

A Systems Thinking based Sustainable Business Model Framework – *An Appropriate Approach for the Design of Sustainable Business Models in Start-Up Consulting*

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Received: October 28, 2024

Accepted: December 9, 2024

Online Published: January 22, 2025

doi:10.5539/ibr.v18n1p54

URL: <https://doi.org/10.5539/ibr.v18n1p54>

Abstract

The Business Model Canvas (BMC), originally developed by Osterwalder and Pigneur, has become a well-established and widely utilised tool for the development, modification, and visualisation of business models. While the Business Model Canvas provides an effective framework for designing business models, there remains a need to enhance the understanding of cause-and-effect relationships within the system, as well as to establish a holistic perspective on its impacts. This is particularly relevant for entrepreneurs and start-up advisors, as start-ups typically have fewer financial resources to mitigate or adapt to unsuitable decisions taken than established companies. Furthermore, many of today's start-ups operate in highly complex and dynamic sectors, such as the digital economy, and often strive for a holistic view of sustainability, balancing economic, environmental, and social impacts.

This paper reviews the traditional Business Model Canvas and explores sustainable business models grounded in the Triple Bottom Line approach. It then introduces a Systems Thinking based Sustainable Business Model framework (STSBM) that offers a robust methodology for designing sustainable dynamic modern business models. Specifically, impact networks are proposed to align mental models, while scenario simulation and evaluation are presented as tools for managing complexity.

The paper outlines the process of model development, details the structural elements of the proposed framework, and suggests its practical application. By integrating these principles, the proposed framework aims to support the creation of sustainable business models that effectively address the intricate challenges faced by start-ups.

Keywords: Business model canvas, consulting, simulation, start-up, sustainability, systems thinking

1. Introduction

Operational business models play an essential role in the success of organisations. Companies must adapt their business models flexibly and quickly to new conditions in order to survive in the ever-changing market (Gassmann, Frankenberger & Choudury 2020). In practice, the innovation process, as well as the conceptualisation of innovative new business models, is often challenging. Multi-layered digitally initiated transformations and increasing environmental complexity significantly influence organisational actions. Digital and/or sustainable business models and the accompanying changes challenge organisations in various ways. However, mature, universally applicable frameworks remain scarce (Becker, 2019).

Start-ups face the challenge of completely rebuilding business models. Established procedures of pattern-based business model development approaches, coupled with entrepreneurship research, provide tools for creating and validating business models in a timely manner. Market benefits, products, services, or hybrid services must be developed, value propositions must be shaped, customer segments and channels defined, and value creation networks established (Bieger & Krys, 2011). Start-ups are often seen as innovative entities aiming to generate profit, whether in the digital economy, classic services, or technology-oriented domains.

Social entrepreneurship, which focuses on addressing societal shortcomings for the common good, is becoming increasingly significant. This trend extends beyond non-profit organisations to profit-oriented companies that

recognise the importance of social responsibility for long-term success. These companies' success is no longer judged solely by financial profits but also by their contributions to social benefit. Nonetheless, economically viable structures remain indispensable for such organisations.

Environmental and social changes affect organisations more rapidly and profoundly than earlier transformation processes. Nosratabadi et al. (2019) define Sustainable Business Models (SBMs) as those integrating economic, social, and environmental goals to provide competitive advantages and foster sustainability. Together with digital transformation, such models can enhance business resilience (Geissdoerfer, Savaget, Bocken & Hultink, 2021).

The rising complexity in the economy, combined with growing organisational networking, restricts the ability to control decisions effectively. The time lag between causes and effects and the non-linearities of dependencies often result in highly dynamic behaviours. Numerous feedback loops and the isolated consideration of influences in decision-making highlight the limitations of static business model approaches. A systemic, holistic view can prevent fragmentary coverage, misdirected focus, and oversteering during business model analysis. (Tewes, 2020)

This paper aims to propose a systems thinking-based framework for sustainable business models (STSBM) by integrating systems thinking into a modified version of the Business Model Canvas (BMC) based on Osterwalder and Pigneur (2010). While the original BMC separates the areas that together form the business model, its operational implementation remains a challenge. Key influencing variables were identified as representative components of the domains and linked together to reflect their interactions. The resulting STSBM abstracts and maps the complex real system of the organisation in a similar way as discussed by Kurti, Salavati and Mirijamdotter (2021) for digital business models.

2. Business Model Frameworks

2.1 Business Model Canvas BMC according to Osterwalder and Pigneur

The Business Model Canvas (BMC) by Osterwalder and Pigneur focuses on comprehensively describing an organisation's business model. It serves as a strategic tool for constructing, evaluating, and visualising business models and is widely used across organisations of varying sizes and types. Their approach aimed to innovate beyond traditional theoretical model concepts and transitions theoretical insights into user-friendly, visualised frameworks. Existing business models can be categorised along dimensions such as customer interface, infrastructure management, product/offering, and financing (Osterwalder, 2004). These dimensions are further divided into nine sub-categories that serve as the fundamental building blocks, as depicted in figure 1 (Osterwalder & Pigneur, 2010).

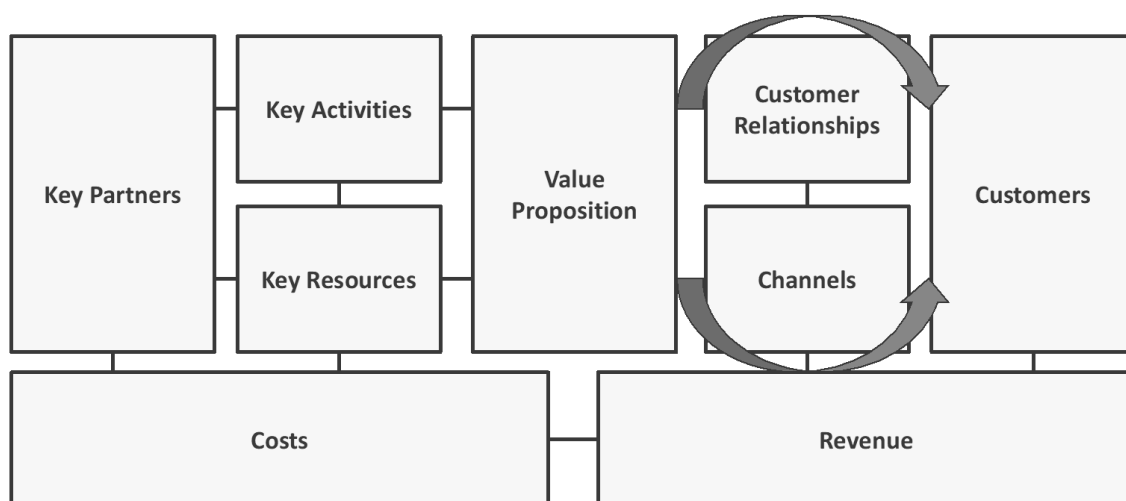


Figure 1. Business Model Canvas according to Osterwalder and Pigneur (2010)

2.2 Review and Discussion of the Business Model Canvas: Is A Model Modification Necessary?

The BMC is widely regarded as an intuitive and flexible tool that can be promptly constructed and utilised iteratively to refine and update business model strategies. Its primary purpose is to serve as a framework for identifying and analysing the core components and building blocks essential for the development of business models. The BMC achieves this by incorporating elements rooted in production and sales theory, framed within a

value-creation context. This framework facilitates an understanding of how roles, activities, and processes interconnect, promoting a comprehensive perspective on organisational operations. With its strong emphasis on customer orientation and value proposition, the BMC provides a robust foundation for business planning.

Developing a new business model necessitates defining critical elements such as value propositions, cost structures, revenue streams, and customer and supplier relationships, which are then integrated into a cohesive structure. Collaborative working is essential during this modelling process to accurately capture the complexity of reality. While the impact of changes on adjacent components can often be understood, a clear representation of the interdependencies among all business model building blocks is more challenging, frequently relying on the subjective interpretation of the user (Becker & Bröcker, 2021).

It seems that the model represents the business model mentally on a single level. Although this is advantageous from the perspective of model creation with as little complexity as possible, it constitutes an oversimplification, because different levels of abstraction were chosen when selecting individual business model components. This makes it harder to understand the model and to apply it in practice (Becker, 2019). The BMC tends to conceptualise the business model on a single level of abstraction. Although this simplifies the modelling process, it oversimplifies the complexity inherent in real-world systems, as different abstraction levels are often required for selecting individual business model components. This can hinder the practical application and comprehensibility of the model (Becker, 2018).

Furthermore, the BMC is inherently static, whereas strategies evolve over time in response to internal adjustments and external changes. Therefore, the BMC is not fully suited to address the growing complexity and dynamics of markets, sustainability considerations, and the influence of digitalisation on business models (Schlimbach & Ashgari, 2020). This can result in short-term thinking detrimental to long-term organisational success.

2.3 Sustainable Business Models (SBM)

Traditional business models often focus on maximising economic value derived from natural and social resources, frequently prioritising short-term gains. In contrast, integrating sustainability into business models is increasingly acknowledged as essential for long-term success. Organisations that focus on sustainable innovations not only in their products and services but also in the processes underlying their development and commercialisation enhance their economic resilience (Young & Gerard, 2021). Recent studies, such as those by Lüdeke-Freund, Carroux, Joyce, Massa and Breuer (2019) and by Ferlito & Faraci (2022), emphasise the importance of aligning profitability with social and environmental responsibilities through innovative frameworks and stakeholder collaboration, adhering to the triple bottom line framework depicted in figure 2.

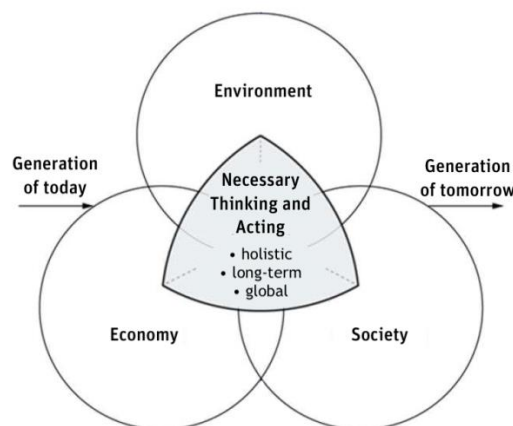


Figure 2. The Triple Bottom Line Concept according to Pufe (2017)

Additionally, Manninen, Laukkanen and Huiskonen (2023) emphasise stakeholder engagement and performance management as critical to sustainable value creation. Schaltegger, Hansen and Lüdeke-Freund (2016) argue that traditional business models also fail to capture the dynamic and systemic interdependencies required for achieving sustainability. This underscores the necessity for integrating dynamic tools like systems thinking, which facilitate iterative processes to navigate complex business environments. Integrating dynamic system simulation with the BMC offers potential for better managing these dynamics, making a compelling case for modifying the BMC framework (Kurti et al., 2021; Becker, 2019). The lack of established frameworks for developing and deploying such dynamic SBMs led to the proposed STSBM.

2.4 Systems Thinking to Explain and Visualise Business Models

Business models are inherently complex systems with numerous interconnected components characterised by non-linear interdependencies, significantly influencing organisational performance in market environments. These systems exhibit emergent properties that surpass the sum of their parts, and their behaviour is challenging to predict due to dynamic interactions within and beyond the organisation. (Massa, Gianluigi & Tucci, 2018)

Systems thinking has proven effective in addressing such complexity, particularly in sustainable business models. It provides a holistic approach, using tools and language to identify fundamental patterns and structures in mental models and relationships (Kurti et al., 2021). Bocken, Short, Rana and Evans (2013) highlight its importance in evaluating trade-offs across environmental, social, and economic dimensions. However, networks cannot be fully predicted over time in practice, even with good knowledge of their elements and interactions. Monat et al. (2020) attribute many business failures to the lack of systems thinking. Tools such as causal loop diagrams (CLDs) effectively visualise feedback loops, identify leverage points (Sterman, 2002), and map value creation processes (Pereira, Medina, Gonçalves & da Silva, 2017). These models also serve as shared learning tools, representing actors' mental abstractions of reality.

Despite the recognised complexity of business models, research remains limited, especially concerning additional challenges from digital innovation. Systems thinking facilitates deeper insights into business realities by uncovering patterns, system structures, and mental models, thereby supporting the implementation of sustainable business models. Integrating components and interactions into frameworks is crucial for building cohesive, interconnected systems. This systemic approach offers a holistic perspective, enabling better management of the dynamic nature of business models. (Kurti et al., 2021)

3. The System Thinking based Sustainable Business Model (STSBM)

As previously discussed, a static framework with varying levels of abstraction is not an ideal foundation for business model development. Nevertheless, the absence of dynamic, system-based models for sustainable business development leaves the traditional BMC as the predominant tool for design and visualisation.

Integrating dynamic capabilities into business models is essential for navigating uncertainty and adapting to changing environments. Teece (2012) emphasises the importance of sensing, seizing, and reconfiguring resources to maintain a competitive advantage. Consequently, the BMC requires enhancement with a stronger operational focus, particularly for guiding the implementation of innovative business models developed by start-ups. Specialised approaches are also necessary for not-for-profit organisations and sustainable business models based on the triple bottom line. By incorporating these considerations, a Systems Thinking Sustainable Business Model (STSBM) can better reflect the demands of modern markets while keeping the model simple and closely aligned with the well-established BMC.

3.1 Business Model Canvas & Systems Thinking

In the BMC, the business model is not merely presented as an outcome or value proposition but also includes the necessary enablers. In this sense, a systems thinking approach is inherently embedded within the canvas although not immediately obvious. However, the traditional BMC incorporates multiple levels of abstraction, such as stakeholders (partners and customers), processes, relationships, and financial aspects. While these collectively define the overall business model, they are difficult to compare and cannot easily be integrated into a unified system model.

To address this, a systems model has been developed where elements are identified as representative components of the building blocks, all aligned on a single level of abstraction to facilitate interlinking. For instance, in the classic BMC, customer channels might explicitly list distribution, marketing, and sales methods. In contrast, the systems thinking model defines elements that reflect the goals necessary for achieving the business model's objectives. Within the BMC's "Channels" building block, the focus shifts from merely naming specific channels to evaluating their effectiveness in supporting the realisation of the business model. The success of these channels depends on their optimal, efficient, and effective alignment with other building blocks and their suitability for the chosen customer segments. The specific design of these elements varies depending on the organisation.

Linkages exist between key resources and key activities, both of which connect to value propositions and are shaped by customer segments. Different customer segments influence the nature of the value propositions, while resources and activities are employed to deliver these services. These value propositions, in turn, affect the revenue streams of the business model, while the efforts required within these building blocks determine the cost structure.

3.2 Elements of the System Thinking based Sustainable Business Model

In the STSBM presented in Figure 3, 9 building blocks with 22 elements have been detailed across the various fields of the BMC, providing a comprehensive framework for analysis and application:

- CS: Customer Segments** – Identification of distinct groups that an organisation aims to serve or reach.
- VP: Value Propositions** – Solutions offered by the organisation to address customer needs or problems.
- CH: Channels** – Methods through which value propositions are communicated, distributed, and delivered.
- CR: Customer Relationships** – Strategies for acquiring, retaining, and nurturing relationships with customers.
- KR: Key Resources** – Essential assets required to develop and deliver the components outlined above.
- KC: Key Competencies** – Critical knowledge and expertise necessary to provide the described building blocks.
- KPr: Key Processes** – Execution of the core processes integral to the organisation's operations.
- KPa: Key Partnerships** – Collaboration with external entities for outsourcing activities and acquiring resources.
- I: Impact** – A holistic consideration of returns alongside environmental and social dimensions

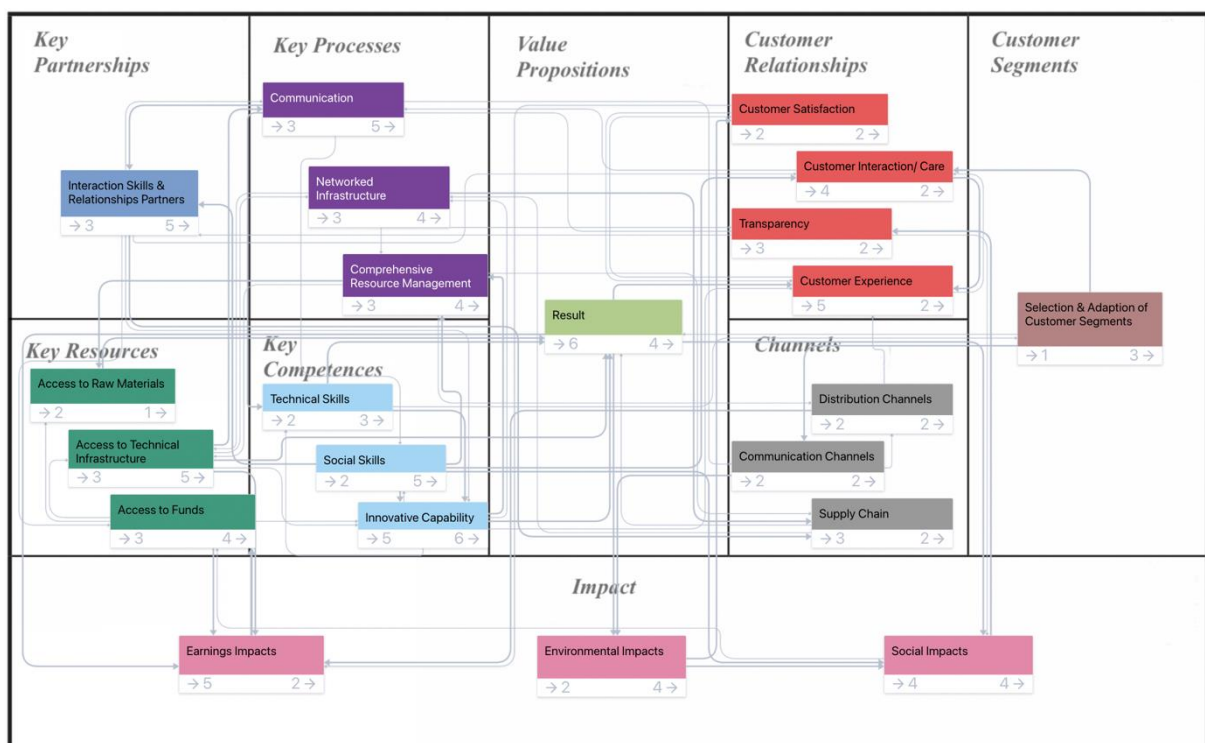


Figure 3. Modified Business Model Canvas: Building Blocks and Elements

3.3 Model Development Process

Initially, the BMC was used as a conceptual framework to identify the building blocks operating at the same level of action. Core elements of the business model were then refined into meaningful components that represent specific goals and can be aligned with corresponding areas, enabling subsequent interlinking. Indicators were defined to measure the achievement of these goals, functioning as Key Performance Indicators (KPIs) within the system, providing a basis for evaluation.

Next, all relevant direct relationships between individual system elements were mapped to visualise cause-effect relationships. The resulting chains of effects were analysed for plausibility. The underlying principle is that any change in the state of a system element propagates as an impulse through the relationship to a target element. The cumulative effect of these relationships drives the system's dynamics over time. For each relationship, the maximum influence of the source element on the target element was estimated using predefined characteristic curves, with potential time delays in the effect also accounted for.

System elements may also undergo changes independently of external impulses, driven by inherent dynamics. These inherent behaviours were estimated and formulated to ensure the model's accuracy. To facilitate robust analysis and evaluation of the relationships, continuous plausibility checks were conducted on the entire effect

chains, including feedback loops. This iterative validation process ensures the system model accurately reflects the dynamics and interdependencies of the business model.

An impact circle can be illustrated as shown in the example of figure 4: when an investor contributes funds, the element "access to finance" receives an impulse, improving its condition — let us assume by 15%. This enhancement in "access to finance" affects the element "technical infrastructure" through their relationship, enabling the acquisition or leasing of new machinery. The improved technical infrastructure (e.g., the new machines) facilitates the creation or enhancement of products or services, thereby improving outcomes. The increased result positively impacts income, with the additional revenue providing new financial resources that support further activities. This example highlights the indirect effects of interventions or actions within the system, demonstrating the value of using a system model to identify interactions and uncover critical connections that inform decision-making.

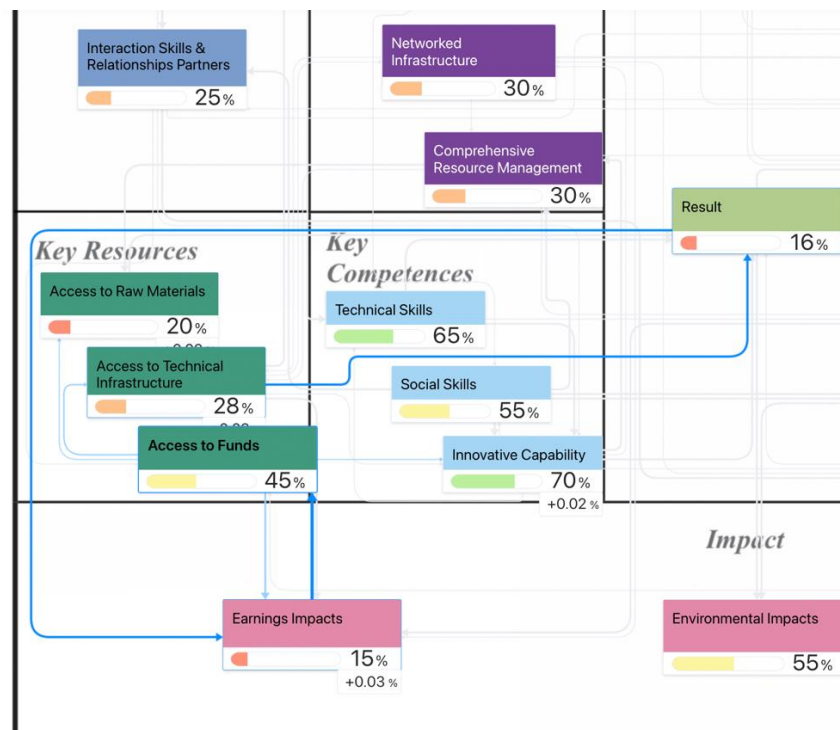


Figure 4. Example of an impact circle

Competitiveness and welfare orientation were mapped as resources, while events were formulated to represent interventions in the system that influence the state of elements and the availability of resources. These events can be either exogenous, originating from outside the organisation, or endogenous, resulting from changes within the organisation itself. Common triggers for events include time, chance, prior actions, or the condition of an element. Events can also lead to subsequent events, enabling the mapping of system dynamics through event cascades.

Goal-oriented interventions by stakeholders or interest groups, referred to as actions, can also be defined within the system. To describe an action, its prerequisites must first be outlined, followed by its effects on the specified resources and system elements. Any resulting events are linked to the action. For evaluating alternatives, actions are assigned to stakeholders and related events, and these are summarised into evaluation scenarios. A simulation-based comparison of various alternative actions and scenarios — comprising bundles of events and actions — is then conducted, enabling data-driven decision-making to improve outcomes.

3.4 Using the System Thinking based Sustainable Business Model

In the start-up scene, where the BMC is widely used, there is a clear demand for its operational evolution into a dynamic model that covers also sustainability aspects. The proposed STSBM is capable to introduce users familiar with the BMC to systemic thinking. This is achieved through a system model that closely mirrors the structure of the BMC, presenting a coherent overall framework. Users can easily navigate the model, recognising familiar aspects and transitioning seamlessly from the BMC to a systemic approach. The BMC serves as an initial framework, offering a structured way to analyse individual elements. The next step is to understand that

these elements are interdependent — customers are connected to partners, activities are linked to revenue streams, and resources are consumed in the process.

In the presented STSBM, the BMC's areas are divided into individual elements, each logically linked to other elements across the framework. This enables users to immediately see how components interact, providing an entry point to consider cause-effect chains and understand the multi-layered interactions within the system. This sets the stage for discussions with entrepreneurs about whether planned activities align with their goals and whether their business model is viable. By incorporating scenarios with varying constraints and environmental influences, the model also supports the assessment of business model resilience, helping to establish robust risk management.

The STSBM serves as both a decision-making tool and a guide. Its greatest value is realised when start-ups engage with the entire modelling process from the outset. During later stages, such as those supported by a Design Thinking process, parallel entries can be made into the model. While events and actions are initially grouped and broadly defined, they are refined during the simulation phase, with greater detail added to account for decision points and time delays. Previous steps can be reviewed and, if necessary, adjusted or removed from the model.

What was once practiced with the traditional BMC is now enhanced by the addition of relationships and system dynamics, delivering greater value. Scenarios can be created and tested to identify events or combinations of events that may hinder planned activities from achieving desired outcomes. New action combinations can be evaluated and compared against the original system model. With each application, the system model evolves, incorporating the strategies envisioned by the founding organisation as bundles of measures for subsequent testing. These strategies can be revised at each step, guided by insights from the simulation. Evaluations of new simulations provide data-driven conclusions about whether and when strategies should be adapted, ensuring the model remains responsive and effective.

4. Conclusion and Outlook

While the traditional Business Model Canvas (BMC) provides a proven framework for innovating and constructing business models, its static nature necessitates critical evaluation. Successful implementation of a business model requires not only theoretical understanding but also practical validation under real-world conditions. Furthermore sustainability becomes an increasingly critical aspect of business strategy. Neglecting these practical dimensions, especially in the early stages, risks losing valuable learning opportunities and insights crucial for assessing future developments, such as the impact of specific events or actions within a system. This highlights the need for a framework that holistically incorporates sustainability into a dynamic business model design and evaluation.

The proposed modification of the BMC into a Systems Thinking based Sustainable Business Model (STSBM) addresses the limitations of static frameworks. By enabling dynamic analysis and visualisation, it facilitates iterative discussions on refining and evolving a business model. Shifting the focus from merely listing building blocks to assessing the achievement of specific goals introduces a new perspective, offering more actionable insights. Additionally, the integration of the triple bottom line — balancing economic, environmental, and social dimensions — responds to growing stakeholder demands for sustainability-oriented business practices.

The STSBM also aligns well with the flexibility required by start-ups. Its ability to simulate interactions and adapt to changing market conditions makes it particularly useful for navigating uncertainties. Start-ups benefit from its agile framework, which supports iterative adjustments and scenario testing to validate assumptions and ensure resilience under various conditions. By visualising feedback loops and interdependencies, the model fosters a shared understanding among stakeholders, enhancing strategic alignment and informed decision-making. Furthermore, it aids in evaluating long-term impacts, ensuring strategies are sustainable across economic, environmental, and social dimensions.

Despite its advantages, the STSBM comes with some constraints and limitations. The iterative nature of systems thinking requires significant time and effort. The model's effectiveness also depends on the ability of users to accurately identify and prioritise key system elements and feedback loops. Subjective biases in this process may lead to variability in outcomes, affecting decision consistency (Maani & Cavana, 2007). The dependence on sound data and realistic assumptions poses a further challenge. Misleading assumptions or incomplete data can affect the validity of the results, especially for complex systems such as business models (Sterman, 2002). Additionally, effective use of the model requires substantial expertise in systems thinking, which may create barriers for small organisations or start-ups with limited resources or experience.

The calibration and validation of cause-effect relationships and feedback loops also present difficulties. Non-linear interactions and emergent properties in real-world systems can result in discrepancies between simulated and actual outcomes. Simplified predefined characteristic curves may further limit the accuracy of long-term predictions.

To address these limitations, future research could explore the integration of artificial intelligence (AI) and machine learning into dynamic business models. These technologies have the potential to enhance the model's ability to adapt to complex, real-world scenarios and improve the accuracy of simulations (Brynjolfsson & McAfee, 2017). In addition, adopting frameworks like the Multi-Level Perspective (MLP) could enrich the STSBM by analysing interactions between niches, regimes, and landscapes in the context of sustainability transitions (Geels, 2002). This would provide deeper insights into the systemic changes required for sustainable business innovation.

Further studies should also focus on improving accessibility for users and reducing the barrier of expertise. The development of user-friendly interfaces and training programmes could facilitate the application of systems thinking models and make them more accessible to start-ups and small businesses. Finally, comparative studies could investigate the practical implementation of the model in different industries and provide empirical evidence to refine its functionality and applicability.

By addressing these avenues, the proposed STSBM could evolve into a robust and versatile tool, supporting not only sustainable business development but also fostering innovation and resilience in a dynamic and uncertain world.

Acknowledgments

Not applicable

Authors' contributions

David Müller and Prof. Dr. Siegfried Zürn were responsible for the study design. Dr. Michael Holzner supported in the application of the systems thinking modelling and revision of the study design.

David Müller was responsible for the literature review, the modeling and drafted the manuscript. Prof. Dr. Siegfried Zürn and Dr. Holzner revised it. All authors read and approved the final manuscript.

Funding

Not applicable

Competing interests

Dr. Michael Holzner is affiliated with iCONDU GmbH, the company that had developed and distributes the development software simcision that was used to visualize the model framework.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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