DOCTORAL CONSORTIUM

THE JOURNEY TO SUSTAINABLE DIGITAL BUSINESS MODELS: EMBEDDING TWIN TRANSFORMATION FOR LONG-TERM SURVIVAL

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This PhD explores how organizations overcome resource constraints and develop dynamic capabilities within the Twin Transformation (TT) to move toward sustainable digital business models. TT–the convergence of digital and sustainability transformations–requires organizations to reshape their business models to stay resilient in an evolving landscape. Yet, as both TT and sustainable digital business models are still emerging concepts, the implications and necessary organizational adaptations remain unclear. The complexity of the TT, with its dilemmas and trade-offs, adds further challenges. This research investigates how internal and external dynamics influence TT adoption, and how organizations orchestrate resources and build capabilities to overcome barriers. Using a qualitative, process-oriented approach findings are expected to show that the TT must be approached as a fundamental organizational change, with similar constraints and capability challenges emerging across organizations. This study contributes to the discourse on TT, organizational change, and sustainable digital business model discourse, offering practical guidance to strengthen organizational resilience.

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1 Introduction

Two major transformative forces are influencing how organizations adapt their business models to stay future proof: the sustainability transformation and digital transformation. The sustainable transformation necessitates a shift towards a business model based on multiple-value-co-creation, integrating ecological, social, and governance dimensions into business models that have traditionally prioritized economic value (Barnes et al., 2024; Breiter et al., 2024), thereby refining their raison d'être. Those that fail to adapt may struggle to comply with regulations such as the Corporate Sustainability Reporting Directive (CSRD) exposing themselves to regulatory penalties (Novicka & Volkova, 2024), lessened employee attractiveness (N. M. P. Bocken & Geradts, 2020) and potential loss of market trust (George & Schillebeeckx, 2022). Simultaneously, the digital transformation compels organizations to integrate transformative technologies–such as platforms, Artificial Intelligence, blockchain, and Internet of Things–into their business model, fundamentally redefining how they operate and innovate (Breiter et al., 2024). Organizations that fail to embrace digital transformation risk operational inefficiencies (Martínez-Peláez et al., 2024) and diminished market resilience (Graf-Drasch et al., 2023), making it increasingly difficult to sustain long-term success as their competitors *will* embrace it. These two transformations are not occurring in isolation, but are converging, leading to what is known as the Twin Transformation (TT) (Graf-Drasch et al., 2023; Kürpick et al., 2024). According to Christmann et al. (2024, p. 7) the TT represents "a value-adding interplay… leveraging digital technologies for enabling sustainability and leveraging sustainability for guiding digital progress.", as shown in Figure 1. However, while the TT offers the potential to harness the synergies of both transformations for sustainable digital value creation, it is not a straightforward process in which their combined benefits automatically add up. Instead, the TT introduces new dilemmas and trade-offs that organizations must navigate (Raihan, 2024). Existing literature highlights two challenges that organizations might encounter in the TT process: sustainability traps and digitalization traps. In sustainability traps, innovations support sustainability goals but lack economic feasibility, making them financially unsustainable (Xu et al., 2024). Notably, this type of trap does not (yet) explicitly incorporate the role of digitalization. Conversely, in digitalization traps technological advancements increase negative environmental impact (N. Bocken, 2023; Rosati et al., 2024), such as the high energy consumption in AI-driven processes. These challenges

underscore the complexity of TT, requiring organizations to move beyond isolated sustainability or digital strategies towards a more integrated and holistic approach to TT. The need for a holistic transformation aligns with Christmann et al.'s (2024, p.5) definition of TT, which I will follow in this PhD: "a fundamental organisational change process that enables organizations to address digital and societal challenges synergistically by harnessing the power of digital transformation to enable sustainable transformation and leveraging sustainable transformation to redesign digital transformation". Because the TT is recognized as a broader geopolitical, social, economic, and regulatory shift (European Commission, 2022), it requires more than superficial adjustments. Organizations need to fundamentally rethink their structures, strategies, and capabilities to fully align with TT imperatives and position themselves for long-term survival (Plotnytska et al., 2024; Riso & Morrone, 2023). So, by actively integrating TT into their business model, organizations could strengthen their competitiveness (van Erp & Rytter, 2023), and could potentially avoid risks that could ultimately weaken their resilience, with potential consequences such as financial instability or even bankruptcy. In other words, organizations have both a strategic imperative and a broader responsibility to effectively navigate TT– not only to secure their own survival but also to contribute to a more sustainable world.

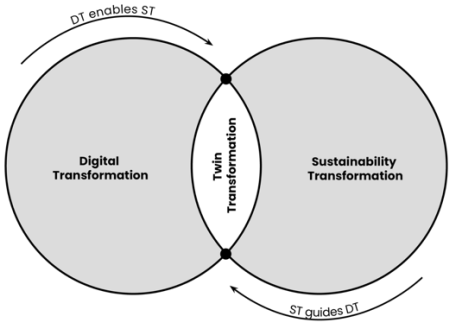

Figure 1: The Twin Transformation dynamic
Source: (Christmann et al., 2024, p. 7)

Before we can start to understand how organizations navigate the challenges and opportunities of TT, it is essential to establish a clear framework that defines what a business model incorporating the TT entails. Without such a foundation, discussions on the TT risk remaining abstract, making it difficult to assess progress, identify

strategic pathways, and develop actionable insights for organizations undergoing this transformation. Within the TT, the objective is to foster the development of Sustainable Digital Business Models (SD-BMs)—business models that integrate sustainability and digitalization to create, deliver, and capture value in a way that is both environmentally responsible and technologically advanced. This raises the question: how do 'sustainable digital' aspects enhance or redefine existing business model constructs? First, what exactly is an SD-BM? Currently, no clear definition exists, although Böttcher et al. (2024) attempt to conceptualize the term within the TT literature by focusing on archetypes, and, along with Xu et al. (2024), call for more research on this topic. Existing frameworks for sustainable business models and digital business models offer relevant foundations to build upon. For example, sustainable business models are defined by Geissdoerfer et al. (2018, pp. 403-404) as models that "incorporate pro-active multi-stakeholder management, the creation of monetary and non-monetary value for a broad range of stakeholders, and hold a long-term perspective". In turn, Bican and Brem (2020, p. 10) offer a framework on how digital business models might sustainably relate to innovation, describing how they "enhance resource optimization, characterized by intangibility, businesses' uniqueness, and core values, centering around experience, platform and content". Encouragingly, organizations are already beginning to rethink sustainable digital value by leveraging digital technologies, such as exchange platforms, to e.g. facilitate resource sharing (Aagaard & Vanhaverbeeke, 2024). Additionally, Green IT initiatives demonstrate how digital transformation can actively support sustainability goals by reducing environmental impacts throughout the ICT value chain (Fors et al., 2024). Thus, although the concept of SD-BMs is still in need of clearer frameworks, the existing theoretical foundations combined with practical examples of business models that integrate both transformations, offer valuable starting points. These insights make it possible to establish a discursive foundation for further exploring and refining what an SD-BM is and how it can guide organizations in practice.

To navigate towards a SD-BM it is important to realize that organizations do no longer modify their business models in a vacuum, since "addressing complex sustainability challenges with uncertain payoffs may require financial trade-offs and lengthy experimentation with a broad range of external stakeholders (N. M. P. Bocken & Geradts, 2020)". In more abstract terms, business models are shaped by, and in turn, shape the specific segment of its external environment that encompasses

the opportunities and expectations relevant to its operations, referred to as the existence-relevant space (Rüegg-Stürm & Grand, 2019), visualized in Figure 2. As the TT is a broader geopolitical, social, economic, and regulatory shift (European Commission, 2022), the TT influences this space one way or another. Because organizations not only adapt to but also actively shape this space, the TT therefore influences both the external environment and the organizations' internal dimensions, such as governance, strategy, structure, and culture. Within the existence-relevant space organizations must continuously balance the continuum of 'renewal' and 'optimization' of their business model (Rüegg-Stürm & Grand, 2019) to sustain organizational value creation over time. Excessive renewal can lead to instability, while over-reliance on optimization risks stagnation. TT adds complexity by requiring organizations to manage both digital and sustainability transformations while navigating this balance. The continuous interaction between complex internal and external dynamics, combined with the increasing need for business models to provide 'complex value' to different stakeholders (Barnes et al., 2024, p. 3), creates additional challenges in effectively transforming toward a business model that ensures long-term survival. This brings us to a key question: where do organizations begin their TT journey within the complex interaction with their existence-relevant space, and how does this initial orientation shape the specific resources and capabilities required to transition towards a SD-BM?

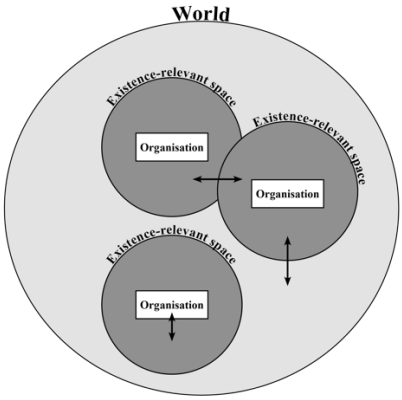

Figure 2: Own Interpretation of Organizations in Relation to the Existence-relevant Space Based on Rüegg-Stürm & Grand, 2019

How organizations start their journey towards SD-BMs is important, as it influences whether the TT is embedded in the organization or remains a superficial exercise. This is important as it determines how organizations will further allocate resources and develop dynamic capabilities to strategically adapt their business models to align with both digitalization and sustainability imperatives. While some scholars have attempted to conceptualize TT pathways (Aagaard & Vanhaverbeeke, 2024; Böttcher et al., 2024), empirical insights remain scarce (Christmann et al., 2024; Jonkers & Vester, 2024). Aagaard and Vanhaverbeeke (2024) propose a quadrant model that maps organizations based on their degree of sustainability integration (high or low) and digital intensity (high or low), outlining potential pathways they may take. Breiter et al. (2024) adopt a maturity model approach, identifying three pathways leading to the "True Twin Transformer". Although these models contribute to the discourse, they do not address a fundamental question: what determines whether TT is adopted as a fundamental entrepreneurial opportunity or merely a marketing task (cf. Rüegg-Stürm & Grand, 2019)? Purpose literature (George et al., 2023) can help analyze the early-stage dynamics of TT adoption to clarify how initial strategic decision-making practices shape resource allocation. Additionally, organizational culture plays a pivotal role in the digital transformation towards sustainable development (Philbin et al., 2022), supported by Martínez-Peláez et al. (2024) who write that "success [in the TT] depends on creating adaptive business models and fostering a culture that embraces change, innovation and dynamic capabilities". However, because the TT literature lacks knowledge on organizational change management (Pacolli, 2022), it leaves a gap in understanding how culture can support TT integration. Therefore, understanding how internal and external influences shape TT adoption is crucial, as these factors directly impact how organizations manage resource constraints and navigate the transition toward SD-BMs.

Once the TT adoption in the context of TT has been examined, a critical gap remains in understanding the specific resources and capabilities required to transform towards a SD-BM (Christmann et al., 2024; Feroz et al., 2023). While some research is emerging in the DT literature (Chen & Tian, 2022; Peretz-Andersson et al., 2024) and circular economy literature (Kristoffersen et al., 2021), the intersection of these two domains has not been sufficiently examined. Resources, defined as combinations of assets (Barney et al., 2001), can be *physical* (e.g., plant and equipment), *human* (e.g., attributes of managers and workers), and *organizational* (e.g.,

structures and technologies) (Barney et al., 2001). To achieve long-term survival, these resources must be continuously adjusted to align with the existence-relevant space. However, the question remains: how can firms effectively manage and develop these resources within the TT context? To address this, Resource Orchestration (RO) theory (Sirmon et al., 2011) provides a framework for understanding how firms structure, bundle and leverage resources. When effectively combined, these resources form capabilities (Barney et al., 2001), as illustrated in Figure 3 (Ahuja & Chan, 2017, p. 81). Dynamic Capabilities (DC) theory extends the RO theory by explaining how organizations develop and adapt capabilities over time (Teece, 2007), critical to transform business models (N. M. P. Bocken & Geradts, 2020). The DC framework, comprising sensing, seizing, and transforming capabilities, enables organizations to respond effectively to external shifts and sustain competitive advantage (Teece et al., 1997). RO and DC therefore together provide complementary lenses for analyzing how firms adjust their resources while moving towards SD-BMs. In summary, while RO explains how firms mobilize and configure their resources, DC clarifies how these resource configurations evolve into adaptive capabilities to sustain business model resilience through time.

Figure 3: The Process View of IT Innovation
Source: (Ahuja & Chan, 2017, p. 81)

2 Problem Definition

As organizations face increasing pressure from TT, they need more empirical examples on how to navigate the intersection of digitalization and sustainability. While these two transformations have the potential to reinforce one another, they also introduce dilemmas and trade-offs, making it challenging for organizations to determine how to modify their business models to sustain long term survival. This has significant implications for how organizations manage resource constraints arising from TT and how they develop (dynamic) capabilities to effectively respond to external shifts. This study aims to identify common patterns among organizations that successfully integrate TT, with the objective of understanding how internal and

external dynamics enable organizations to navigate TT's complexities and constraints.

The main research question is: How can organizations embed the Twin Transformation in their organization for sustainable digital business model development? To answer this question the following sub-research questions are formulated.

SQ1: What constitutes a sustainable digital business model?

SQ2: How do organizations initiate their journey towards a sustainable digital business model?

SQ3: What resource constraints do organizations encounter when moving towards a sustainable digital business model and how do they cope with them?

SQ4: How do organizations develop the necessary dynamic capabilities in order to move towards a sustainable digital business model?

SQ5: What patterns can be identified in organizations embedding a sustainable digital business model?

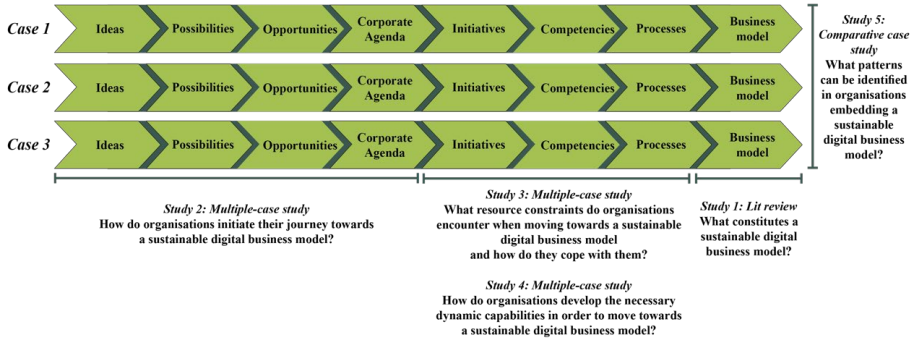

Figure 4: Visualization of Sub-question Alignment for SD-BM Development, Based on Rüegg-Stürm and Grand's (2019, p. 176) Strategy Development Framework

3 Methodology

The complexity and evolving nature of TT, coupled with its predominantly conceptual literature (Christmann et al., 2024; Jonkers & Vester, 2024), necessitate an explorative approach. This PhD adopts social constructionism, which views reality as socially constructed through shared meanings, interactions, and language (Berger & Luckmann, 1991). This perspective is grounded in a relational process ontology (Langley, 1999; Van de Ven & Poole, 2005), emphasizing that organizations continuously adapt their business models in response to changing internal and external dynamics. I therefore take a temporal approach within three organizations over the period of two years to capture both the intertwined context and more contextual specificity that shape SD-BMs (Hoorani et al., 2023). By integrating multiple forms of knowledge-exchange throughout the research period, I ensure temporal data access while simultaneously creating value for the case organizations throughout their journey. This continuous data collection will ensure sufficient and sufficiently rich data to capture in-depth, embedded, and processual insights, while allowing for theoretical grounding in the phenomenon (Van de Ven, 2016). Through ongoing reflection and practitioner engagement, this study aims to provide a sincere, credible, and meaningful account (cf. Tracy, 2010) of how organizations shape SD-BMs. I conduct the following studies: A scoping review to build common language (SQ1), three multiple-case studies, analyzing adoption, resource constrains and dynamic capabilities separately (SQ2-4) and a study to identify overarching patterns across the three case studies (SQ5).

To support this approach, I combine social constructionism with a strong process orientation (Chia, 2002), as it allows for understanding transformation as an unfolding process, examining how organizations make sense of and embed TT in practice through time. Before a new initiative like TT becomes embedded within an organization's structural foundation, several organizational processes must unfold. Understanding how this happens is the core focus of my PhD. To provide theoretical structure for designing this process, I draw on the Strategy Development Framework (Rüegg-Stürm & Grand, 2019). This framework is particularly valuable as it helps to clarify the underlying creation and decision-making processes that ultimately lead to value creation–which, in this case, translates to the development of an SD-BM. In my PhD, I aim to provide clarity on the TT embedding process by systematically studying different phases of this process. While Figure 4 illustrates

how my studies cover all phases towards business model development, the studies themselves will be conducted in a sequential order–1, 2, 3, 4, and 5. Even if the visual representation suggests a different order, my research follows a progression where each study builds upon the insights of the previous one. Ultimately, this approach will allow me to construct a more comprehensive and integrated overview of the processes underlying SD-BMs development within organizations.

This study focuses on frontrunner organizations who act as catalysts for the TT. Frontrunner organizations actively shape their existence-relevant space through collaborative and coordinative activities (Kilpatrick & Conroy, 2024), influencing the actions and strategies of other actors operating within, and extending from, this space. By examining how frontrunners create enabling conditions and overcome barriers, this study provides insights that can inspire and guide other organizations in moving towards SD-BMs. Mid-to-large-size enterprises (MLEs) provide a structured setting for examining TT adoption over time, with defined processes and decision-making structures suited for temporal and process research. Unlike smaller firms, MLEs face more complex structural constraints, requiring deliberate strategic adaptations to embed TT effectively. I follow the classification of MLEs as outlined by the Sociaal-Economische Raad (n.d.), in Table 1.

Table 1: Definitions of Mid-to-large size Companies (Sociaal-Economische Raad, n.d.)

	Mid-size	Large
Assets	No more than €25 million	More than €25 million
Net sales	No more than €50 million	More than €50 million
# employees	Less than 250	250 or more

3.1 Study 1: What constitutes a sustainable digital business model?

This study uses a scoping review, supplemented by focus groups, to establish a foundational understanding of SD-BMs within the TT. As SD-BMs lack a clear definition, this research provides an initial framework to guide the PhD. Focus groups add depth by capturing practitioners' interpretations of TT, ensuring alignment with real-world applications. Data collection includes academic literature and industry reports on business models, sustainability, and digitalization. Given the TT's limited academic discourse, industry reports offer practical insights. Focus groups with sustainability and digital transformation leads further explore how these concepts are applied in practice. For data analysis, the scoping review systematically

maps existing knowledge, while focus group insights are coded and analyzed to identify key themes and contextual applications, refining the SD-BM framework. The planning of this study can be found in Figure 5 in the appendix.

3.2 Study 2: How do organizations initiate their journey towards a sustainable digital business model?

This study employes a multiple case study based on dynamic capability lens (Teece, 2007; Teece et al., 1997) to examine early-stage TT adoption. By integrating Purpose literature (George et al., 2023) I explore how the TT is initially approached (e.g., top-down or bottom-up, fundamental entrepreneurial opportunity or marketing task (Rüegg-Stürm & Grand, 2019) to understand how this orientation later shapes resource orchestration (Study 3) and dynamic capability development (Study 4) in the following sub studies. Data collection focuses on frontrunner mid-to-large enterprises (MLEs), which have likely been engaged in TT for some time, necessitating a retrospective approach. Using the "timeline and eye-opener workshop" method (Van Mierlo et al., 2010) key stakeholders will reflect on challenges, successes, and experiences in their early TT journey. The key stakeholders involved are expected to vary across case organizations, depending on their structure, industry, and stage of TT adoption. Following this phase, interim reflection workshops will track how organizations introduce, frame, and embed TT in real time, providing longitudinal insights into their transformation process. The planning of this study can be found in Figure 6 in the appendix.

3.3 Study 3: What resource constraints do organizations encounter when moving towards a sustainable digital business model and how do they cope with them?

This multiple-case study applies the resource orchestration lens (Sirmon et al., 2007, 2011) to examine how organizations prioritize, restructure, and allocate resources while balancing the demands and trade-offs of digitalization and sustainability. Despite emerging research on digital transformation (Chen & Tian, 2022; Peretz-Andersson et al., 2024) and circular economy (Kristoffersen et al., 2021), resource orchestration at their intersection remains underexplored (Jonkers & Vester, 2024). Data collection includes semi-structured interviews and observations with key decision-makers (e.g., executives, sustainability officers, digital transformation leads). This study will

analyze the underlying processes through which organizations restructure, prioritize and deploy resources in response of the demands of the TT. Using pattern mapping, it will identify common strategies for navigating and overcoming resource constraints. The planning of this study can be found in Figure 7 in the appendix.

3.4 Study 4: How do organizations develop the necessary dynamic capabilities in order to move towards a sustainable digital business model?

This multiple-case study uses a dynamic capabilities lens (Teece, 2007; Teece et al., 1997) to explore how organizations develop the capabilities needed for the TT. While literature on dynamic capabilities in TT is emerging (Christmann et al., 2024; Feroz et al., 2023), empirical evidence on how organizations develop the necessary dynamic capabilities remains scarce (Christmann et al., 2024). Additionally, existing dynamic capability studies predominantly focus on ecological aspects, while the integration of social, economic, and governance dimensions into these strategies remains underexplored (Feroz et al., 2023). Building on SQ2 and SQ3, this study examines how an organization's Purpose and resource orchestration influence re- and upskilling strategies, which are essential as the TT necessitates re- and upskilling across the entire organization on many different levels (Jonkers & Vester, 2024). Doing so, it is essential to align with evolving competency frameworks, such as the Circular Economy Education Map (Vitti et al., 2025). Data collection includes workshops with industry, government, and education stakeholders to leverage triple-helix interactions. This aligns with ongoing initiatives like the Nationale Coalitie Duurzame Digitalisering (NCDD) and the ErasmusPlus project Digital4Sustainability. Internal document analysis of training programs and job descriptions will offer insights into learning strategies, while observational studies, where feasible, will assess engagement with skill-building initiatives like on-the-job training and mentoring. The Digital4Sustainability project's training materials will be piloted to evaluate their effectiveness. Data analysis will involve process tracking to capture the evolution of DCs and qualitative coding to identify capability-building patterns and decision-making processes in workforce development. The planning of this study can be found in Figure 8 in the appendix.

3.5 Study 5: What patterns can be identified in organizations embedding a sustainable digital business model?

This comparative case study, complemented by a qualitative survey, analyzes the three organizations from SQ2-4 to identify factors explaining similarities in TT adoption, resource allocation, and dynamic capability development. It bridges TT and organizational change literature by examining the dynamics that shape these patterns (Pacolli, 2022). Data collection includes workshops, observational studies, and a qualitative survey to validate findings across a broader set of organizations. After 2–3 years of research, emerging patterns will be analyzed through iterative feedback loops and a cross-case synthesis to distill transferable process principles across sectors and structures. The planning of this study can be found in Figure 9 in the appendix.

4 Expected Results

This research is expected to reveal common patterns among organizations that are reconfiguring their business models in response to the challenges and opportunities of the TT. In this process, organizations are anticipated to encounter resource constraints and dynamic capability challenges to facilitate this transformation. Organizations are likely to face similar types of dilemmas, encountering common barriers such as knowledge gaps, limited adoption of digital technologies, misalignment internal incentives, and insufficient cross-functional coordination. Despite variations in business models, these barriers are expected to reflect shared underlying structural challenges. By examining front-runner organizations, the study expects to identify key enablers to overcome these constraints, such as an innovation-stimulating culture, adaptive governance structures, collaborative cross-functional practices, and strategic flexibility–all of which support organizations in effectively embedding TT toward resilient SD-BMs.

This brings me to the most significant limitation of this study, which stems from the decision to examine SD-BM development as a process embedded in complex internal and external dynamics. While this perspective is essential to capture the interconnectedness of the various elements and to generate insights that are truly meaningful for practice, this approach also means that the findings are based on an in-depth study of three organizations. As a result, the outcomes are highly context-

specific and not directly transferable to other settings, possibly limiting the generalizability of the results. Moreover, the reliance on qualitative data introduces the risk of interpretation bias, despite efforts to ensure methodological rigor through triangulation and transparent data analysis procedures. To mitigate these limitations, Study 5 incorporates a qualitative survey to validate and refine the emerging patterns across a broader set of organizations, thereby enhancing the robustness and applicability of the conclusions. Ultimately, the findings should be viewed as contextually grounded insights that can inform—but not prescribe—strategic approaches to Twin Transformation in other organizational settings.

5 Future Development

This PhD offers a starting point for understanding how organizations develop SD-BMs while overcoming resource constraints and dynamic capability limitations. As the TT continues to evolve, future research can expand across sectors and organizational types, exploring industry-specific approaches to SD-BM development. A key area for further study is the role of digital technologies, such as AI-powered expectation models, which could generate predictive insights to guide SD-BM design. As organizations become more interdependent on their external environment, future research should also examine the role of supply chains and network collaborations in fostering collaborative SD-BMs, driving systemic change in the existence-relevant space. Finally, combining qualitative and quantitative methods could enhance generalizability and validation, offering a more robust understanding of how TT is embedded across different contexts.

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Appendix

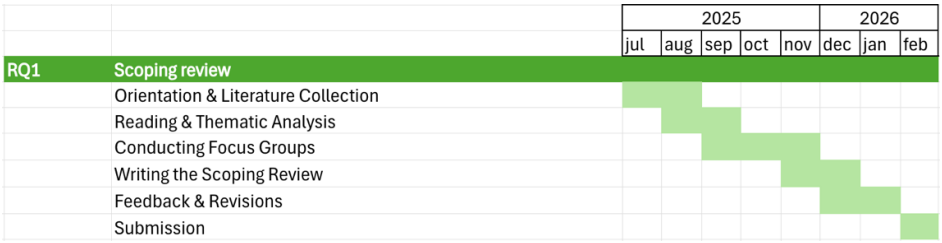

Figure 5: Planning Study 1

Figure 6: Planning Study 2

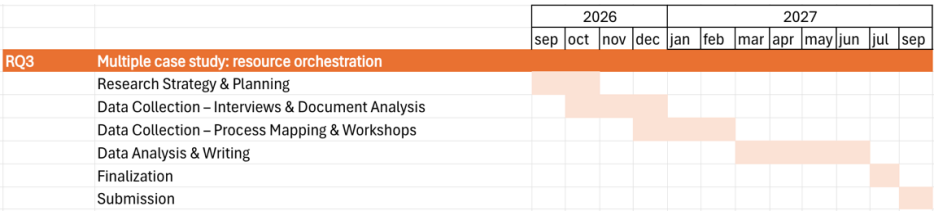

Figure 7: Planning Study 3

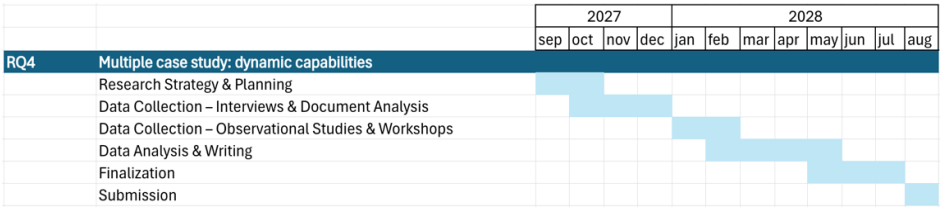

Figure 8: Planning Study 4

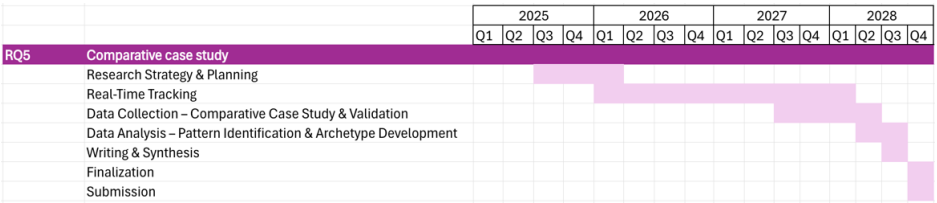

Figure 9: Planning Study 5