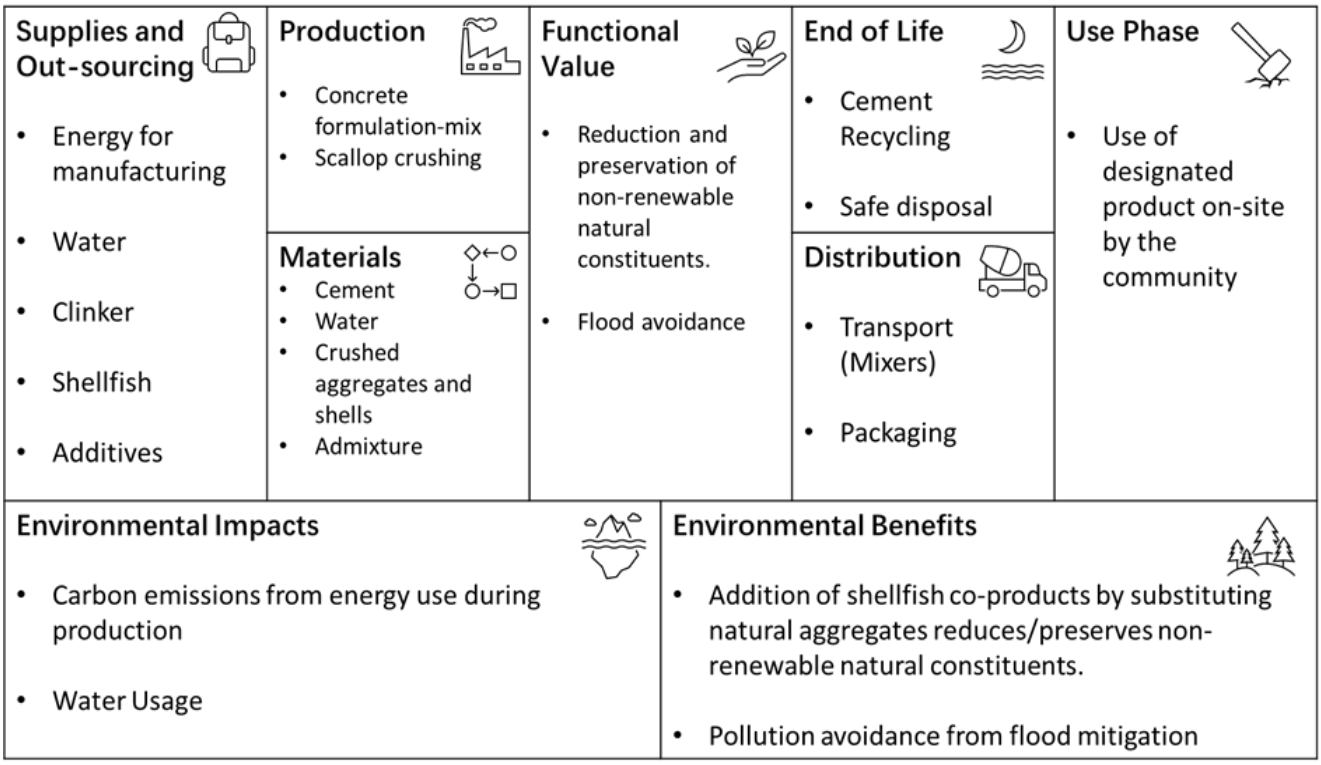

Figure 3. The environmental layer of the TL-BMC, adjusted for CIRCLE and sustainable concrete, following the concept of Joyce & Paquin [4].

stage, pre-selected sites in France and the United Kingdom. The commercial deployment seeing a customer base growth, will subject this element to change, but holding no influence on the value offer. Finally, cement-concrete sales and any fees that aim to enable or accelerate a seamless transfer to the new solution for interested clients generate revenue streams.

3.2 The TL-BMC Environmental Layer

The environmental layer includes activities such as development, operation, and decommissioning, essentially following the cement-to-concrete life cycle. The functional value involves reduced consumption and the preservation of non-renewable aggregates. It emphasises flood avoidance as a functional value option, a mitigated risk caused by climate change [10].

The supply and outsourcing component of the TL-BMC represents the provisions required to realise the project's environmental value. The element alternatives provide the essential support to begin the production process and are all critical to the final product, while the energy input can be used in a variety of ways with minimal carbon content, bolstering the case even further. In particular, sustainable concrete for CIRCLE in the supplies and outsourcing segment comprises manufacturing energy requirements, as well as core supplies for concrete production such as water, clinker, and additives. It also includes shellfish as a material that replaces non-renewable aggregates, being the enabler of the final product sustainability properties

The production element of the environmental layer defines the location where the finished product is made and sourced for further application and use by customers. This component focuses on the origin, or method of production, as well as the methods utilised to differentiate. It deviates from the materials element since it does not describe any fundamental technologies. As a result, it includes concrete manufacturing as well as any aggregate processing requirements, such as seashell crushing [6]. The materials element comprises the alternatives utilised to create the final product. The materials element focuses between the manufacturing output and the finished product, whereas supplies comprise raw materials utilised as input for production. As a result, the industrial output is a distinct material: cement. Crushed aggregates, water, and admixture are among the other materials. The environmental impacts generated, match those found in conventional cement/concrete production processing and are the result of high energy requirements and water usage in clinker production. Clinker production is an energy-intensive operation, and the energy carbon content can

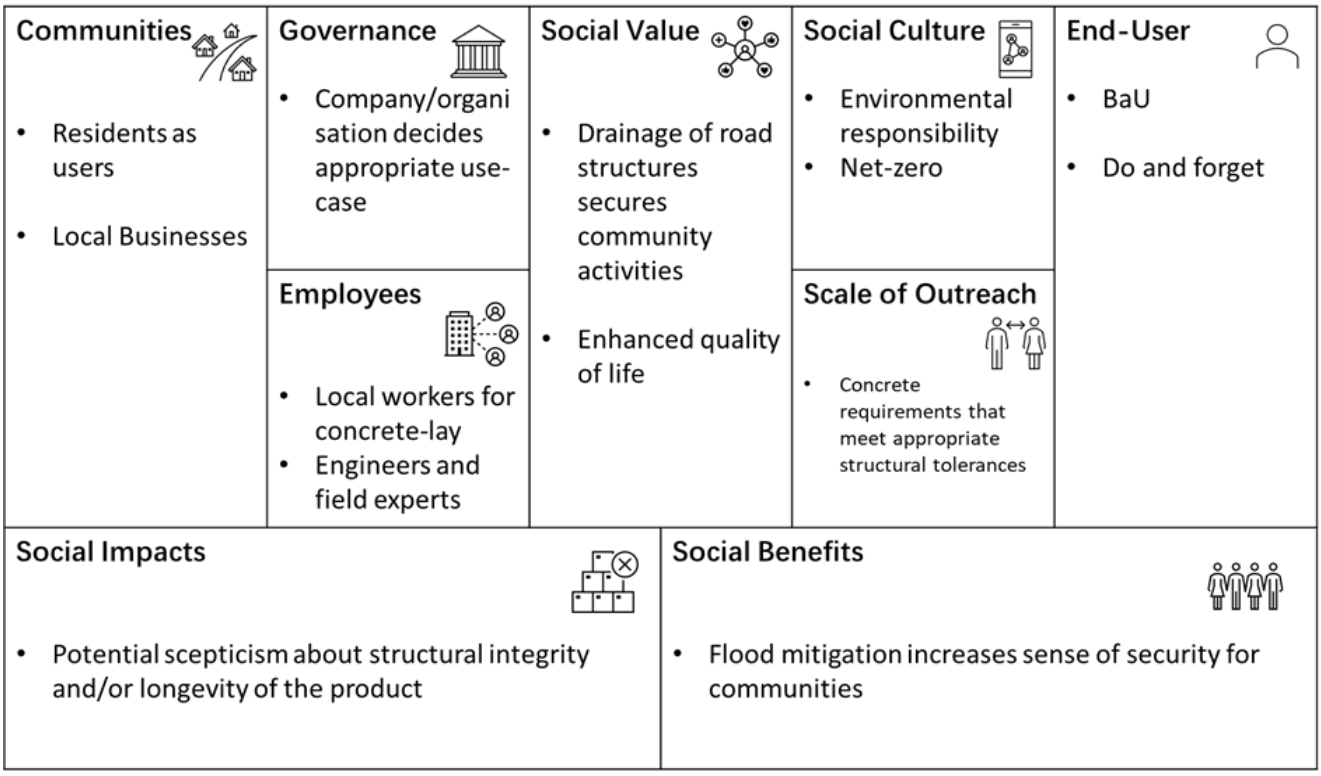

Figure 4. The social layer of the TL-BMC, adjusted for CIRCLE and sustainable concrete, following the concept of Joyce & Paquin [4]

vary greatly depending on the manufacturing site and methods employed [11–14].

The use-phase element, which is found on the right side of the environmental layer, incorporates consumer interaction, which ultimately adds to the environmental value. Because of the nature of the product, this contribution appears to be passive. If the end-users of the final concrete product, such as a pavement, a road, or other community structures, do not differentiate their behavioural patterns and continue to use the structure throughout its life expectancy, the generated environmental value becomes apparent. The sustainable concrete product was used for the same end-result and use case, reducing carbon emissions and risks. The distribution element in the context of sustainable concrete refers to the physical transport of the final product, such as that which exists between production and on-site laying. Furthermore, if a sustainable cement product is packaged and transportable, it is applicable to the category because it allows distribution, either between locations or between the producer, the retailer, and/or the end-user. We describe the End-of-Life (EoL) as equal to the concrete's use-phase life expectancy, which is approximately 70 to 75 years for building blocks [15]. EoL options include recycling the product, recovering its components for reuse in the built environment, or, if that is not possible due to logistics or structural constraints, the business model accounts for its safe disposal, emphasising the product's added functional value. Following horizontal coherence on the right side of the canvas, the element includes the added value or potential mitigation provided by the final product. The environmental benefits may overlap with the functional value, but the former is usually quantifiable. As a result, the main environmental benefits realised by the sustainable concrete solution are the substitution of non-renewable natural aggregates by shellfish and pollution avoidance through flood mitigation.

3.3 The TL-BMC Social Layer

The social value aspect of CIRCLE's sustainable cement solution is defined as both the direct use benefit provided to the community and the benefit it provides for future social development. This strategy realises both the benefits to sustainable concrete users in terms of improved quality of life through environmental hazard mitigation [16], transportation security, and uncertainty reduction at the communal and personal levels. As a result, we define the social value found in the appropriate layer of the canvas as ensuring community activities through the drainage of road structures. As previously stated, this directly results in an improved/enhanced quality of life for users.

Focusing on the social layer TL-BMC analysis starting from the left side of the canvas, the sustainable concrete

use case is location specific. The sustainable concrete use case is location specific, with a focus on the social layer TL-BMC analysis beginning on the left side of the canvas. As a result, the community element includes all stakeholders who passively use or live within the project boundaries. As a result, the element includes residents and local businesses because they are passive users of the site. The employee component can be classified as a qualitative variable rather than just the number of people on the payroll, and we investigate the workforce's origin in terms of location or skill set. Local workers for concrete mix-lay processes are required for the sustainable concrete project, as are engineers or field experts on-site or within the production and mix processes. Governance goes beyond the partnership aspect of the economic TL-BMC layer. Its purpose is to present the various types of bodies in charge of decision making in the sustainable concrete use case; in the current business model shown in Figure 4, this is the company or organisation, i.e., local administration, that decides on the appropriate use-case. The business model's social impacts component investigates societal costs from the design stage to the operational stage. We anticipate that there will be some scepticism within the community about the structural integrity or longevity of the final product proposed by CIRCLE, due to its innovative and non-mainstream nature, which has yet to be tested. However, we do not expect the social impacts to be present throughout the product's lifecycle, as continuous delivery of results as described across the three layers will mitigate the impact.

Examination on the right side of the canvas, presents the end-user defined as the benefit(s) received by the project's beneficiaries, the passive users, who are referred to as 'core customers' in the economic layer of the business model canvas. We consider passive usage to be core to the business model, as it will not affect every-day activities when at normal state, an option amplified by the mitigation of obstructions such as flooding. As a result, through the end-user lens, business-as-usual utilisation and "do and forget" following concrete lay, by nature deemed passive, are central to the end-user element. The social culture component is the attitude of the local community toward sustainable concrete, including the selection, lay-process, and use. This social layer component assesses the success of a project deployment, from its inception to its long-term operation stages. We expect the social culture to be inclusive of a “do-good” approach, showcasing environmental responsibility by the community, and the utilisation to offer the community a practical demonstration of commitment towards net-zero targets. In general, the scale of outreach aspect attempts to give the extent of the customers participating in the project, both in breadth and depth [4], in this business model though limited by the geographical restrictions defined by the product use-case. We expect the scale of outreach to be extensive, only limited by required structural tolerances applicable to the sustainable concrete specifications. In the same context between benefits and value as seen in the environmental layer, social benefits and social value are closely related. The mitigation of environmental risks posed by climate change increase the sense of security, as core to survival, and favour community growth and development [17], with the ideal outcome being part of a broader sophisticated planning based on renewable sources and materials [18]. We anticipate that the product's claimed and achieved social benefit of flood reduction will be a significant factor in value generation. Flood mitigation exists across layers and has a variety of positive effects.

4. CONCLUSIONS

The use of TL-BMC as the analytical framework for CIRCLE and its modular approach and description allows its usage as a template for establishing business models that extend in a range of sustainable concrete solutions. The chosen framework can provide a vital tool that describes value discovered in areas other than economics and perform an environmental and social layered analysis based on the modular elements that comprise each layer. The breakdown and composition of the sustainable concrete business model can expose weak project areas, hence benefiting the efficient production of pursued value streams. Considering the variety of layers in which the project is deemed relevant, the TL-BMC can therefore be the enabler for sustainable concrete successful project development, usage, and decommissioning phase, unlocking circularity [19].

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