BUSINESS MODEL CHAGES FOR SUSTAINABLE CONSTRUCTION: A SYSTEM DYNAMICS PERSPECTIVE

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INTRODUCTION

Construction industry is one of the major contributors of carbon emissions and according to the global status report for building and construction of 2021, emissions from the construction sector account for 37% of the global carbon emissions (United Nations Environmental Programme, 2021). The predominant factors that contribute to the emissions of the construction industry are raw material consumption and energy requirements during construction and operations of the built environment. The United Nations insists on a three-pronged strategy to cut down emissions from the sector, through reducing the energy demand of buildings, decarbonizing power supply and reducing the embodied carbon in buildings.

The strategy on reduction of embodied carbon of buildings through material strategies has a massive potential to reduce carbon emissions (Hertwich et al. 2020), but is in a comparatively primitive phase among the three. Although there have been substantial advancements in research and development on sustainable and low-carbon building materials and technologies, the rate of adoption of these technologies is low which in-turn leads to their decarbonization potential being highly under-utilized. This paper proposes a conceptual framework and a descriptive model to demonstrate the role of business model change and institutional change towards higher adoption of sustainable building technologies and construction practices.

SUSTAINABLE CONSTRUCTION

Sustainable buildings or sustainable construction is a prominent approach to decarbonize the built environment. Researchers highlight that ‘sustainability’ and ‘construction’ are both highly complex concepts and combining these terms further magnifies the complexity (Du Plessis, 2007). According to the International Council for research and innovation in building construction, sustainable construction is defined as ‘the sustainable production, use, maintenance, demolition and reuse of buildings or constructions or their components’ (CIB,

2004). The different facets of sustainable construction include economic sustainability, functional sustainability, environmental sustainability and social & human sustainability (CIB Agenda 21, 1999). Green buildings, eco-friendly buildings, zero-energy buildings, high performance buildings, etc. are some of the other frequently used terms in practice to refer to the different aspects of sustainable buildings and there are significant differences between each of these.

To simplify the complexity associated with the term and to define the scope of our work, 'sustainable construction' in this paper refers to the adoption of building technologies and construction practices that are environmentally friendly and resource efficient along with consideration for the economic aspects such as cost-effectiveness, scalability of the technology, thus referring only to the production phase of a building in its life-cycle.

THE PROBLEM: WHAT RESISTS SUSTAINABLE CONSTRUCTION?

In response to the global need to shift to a more sustainable built environment, there has been different lines of fragmented efforts by stakeholders such as development of sustainable building technologies and innovation, regulatory mechanisms to promote sustainable buildings, independent bodies promoting awareness among professionals and public, etc. While the technological push and regulatory factors contribute to increased awareness and demand for sustainable construction among the clients, the business organizations in the construction sector respond to these by complying with the regulations, exploring new market opportunities associated with the technological innovations and regulations and extending their capabilities to exploit the opportunities. Since both the efforts to decarbonize and their responses remain highly fragmented, despite the technological push and regulatory pull factors, sustainable building technologies and construction practices fail to diffuse at a larger scale.

Academic literature describes several barriers to adoption of sustainable building technologies such as immature supply-chain of sustainable products, knowledge gaps, lack of skilled professionals at various levels, weak innovation culture of the industry, lack of demand from clients, etc. Also, these factors correspond to different groups of stakeholders across the value chain such as manufacturers, developers, builders & contractors, consultants and clients. Each stakeholder's business is intricately connected to one another, thus forming vicious loops which are difficult to break as shown in Figure 1.

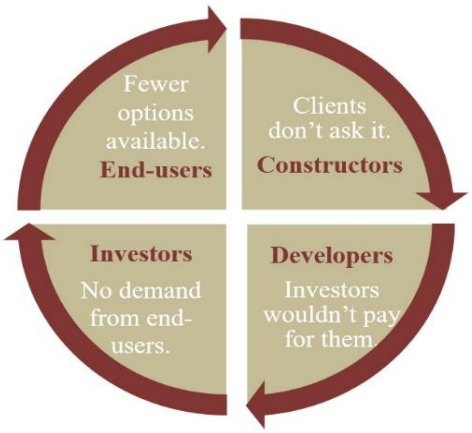

Figure 1: Vicious circle of blame (Cadman, 2000)

In order to efficiently contribute to the agenda of sustainable built environment, each of the stakeholder's business practices would require significant changes from that of their current practices. The business model changes of an organization would not only affect their own business, but also that of the other connected stakeholders. But, a comprehensive understanding of the dynamics among the stakeholders is unexplored in the literature.

The objective of this paper is 1) To propose a conceptual framework that highlights the role of business model changes and institutional changes towards sustainability 2) To present and discuss a descriptive model of the business dynamics involving institutional elements among the key-stakeholders in the construction industry in the context of undertaking sustainable construction utilizing causal loop diagrams from a system dynamics perspective. The findings of the paper are based on practice review from secondary data sources, review of academic literature and few preliminary discussions from construction practitioners implementing sustainable construction.

KEY FINDINGS

THE CONCEPTUAL FRAMEWORK: THE ROLE OF SUSTAINABLE BUSINESS MODELS & INSTITUTIONS

It is often witnessed that great technological innovations paradoxically fail, in terms of its ability to penetrate into the market and to be commercially successful, and this could be attributed to lack of attention to business models (Teece, 2010). Some of the aforementioned challenges to sustainable building technologies could be navigated and adoption could be better

fostered through business model changes of organizations or designing innovative business models (Ludeke, 2018). Sustainable business models or business cases for sustainability is relevant in this context; they are about integrating environmental or social activities into the core business of the firm and economic success is achieved through, not just along with, environmental or social activities (Schaltegger, 2006).

Although business model changes can be argued as a better strategy to enable higher adoption of sustainable construction, the existing structures and inherent practices in the industry (also called the institutions) highly resist the business model changes (Leudeke et al, 2018, Collins, 2010). As the major impediments to sustainable construction are deep-rooted industrial practices that are inherent to change, significant institutional change would be required for higher scale of adoption of sustainable building technologies. Stubbs & Cocklins (2008) highlight the significance of internal structural and cultural changes within the organization and collaboration among organizations that were required to create sustainable business models.

Utilizing the theoretical building blocks from the concepts of business models and institutional change, we propose a conceptual framework with an underlying idea that institutional changes and business model changes have a prominent potential to contribute to overall sustainability of the built environment and the construction sector. Also, institutional changes are essential for business model changes and business model changes drive institutional changes, forming a virtuous cycle. The conceptual framework is derived from understanding from the academic literature as presented in Figure 2a and the simplified form of the same framework is presented in Figure 2b.

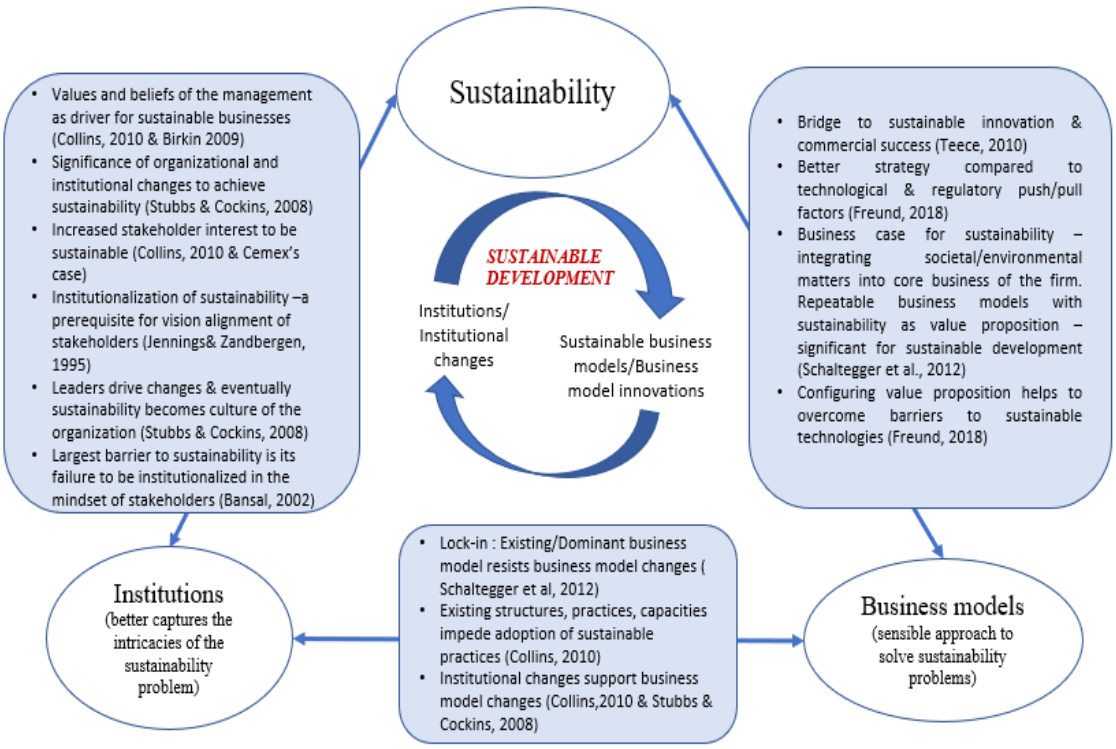

Figure 2a: Interconnectedness between sustainability, institutions and business models

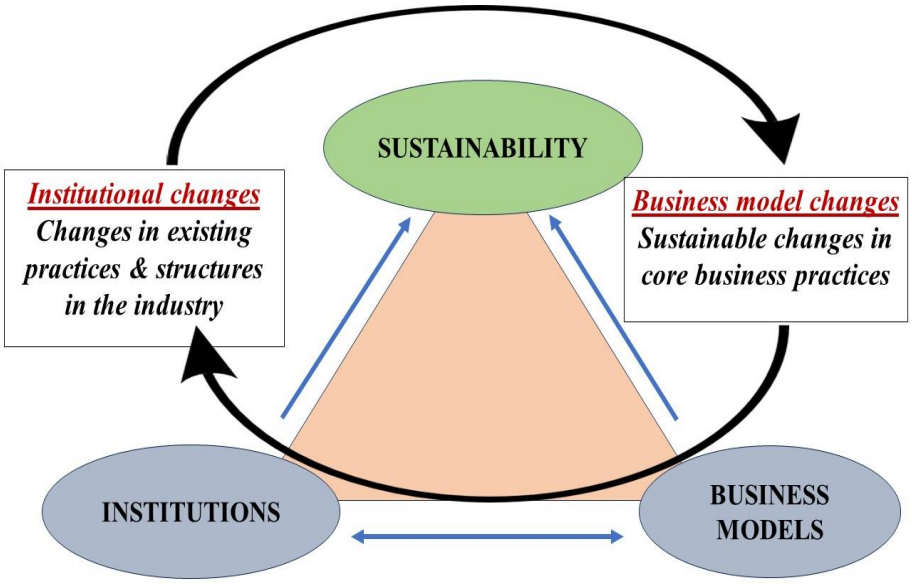

Figure 2: Role of business model changes and institutional changes towards sustainability

THE SYSTEMS FRAMEWORK

A descriptive system dynamics-based model has been arrived utilizing empirical understanding from the academic literature, secondary sources of data, and a few preliminary discussions

from construction practitioners implementing sustainable construction. The model considers five different groups of key-stakeholders involved in any construction project- manufacturers, clients/developers, builders & contractors, service providers (such as architects, consultants) and end-users. Each stakeholder is influenced (supported/resisted) by multiple institutional elements to adopt sustainable construction and these factors form the reinforcing and balancing loops within the system.

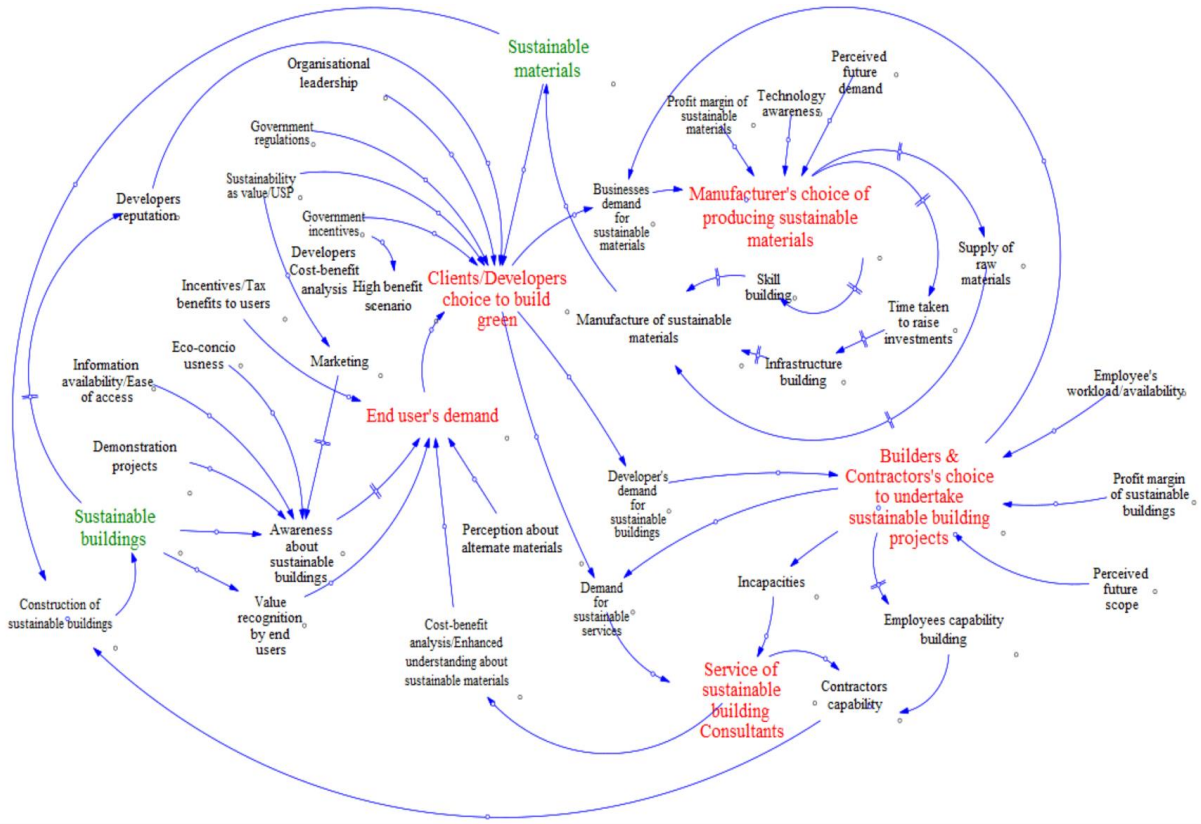

Figure 3: Business model changes for sustainable construction

For example, Eco-consciousness → Increased awareness → Increased demand from end-users → Developer' choice to build green → Builders undertaking sustainable projects → Demand for sustainable materials → Increased production & consumption → Increased rate of sustainable construction is a positive reinforcing loop in the causal loop diagram presented in Fig. 3. This loop demonstrates the role of cognitive elements of end users such as eco-consciousness, awareness leads to higher demand eventually leading to higher rate of construction of sustainable buildings. Low-profit margin (compared to conventional materials) → Decrease in manufacturer's choice to produce sustainable materials → Decreased production → Decreased rate of sustainable construction is a negative reinforcing loop that

demonstrates how the normative institutional elements such as profit margin resists stakeholders to undertake sustainable construction. The causal loop diagram contributes to enhancing our understanding on the institutional elements that significantly influence each of the stakeholders and to map the intricacies in the interconnectedness between the key-stakeholder's businesses in their shift towards sustainable construction.

CONCLUSION & FUTURE WORK

The proposed conceptual framework encompassing the role of business models and institutions towards sustainable construction and the descriptive model on institutional elements influencing construction organizations to adopt sustainable construction in this paper have been arrived from thorough review of the academic literature and inputs from secondary data. The framework and the descriptive model would contribute as a base to our future qualitative study through semi-structured interviews of business stakeholders to investigate the business model changes construction organizations are attempting towards sustainability and to understand how existing institutions support or resist these business model changes. Further improvisation of the framework through inputs from qualitative studies would lead to a more robust simulation-based model that could help design and validate efficient strategies for different stakeholder groups for enhancing the agenda of sustainable built environment.

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