How to Expedite the Process of Circular Built Environment in Toronto: A Systemic Approach

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Abstract

This research addresses the pressing need to reduce global emissions by 55% by 2030, as determined by recent UN evaluations, in response to the rapid temperature increase over the past five decades. The Paris Agreement was ratified with the aim of reducing global warming to below 2°C over pre-industrial levels. Toronto is striving to become a circular city through the implementation of circular economy strategies and initiatives. The aim of this research project is to gain a deeper understanding of the current state of the circular-built environment in Toronto and identify the barriers and enablers to transitioning towards circular practices. The study identifies the primary stakeholders in the built environment using the Actors Map and describes their roles and transformations, highlighting the obstacles and challenges to circularity as well as mapping them against circular strategies, approaches, and best practices. The researcher also maps circular strategies against the key stakeholders, identifies trends using STEEP-V analysis and the Three Horizons (3H) approach to examine the relationships between changes and innovations required to reach desired future outcomes. The study reveals gaps in the existing system and recommends the emergence of an abundance of trends that cover the entire range of circular practices, including those that have not yet been addressed, to bridge the divide between Toronto's circular vision and current progress.

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Section 1: Introduction

The world economy uses a record 100 billion tonnes of materials each year to provide for the needs of the planet's 8 billion people in terms of housing, food, transportation, and clothing (Circle Economy, 2023). The amount of material extracted and used is predicted to double by 2050 compared to 2015 levels, endangering the collapse of Earth's life support systems, which are already near their breaking point (UNEP (United Nations Environment Programme), 2017). Until now, natural resource utilisation and consumption have followed a linear approach, known as the take-make-use-dispose model, where materials are sourced, used, and finally disposed of as waste producing negative externalities that include rising carbon emissions, increased pressures on landfill, unsustainable levels of water extraction and widespread ecosystem pollution (Arup, 2016). Hence, in the absence of material management strategies that keep us within planetary limitations, the UN has warned that simultaneous climate change disasters, economic vulnerabilities, political instabilities, and ecosystem failures will result in a "total societal collapse" (UNDRR, 2022). Therefore, the need for change is increasingly evident.

1.1 A Need for Change

Climate change and environmental restoration are top priorities for countries and cities around the world. The damaging consequences of rising temperatures and the increased frequency of extreme weather events are impacting social, economic, and environmental systems. Cities generate around 70% of global carbon emissions, account for over 60% of resource use (United Nations, 2023) and produce 50% of global waste (Romano, n.d.). The consequences, however, go far beyond emissions. The extraction and use of materials are powerful indicators of environmental harm (Steinmann et. al., 2017); for instance, it accounts for over 90% of all worldwide biodiversity loss and water stress (International Resource Panel (IRP), 2020). Five of the nine planetary boundaries—climate change, biodiversity loss, land system change, chemical pollution, and nitrogen and phosphorus cycles—that must be maintained to keep the planet healthy are currently being crossed (Circle Economy, 2023). It is obvious that while working with materials, we need equilibrium.

1.2 Circular Economy: An Opportunity for Sustainable Growth

"Adopting circular economy principles could significantly enhance global construction industry productivity, saving at least US$100bn a year."—World Economic Forum, 2016

According to a projection made by the World Bank (2022), urban regions will house approximately two-thirds of the global population by 2050. Cities will thus play a critical role in tackling the effects of climate change. By embracing extra policies and concepts like the circular economy, they may contribute to addressing the issue. The pursuit of a circular economy necessitates more efficient, and occasionally less, material used to reduce environmental stresses and create a thriving society for people (Circle Economy, 2023). A circular economy, as defined by the Ellen MacArthur Foundation (2021)—one of the front-running organisations on circular economy thinking, is *"A systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature*".

The circular economy has significant potential for global economic growth and a sustainable future. It is estimated to be a USD $4.5 trillion opportunity (ING Economics Department, 2015). The circular built environment not only results in material savings but also impacts the balance between new buildings and renovations that can be more circular and less costly. Hence, the benefits of the circular economy should be measured in terms of saved material, energy, and water costs, as well as reduced externalities and local job creation through reuse, repair, and refurbishment markets, particularly SME-driven (Thelen et al., 2018).

1.3 The Built Environment: from Linear to Circular

"In the built environment, it's all about maximising utility of resources — extending product life or providing a proper end-of-life recovery."—Nick Cliffe, Innovate UK (Zimmann et al., 2016)

The circular economy is a promising solution to achieve global sustainability targets and fulfill the goals of the Paris Agreement, especially concerning environmental concerns. The built environment sector, which utilizes almost 50% of the world's annually extracted resources and leaves a substantial environmental impact, plays a crucial role in facilitating the transition from a linear to a circular economy that is more sustainable since the greatest world user of raw materials is the engineering and construction sectors (Zimmann et al., 2016). It uses more than 3 billion tonnes of raw materials and produces 50% of the world's steel (Renz & Solas, 2016).

Only 7.2% of the world's economy is currently circular, down from 9.1% in 2018 and 8.6% in 2020, according to the Circularity Gap Report 2023 (Circle Economy, 2023). This decrease is attributed to increased material extraction and consumption. The shift to a circular economy requires businesses, government, and the public to work together and rethink not only their use of materials, products, and assets but also to redesign and adopt new business models. For this circular transition, a city needs to establish circular city functions, services, infrastructure, and tools that facilitate circular business models (Circular Cities, 2020). Such a transition entails transformative changes in all economic sectors. From an urban perspective, circularity is described in the following nine sectors (Circular Sectors, 2020): built environment, mobility, tourism, textiles, waste management and material recycling, manufacturing, consumer goods, food and biomass, and finally water and wastewater.

The built environment sector constructs and maintains the required buildings, roads, and other infrastructure. According to Assembly (2008), the term "built environment" refers to the intentional human-made physical surroundings developed using science and technology for the betterment of humanity. It is made up of a variety of man-made infrastructure systems, such as buildings, roads, bridges, railroads, etc., and utilities like water, power, and telecommunications (Crawford, 2011). The growth and operation of cities are fundamentally dependent on it. Since the built environment sector

consumes a lot of natural resources, it must fundamentally develop the systems, components, and processes it employs to reduce waste and increase efficiency, which will eventually create a vast array of opportunities for the whole supply chain (Arup, 2016).

Existing circular frameworks communicate effectively the fundamental ideas. However, they do not provide details on how we can transform from a linear built environment to a circular one. In a circular economy, buildings, for example, will be planned for their whole lifecycles, not just their final use; stakeholders will work together on cloud-based BIM (Building Information Modelling) models with analytical software that distinctly visualizes the externalities of a proposal, clients will be pushed to issue comprehensive lifetime contracts, covering everything from design through operation and dismantling, as well as to pursue their goals of earning holistic lifecycle certification and awards, thanks to policy and incentives; structures and parts are frequently leased instead of purchased; and finally tenants and landowners will pay for a service like lighting under performance-based contracts rather than specific fixtures or supplies (Zimmann et al., 2016). All components of an ecosystem will be incorporating circularity. Individual assets will be adaptable, replaceable, and highly customizable, improving users' perceptions of the environment.

1.4 The Canadian Context

As highlighted by Peter Sanguineti, Vice President at Lafarge Canada, in the virtual workshop with Globe Series: "Material innovation can drastically reduce the environmental impact that results from construction and supports the pathway to net-zero carbon"(Shorthouse, 2021c).

1.4.1 Canada: A Shift Country

The introduction of country profiles that assess countries' performance on both human development and ecological impact in the Circularity Gap Report 2020 enables us to prioritize circular solutions for each country (Wackernagel et al., 2017). The three country profiles are Build, Grow, and Shift. Canada falls under the Shift profile. According to Hickel et al. (2022), Shift countries are accountable for the majority of the material overshot and frequently have a material footprint that is two to three times higher than the global average. According to The Circularity Gap Report 2023 (Circle Economy, 2023), Shift countries, despite being home to a small fraction of the world's population, must reduce their excessive consumption of the earth's resources to maintain their luxurious and prosperous lifestyles (although disparities within these countries are prevalent). These countries consume 31% of the world's materials and produce 43% of greenhouse gas emissions.

Compared to the rest of the world, Shift countries have had a higher degree of urbanization in their history, with 50% to 80% of their population already residing in urban regions by 1950 (UN, Department of Economic and Social Affairs, Population Division, 2019). The expansion of urbanization and increasing affluence has led to a growing demand for larger living spaces outside of densely populated urban areas, resulting in an increase of the built environment in suburban and rural areas (Circle Economy, 2023). Contributing to this trend are factors such as an increase in single-person households and lower costs and greater floor space outside of urban areas (Brody, 2013). This demand for larger living spaces and rising incomes has led to a scarcity of crucial construction materials (Ortiz-Ospina, 2019). However, it is not just the materials used in construction that have an impact, but also the way in which buildings are designed and constructed, which can affect material demand during their use phase, including energy efficiency and the longevity of the building itself (Circle Economy, 2023). The current lack of circular

design and integrated planning has resulted in buildings that are significant carbon emitters and responsible for almost one-third of global energy consumption (Globalabc, 2021). The construction and demolition sector accounts for almost one-third of global material consumption and waste generation, making it one of the most impactful industries worldwide (Globalabc, 2021).

1.4.2 Canada's Built Environment

Canada's built environment is a major consumer of raw materials and energy, and it is also the leading contributor to the waste stream in terms of weight (Shorthouse, 2021b). Every year, 3.4 million tonnes of construction materials are sent to landfills in Canada, resulting in an estimated 1.8 million tonnes of embodied carbon (Racine et al., 2021). Studies indicate that increased material circulation can have a considerable impact on reducing greenhouse gas emissions (GHGs) in the construction industry. According to a report by the National Zero Waste Council, disassembling and reusing all buildings that are renovated or demolished in Canada could prevent 1.3 million tonnes of embodied carbon emissions per year (Dillon Consulting & Oakdene Hollins, 2021).

1.4.3 Circular Built Environment – Toronto City

According to Shorthouse (2021b), while circular building practices have been implemented in Canada for some time, initiatives and policies promoting sustainable construction and demolition waste management, material innovation, and lifecycle analysis have been the primary focus. This emphasis has led to decreased greenhouse gas emissions and increased material reuse. However, there has been limited attention on upstream circular strategies, such as using circular inputs and offering products as a service. Nonetheless, there is a growing interest in circular economy solutions among industry, governments, academia, and other stakeholders in Canada, indicating significant market potential (Shorthouse, 2021b). Therefore, it is reasonable to suggest that circular economy solutions could be more widely adopted to further promote sustainable development in Canada.

1.4.3.1 Toronto's Circular Vision

Before delving into the vision for a circular city presented in the Circle Economy & David Suzuki Foundation report (2021), it is important to first define what is meant by a circular city. A city that encourages the shift from a linear to a circular economy in an integrated way throughout its urban landscape through cooperation with its residents, enterprises, and academic institutions is referred to as a circular city (ICLEI Circulars, n.d.). The vision to a Circular Toronto includes:

- More efficient resource management systems
- Transformative design for the built environment
- Regenerative urban food system
- A social circular economy
- An enabling environment for emissions reduction, and
- A circular City of Toronto leading the way

The focus of the paper is on the built environment in Toronto, where the concept of transformative design for buildings is discussed. This involves designing buildings that are durable, adaptable, modular, and easy to maintain and repurpose. The construction industry in Toronto has a substantial environmental impact concerning resource extraction, energy and water use, as well as greenhouse gas emissions and waste production (Circle Economy, 2021a). According to research, Toronto's construction industry uses over 17 million tonnes of materials annually, generates 366,300 tonnes of Construction and Demolition waste, and emits 399,200 tonnes of greenhouse gas emissions during operations alone (Circle Economy, 2021a). By implementing new design principles, it is possible to minimize environmental harm by allowing buildings to be reconfigured as required, utilizing on-demand and on-site produced products and parts, transforming construction methods, and reducing storage needs. Additionally, non-toxic, locally sourced, recycled materials can be prioritized, and environmentally friendly disposal processes can be employed to repurpose or recover them.

1.4.3.2 Toronto's Current Circular State

The City of Toronto, being hubs of human activity, has a unique opportunity to take advantage of the shift towards a circular economy. It is actively working to support the transition towards a circular economy as part of its vision to become a thriving, healthy, and resilient city (Circle Economy & David Suzuki Foundation, 2021a). Over the past few years, Toronto has emerged as a leader among Canadian

cities in exploring alternatives to the traditional "take-make-dispose" linear approach and is striving to be the first municipality in Ontario to adopt a circular economy (Circle Economy & David Suzuki Foundation, 2021a). The city is working towards zero waste (City of Toronto, 2017), among other circular economy initiatives such as investment in infrastructure to turn organic waste into renewable natural gas and the development of a 'Circular Procurement Implementation Plan and Framework' (Circle Economy & David Suzuki Foundation, 2021a). The aim is to create a circular economy that promotes a resilient, inclusive, green, and prosperous future for all residents and businesses (City of Toronto, 2021a).

Community and business leadership has been identified as another factor that is providing a strong foundation for a circular transition in Toronto (Circle Economy & David Suzuki Foundation, 2021a). Toronto has a considerable number of circular initiatives driven by both the community and businesses, demonstrating a high level of awareness among civil society regarding essential circular economy issues. The involvement of businesses from various sectors, along with community engagement, suggests that the local market is open to circular economy solutions. Moreover, individuals in Toronto seem to be adopting circular and zero-waste lifestyles, indicating a growing sustainability culture (Circle Economy, 2020).

Toronto, also, is working to modernize public services and become a smart city (City of Toronto, n.d.) through digitalization, which can facilitate a circular ecosystem at the industry level by coordinating material processing and tracking material flows. The growing IT sector in Toronto has already facilitated resource sharing and waste minimization through initiatives like online resource trading platforms and applications (Circle Economy, 2020). This indicates the potential to leverage digitalization for scaling up circular business and transitioning towards a more circular economy.

The information and financial services sector can contribute to the transition to a circular economy by providing financial services and supporting circular models in various sectors. This sector operates beyond the city's boundaries and can help accelerate the transition through financing and contracting circular models (ValueC, 2017). In Toronto, where this sector is highly specialized and expected to grow, its potential contribution should be considered when developing circular economy strategies and plans (Circle Economy, 2020a).

In the end, achieving a truly circular Toronto will require the participation of all stakeholders to generate positive social, economic, and environmental outcomes for the wider community. To support this transition, the City of Toronto has launched '*Baselining for a Circular Toronto'*, a research project aimed at assessing Toronto's current level of circularity and informing future efforts to advance the goals of a circular economy.

1.5 About this Study

This study aims to examine the prospects and difficulties associated with developing a more circular built environment in Toronto. The main objective is to expedite and optimize the circularity process while also assessing the current state of the circular built environment in Canada. The analysis will take into consideration global trends and the principles and practices of circular economy to determine which maturing, emerging, and weak trends must be considered when applying the circular strategies recommended by the Delphi Group study in 2021 (Shorthouse, 2021b), and how can the gap be closed. The intention is to raise awareness of the circular approach and to identify the many challenges, enablers, and opportunities available in making the circular economy a reality across the built environment as we examine the stakeholders' engagement.

Achieving a circular-built environment requires a significant shift in roles and business models for stakeholders involved in this sector. However, various barriers related to culture, regulations, market, technology, and education are impeding the transition. Hence, this study will explore how the role of stakeholders is evolving as the industry moves towards a circular built environment, and what challenges they encounter.

This report brings together the insights from the research, summarized in the following sections:

- **Section 2: Research Approach** – This section provides an overview of the research approach. It outlines the research rationale, primary research question, objectives, and methodology employed in the study. Additionally, it identifies the research limitations that were constraints during the research process.
- **Section 3: Stakeholders Engagement** – This section discusses the key stakeholders involved in the linear built environment using the Actors Map and their changing roles in transitioning to a

circular built environment. It identifies barriers to this transition and enablers to overcome them. The section maps circular business models against stakeholders to support the implementation of circular practices in the Canadian built environment.

- **Section 4: Understanding Toronto's Built Environment** – Using STEEP-V analysis and Three Horizons approach, the researcher analyzed trends related to transitioning to a circular built environment in Toronto. Mapping these trends against recommended circular strategies revealed gaps that need to be addressed to optimize the transition.
- **Section 5: Recommendations and Future Works** – This section concludes the research by summarizing the findings, presenting recommendations, and outlining the next steps for further development.

Section 2: Research Approach

2.1 Rationale

The most recent UN assessment states that emissions must be reduced by 55% by 2030 because temperatures have risen more rapidly during the 1970s than they have in the previous 2000 years (United Nations Environment Programme, 2021; IPCC, 2021). The Paris Agreement, a worldwide framework for tackling climate change, was ratified at COP21 in 2015, with the aim of reducing global warming to well below 2°C and ideally to 1.5°C over pre-industrial levels (Arup et al., 2022).

That said, Toronto is working towards becoming a circular city. In order to do so, the City is developing strategies and programs (i.e. establishing a Circular Economy Working Group), engaging in multiple networks (i.e. the National Zero Waste Council (NZWC) and the global Circular Economy 100 (CE100) network created by the Ellen MacArthur Foundation) and establishing various circular economy initiatives (i.e. formalization of a city-focused extended producer responsibility policy, investment in infrastructure to turn organic waste into renewable natural gas, development of a 'Circular Procurement Implementation Plan and Framework', etc.) (*Working Towards a Circular Economy*, 2022). The City of Toronto has completed the "Baselining for a Circular Toronto" study. It is one of the first of its kind in Canada, establishing a current context for circularity at the city-wide scale and studying consumption and disposal in key sectors through material flow analysis. The study has proposed an inspiring vision, potential goals and indicators that can steer a path toward a Circular Toronto. Now, the City of Toronto intends to engage the community to verify its vision, gather fresh concepts and possibilities, and join forces to create a Circular Economy Road Map for Toronto which will not only guide the municipal government's course but also inspire change in other sectors of the economy (Greenwalt, 2021).

This Major Research Project (MRP) aims to develop a deeper systemic understanding of the current built environment in Toronto. The project navigates through the current state of the circular-built environment landscape and market readiness in Toronto in line with global construction trends, Toronto Net Zero Strategy, and circular economy principles and practices. To create a circular built environment in Toronto, we must first understand what is not circular in the current situation. In 2021, a study on *'Circular Economy & The Built Environment Sector in Canada'* suggested circular strategies for the built environment and construction sector. After two years of study, how can we **expedite circularity** in Toronto's built environment?

2.2 Primary Research Question

What are the **current barriers** that interdict the changing role of key stakeholders in implementing circular economy strategies, approaches, and best practices for the built environment, and what trends need to stay and/or emerge to **expedite circularity** in Toronto's built environment?

2.3 Objectives

The main aim is to expedite the circularity process in the built environment. The following objectives are the focus of this research:

- **Objective #1:** Understand the current system.
- **Objective #2:** Identify the key stakeholders in the circular built environment and map them against the recommended circular economy strategies, approaches, and best practices for the Canadian built environment by the Delphi Group study in 2021 (Shorthouse, 2021b).
- **Objective #3:** Analyze global trends in key sectors and identify the emerging trends that are required to support the implementation of circular economy strategies
- **Objective #4:** Identify recommendations that accelerate the shift towards circularity.

2.4 Methodology

> *Problem with Problem-Solving: "From a very early age, we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price." Peter Senge, The Fifth Discipline*

This research project utilized a 'systems thinking' approach, in line with the circular economy's systemic solution framework, to develop a comprehensive understanding of Toronto's built environment.

According to Meadows (2008), a system is a group of interconnected components that work together within a particular environment to achieve the system's objectives. Systems thinking, as noted by Hodgson and Sharpe (2012), enables us to grasp the underlying structure of potential future scenarios and the nature of sudden changes over time. It considers the entire system, including the interplay between processes, people, products, and services, and how they collectively impact the system's overall behavior.

The study employed a mixed-methods approach, involving primary research, literature review, stakeholder mapping, and analysis of global trends, to investigate how to expedite circularity in Toronto's built environment. The research process used the actors map tool to identify key stakeholders involved in the linear built environment and analyzed their roles to determine how they would change during the transition to a circular built environment. The study also identified the barriers and enablers of this transition and mapped circular business models against stakeholders to support the implementation of circular practices in the Canadian built environment.

By utilizing the STEEP-V analysis, the researcher systematically examined global trends in crucial sectors like construction, urban planning, and transportation. In addition, the Three Horizons approach was employed to distinguish the trends that should be retained and the emerging trends necessary for the effective execution of circular strategies. This approach aided in identifying the path that stakeholders must pursue to facilitate the transition in their roles, thereby accelerating the implementation of circularity in Toronto's built environment.

Overall, this methodology employed a combination of desk research, stakeholder engagement, global trend analysis, and future scenario planning to gain a comprehensive understanding of the gaps in implementing circular economy strategies in the built environment. The study aimed to re-define stakeholder roles and remove barriers to expedite the transition towards a circular built environment.

2.5 Research Limitation

The design thinking methodology is characterized by its collaborative and multidisciplinary nature, requiring active participation from various parties. Nonetheless, this research project had certain limitations due to the researcher working alone and time constraints in conducting the research. Finally, the circular economy is an extensive and all-encompassing approach, and this research study centered on only one aspect in one sector.

Section 3: Stakeholders Engagement

The built environment assets, such as buildings, roads, and other infrastructure, are designed and constructed to last for a long time. However, their long lifecycles make them subject to interactions and collaborations between multiple stakeholders with diverse interests and incentives. This can result in difficulties in maintaining control and ownership of the assets (Zimmann et al., 2016). Moreover, the designers and architects who develop these assets are not usually held accountable for the consequences of their operation or end-of-life. For example, the environmental impact of the construction and demolition of buildings is often not attributed to the designers and architects responsible for their creation. To apply circular economy principles to the built environment, it is crucial to create industry-specific frameworks and rules, claims the Zimmann et al. research (2016). These guidelines should focus on creating a unified vision and plan for all stakeholders involved in the value chain, including designers, builders, operators, and users of the assets. By collaborating effectively and reconciling the differing and potentially clashing components of built environment initiatives, stakeholders can benefit both individually and as part of the broader industry. Overall, a joint effort is necessary to establish circular economy principles in the built environment and to achieve sustainable and resilient infrastructure.

3.1 Stakeholders in the Linear Built Environment

> *"In traditional building projects, working intensively with suppliers is not common practice for architects. In a more circular economy suppliers and architects will need to share responsibilities." Peter van Assche - Architect, bureau SLA (Thelen et al., 2018)*

In the built environment, numerous stakeholders are involved, each with respective but interconnected roles and interests. As the built environment shifts from a linear to a circular one, the stakeholders and their roles will also change. The first step is identifying the key stakeholders involved in the current built

environment in Toronto. Then, the Actors Map tool is used to represent the key participants involved in the system, such as organizations, individuals, and other agents (human and non-human). The tool maps out the relationships between these stakeholders, their power, and knowledge levels as well as establishes the system's boundaries. A critical aspect of the research is to identify the relationships between these key stakeholders and their connections to the issues of concern or outcomes in the system. Table 3.1.1 explains the roles of the key stakeholders in the linear built environment, adapted from Thelen et al. (2018).

Key Stakeholders	**Roles in the Built Environment**
Architects, Advisors, and Engineers	They plan, design, calculate, and evaluate the construction of structures in line with a predetermined budget and design requirements.
Building Companies	Individual and multi-unit building projects are constructed under the supervision of a general or building contractor.
Deconstruction or Demolition Companies	Buildings are brought down by demolition contractors, who also separate bulk trash streams of low value. Demolition contractors, however, tear down a structure while carefully preserving valuable components for future use.
Developers	Buildings can be built, renovated, or redeveloped by developers. They view a building as a temporary asset. The objective is to make a profit. To execute the design, construction, maintenance, and demolition, they contract other companies.
Facility Managers	The management of facilities is accountable for the efficient functioning of a building. They oversee the contracting of services such as lighting, IT facilities, utilities, and waste management.
Financial Institutions and Banks	Financial institutions and banks play a crucial role in driving the economy by utilizing evaluation and risk models to maximize profits across their portfolio. They support the building sector by providing investments, loans, and other traditional financial banking products.
Owners	A building owner considers their property an asset in both the short and long term and aims to ensure its maximum value and operating profit. Maintenance decisions are based on profitability. In some cases, the owner may also be the user of the building and take on the role of developer.
Real Estate Investors	Investors assess the real estate market to create wealth over the long term. Sustainability factors are considered in long-term investments, such as those made by pension funds. However, there is often little focus on sustainable aspects in the short term, and sustainable considerations are typically not integrated into risk management systems.
Regulators and Legislators	Regulators utilize legislation and policy to safeguard users, citizens, companies, and employees from unfair and negative impacts. Regulation and legislation are based on risk assessments. Regulators use various measures to influence the market while maintaining a linear built environment, such as taxing labor instead of physical resources.

Specialized Construction and Installation Companies	These companies specialize in selling and installing products for new construction and renovation projects. They are also responsible for maintenance and replacement activities during the operational phase of the building.
Suppliers and Vendors	A supplier is an entity that provides goods such as raw materials, building materials, or products, or services. Unlike a contractor or subcontractor, a supplier usually does not add specialized input to the final product or service. In a linear economy, the general contractor is typically responsible for purchasing most of the materials, primarily driven by cost considerations, leaving limited room for improvement or customization. Changes to the construction plans or documents can result in planning or capital risks.
Users	Users perceive a building as an object that serves a spatial purpose or function. The price of an asset is related to the demands and requirements of the client.
Waste Treatment Companies	Companies specializing in waste treatment collect several types of waste, which they partially recycle, incinerate for energy recovery, or dispose of in landfills. In addition to waste resulting from building demolition, these companies also collect other types of waste, such as paper or household waste.
Wholesale	Distributors and similar organizations purchase massive quantities of goods from various producers or vendors and then sell them to traders and end clients. However, there is limited awareness regarding the sustainability performance of these bulk goods due to insufficient reporting and inadequate transparency across the entire supply chain.

Table 3.1.1: Role of the Stakeholders in the Linear Built Environment (Thelen et al., 2018)

Following the identification and definition of the key stakeholders involved in the current built environment, the Actors Map is used to classify the stakeholders based on their level of knowledge and power. Figure 3.1.1 is an Actors Map of the linear built environment, which maps out stakeholders across four quadrants based on their level of knowledge and power. It illustrates two types of relationships: action and impact. Action is represented by a solid line arrow, indicating that one stakeholder is directly involved in the decision-making process or implementation of a particular action. Impact is represented by a dashed line, indicating that one stakeholder is affected by the decisions or actions of another stakeholder.

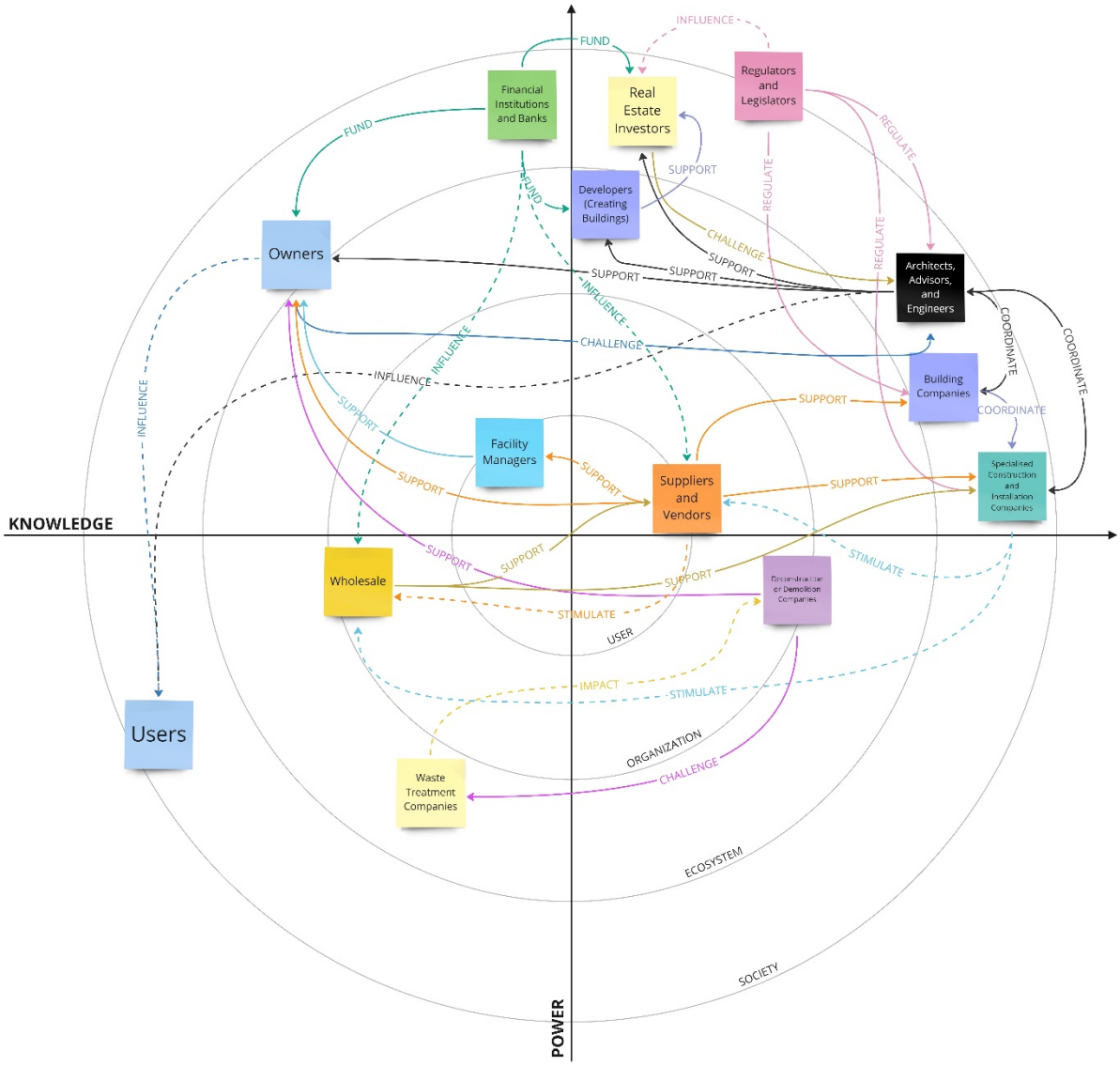

Figure 3.1.1: Actors Map of Linear Built Environment

The first quadrant is the Key Players quadrant, comprising stakeholders who wield significant power within the built environment system and have a good understanding of the issues involved. These stakeholders include regulators and legislators; architects, advisors, and engineers; building companies; suppliers and vendors; specialized construction & installation companies; real estate inventors; and finally, developers. Regulators and Legislators are agents of change who have the necessary resources, such as design, technology, and policy tools, to enact circular policies, oversee funding, and influence real estate investors. Architects, advisors, and engineers are among the most knowledgeable

stakeholders in the built environment, owing to their extensive education, daily work, and professional experience within the industry. They support Owners, Developers, and Real Estate Investors in their projects while collaborating with Building Companies and Specialized Construction & Installation Companies and influencing the Users of these spaces by their decisions. On the other hand, Building Companies and Specialized Construction & Installation Companies have less power but possess greater knowledge and receive support from Suppliers and Vendors who even have lower power and less knowledge. Finally, Real Estate Investors and Developers may be less knowledgeable, but they possess immense power and are at the heart of construction projects. Without their involvement, the projects would not exist. They are responsible for creating project budgets, determining the scope of work required to meet project requirements, identifying needs and conditions, and establishing a funding plan for designers and contractors involved (Jackson, 2020).

The Show Consideration quadrant is the second quadrant, which encompasses stakeholders who have a prominent level of interest but low influence. This quadrant includes Deconstruction or Demolition Companies, which possess a significant amount of expertise and knowledge but have limited influence on the built environment. They can be valuable supporters, especially in low-risk areas, and their input on areas of interest can be consulted. These companies work in silos in a linear built environment and support the owners while also challenging Waste Treatment Companies.

The third quadrant comprises three primary stakeholders, namely, Users, Wholesale, and Waste Treatment Companies, and is considered the quadrant of least importance. Stakeholders in this quadrant have low levels of interest and influence and are therefore not significantly powerful or invested in the project or business. Users have limited knowledge and weak power, and their behavior is influenced by what Owners, Architects, Advisors, and Engineers provide in the built environment. Waste Treatment Companies impact the performance of Deconstruction or Demolition Companies. Wholesale is the most potent stakeholder in this quadrant, whose role is influenced by the loans they secure from Financial Institutions and Banks, and they are driven by the needs of Specialized Construction and Installation Companies. However, Wholesale also supports Suppliers and Vendors as well as Specialized Construction and Installation Companies, creating a reinforcing loop with them.

The Meet Their Needs quadrant is the final quadrant, comprising stakeholders with high influence but low interest, who must have their needs met to avoid potential issues. The most significant stakeholder

in this quadrant is Owners, who receive support from most of the other stakeholders, challenge Architects, Advisors, and Engineers, and obtain funds from Financial Institutions and Banks. Facility Managers also support Owners in meeting their needs. Lastly, Financial Institutions and Banks are the second most powerful stakeholder in the linear built environment, after Regulators and Legislators, and provide financial backing to many of the involved stakeholders.

3.2 Stakeholders in the Circular Built Environment

The present state of the built environment makes it difficult to gain support for circular solutions due to various stakeholders who work in isolation and are not inclined to collaborate. Hence, to implement a circular built environment, it is necessary to bring about changes in the roles and responsibilities of these stakeholders. Many municipalities, including the City of Toronto, are leading the way in promoting a transition towards a circular economy. They are building on the circular goals set out in the Baselining for a Circular Toronto Final Report (Circle Economy & David Suzuki Foundation, 2021a) and using policy instruments, such as creating regulatory conditions that encourage resource loop closures, providing financial incentives for circular innovations, and bringing together diverse stakeholders to collaborate. In summary, the City of Toronto can play a crucial role in promoting the circular economy by fostering an environment that encourages circular innovation, with the involvement of various partners, such as individuals, private sector, governments, civil society, and others. Table 3.2.1, adapted from Baselining for a Circular Toronto – Highlights 2022 (Circle Economy & David Suzuki Foundation, 2021b), summarizes the roles of the City of Toronto and its partners. It is worth noting that the list of partners is not exhaustive, and their roles and contributions may vary.

Stakeholder	Roles in the Built Environment
City of Toronto	It has the potential to be a frontrunner in the shift towards a circular economy by fostering an atmosphere that facilitates the growth of circular innovation through: 1. Bringing together stakeholders to work towards circular objectives 2. Enhancing knowledge and awareness of circular opportunities through city services and business procedures 3. Implementing circular principles in the management of the city's assets, such as circular procurement 4. Providing incentives and regulations to encourage and regulate Toronto's circular business environment.
Business	Organizations have the ability to realize the benefits of circular finance and business models by prioritizing creative design and production methods and discovering novel approaches to acquiring, utilizing, and reusing materials.
Civil Society	1. Individuals: reduce overconsumption and promote demand for circular goods and services 2. Civil Society Organizations: support a more equitable transition by engaging in decision-making. 3. Social Partners, such as trade and labour unions, can represent the interests of workers and employers during the transition. 4. Standards Authorities: can establish international circular metrics and indicators to measure progress toward the circular economy.
Education & Research Institutes	They can promote the development of knowledge and provide workers with the necessary skills for a fair transition to a circular economy.
Provincial & Federal Governments	Collaborative efforts between governments can establish a supportive environment for businesses, industries, and communities to undertake a circular transition.
Indigenous Communities & Equity Deserving Groups	The move towards a circular economy in Toronto presents an opportunity to allow for diverse viewpoints and methods of understanding and to confront past and ongoing inequalities. This is essential to establish a more robust and inclusive future. The City can pursue avenues to collaborate with and gain knowledge from Indigenous Peoples (as holders of rights) and communities deserving of fairness during the transition to a circular economy, which includes removing obstacles to their involvement.

Table 3.2.1: Summary of the Roles of the City of Toronto and its Partners (Circle Economy & David Suzuki Foundation, 2021b)

Table 3.2.2, derived from Thelen et al.'s (2018) research, shows the shift in the roles of the key stakeholders in the circular built environment.

Key Stakeholders	**Roles in the Built Environment**
Architects, Advisors, and Engineers	Architects and consultants collaborate with clients such as developers, design-build contractors, and investors to adopt a lifecycle approach in designing. They work together, especially in the initial design phases, to identify new roles for suppliers, building companies, and installers.
Building Companies	Building companies incorporate supplementary expertise and services and assume the role of chain director for the project, engaging with installation companies, wholesalers, and other relevant parties. They might broaden their offerings to include decommissioning or facility management, utilizing their expertise and data about the building and materials to assist the owner in maximizing their building's use.
Deconstruction or Demolition Companies	Demolition and recycling firms function as suppliers of materials and components and advise architects and engineers on material lifespan. They disassemble individual building elements to prepare them for reuse, refurbishment, or recycling, aiming to preserve the maximum value of these elements (materials, products). They cooperate with service providers such as installation companies to recover valuable elements. Moreover, they may partner with traders and wholesalers to sell materials or act as a vital stakeholder to supply the market with information about the availability of resources (quantity, quality, and timing). They may also broaden their business to include the role of a supplier.
Developers	Developers have a comprehensive grasp of the circularity needs during the user and decommissioning phases. They broaden the range of circularity requirements in their tender requests and undertake corresponding actions to promote circularity during the use and deconstruction phases. As a crucial collaborator in the user and deconstruction phases, their role is multifaceted and intricate.
Facility Managers	Facility managers broaden their function to encompass the acquisition and analysis of data. By managing building performance data, Facility managers can identify patterns, anticipate issues or maintenance requirements, and provide current inventories for use in the building's end-of-life phase.
Financial Institutions and Banks	Financial institutions are adapting to the circular economy by developing new financial instruments with more complex ownership structures. They are expanding their services to include consultancy on the development of new business models that support circularity. For example, they may provide market analysis for areas of the built environment that lack a proven return on investment. However, financial institutions must adjust their risk perception and require more insight into the processes and possibilities of the circular economy and promising entrepreneurs. They will also need to adjust their risk models to address the risk associated with the use of secondary materials and products, complex approval procedures, and maintenance risks.
Owners	As buildings transform into resource banks that consist of service agreements, the owner's function assumes additional responsibilities, such as managing contracts, data, providing smart solutions, and offering support for optimal use.

Real Estate Investors	Real estate investors consider the Total Cost of Ownership and Usage, aiming to achieve optimal building performance via smart maintenance and regular renovations. They also identify new roles for architects, suppliers, contractors, installers, and real estate managers. Additionally, real estate investors may sell materials to demolition and recycling firms or construction companies.
Regulators and Legislators	Regulators and legislators enforce measures that promote circularity in the built environment. These measures stimulate innovation and aim to create a level playing field.
Specialized Construction and Installation Companies	Construction and installation firms provide services and retain ownership of their often-advanced technology-based products or services. As they remain owners, they disassemble their products at the end of their lifecycle and take them back to be renovated, reused, or recycled. They might expand their operations to include the decommissioning phase.
Suppliers and Vendors	Suppliers are not solely focused on providing and advancing sustainable, non-toxic, and renewable materials (including bio-based and recycled materials); they also offer supplementary services like leasing or remanufacturing. However, their capacity to extend their business model is contingent upon the type of goods they offer. To meet the transparency demands of their clients, products must be accompanied by a material passport or another method to demonstrate their circular characteristics, origin, and quality.
Users	Buildings have evolved from being mere objects serving a single purpose to being integrated into the environment. The sustainability level of a building now affects its asset prices. Buildings are designed to cater to a specific purpose and promote a healthy environment for living and working. Consequently, the role of a user may shift to encompass a broader range of activities during the user phase. Current Users may become more cognizant of the requirements of the next User of the building.
Waste Treatment Companies	Waste treatment companies have a crucial role in recycling materials into new use cycles. They undertake the duty of waste management from their clients and apply sophisticated technical solutions to segregate waste streams into individual components. Waste treatment firms are suppliers of secondary materials. This might be supplementary to demolition or deconstruction companies or as a collaborative effort where the waste companies handle the waste from demolition companies.
Wholesale	Wholesalers transform into material banks, broadening their function as suppliers to include consultancy, leasing, or buy-back services. As a result, they evolve into chain directors.

Table 3.2.2: Roles of the Key Stakeholders in the Circular Built Environment (Thelen et al., 2018)

To achieve a circular built environment, stakeholders must realign their roles and responsibilities to conform to circular principles, which necessitates a shift in mindset and a willingness to cooperate toward a shared objective. It is vital to acknowledge the interdependence of stakeholders and their functions to attain a sustainable built environment. Ultimately, the broader players, such as educational institutions, research agencies and academic think-tanks, industry associations and non-profits, standard bodies, and citizens, play a critical role as facilitators and supporters of Canada's circular built environment, forming the enabling system (Shorthouse, 2021b).

"While we are always looking to minimise waste on our projects, the language and communication side (of the circular economy) can be alienating, meaning it is hard to get people on board because it seems like another form of sustainability. People are still trying to get their heads around the direct benefits of participating."—Jocelyn Horwood, Skanska (Zimmann et al., 2016

3.3 Navigating Barriers for Stakeholders in the Transition towards a Circular Built Environment

"We need to get the whole supply chain together to identify overlapping obstacles, remove the barriers, show the opportunities and discuss how to work together. Contractors might see the benefits of CE but mainly they see the risks; we need to remove these and show them the opportunities. We need to engage with them about where they get their materials, how much they use and what can be reused." —Nille Juul-Sørensen, Arup (Zimmann et al., 2016)

In the previous sections, we have discussed the changes needed in the roles of various stakeholders to change from a linear to a circular built environment. However, there are still barriers that must be addressed to expedite this transition. By recognizing these barriers, we can develop strategies to overcome them and facilitate the transition. At the same time, there are also enablers that can help accelerate the transition. Understanding the enablers can help to identify areas of opportunity and prioritize actions that can lead to successful adoption of circular solutions. Therefore, before mapping the roles of key stakeholders against suggested strategies, it is essential to identify both the barriers and enablers of the circular built environment transition in Canada.

Shorthouse's final report (2021b) identified five barriers of a structural and systemic nature that impede the transition towards a circular built environment in Canada. However, the report also outlined five essential enablers that can effectively surmount these barriers. Table 3.3.1 provides a summary of the barriers and the corresponding enablers. For further details, refer to Appendix A.

Barriers	**Enablers**
Cost challenges of transition to a more circular built environment versus the linear status quo	Embracing circularity in the design stage
Lack of awareness and understanding	Education and awareness building
Fragmentation across construction industries and sectors	Supporting cross-sector collaboration
Misaligned policies, incentives, and market signals	Developing supportive policy, incentives, regulation, standards, procurement practices
Infrastructure gaps and supply chain issues	Supporting business model, process, supply chain, and technology innovation

Table 3.3.1: Summary of the Barriers and the Enablers to the circular built environment transition in Canada (Shorthouse, 2021b)

According to the Material Flow Analysis conducted by Circle Economy (2021) for Baselining for a Circular Toronto, the construction sector in Toronto is highly resource-intensive and consumes 17 million tonnes of material per year, with waste generation estimated to be 366,300 tonnes per year, of which only 12% is diverted from landfill. Furthermore, the emissions from construction and demolition of buildings are approximately 399,200 tonnes of GHG emissions during operations. These figures are expected to increase by 2030 due to increased construction activity, despite existing efforts to encourage circular resource management in the sector. While some policies and initiatives are in place to encourage circular resource management, significant challenges remain (Circle Economy & David Suzuki Foundation, 2021a). These challenges are:

- **Lack of Detailed Data on Construction Materials**
  Insufficient information on material consumption, resource stocks, and waste in Toronto hinders the development of policies and programs to achieve a circular economy. Additionally, obtaining accurate estimates of embodied energy profiles for buildings is complex, but it could help identify carbon-intensive construction materials that need replacing, such as concrete and steel, to decrease the energy used in building construction.
- **Low Diversion Rates for Construction and Demolition Waste Materials**
  The construction sector in Toronto has low diversion rates, and the City diverts minimal amounts of construction and demolition (C&D) waste, primarily from residential renovations. To expand waste management services to this sector, extensive political and public discussions, feasibility studies, and collaboration with other levels of government, private C&D sector, and local haulers are essential.
- **Lack of Systems to Upscale the Diversion of Construction and Demolition Waste**
  The City of Toronto has faced challenges in implementing diversion programs for construction and demolition (C&D) waste due to the absence of appropriate and stable secondary markets to make such programs financially viable (City of Toronto, 2017). Furthermore, private sector initiatives to construct and operate C&D recycling facilities in the Greater Toronto Area (GTA) have failed economically, as landfill disposal remains the most affordable option (City of Toronto, 2017). To increase C&D waste diversion, established end-markets and effective data management and material separation at the source are necessary, along with regulatory and financial incentives to make circular business models economically viable.

Achieving a circular city is a difficult task that demands collaboration across multiple systems involving various stakeholders. In the upcoming section, the researcher will depict the roles of primary stakeholders in correlation with the proposed strategies.

3.4 Mapping Stakeholders Roles against Strategies

In this section, each of the stakeholders will be mapped against the suggested strategies and best practices in the 'Circular Economy & The Built Environment Sector in Canada - Final Report' (Shorthouse, 2021b). This report used five well-established circular business models that aim to capture the full value of resources and do away with the idea of "waste." These business models adopt a life cycle perspective to products and services. According to Lacy et al. (2020), there are five circular business strategies:

1. **Circular Supplies:** In a circular economy, waste and pollution are partially or totally eliminated by using renewable, recycled, or highly recyclable inputs in the production process. Waste turns into an asset rather than a cost-related issue.
2. **Sharing Platforms:** Sharing products or assets combat underutilization or surplus capacity and optimize their use.
3. **Product as a Service:** Provide a service rather than a product while keeping ownership. Monitor and stay in control of raw materials. Offer of a product (or asset) use with retention of the product at the producer to increase resource productivity (e.g., leasing models).
4. **Product Lifetime Extension:** Maintain and extend lifetimes through smart maintenance, repairs, upgrades, and renovation.
5. **Resource Recovery:** Utilize waste from used goods and resources to create new raw materials and products.

Table 3.4.1 presents the researcher's mapping of the circular business model strategies to the key stakeholders (Thelen et al., 2018; Shorthouse, 2021b; Racine et al., 2021).

Circular Business Model Strategies	Key Stakeholders	
Circular Supplies	× Architects, Advisors, and Engineers × Deconstruction or Demolition Companies	× Real Estate Investors × Suppliers and Vendors × Waste Treatment Companies × Wholesale
Sharing Platforms	× Architects, Advisors, and Engineers × Building Companies × Developers	× Suppliers and Vendors × Users × Wholesale
Product as a Service	× Deconstruction or Demolition Companies × Developer	× Facility Managers × Specialized Construction & Installation Companies
Product Lifetime Extension	× Building Companies × Facility Managers × Suppliers and Vendors	× Specialized Construction & Installation Companies × Users
Resource Recovery	× Architects, Advisors, and Engineers × Deconstruction or Demolition Companies × Real Estate Investors	× Specialized Construction & Installation Companies × Suppliers and Vendors × Waste Treatment Companies × Wholesale

Table 3.4.1: Mapping of Circular Business Models to Key Stakeholders (Thelen et al., 2018) (Shorthouse, 2021b) (Racine et al., 2021)

After analyzing the circular strategies recommended by the Delphi Group study in 2021 (Shorthouse, 2021b), studying the roles of stakeholders in the 'Scaling the Circular Built Environment: pathways for business and government' Report (Thelen et al., 2018), conducting desk research, and drawing upon the researcher's own field experience in design and construction, the researcher identified key stakeholders associated with each circular business model strategy. This facilitated the recognition of the stakeholder(s) best suited to take the lead in implementing circular approaches and best practices for the Canadian built environment. It is worth noting that the Shorthouse final report (2021b) has suggested 19 best practices grouped into eight approaches for the Canadian Built Environment. Figure 3.4.1 maps the recommended best practices to key stakeholders.

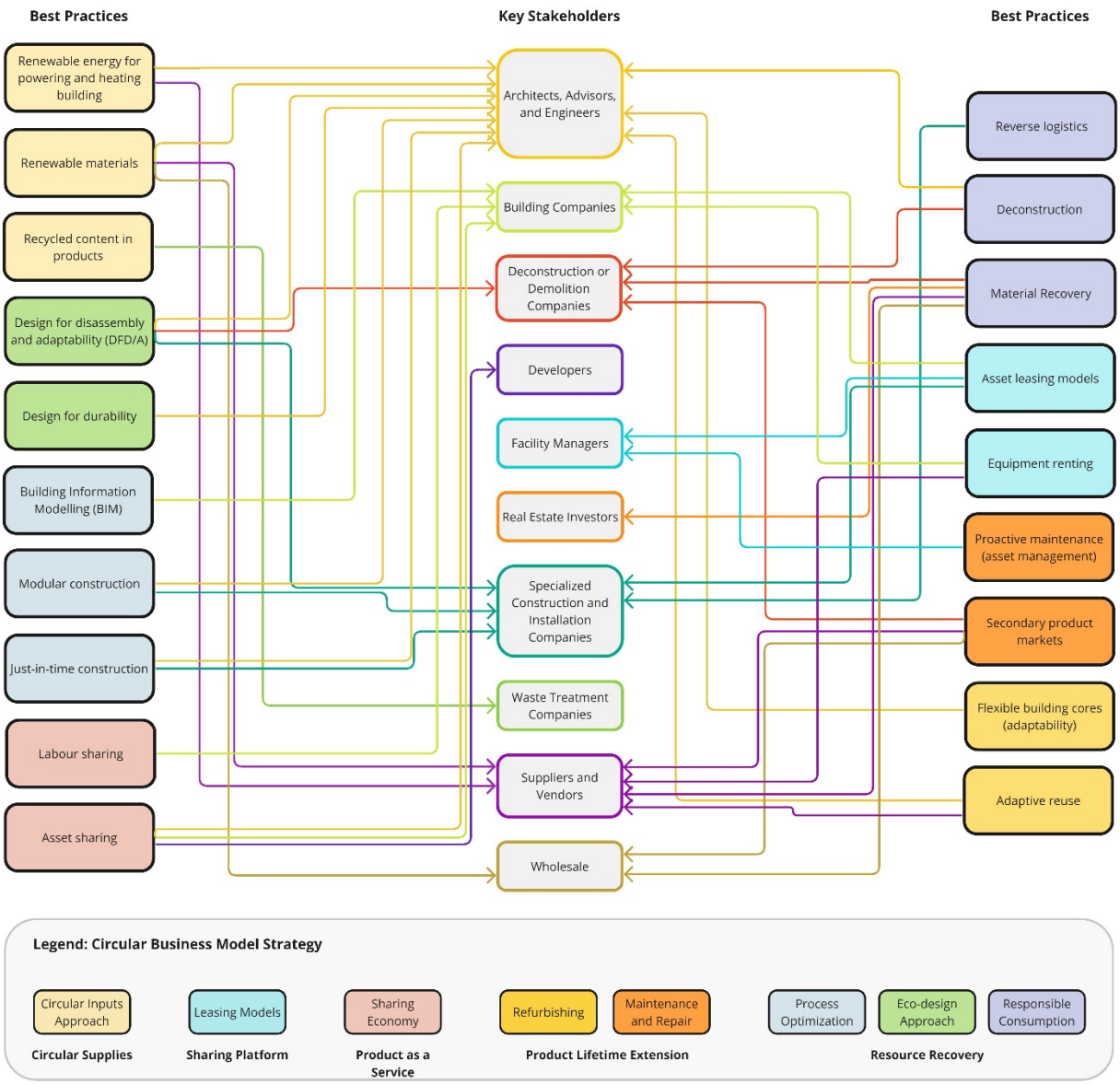

Figure 3.4.1: MAPPING OF RECOMMENDED BEST PRACTICES TO KEY STAKEHOLDERS

Figure 3.4.1 is a visual representation that illustrates the recommended best practices for a circular built environment in Toronto, and how key stakeholders can contribute to its implementation. The figure presents 19 best practices suggested in Shorthouse's final report (2021b) on the left and right sides of the diagram, color-coded based on the approach for the Canadian Built Environment. The legend categorizes these approaches based on the circular business model strategy. The middle section of the diagram depicts the major key stakeholders involved in the transition to a circular built environment, and which best practice each stakeholder can lead. The diagram highlights the collaborative nature of

this transition and underscores the importance of all stakeholders working together to achieve a circular built environment in Toronto.

Circular inputs focus on reducing waste and maximizing resource efficiency in building design and construction. This approach involves utilizing renewable energy, renewable materials, and recycled content in products. Architects, advisors, and engineers are key stakeholders in this approach, as they play a critical role in designing energy-efficient buildings that generate renewable energy and utilizing renewable materials such as mass timber. Suppliers and vendors also play an essential role in providing energy-efficient products and co-creating materials and services with a focus on renewable or recycled raw materials. Wholesalers are transitioning into circular supply providers by offering reusable and renewable materials and products. Waste treatment companies are also important stakeholders in this approach, as they manage resources effectively and establish connections with markets to sell their resources for new applications, such as incorporating recycled content in products like concrete. Through collaboration and innovation, these stakeholders can create a closed-loop system that maximizes resource efficiency and minimizes waste.

Eco-design is the second approach that focuses on designing buildings and products with a reduced environmental impact. This approach involves designing for disassembly and adaptability (DFD/A) and designing for durability. Architects, advisors, and engineers are key stakeholders in this approach, as they play a critical role in designing spaces to accommodate different functions with minor system changes and for easy access to materials. They also rethink the way buildings are put together so that the materials can be disassembled and reused, maintaining both their resource and carbon value. Deconstruction or demolition companies, as well as specialized construction and installation companies, can provide insights to architects, advisors, and engineers to design space efficiently. By designing for DFD/A and durability, stakeholders can reduce waste and promote a circular economy. This approach can result in long-lasting, adaptable, and environmentally friendly buildings and products.

Process optimization, the third approach, focuses on streamlining building construction processes to minimize waste, time, and costs. This approach involves utilizing building information modelling (BIM), modular construction, and just-in-time construction. All stakeholders are involved in BIM. However, for larger and more complex projects, building companies commonly offer BIM models that can be utilized by the building control system or transferred to it. Architects, advisors, and engineers play a crucial role

in designing modular buildings, while specialized construction and installation companies are involved in technologies such as 3D printing. Just-in-time construction involves the same stakeholders as in modular construction. By optimizing processes, stakeholders can reduce construction waste, increase efficiency, and minimize the environmental impact of construction activities. This approach can also result in cost savings, improve project outcomes, and promote a sustainable construction industry.

Responsible consumption is the fourth approach that focuses on reducing waste and promoting the recovery and reuse of valuable resources. This approach includes deconstruction, material recovery, reverse logistics, and more. Deconstruction or demolition companies play a crucial role in deconstructing buildings piece by piece, allowing for the recovery and reuse of valuable materials. Architects, advisors, and engineers also play an important role in designing buildings for deconstruction. Material recovery involves the recovery of valuable resources from buildings and the reduction of waste incinerated or dumped on landfill sites. Waste management companies separate waste into different resources, while suppliers and vendors broaden their business models to include more service-based solutions such as resource recovery. Wholesalers may expand to resource recovery, and investors focus on the potential value of residual materials and components available at the end of a building's life. Finally, specialized construction and installation companies retain ownership of high-tech products and services, disassembling them at the end of their lifecycle for refurbishment, reuse, or recycling. These practices promote responsible consumption, reduce waste, and contribute to a more sustainable construction industry.

The sharing economy approach focuses on the sharing of resources and assets to reduce waste and promote sustainability in the construction industry. Labour sharing is promoted by building companies through a platform that connects workers with available job opportunities. Architects, advisors, and engineers engage in collaborative sharing platforms to remain knowledgeable about resource recovery and have access to a real-time or digital database and marketplace for the supply and demand of reusable materials. This helps to establish connections with suppliers and promotes the sharing of assets. Building companies also provide a platform for asset sharing, allowing for the sharing of resources such as equipment, tools, and materials. These practices promote the sharing of resources, reduce waste, and contribute to a more sustainable construction industry.

The leasing models approach focuses on the concept of leasing equipment and assets to reduce waste and promote sustainability in the construction industry. Asset leasing models involve facility managers broadening their responsibilities to encompass the management of additional contracts with service providers and leased constructions. This allows for better utilization of resources and promotes sustainability. Building companies, as well as specialized construction and installation companies, play a significant role in implementing asset leasing models. Equipment renting is another practice within this approach, where building companies provide a platform for construction equipment rentals. This helps to reduce the cost of purchasing new equipment and reduces waste by promoting the sharing of equipment. Suppliers and vendors, as in material recovery, also play a crucial role in promoting equipment renting by providing services such as maintenance and repair. These practices promote the sharing of resources, reduce waste, and contribute to a more sustainable construction industry.

In the context of the maintenance and repair approach, secondary product markets involve several stakeholders. Suppliers and vendors play a crucial role in ensuring that repairable and reusable materials are available for repair and maintenance purposes. Wholesalers also participate in the secondary product market by providing reusable and recyclable materials. Deconstruction or Demolition Companies can also contribute by recovering valuable resources during the deconstruction process and making them available in the secondary product market. Facility Managers are responsible for identifying repair needs and sourcing the necessary materials from the secondary product market to perform maintenance and repair work. Finally, users also play a role by participating in waste reduction and resource conservation practices that reduce the need for maintenance and repair.

Refurbishing is the last approach that involves various stakeholders, including architects, advisors, engineers, suppliers, and vendors. When it comes to flexible building cores, these stakeholders work together to design spaces that can accommodate different functions with minor system changes and easy access to materials. This practice requires close collaboration between the architects, advisors, and engineers to ensure that the spaces can adapt to changing needs without significant disruptions. In the case of adaptive reuse, architects, advisors, and engineers work to design spaces that can be remodeled to meet the requirements of the owners and users. Suppliers and vendors also play a crucial role in providing the materials and solutions needed for the refurbishment process, ensuring that the new spaces meet the desired standards. Overall, refurbishing is a complex process that involves various stakeholders working together to create functional, adaptable, and sustainable spaces.

This section identified key stakeholders in the linear built environment and their changing roles in transitioning to a circular built environment. There are obstacles to this transition, but there are also enablers to overcome them. The section maps circular business model strategies against stakeholders to support implementation of circular approaches and best practices in the Canadian built environment. Collaboration among stakeholders is essential for success, as no single stakeholder can lead the transition alone. Nonetheless, the City of Toronto and its partners will play a critical role in fostering collaboration and incentivizing stakeholders.

Section 4: Understanding Toronto's Built Environment

The physical structures we inhabit are shaped by a variety of factors, including social, technological, economic, environmental, political, and ideological influences at local, regional, and global levels. The City of Toronto is a sophisticated socio-technical entity that changes and grows in response to these circumstances. To expedite the shift towards a circular built environment and surmount obstacles confronting those involved, the researcher employed the STEEP-V analysis and Three Horizon tool.

4.1 STEEP-V Analysis

The STEEP+V analysis tool was utilized to assess and analyze various trends related to the construction industry, urban planning, sustainable initiatives, and Canadian city trends (Evergreen, 2023). The tool evaluated these trends across six different dimensions: social, technological, economic, ecological, political, and value-based. The purpose was to identify and evaluate trends that are mature, emerging, and weak in each dimension. The maturity of the trend indicates its progression in a chosen context (i.e., Canadian urban regions). By assessing trends across these different dimensions, the analysis provided a comprehensive understanding of the several factors that are shaping the built environment and influencing decision-making.

After examining an extensive list of current and future trends from a bird's-eye view, the researcher was able to identify larger patterns in the trends, including their interconnections and potential impacts on the future of planning. According to a report by Hurtado et al. (2022), the most significant factors presently driving change and upheaval are climate change, the COVID-19 pandemic, the growing awareness of social inequalities, and the rapid pace of technological advancements. These factors have accelerated, exacerbated, or disrupted existing trends, stimulated the emergence of new trends, and are visible in signals that give us cues for potential future trends.

4.1.1 Social Trends

The way we live, connect, and relate is the driving force behind these trends (Evergreen, 2023). Mature trends can be categorized into four themes, with the first being the complexities of health and well-being. Hurtado et al. (2022) suggest that social determinants of health are linked to the decline in life

expectancy. Additionally, there has been a rise in mental illness and suicidal ideation among both youth and adults, which has been worsened by pandemic-related factors such as social isolation, economic stress, and increased mortality (Public Health Agency of Canada, 2017; Centre for Addiction and Mental Health - CAMH, 2018; Kirkey, 2019). Meanwhile, the aging population is causing Canadians to exit the workforce faster than new Canadians can join it (Martin, 2018; Statistics Canada, 2017; Mauldin, 2017; McQuigge, 2019).

The second theme is centered on inclusivity. As stated by Hurtado et al. (2022), the increase in racial and ethnic diversity has led to greater awareness of these changes, and young adults and youth are actively participating in planning-related movements and climate activism, empowered by the potential for mobilization through social media. The third theme explores the intersection between technology and society. For example, the digital divide creates disparities in opportunities for progress between communities with access to high-speed internet infrastructure and those without (Fox, 2019; Vick, 2017; Ivus and Boland, n.d.). At the same time, social media is experiencing a period of lawlessness, with misinformation spreading and individuals deciding whom to criticize and how, resulting in a sort of public opinion court. Lastly, the fourth theme concerns housing challenges. The primary trend is the increasing homelessness caused by rising costs of basic needs, such as food, goods, and housing, which is caused by supply chain disruptions and pent-up demand (Hurtado et al., 2022). Another trend is gentrification and displacement, which can force communities out of their neighborhoods, causing a reduction in diversity of race, ethnicity, and income level. This decrease in diversity can negatively impact the economic strength and growth potential of the city (Hurtado et al., 2022).

Regarding emerging trends, there is a growing trend of socio-economic mixing, which involves constructing public and affordable housing in neighborhoods with a mix of different income levels (Debergh, 2019; Dimoff, 2017; Lindeman, 2019; Khoo, 2019; Statistics Canada, 2018). Another trend is digital activism, where social media platforms are increasingly being used to mobilize people towards shared political objectives, as the number of users on these platforms continues to grow (Suciu, 2019; Stauffer, 2019; Anderson et al., 2018). Lastly, there is a weak trend known as Education 4.0 (Takahama, 2019; Oltermann, 2016; Burrows, 2019). Education 4.0 aims to provide an all-inclusive and continuous learning process that places the responsibility of skill development on the learner, while teachers and mentors take on a supportive role as facilitators and enablers (Advani, 2023).

4.1.2 Technological Trends

Technological trends are shaped by advancements in technology and their effects (Evergreen, 2023). The emergence of new transportation modes and services from private companies has caused significant disruptions in the transportation sector, which people are unprepared for, as per Hurtado et al. (2022), Hannon et al. (2016), Shaver (2019), the City of Toronto (2019), and Liddell (2020). Another mature trend is Data Ownership Tensions. As technology continues to progress, there is a growing concern about how resident information is collected and who has the rights to store and own it, as noted by Hardinges (2018), Hafen (2018), and Fingas (2019).

In terms of emerging trends, there is a focus on urban infrastructure and artificial intelligence (AI). AI has diverse uses that can enhance government efficiency, address resource constraints, and automate manual tasks. AI is increasingly being implemented in urban technology and infrastructure systems, including maintenance, decision-making algorithms, and process optimization. However, the consequences of widespread integration of AI technology are not entirely clear, and there is a need for a flexible, fair, and deliberate approach to tackle potential obstacles (Hurtado et al., 2022). Cities are also incorporating intelligent technology to establish eco-friendly infrastructure, enhance energy efficiency, and bolster resilience to climate change (Levinson-King, 2018; Bannerman, 2019; Mulgan et al., 2018; Infrastructure Canada, 2019b). Novel technological advancements in green infrastructure are also revolutionizing the way we approach resilience and economics in our infrastructure systems (Fullerton, 2018; Infrastructure Canada, 2019a; Dade-Robertson, 2019). As online trust continues to decline, there is a pressing need to enhance encryption, security standards, as well as laws and regulations to protect privacy and security (Studaras, 2019; Morrison, 2020; Rainie and Anderson; 2017; Martin, 2018; Delphia website, n.d.).

Finally, weak signals suggest the rise of disruptive technologies like AI and blockchain, which are causing significant disruptions in entire industries and providing advantages to early adopters (Beeby, 2018; Spatz, 2018; Shroff, 2020; Marr, 2018).

4.1.3 Economic Trends

The distribution of wealth, financial systems, and markets are the driving forces behind economic trends (Evergreen, 2023). Mature trends can be categorized into three major themes. The first theme is the

great economic divide, where increasing urban prices have resulted in urban living becoming less accessible due to stagnant wages, rising housing expenses, and inflated prices of goods and services (Adamczyk, 2019; Mikhitarian, 2018; Lisa, 2019; Thompson, 2019). Additionally, the proportion of high-paying and low-paying jobs will increase, while middle-paying jobs will decline based on the wage levels of these professions (Shah, 2019; OECD, 2017; Snider, 2020; Manzocco, 2019). The second theme is upskilling and reskilling, where professions have adapted to changing circumstances and technological advancements, with some becoming outdated while others regain popularity (Hurtado et al., 2022). Finally, the third theme is economic restructuring, which includes the tremendous growth of e-commerce (Hurtado et al., 2022), the rise of the gig economy (Jeon et al., 2019; McNeil, 2019; Nazareth, 2017; OECD, 207), and the shift towards shared ownership models and subscription services (Tabcum, 2019; Miller, 2019; Ministry of Finance Ontario, 2018; Rosenberg, 2020). These trends have various impacts, including the decreasing demand for brick-and-mortar retail space and the transition towards services instead of goods, as well as the digital transformation of industries towards subscription services (Hurtado et al., 2022).

There are five emerging themes to consider. The first theme concerns the future of work, where automation could render about 50% of jobs in Canada obsolete in the next decade (Vomiero, 2018; Yahoo Finance, 2019; Alexe, 2019; Sterling, 2019). The increasing trend towards remote work is being driven by advancements in communication technologies and a culture of inclusivity (Reynolds, 2019; Hamingson, 2023; Bishop, 2018; QCosta Rica Website, 2019; Pelley, 2019). Cooperative workplaces are replacing conventional business models, and they are managed by the individuals who utilize their services (Anzilotti, 2018; Kahn, 2018; Sanders, 2018; Denovan, 2019). The second theme revolves around green investments, which have emerged due to growing environmental concerns. These investments aim to fund sustainable infrastructure initiatives (Climate Bonds Initiative, 2019; Temple-West, 2019; Shrestha, 2019; Sustainalytics, 2019). The third theme is digital currency, where countries and corporations are developing cryptocurrencies, paving the way for a cashless society (Fulton, 2020; Bram, 2020; Paul, 2019; Schwartz, 2019). Technology firms are exploring the possibility of using AI's economic efficiencies to compensate communities affected by job losses due to automation (Hurtado et al., 2022). Another trend is the rising cost of air pollution, which is costing the Canadian economy over CAD30 billion annually (Roy and Braathen, 2017; McCarthy, 2020; The World Bank, 2016; Hodgson and Dowdall, 2017). Finally, private-sector community investment is gaining momentum, with large tech

companies investing in affordable housing programs near their operations, and private and philanthropic foundations increasing funding for community development (Hurtado et al., 2022).

However, there are also three weak trends to consider. Firstly, there is an ongoing energy revolution where the cost of producing electricity through sustainable energy sources is continually decreasing, making it an attractive alternative to traditional energy sources (McBride, 2020; Woetzel and Kejun, 2017; Cleland, 2017; Berke, 2018). The second weak signal pertains to remote governments using state-supported relocation systems to move entire communities due to the decline of local economies. This may indicate the potential use of such systems in scenarios related to climate crises and similar situations (Coletta, 2019). Finally, the growing global population, advancements in medical science, stressed food systems, and increased deforestation are causing the emergence of drug-resistant bacteria and new pathogens that require attention (Lee, 2017; Belluz, 2016; Morrison, 2020).

4.1.4 Environmental Trends

These trends are driven by sustainability, climate change and natural resources (Evergreen, 2023). Mature trends can be categorized into four themes. The first theme is the environmental cost of our digital lives, with the increasing shift towards digitalization resulting in more greenhouse gas emissions (Hurtado et al., 2022). The second theme pertains to inequitable impacts of climate change. Underserved communities are disproportionately affected by climate change, mostly because policies have resulted in environmental damage, greater exposure to natural disasters, and a lack of investment and care (Hurtado et al., 2022). Another trend is the occurrence of extreme weather events such as floods, wildfires, heatwaves, and other sudden natural disasters are becoming more frequent and severe due to climate change (Quackenbush, 2018; City of Calgary, 2017; Johnston, 2018; Kane, 2018). Due to the growth of cities and the impact of climate change-induced droughts and natural disasters on water resources such as reservoirs and rivers, cities are implementing plans to cope with the impending water scarcity in the future (Hurtado et al., 2022). The third theme is the contrasting trends in urban development, with suburban expansion (Mangione, 2019; Gordon et al., 2018; Rosenthal, 2020; Curry, 2017) continuing alongside urban densification (Mangione, 2.18; Conticelli et al., 2017; Croeser and Gunn, 2020; Ricci, 2020). The last theme is green and nature-based solutions, with more governing bodies recognizing the benefits of nature and biodiversity since the start of the pandemic. As a result,

more municipalities are considering implementing urban forests, green spaces, and nature-based solutions to address various issues such as climate change and mental health (Hurtado et al., 2022).

There are three main emerging trends. The first pertains to the emergence of the circular economy. Due to the rising environmental consciousness and customers' growing willingness to pay for eco-friendly products, upcycling and circular economy models have arisen as an innovative business opportunity (Government of Canada, 2019; Petro, 2019; Singh et al., 2019). The second trend involves climate migration, resulting from changes in the natural world. Global warming is predicted to create food shortages that could lead to a massive migration of people because of climate-related factors, unlike anything witnessed before (Lu and Flavelle, 2019; Carrington, 2019). In some regions, the shoreline is eroding due to turbulent waters, whereas in others, the same turbulent waters are causing growth (The Canadian Press, 2019; Welsh, 2019; CBC News, 2019; Lemmen and Warren, 2016; Nanowski, 2019). The final trend is building retrofitting. As carbon costs continue to increase, retrofitting buildings is an increasingly favored solution to meet densification requirements while also lowering emissions (Dreessen, 2017; Infrastructure Canada, 2019c; Natural Resources Canada, 2017; Fan and Xia, 2015).

The phenomenon of wildlife sightings in urban areas, which is commonly referred to as "wild in the city," is a trend that has been weak in the past. However, due to the expansion of human settlements into animal habitats over the years, it has become increasingly common to see various wildlife in populated areas. This trend was further accelerated during the COVID-19 pandemic as a result of social distancing measures (Bassetti, 2019).

4.1.5 Political Trends

Political trends, driven by governance, political affiliation, and regulatory processes (Evergreen, 2023), can be categorized into three main themes. The first is the growing wealth inequality, which necessitates the implementation of robust policy measures, including taxation, to address the widening gap between the rich and poor (Poitras, 2019; Wang, 2019; Saltman, 2019). Austerity measures are also expected following crises such as financial crises or pandemics (Hajer and Fernandez, 2020; Ortiz and Cummins, 2019; Hu, 2020; Keung, 2017). The second theme is political shifts, with specialized online communities playing a crucial role in shaping public discourse and encouraging participation in specific topics, regardless of geographical location (Hurtado et al., 2022). These communities offer a platform for

individuals to become experts on various issues and provide valuable insights during public decision-making processes. According to Hurtado et al. (2022), public trust towards local governments remains higher than trust in federal governments. The final theme is political polarization, with support for political movements located at opposite ends of the spectrum increasing (Chamandy, 2019; Zhou, 2018; Corbet and Larkin, 2019; Tayler, 2019). State-level governments are also becoming more involved in land-use planning, with legislators preempting local regulations or adding a secondary layer of state intervention to project approvals (Hurtado et al., 2022).

One of the emerging trends is the strain in trade relationships among the US, China, and Mexico, which is having a ripple effect on their trading partners (Hanson, 2019; Common and Mancini, 2019; Connolly, 2019; Reuters, 2019). Another trend is the increasing recognition by municipal and federal authorities of the history and unceded lands of Indigenous communities as part of the Truth and Reconciliation movement (Fraser, 2019; Troian, 2017; Mosleh, 2019); Grin, 2019). Finally, the combination of the growing influence of tech companies and tax incentives from state and local governments is leading to the revival of "company towns" (Hurtado et al., 2022).

As urban areas continue to grow, the trend of empowering megacities is emerging as a weak signal. This trend entails cities gaining more power and influence compared to provincial and federal governments, leading to increased municipal autonomy and self-governance (Swiney and Foster, 2019; Bañares and Rayment, 2018; Hudes and Graney, 2019).

4.1.6 Value-Based Trends

According to Evergreen (2023), these patterns are influenced by attitudes, culture, and in-group identity. There are three significant trends. Firstly, there is an increasing emphasis on access and inclusion as institutions strive to meet legal requirements and include all members and users meaningfully (Bartleby, 2018; Fleming, 2018; Keohane, 2017). Secondly, the existence of controversial symbols in public spaces can create a sense of exclusion among certain individuals and communities, and this can undermine efforts to promote equity, diversity, and inclusion. Consequently, there is a growing tendency to discuss the removal of such symbols from public spaces, with some of these discussions resulting in their actual removal (Hurtado et al., 2022). Thirdly, there is an ongoing debate about whether social media should prioritize safeguarding freedom of expression or monitoring false information as online polarization

intensifies (Hern, 2019; The Day, 2019; Hong, 2016). Lastly, urban and rural voters are becoming increasingly polarized along political and ideological lines (The Canadian Press, 2019; Robinson, 2019; Hyslop, 2019).

Social media is being increasingly acknowledged as a trustworthy source of information that can assist decision-making and provide validation by governments and other organizations (Brekke and Staver, 2019; CareerBuilder, 2018; Fingas, 2019b; StopGap Foundation Website, n.d.), representing one of the emerging trends. Also, the growth of AI technology markets necessitates the implementation of ethical guidelines due to the limited applications of AI technology. The use of AI systems in communities raises concerns about human rights, civil liberties, privacy, and social equity (Hurtado et al., 2022). Local, state, and federal programs are mandating that communities swiftly and accurately evaluate and describe their efforts towards equity, diversity, and inclusion in local planning projects, which is another emerging trend. Finally, there is a need to improve the engagement of individuals who possess lived experiences at the intersection of multiple social identities, including disability and class, in addition to gender and race (Hurtado et al., 2022).

One trend that is not as strong as the others is the growing desire and attempts to de-colonize or re-indigenize physical spaces (CBC News, 2016; Deer, 2019; CBC News, 2018; Tunstall, 2018).

4.1.7 Summary of STEEP-V Analysis

A summary of the STEEP-V analysis is presented in Table 4.1.

Trends Type	**Maturity Legend**	**Trends Themes**
Social Trends	Mature	× Complexities of health and well-being × Inclusivity × Intersection between technology and society × Housing Challenges
	Emerging	× Socio-economic mixing × Digital activism
	Weak	× Education 4.0
Technological Trends	Mature	× Data Ownership Tensions × New transportation modes and service
	Emerging	× Urban Infrastructure & AI

		× Eco-Friendly Infrastructure × Green Infrastructure × Data Protection & Privacy
	Weak	× Rise of Disruptive Technologies
Economic Trends	Mature	× Great Economic Divide × Upskilling & Reskilling × Economic Restructuring
	Emerging	× The Future of Work × Green Investments × Digital Currency × Rising Cost of Air Pollution × Private-Sector Community Investment
	Weak	× Energy Revolution × State-Assisted Relocation × Fear of Pathogen Exposure
Environmental Trends	Mature	× The Environmental Cost of Our Digital Lives × Inequitable Impacts of Climate Change × Contrasting trends in Urban Development × Green and nature-Based Solutions
	Emerging	× Rise of circular Economy × Climate Migration × Building Retrofitting
	Weak	× Wild in the City
Political Trends	Mature	× Increasing Wealth Inequality × Political Shifts × Political Polarization
	Emerging	× Tensions with Trade Partner × Truth & reconciliation × The return of Company Towns
	Weak	× Empowered Megacities
Value-Based Trends	Mature	× Accessibility & Inclusive Design × Free Speech Debate × Urban-Rural Division
	Emerging	× Social Media Legitimization × AI Ethics × Recognizing the Importance of Intersectionality
	Weak	× Decolonizing Spaces

Table 4.1: A summary of the STEEP-V Analysis

4.2 Three Horizons Approach

After understanding the current system and analyzing trends, the Three Horizons (3H) approach examines the relationships between changes and innovations required to reach desired future outcomes. The concept of Three Horizons, intoduced by Bill Sharpe, can serve as a starting point for cultivating a "future consciousness," which involves developing a deep and nuanced understanding of the future possibilities that exist in the present moment (Sharpe, 2013). By exploring how to harness this awareness, we can take action to shape the futures we desire. This approach aims to identify emerging trends that may facilitate the implementation of circular strategies, determine what trends are needed to achieve goals, and identify gaps between emerging trends and those that need further development. The time frame for the 3H approach is based on Toronto's ambitious strategy to achieve net-zero community greenhouse gas (GHG) emissions by 2040, a target that is one of the most ambitious in North America and is 10 years earlier than initially proposed. Ultimately, the 3H approach helps accelerate the path towards a more circular system by identifying potential innovations and changes required to reach the desired future state.

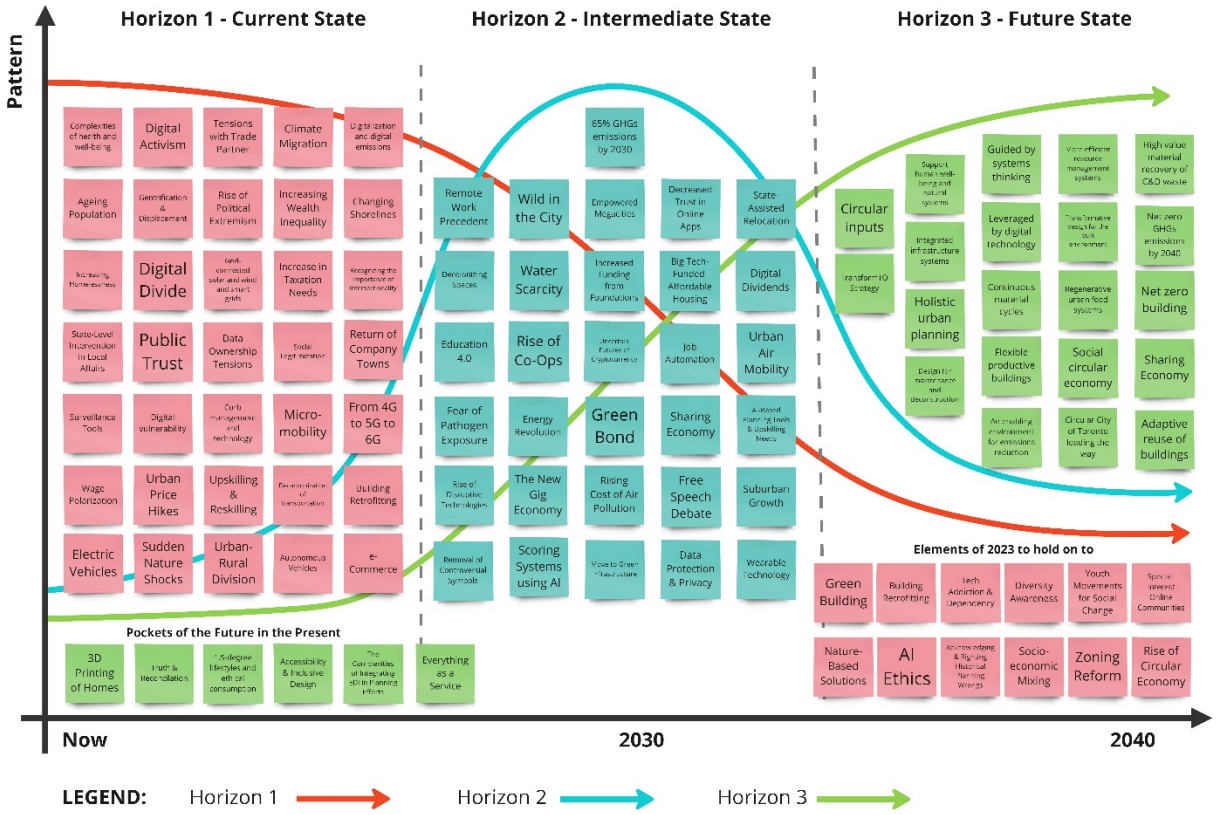

Figure 4.2: THREE HORIZONS

4.2.1 Horizon 1 – Current State 2023

Horizon 1 illustrates the significant trends of the current era, focusing on Toronto's built environment. These trends mainly consist of current practices that are becoming less suitable for the emerging needs of the societal system. Although many aspects of Horizon 1 will persist, they will also undergo transformation in Horizon 2. The dominant trends in the present time, such as mental health issues, inclusivity, the interplay of technology and society, housing problems, rising homelessness, public trust, and political polarization, are gaining more significance and require urgent attention.

Figure 4.2 exhibits the trends that we must retain to attain our envisioned future state, which can be categorized as follows:

1. Sustainable Development: Green building, Building retrofitting, Nature-based solutions, Growth of circular economy

2. Social Equity and Justice: Diversity awareness, Youth movements for social change, Socio-economic mixing, Recognition and rectification of historical planning errors
3. Technology and Ethics: Technology addiction and dependency, AI ethics
4. Community and Participation: Special-interest online communities
5. Governance and Policy: Zoning reform.

Furthermore, there are currently weak trends that may have a significant impact on the future. These include 3D printing of homes, truth and reconciliation, 1.5-degree lifestyles and ethical consumption, accessibility and inclusive design, the challenges of integrating EDI in planning efforts, and everything as a service.

4.2.2 Horizon 2 – Intermediate State 2030

During the transition phase, the second horizon refers to the intermediary measures that bridge the gap between the present state (Horizon 1) and the intended future state (Horizon 3). In this phase, trends such as the decolonization of spaces, data security and privacy, Education 4.0, the energy revolution, the emergence of disruptive technologies, and the growth of green bonds are some of the notable factors.

4.2.3 Horizon 3 – Future State 2040

This horizon encompasses the desired future outcomes and innovative practices, which includes Toronto's circular vision as outlined in Section 1.4.3.1, as well as the TransformTO climate action strategy. The objective of TransformTO is to achieve a low-carbon emission future while also meeting various community-wide goals such as reducing poverty, creating employment opportunities, promoting healthy communities, and enhancing resilience to extreme weather conditions (City of Toronto, 2021b). Additionally, the 'Circular Economy & The Built Environment Sector in Canada - Final Report' (Shorthouse, 2021b) provides suggested strategies and best practices, which are outlined in Section 3.4: Mapping Stakeholder Roles against Strategies. Lastly, the researcher included in Three Horizons the principles of circular economy embedded in the built environment, such as *supporting human well-being and natural systems, guided by systems thinking, leveraged by digital technology, holistic urban planning, continuous material cycles, design for maintenance and deconstruction, flexible productive buildings, and integrated infrastructure systems* (Arup et al., 2018).

4.3 Analyzing Trends to Optimize the Transition to a Circular Built Environment in Toronto

Following the identification of trends employing the STEEP-V analysis and mapping them using the Three Horizons approach, the researcher analyzed the various groups of trends to determine the necessary steps for expediting and optimizing the transition to a circular built environment in Toronto. To achieve this goal, it is essential to address the challenges and close the gaps in the current system. The researcher focused on the trends categorized under "Pockets of the Future in the Present" in the Three Horizons analysis, as these weak trends have the potential to significantly impact the future. In addition to these trends, the researcher also considered the trends of 2023 that must be retained. As a result, gaps in the current system were identified when mapped against the recommended circular strategies. Figure 4.3 maps the relationship between the trends and the suggested best practices (Shorthouse, 2021b) for the Canadian built Environment.

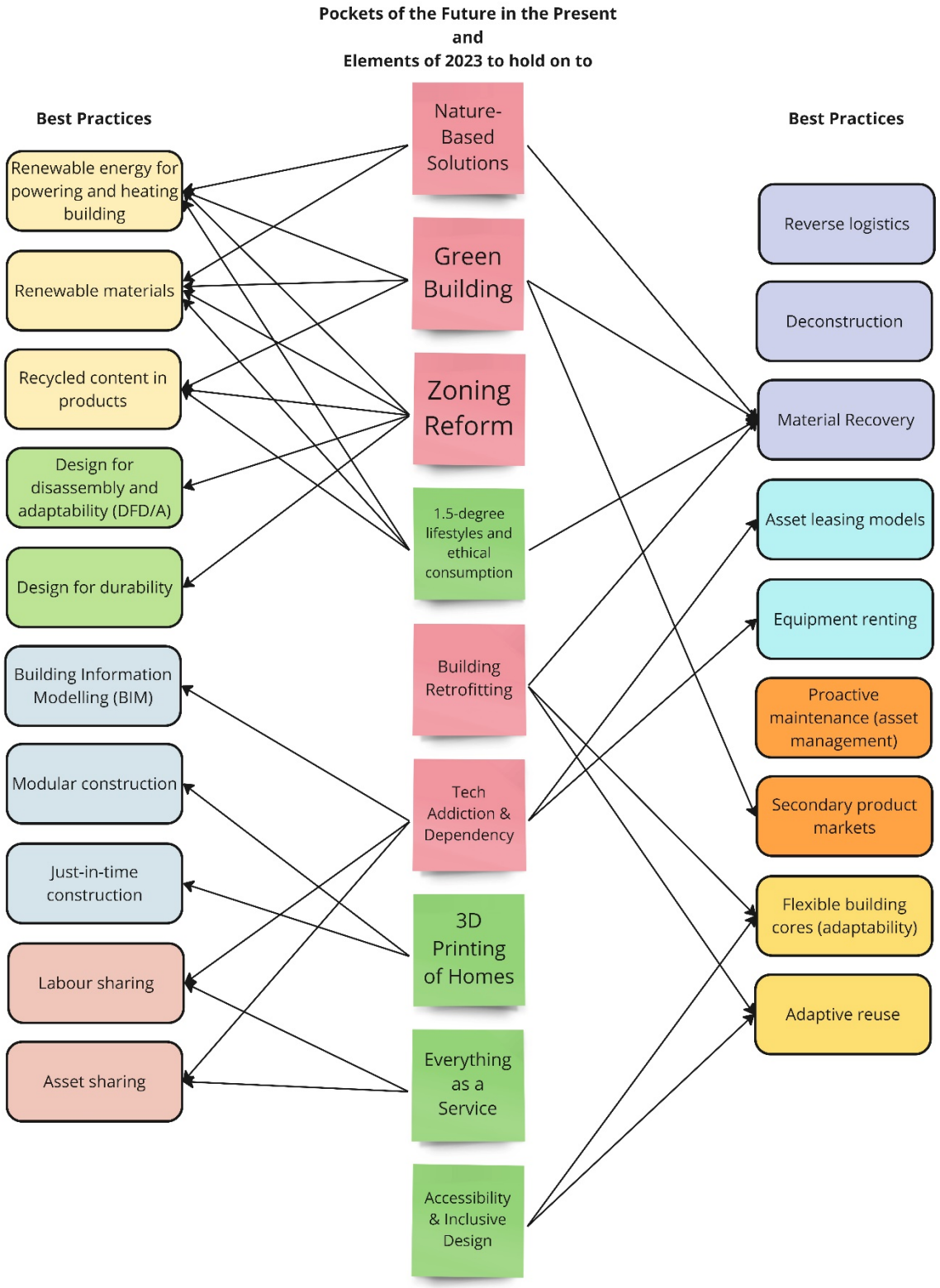

Figure 4.3: RELATIONSHIP BETWEEN TRENDS AND BEST PRACTICES

The map illustrates the limited strength of current trends that drive the adoption of circular practices in Toronto's built environment. While there are some initiatives in Toronto aimed at implementing these practices, they are relatively weak signals. Merely having one to three trends that prepare the built environment for these practices is insufficient. For instance, many of these trends focus on circular inputs including renewable energy for powering and heating building, renewable materials, and recycled content in products, with none leading toward reverse logistics and deconstruction, which is necessary for responsible consumption. To bridge the gap between Toronto's circular vision and our current progress, a profusion of trends covering the entire spectrum of these practices, particularly those that have not yet been addressed, must emerge.

Several trends might hinder the implementation of circularity. For example, one trend is the issue of public trust in governments, which needs to be addressed in order to collaborate with the community to create policies that promote and incentivize circularity. One way to overcome this is to leverage another trend, online communities, to build trust and engagement. Additionally, another trend that needs to be integrated into planning efforts is equity, diversity, and inclusion (EDI). Planners should review their current data collection and project evaluation methods to ensure that they meet the necessary requirements for EDI, as noted by Hurtado et al. (2022).

Conversely, there are some trends that can serve as facilitators to ease the shift to a circular built environment in Toronto. One such trend is youth movements for social change, which can contribute to the dissemination of knowledge and awareness. Another example is zoning reform, where cities are revising their zoning policies to address population density and eliminate restrictions on supply chains, resulting in reduced housing costs.

Section 5: Recommendations and Future Works

The primary objective of this extensive research project was to pinpoint the gaps that need to be addressed to accelerate the shift to a circular built environment in Toronto. The study also shed light on the evolving role of stakeholders in this transition. Despite the challenges and obstacles in the process, there are enabling factors that can help overcome them. Therefore, based on the researcher's analysis and synthesis, several recommendations have been put forward to expedite the transition. These include:

- **Recommendation 1:** To accelerate the adoption of circular strategies, approaches, and best practices, it is necessary to conduct a backward study by exploring various emerging trends for each of these practices and proposing an implementation plan.
- **Recommendation 2:** The transition to a circular built environment demands a systemic and comprehensive approach, as well as cross-sectoral collaboration. It is crucial that all stakeholders are engaged in formulating a roadmap that steers the transition process.
- **Recommendation 3:** Given that each stakeholder has different incentives and requirements for the built environment, a shift in mindset is necessary to reform their perspectives. A set of tools, such as Causal Layered Analysis, can be utilized.

Next steps required to expedite the transition towards circularity in the built environment of Toronto will involve a detailed study for each stakeholder using system thinking. This involves analyzing their incentives, needs, and potential barriers to involvement. The study will inform the development of a comprehensive roadmap with clear goals and strategies for implementation, considering potential challenges and developing strategies to overcome them. The roadmap should foster cross-sectoral collaboration and consider each stakeholder's unique requirements.

Glossary of Terms

Built Environment: It refers to the intentional human-made physical surroundings developed using science and technology for the betterment of humanity (Assembly, 2008).

Circular Economy: A systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution. It is based on three principles, driven by design: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature (Ellen MacArthur Foundation, 2021).

Circular City: A city that encourages the shift from a linear to a circular economy in an integrated way throughout its urban landscape through cooperation with its residents, enterprises, and academic institutions (ICLEI Circulars, n.d.).

Construction Sector: The construction industry is a vast, constantly changing, and intricate sector. It encompasses a range of activities, including the creation of new structures, which may involve tasks such as dividing land for sale as building sites or preparing sites for construction. Additionally, construction work includes renovations that involve adding, modifying, or maintaining buildings or engineering projects like highways or utility systems (Behm, 2008).

Four Resource Categories: Minerals, ores, fossil fuels, and biomass (Circle Economy, 2021b)

Greenhouse Gases (GHGs): Greenhouse gases, including carbon dioxide (CO2) and methane (CH4), play a crucial role in maintaining the Earth's temperature at a level that can support life. However, excessive amounts of these gases can trap heat within the Earth's atmosphere, leading to an increase in temperature and causing imbalances in the atmosphere that result in more severe and unstable weather events. The primary cause of climate change is the increase in GHG emissions resulting from human activities, including the burning of fossil fuels (City of Toronto, 2021b).

Net Zero Building: A structure that exhibits exceptional energy efficiency and generates or acquires carbon-neutral and/or sustainable energy on-site, enough to counterbalance the yearly carbon footprint resulting from its functioning, or eliminates carbon emissions entirely (City of Toronto, 2021b).

Net Zero (Toronto's Strategy): The concept of net zero means achieving zero emissions by eliminating human-caused greenhouse gas (GHG) emissions and balancing any remaining emissions with equivalent carbon removals. This can be achieved by restoring natural lands and soils or through direct air capture and storage technologies. The City of Toronto aims to achieve net zero by reducing GHG emissions from various sources, such as transportation, buildings, goods production, and waste disposal (City of Toronto, 2021b).

Nine Consumption Groups: Nutrition, Housing, Energy, Capital Equipment, Consumables, Communication, Services, Mobility and Healthcare (Circle Economy, 2021b).

Pockets of the Future: It is defined as an observable practice, idea, or thing that is rare and insignificant in the present moment but has the potential to become more prevalent and impactful. Pockets of the futures are important weak signals that have the potential to profoundly influence the organization's core challenge (Githens, 2019).

Seven Key Societal Needs: Nutrition, Housing, Consumables, Communication, Services, Mobility and Healthcare (Circle Economy, 2021b).

Systems Thinking: It enables us to understand the deep structure of alternative futures and the nature of discontinuous change over time (Hodgson & Sharpe, 2012).

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Appendices

Appendix A: Barriers and the Enablers to the Circular Built Environment Transition in Canada

Barriers	Description	Enablers	Description
Cost challenges of transition to a more circular built environment versus the linear status quo	The existing linear system does not factor in the actual costs of consumption, which society usually bears as externalities. The building industry lacks accountability for their products and waste, which leads to disregard for environmental impact. Additionally, virgin resources are typically less expensive than recycled materials, and reducing waste during construction and operations does not translate into benefits for those who bear the costs.	**Embracing circularity in the design stage**	To achieve circularity in the construction industry, industry collaboration is essential, and systems thinking for circularity is a necessary approach. By incorporating systems thinking for circularity into value chains, companies and other key stakeholders can innovate and create solutions focused on displacing linear solutions.
Lack of awareness and understanding	The circular economy is not widely understood in the built environment, and where it is, the focus is often limited to waste management and recycling. There is a need for greater emphasis on design, material innovation, and circular strategies such as leasing. The absence of standardized definitions, information, and data presents challenges for collaboration across various levels.	**Education and awareness building**	To shift away from prevailing mindsets and business-as-usual approaches, stakeholders across the value chain need more education and awareness.

Fragmentation across construction industries and sectors	The building industry and its ecosystem operate in silos and are often at odds with each other, creating barriers to collaboration and systems thinking needed to promote circularity. These silos are often based on services or functions within the building's lifecycle.	**Supporting cross-sector collaboration**	It is crucial for stakeholders to comprehend the needs and limitations of other value chain participants. By collaborating with other value chain actors, financial risk can be spread across a wider range of stakeholders, reducing potential risk to any one party.
Misaligned policies, incentives, and market signals	The policies, laws, and incentives currently in place do not fully support the circular economy principles in the building industry. There is a lack of access to capital for circular solutions, and conflicting market signals lead to a misalignment of short-term and long-term investment interests.	**Developing supportive policy, incentives, regulation, standards, procurement practices**	Implement regulations that address materials management, construction practices, and asset management. Incentives and fiscal policies include higher landfill fees, taxes on virgin materials, grants for innovation and new business models, and capacity building programs to assist in re-skilling labor.
Infrastructure gaps and supply chain issues	The supply chain is complex and region-specific. The market for recycled materials is usually regional, creating problems for cross-border material flow and jurisdictional control. Finally, the current limited demand for reclaimed materials in Canada creates obstacles to investment in new infrastructure and activities such as material marketplaces and reverse logistics.	**Supporting business model, process, supply chain, and technology innovation**	Improved productivity and cost-effectiveness can be achieved through innovation, while digital solutions and technology can facilitate better sharing of information and tracking of material and resource flows.

*Retrieved from Circular Economy & the Built Environment Sector in Canada – Final Report (Shorthouse, 2021b)