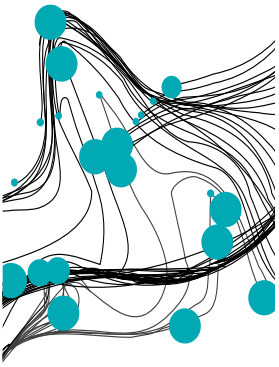

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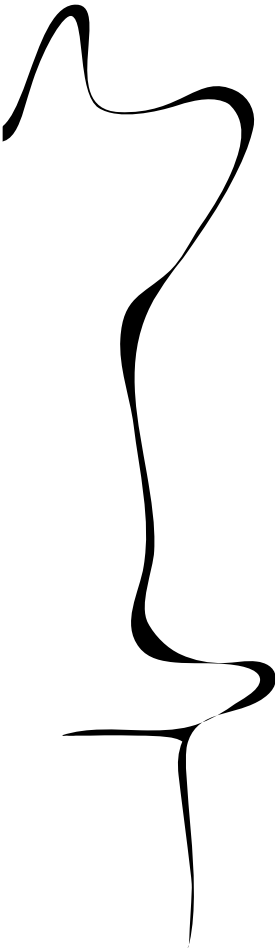
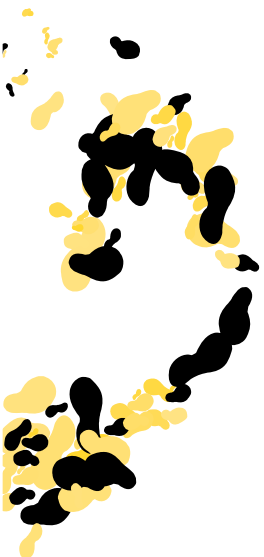


Capturing the Dynamics in Organizational Digital Transformation Using System Dynamics Modelling



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Aug 2024

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Chapter 1

Introduction

In the changing digital environment, organizations across sectors embark on the digital transformation journey to meet customer demands, enhance operational efficiency, ensure adherence to regulations, and maintain competitiveness. Leveraging digital technologies aids in streamlining processes, boosting flexibility, fostering innovation, and broadening market presence. Ultimately, successful digital transformation future-proofs organizations against technological disruptions and market fluctuations, ensuring sustained success in the digital era. (Hess, 2016)

However, organizational digital transformation is a complex and multifaceted journey involving not just the integration of new technologies but also fundamental shifts, making successful outcomes challenging to achieve (Vial, 2019). The previous topic research indicates that digital transformation changes happen in eight areas - technology, strategy, finance, organizational structure, processes, culture, people, and leadership. For example, successful digital transformation requires aligning technological efforts with business goals and fostering a culture of innovation and continuous learning.

Furthermore, the dynamic interaction and continuous evolution of those eight digital transformation areas introduce dynamics and uncertainties into the transformation process, thus amplifying its complexity (Suat Teker, 2022). Research shows that organizations may struggle to effectively navigate this intricate process, leading to digital transformation initiatives failing their initial goals due to factors such as resistance to change, inadequate strategic planning, and a lack of comprehension of the dynamic nature of digital transformation (Adriana Hofmann Trevisan, 2023).

General Electric (GE) started its digital transformation in 2013 under the leadership of then-CEO Jeffrey Immelt, aiming to transform itself into a ‘digital industrial’ company by utilizing software and data analytics. To achieve this goal, GE took a series of comprehensive initiatives. Starting with the development of the Predix platform, a cloud-based operating system designed for its Industrial Internet of Things, GE created a new business unit, GE Digital, to lead this transformation one year later. At the same time, GE was conducting a rapid cultural shift to a digital organizational culture by investing in digital talent and introducing new ways of working. The business model was even changed by integrating digital solutions with its traditional industrial products. Despite the intent being right, GE got lost in its digital transformation process and had to scale it back in 2018. A report shows that the reasons lie in lacking a clear vision of digital transformation, technological complexity, cultural resistance, and lacking prioritization. (Moazed, n.d.; Technologies, 2020)

Therefore, gaining a deeper understanding of digital transformation and its influencing factors is imperative for organizations striving for success in their digital transformation initiatives. This includes understanding and navigating the dynamics within and between those factors, and their impact on the overall digital transformation trajectory.

System Dynamics Modelling has emerged as an interesting and suitable methodology to study the complexity and dynamics inherent in the digital transformation of organizations because of its superior ability to study complex dynamic systems (K. Mokgohloa, 2022). System dynamics modeling is a methodology utilized to simulate, analyze, and comprehend complex and dynamic systems over time. It provides a comprehensive framework for understanding the interactions among various factors within an organization and their dynamic influence on digital transformation over time (Miles M. Yang, 2017).

This research aims to improve the current practices of organizations coping with the complexity and dynamics of digital transformation by designing a general system dynamics model of organizational digital transformation. The model provides a comprehensive organizational digital transformation framework and captures the dynamics within the transformation, aiming to offer users a deeper understanding of digital transformation and predictive insights into various digital transformation scenarios. Hence, the model was designed to be generic and adaptable for implementation across diverse organizational contexts. Ultimately, it is hoped that the potential application of this model can facilitate organizations to navigate the complexities of digital transformation, improve their success of digital transformation, and attain sustainable competitive advantage in the digital era.

To effectively address the issues mentioned above and achieve the research goal, the general research question was defined as follows:

How can the dynamics of organizational digital transformation be represented in a system dynamics model?

Also, the general research question was subdivided into four sub-questions. These sub-questions serve as guides throughout the research process, helping explore and ultimately resolve the main research question. The four sub-questions are as follows:

- How can the elements and their relationships involved in the system dynamics model of organizational digital transformation be identified?
- How can the elements and their relationships be dynamically represented in the system dynamics model of organizational digital transformation?
- How to theoretically validate the system dynamics model of organizational digital transformation?
- How to ecologically validate the system dynamics model of organizational digital transformation?

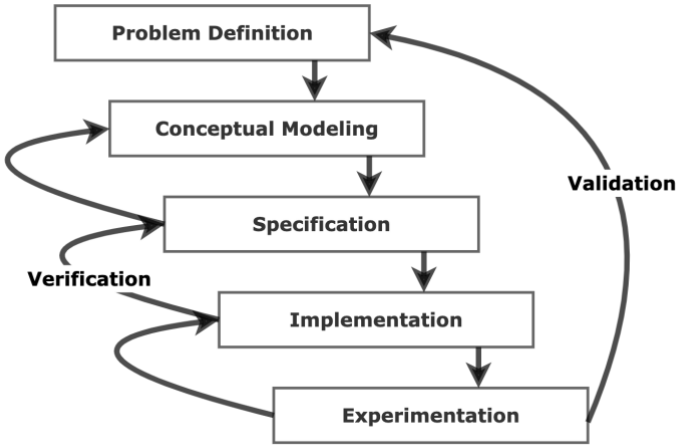

Figure 1 Modeling and Simulation Design Cycle

To address the research questions in a structured and systematic way, this research follows the guidance of the Modelling and Design Cycle introduced by Cetinkaya (Cetinkaya, 2011). As shown in Figure 1, this design cycle consists of five phases, namely, problem definition, conceptual modeling, specification, implementation, and experimentation. Verification and validation are integral components of the implementation and experimentation phases, respectively, to provide essential feedback loops to refine the specification and problem definition phases, thereby fostering an iterative design cycle. At each phase, an appropriate approach was applied to achieve the objectives of this phase.

In this report, the problem is defined in Chapter 1.

Chapter 2 focuses on conceptual modeling and answers the first sub-question. To establish the theoretical basis for this research and then identify the elements and their relationships involved in the model, a literature review was conducted. The review involved organizational digital transformation and its key influencing factors, change management, and system dynamics. The scope of this research was determined to be eight factors under organizational factors and technological factors, including strategy, finance, organizational structure, process, culture, people, leadership, and technology & data. Subsequently, a conceptual model, serving as a high-level abstraction of the organizational digital transformation system, was made to bridge between the real system and the system dynamics model.

Chapter 3 describes the specification phase where eight sub-models were designed independently of each other based on the conceptual model by utilizing Insight Maker, a web-based tool. Following established design principles for modeling system dynamics, each sub-model was translated from its corresponding conceptual model. Following this, the eight sub-models were integrated into a final system dynamics model and implemented into an executable model. This chapter answers the second sub-question.

Chapter 4 presents the expert validation process and answers the third sub-question. After the implementation of the system dynamics model, the model was validated by conducting expert interviews to assess the theoretical soundness and accuracy of the model and to gather feedback for further refinement.

Chapter 5 presents the ecological validation process and answers the fourth sub-question. After the model was refined based on the expert validation results, the refined model was then

validated through simulated scenario testing to examine the model's ability to represent the real-world organizational digital transformation system.

Finally, Chapter 6 gives the conclusions, contributions, and limitations of this study, as well as potential topics for future research.

Chapter 2

Conceptual Modeling

This chapter describes the conceptual modeling underpinning this research. The conceptual modeling process aims to provide a high-level abstraction of the organizational digital transformation system and its sub-system, as well as the theoretical basis of this research by means of a literature review. To provide a better overview of this chapter, the overall conceptual model of organizational digital transformation is presented first which summarizes this chapter. The conceptual model was developed based on the theories from the literature. As shown in Figure 2, the conceptual model integrates organizational digital transformation theories and change management theories, illustrating the temporal relationships and impacts among the components of the transformation. In the conceptual model, the organizational digital transformation process is divided into three phases: unfreeze, change, and freeze, in which different factors play important roles. Those factors are categorized into organizational factors and technological factors.

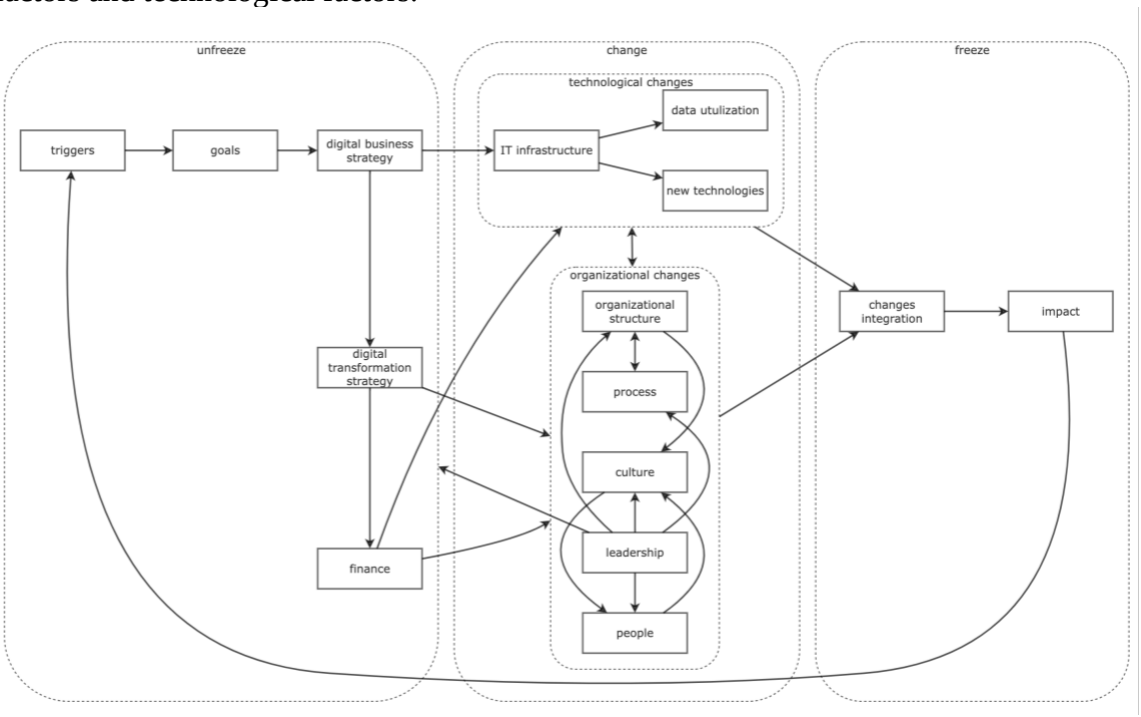

Figure 2 Conceptual Model of Organizational Digital Transformation

The rest of this chapter details the theories related to digital transformation, the organizational and technical elements of digital transformation, and the conceptual models for each of its subsystems.

2.1 Organizational Digital Transformation

This section reviews the prevalent theories on digital transformation in organizations and provides an overview, focusing on its nature, core components, frameworks and models, and challenges faced. It aims to deepen the study's understanding of the conceptual and theoretical frameworks underpinning digital transformation and to provide general direction for the design of the model.

Digital transformation (DT) has become a focus of attention for organizations across industries as it offers opportunities for organizations to enhance their efficiency and productivity, improve customer experience, establish new revenue streams, and improve agility and adaptability (Skog, 2019). A generally accepted conceptual definition of digital transformation, proposed by Vial (2019), is "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies". In essence, the integration of technology, strategy, and organizational change forms the multifaceted puzzle that organizations must proactively navigate to thrive in a digital-centric environment. Therefore, the realization of successful digital transformation has become a concern (Vial, 2019).

Vial (2019) also presents a framework that outlines the building blocks of the organizational digital transformation process. As shown in Figure 3, the transformation process is triggered by internal and external disruptions that result from the use of new technologies in the industry. Those disruptions manifest in ways including changes to consumer behavior, shifts in competitive dynamics, increased data abilities, or increased demand for efficiency. In response, organizations must strategize to stay competitive and leverage digital technologies to enhance their value creation path and overall performance.

However, technology alone is insufficient for success. Besides technological advancements, strategic adjustments, and organizational changes are imperative. This includes adjustments to organizational structure, process, culture, and other aspects that together empower organizations to achieve their intended goals (Vial, 2019). This makes digital transformation a multifaceted and dynamic process that goes beyond mere digitalization, impacting the entire organizational landscape and business operations (Peter C. Verhoef, 2021).

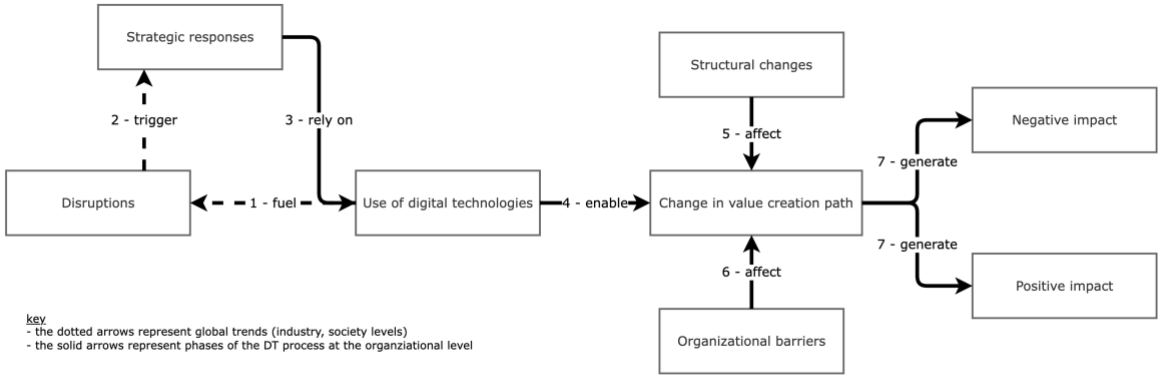

Figure 3 Building Blocks of the DT Process (Vial, 2019)

Rooted in the Technology-Organization-Environment (TOE) framework (Oliveira Tiago, 2011) shown in Figure 4, technological transformation is driven by the intricate interplay between technological factors, organizational factors, and the external task environment. Hence, a holistic approach that addresses both internal resources and external influences is required. The dynamic nature of digital transformation is underscored by the fact that the constant evolution of digitization continues to reshape both internal operations and external market dynamics.

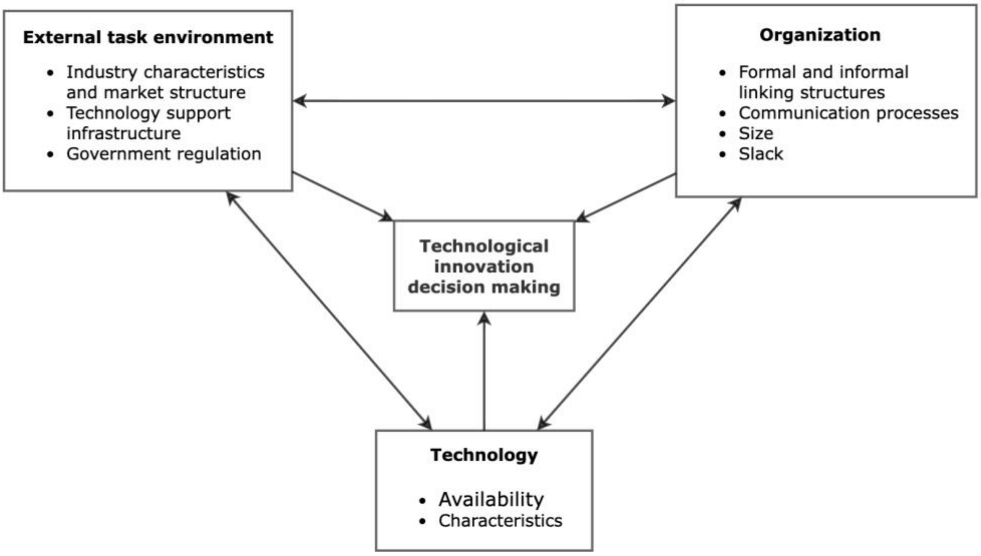

Figure 4 Technology-Organization-Environment (TOE) Framework

Figure 5 shows Megel's (2019) procedural pattern map that elucidates the temporal aspects of digital transformation values. Digital transformation can be generally divided into digital transformation reasons, digital transformation objects, digital transformation process, and the result of digital transformation in a timely manner. This iterative process is characterized by a continuous feedback loop from digital transformation impact to internal pressure, making the whole process dynamic (Daradkeh FM, 2023).

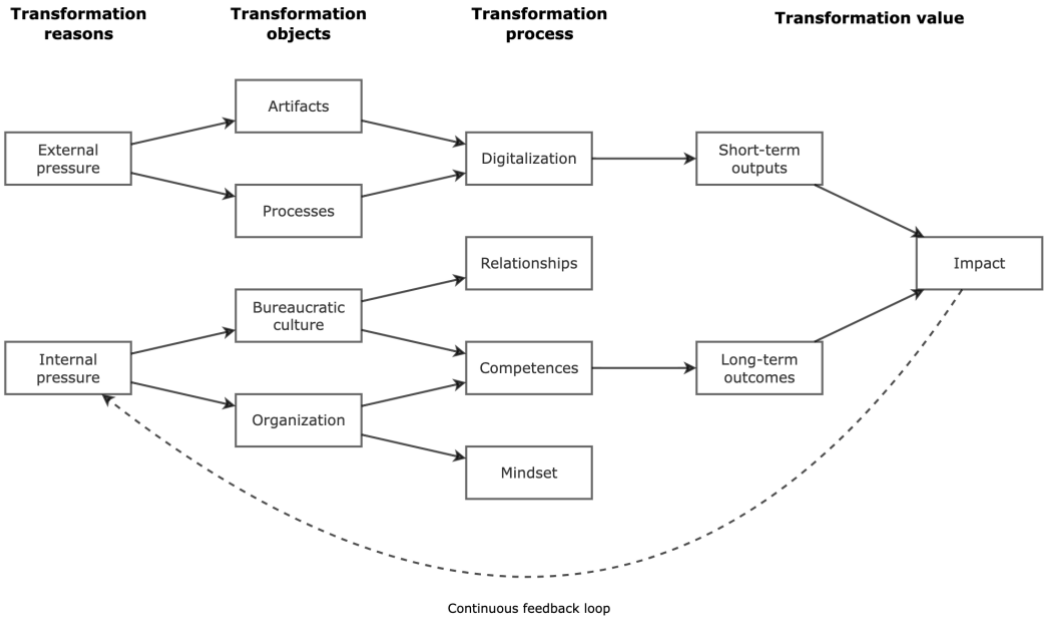

Figure 5 Procedural pattern map

Despite the considerable benefits of digital transformation, its complexity and dynamics also present organizations in managing change and navigating the transformation. Besides, the other

digital transformation inhibitors also include resistance to change, lack of digital transformation experience, limited resources, cybersecurity risk, and privacy concerns. To overcome these digital transformation inhibitors, organizations need to recognize them and take proactive steps to mitigate them through a holistic approach (Skog, 2019).

Existing research offers guidance on navigating the complexities of digital transformation, presenting digital roadmaps, agendas, and maturity models (Kraus, 2021; Dmitry Plekhanov, 2022; Fadwa Zaoui, 2020). These frameworks emphasize the importance of developing competencies, including strategic, leadership, cultural, and governance capabilities, to effectively address the dynamic nature of digital transformation. There are also models and frameworks that have been developed to visualize the conceptual structure and illustrate the interrelationships between these capabilities (Doerr, 2023). Additionally, studies describe the drivers and barriers to digital transformation in detail, providing valuable insights for organizations embarking on their digital journey (Crisan, 2023; Nazari Z, 2023)

As can be seen, each of these theories of digital transformation has its focus and offers different values in different contexts. The TOE framework provides an overview of digital transformation and based on this, defines three categories of organizational digital transformation factors: external, organizational, and technological. The digital transformation process building blocks show what the transformation is about and the causal logic behind the transformation process. On the other hand, the process model diagrams show the more granular digital transformation components and present the time and phase aspects of the transformation. Therefore, there is a strong need to integrate these theories into the required model to make it comprehensive.

External factors such as market and industry conditions, government regulations, and customer and partner dynamics are difficult to predict and outside the control of organizations, making them hard to study in a way that generates consistent and reliable insights (Brown, 2019). Therefore, this research focuses on organizational and technological factors rather than external factors, which keeps the scope of the study focused and provides more specific and actionable findings in terms of what organizations can control and influence. As the main drivers of digital transformation, technological factors focus on the adoption of technologies and the enhancement of data capabilities. Organizational factors such as strategic planning, financial aspects, and structural elements are critical to the success of digital transformation. The study of organizational and technological factors can provide additional theoretical understanding and practical insights to contribute to navigating organizational digital transformation. In this context, gaining a comprehensive understanding of organizational factors and technological factors and identifying their components and relationships becomes critical.

2.2 Organizational Factors of Digital Transformation

This section reviews the organizational factors that influence digital transformation and accordingly presents the conceptual model of each factor, aiming to identify and understand the key organizational elements that contribute to the success of an organization’s digital transformation. Previous research has identified seven key organizational factors including strategy, finance, leadership, organizational structure, process, people, and culture. This provides a structured framework for navigating the complexities of digital transformation and helps in effective organizational modeling. These seven factors will be discussed chronologically based on the Building Blocks of the DT Process (Vial, 2019) and the Procedural Pattern Map (Ines Mergel, 2019).

Firstly, as the core elements of the initial readiness phase, strategy, and finance will be reviewed first. Next, leadership will be reviewed, as it plays a critical role in driving digital transformation. Following this, organizational structure and process will be reviewed as they represent structural changes. Lastly, people and culture, the interconnected people and culture will be reviewed to understand their long-term impact on digital transformation.

2.2.1 Strategy

To understand what role strategy plays in digital transformation and what are the internal factors in strategy development, this section reviews the theories related to digital transformation strategy. This understanding also helps to identify the strategy-related variables in the model.

The onset of digital disruption presents both threats and opportunities for organizations. Organizations strive to leverage digital technologies to drive innovation, adapt to changing customer needs, and improve competitiveness, prompting strategic responses aimed at reshaping value-creation pathways and navigating for sustainable growth and success (Yucel, 2018). Organizational strategy, commonly defined as a set of articulated goals, objectives, policies, and plans tailored to an organization toward success, serves as the foundation for orchestrating digital transformation initiatives (Lokuge, 2021).

Before embarking on policy development, organizations must establish a clear vision and goals to chart their course forward (Yang, 2022). Aligning visions and fostering a shared understanding among stakeholders is essential for impelling organizational commitment and driving successful digital transformation. Top management plays a crucial role in articulating these goals and ensuring alignment throughout the organization. However, differing perspectives among stakeholders, influenced by their departmental backgrounds, can lead to discrepancies in vision interpretation. Such misalignment may hinder organizational buy-in and investment in digital transformation growth initiatives. (Ratajczak, 2022)

Organizations adopt strategies to navigate the integration of digital technologies with business objectives. Recognizing the growing importance of digital technologies and the imperative for business-IT alignment, organizations combine digital technology strategies with business strategies, giving rise to what is termed digital business strategies. In this paradigm, technology often assumes an enabling role rather than one that directly drives or influences business strategy. (Brown, 2019) As a fusion of business and IT strategies, a digital business strategy depicts an organization's vision and desired state in the digital economy, serving as a comprehensive blueprint for leveraging digital technologies and capabilities (Yucel, 2018).

Building upon previous research, Collou and Bruinsma (2021) propose a digital business strategy framework comprising five key sub-strategies:

- Service Strategy: This sub-strategy is centered on delivering superior and cost-effective services to both internal stakeholders and external customers, emphasizing optimization of service delivery processes and enhancement of customer satisfaction.

- Information & Data Strategy: Aimed at preserving the integrity, availability, and accuracy of business data across diverse processes, this sub-strategy underscores the importance of robust data management and governance practices.

- Platform & Application Strategy: Focusing on furnishing essential business functionality while minimizing the total cost of ownership, this sub-strategy emphasizes the development and maintenance of scalable and efficient digital platforms and applications.

- Infrastructure Strategy: This sub-strategy concentrates on provisioning a high-performing, reliable, and energy-efficient IT infrastructure to support the organization's digital initiatives, ensuring seamless operations and optimal resource utilization.

- Security Strategy: With a focus on safeguarding the confidentiality, integrity, and availability of information assets, this sub-strategy emphasizes the establishment of robust physical and logical controls to mitigate cybersecurity risks and protect organizational assets.

According to Matt (2015), strategies for digital transformation must address four essential dimensions that are the use of technology, changes in value creation, organizational changes, and financial considerations. Notably, the dimensions of the use of technology and changes in value creation are inherently covered within the digital business strategy, establishing a foundational framework for subsequent transformation efforts. Therefore, upon finalizing the digital business strategy, the formulation of the digital transformation strategy is also important which serves as the vehicle for realizing the objectives outlined in the digital business strategy and achieving the desired transformed state.

Organizational changes are critical to provide a conducive environment for new operations, necessitating variations in the organizational setup. These encompass changes in roles, responsibilities, culture, reporting structures, and decision-making processes to align with the objectives of the digital transformation. Furthermore, successful transformation across these dimensions is also dependent on consideration of financial aspects, including an organization's urgency to act in response to declining core business areas and its financial capacity to support digital initiatives. (Matt, 2015)

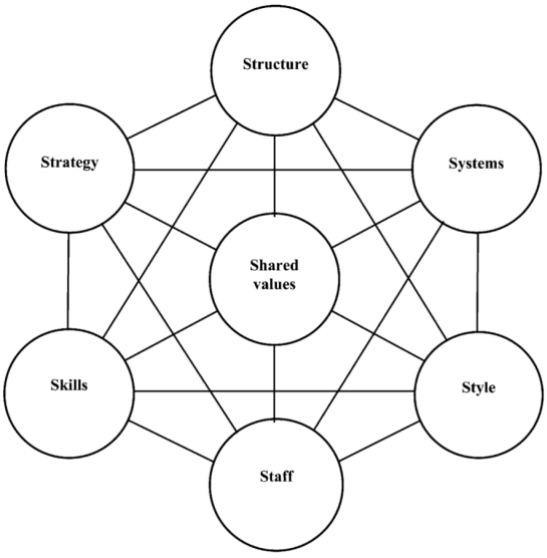

Figure 6 The McKinsey 7-S Framework

Similar to the digital business strategy framework, based on the McKinsey 7-S Model (Suwanda, 2022), the eight sub-strategies break down the digital transformation strategy into manageable parts, allowing for a more detailed and structured design of the strategy model. The 7-S Model, as shown in Figure 6, is a change management framework for assessing an organization's readiness for change and is often used as an organizational analysis tool to assess and monitor changes in the internal situation of an organization. It distinguishes between hard elements, such as strategy, structure, and systems, which are relatively straightforward to identify and manage, and soft elements, such as skills, staff, styles, and shared values, which are more dynamic and subject to continuous change. It's worth noting that, except the financial factor, the elements of the 7-S Model are aligned with the selected organizational factors. More specifically, the 'Systems' component relates to the processes guiding organizational work, while 'Skills' and 'Staff' encompass the competencies and capabilities of personnel, falling under the broader category of 'People'. 'Shared Values' represents the core values, beliefs, and norms that are shared among members of an organization, which compose the organizational culture. Additionally, 'Style' implies the necessary changes in organizational leadership, highlighting the importance of adaptive leadership approaches in navigating digital transformations. (Suwanda, 2022) Therefore, the eight sub-strategies are defined as follows:

- Digital Business Strategy: This sub-strategy is an overarching action plan aligned with the organization's mission and vision and forms the basis of the digital transformation strategy.

- Finance Strategy: This sub-strategy addresses financial considerations, including budget allocation, funding sources, and financial planning to support digital transformation endeavors.

- Leadership Strategy: This sub-strategy concerns the management style exhibited by leaders and typical patterns of key groups within the organization.

- Organizational Structure Strategy: This sub-strategy deals with the organizational framework and the arrangement of roles, responsibilities and decision-making processes.

- Process Strategy: This sub-strategy addresses processes within the organization, such as HR or risk management processes, and formal and informal procedures for measurement and resource allocation.

- Skill Strategy: This sub-strategy focuses on enhancing the capabilities and competencies of team members to support digital transformation objectives.

- People Strategy: This sub-strategy encompasses strategies for recruitment, training, and motivation of employees to support digital initiatives effectively.

- Culture Strategy: This strategy defines the overarching objectives and aspirations guiding the organization, including the norms, values, and beliefs shaping actions and decisions.

Moreover, the digital transformation strategy requires a clear and actionable plan that includes a detailed set of specific steps, tasks, and timelines to execute the strategy effectively (Aditya, 2021). Strategic alignment is important, requiring the digital transformation strategy to be

effectively communicated across all organizational departments and embraced by the entire organization (Lokuge, 2023). This necessitates effective organizational communication, both vertical and horizontal. Vertical communication flows up and down the hierarchical structure of the organization, involving information dissemination from top management to lower levels and feedback or reports moving upward. Horizontal communication refers to the exchange of information, ideas, messages, or feedback among individuals, departments, or units at the same hierarchical level or within the same functional area in an organization. (Afef Saihi, 2022) Thus, a well-structured digital transformation strategy must include detailed planning and execution steps, along with strong strategic alignment and effective communication throughout the organization.

A conceptual model of the digital transformation strategy, as shown in Figure 7, is made to summarize and visualize the results of the review of strategy in this section. This conceptual model will be used in the model specification.

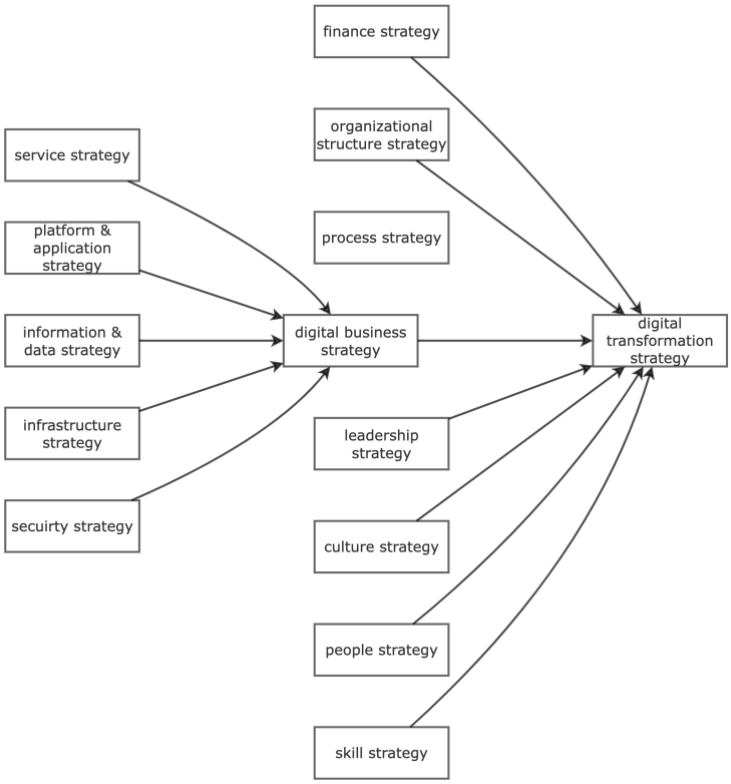

Figure 7 Conceptual Model of Strategy

2.2.2 Finance

To understand what financial factors are involved in organizational digital transformation and to help identify the relevant financial variables for the model design that follows, this section reviews the theories on the financial aspects of organizational digital transformation.

Financial resources are indispensable in digital transformation, as the implementation of digital transformation initiatives demands substantial investment and prudent resource allocation (Weerabahu, 2022). Investments across all digital transformation endeavors are imperative.

These resources can take the form of internal funds, external investments, or a combination thereof (Mihu, 2023).

Internal funds are generated from the organization's operations, while external funds stem from sources such as public funds, venture capital, and government initiatives like the National Recovery and Resilience Plan and the Digital Europe Program, which offer strategic funding and support for digital transformation endeavors (Lammers, 2019). The lack of financial resources often emerges as a primary obstacle to organizations' digital transformation, particularly for small and medium-sized enterprises (SMEs) facing challenges in self-financing and obtaining financial support (Weerabahu, 2022).

The substantial costs associated with digital transformation, including procurement, delivery, staff retraining, management training, digital tools, equipment setup, implementation, and maintenance, further underscore the financial considerations (Mihu, 2023). Organizations may hesitate to prioritize digital initiatives amidst perceived high costs, leading to delayed adoption (Trevisan, 2023). However, starting with low-cost investments to gain initial experience can mitigate this barrier (Doerr, 2023).

Limited resources compel organizations to prioritize digital initiatives and allocate resources judiciously (Barthel, 2021). Assessing return on investment and profitability serves as vital indicators of digital transformation success, necessitating feasibility analysis and profitability assessments (Mihu, 2023). Promising profitability attracts more investment, enhancing the likelihood of successful digital transformation, although uncertainties may arise due to the lack of demonstrated business cases justifying investment (Lammers, 2019).

Thus, a comprehensive understanding of financial factors and strategic resource allocation is essential for organizations to achieve successful digital transformation. By addressing financial challenges and leveraging internal and external funding sources, organizations can better position themselves to achieve their digital transformation goals.

Based on those theories, a conceptual model of the financial system of digital transformation, as shown in Figure 8, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

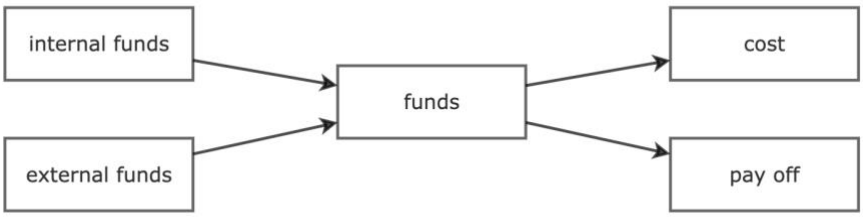

Figure 8 Conceptual Model of Finance

2.2.3 Leadership

To be able to understand the importance of leadership to organizations' digital transformation and the specific leadership factors involved, this section reviews relevant theories on digital transformation leadership.

Studies underscore the important role of leadership in driving successful digital transformations. Leadership is more than setting a vision; it encompasses the ability to influence, motivate, guide, and enable others, making it a collective, relational, and dynamic effort (Kokot, 2021). Effective leadership involvement is vital for organizational performance and survival, particularly in the face of digital transformation's evolving demands. Empirical evidence highlights the critical role of digital leadership in spearheading digital initiatives and guiding organizational change (Thekkoote, 2022). Digital leadership entails transforming the role, skills, and style of leaders, establishing digital organizations, and adapting people management practices (Azizan, 2021).

Digital leader transformation entails a comprehensive evolution to navigate and thrive in the digital age, necessitating the adoption of new mindsets, acquisition of digital skills, and redefinition of leadership practices. Effective digital leader transformation positively impacts organizational leadership involvement and people's engagement (Hoessler, 2023).

Tailoring leadership styles to the situation is crucial for driving successful digital transformations (Thekkoote, 2022). Leadership style is shaped by internal and external organizational constraints (Rajan Ranjith Kumar, 2021). Commonly observed leadership styles in digital transformation include transformational, transactional, and authentic leadership, each serving varying purposes. While transactional leadership ensures compliance through rewards, transformational leadership fosters engagement through consultation and delegation, with digital leadership encompassing elements of both styles, fostering innovation. Despite the enduring value of authentic leadership, the dynamic nature of change necessitates continual skill development and behavioral adaptation across all organizational levels (Rajan Ranjith Kumar, 2021).

Equipping leaders with digital knowledge and skills is imperative for informed decision-making and effective management actions (Yang, 2022). Even if lacking in digital expertise initially, leaders should demonstrate a commitment to learning, setting a precedent for continuous improvement (Eberl, 2021). Embracing experimentation and adaptability fosters innovation and expedites product launches, while strong managerial skills facilitate stakeholder management (Ratajczak, 2022). Furthermore, introducing new top management roles such as Chief Digital Officer (CDO) and Digital Transformation Officer (DTO) further reinforces transformation efforts (Abdul Karim Feroz, 2023).

Top management commitment is critical to demonstrate dynamic capabilities by reconfiguring organizational resources to support exploration and exploitation (Hoessler, 2023). Top management should spearhead digital and transformation strategy development, with digital governance implemented through approaches such as a work-centric approach, bottom-up and top-down approach, and shared governance model (Hoessler, 2023). Top management also plays a crucial role in cultivating a quality culture, as leadership and culture share a symbiotic relationship, each influencing the other significantly (Alrasheedi, 2022).

Individuals' needs must not be overlooked in the digital transformation journey, with leadership focusing on empowering all employees (Sheshadri Chatterjee, 2023). Middle management plays a key role in implementation and operations, necessitating leadership shifts to empower them effectively. They have an in-depth understanding of the organization and maintain connections throughout multiple levels within it. (Henderikx, 2022)

To excel in people management, leaders must monitor employees' beliefs, recognizing how these attitudes influence others' responses. They should proactively address any resistance, particularly stemming from fears of job loss, while actively facilitating employee empowerment by stepping aside and refraining from unnecessary interference. (Sheshadri Chatterjee, 2023) Additionally, leaders should openly acknowledge and appreciate risk-taking, innovative methods, and resilience in the face of failure. While encouraging and motivating employees to participate in strategy development, it is paramount to foster an engaged and supportive work culture. Prioritizing tasks ensures that crucial responsibilities are never overlooked, even while granting employees more autonomy. Providing ongoing coaching, feedback, and robust communication platforms is important. (Eberl, 2021) Furthermore, leaders must promote intrinsic motivation by fostering alignment with the organization's values, enhancing work-life balance, and nurturing personal well-being (Alrasheedi, 2022). Lastly, Digital leaders must also be adept at leading virtual teams and fostering extended collaboration across functions and organizations to promote agility and innovation (Sheshadri Chatterjee, 2023).

Based on those theories, a conceptual model of the system of digital transformation leadership, as shown in Figure 9, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

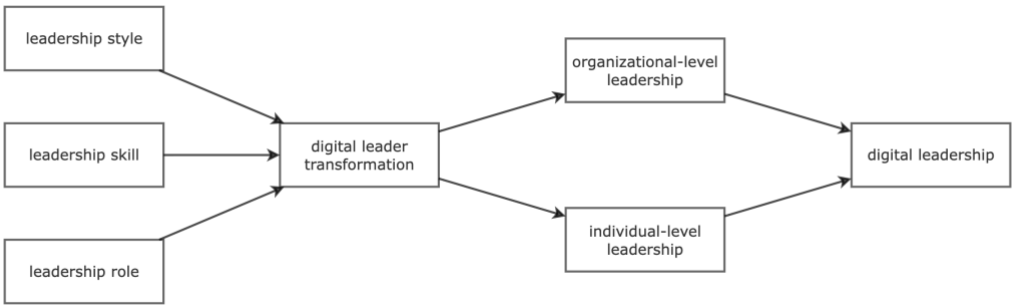

Figure 9 Conceptual Model of Leadership

2.2.4 Organizational Structure

To understand the importance of organizational structure for organizations' digital transformation and the characteristics of the ideal organizational structure in such context, this section reviews the theories on organizational structure in digital transformation.

Digital transformation often demands significant organizational restructuring, as existing structures may no longer suffice to address the evolving needs (Vial, 2019). Traditional hierarchical models, characterized by multiple management tiers and a rigid top-down approach, may prove ineffective in dynamic digital landscapes due to bureaucratic constraints, hindering responsiveness and innovation. Hence, organizations need agile structures capable of swiftly adapting to ongoing digital changes (Peter C. Verhoef, 2021). While the ideal organizational structure configuration varies based on the unique requirements and stages of digital transformation, agility, flexibility, and clarity are fundamental traits for digital organizations (Daradkeh FM, 2023).

Structural agility underscores an organization's ability to swiftly adapt to evolving environmental factors such as market trends, customer needs, and technological advancements,

while structural flexibility enables organizations to adjust and modify their structures without compromising core stability or identity, ensuring adaptability to the continuous changes inherent in digital transformation (Vial, 2019). Structure clarity further enhances this adaptability, providing clear guidelines and delineation of roles and responsibilities within the organization's framework (Doerr, 2023).

Cross-functional collaboration emerges as a key element that organizations must prioritize in navigating digital transformation as it helps realize agility and ambidexterity (Vial, 2019). It creates opportunities for different departments or teams to collaborate, encouraging knowledge-sharing and interdisciplinary projects to enhance problem-solving and innovation (Bernardo Henrique Leso, 2022). By adjusting organizational structure, such as building cross-functional and interdisciplinary teams, organizations can foster effective communication and combine different skills (Saihi, 2022). Forming multidisciplinary teams comprising individuals from diverse departments or expertise areas facilitates innovation and diverse perspectives while breaking down silos (Mirkovic, 2019).

Flat hierarchies can enhance structural agility by facilitating quicker decision-making and more direct communication between teams, promoting agility in responding to digital trends and changes (Mirkovic, 2019). Organizations can streamline the decision-making process through an organizational structure with minimal hierarchies, increasing the likelihood of obtaining desired outcomes (Toward effective digital transformation: The role of organizational capabilities, 2023).

Establishing a separate autonomous unit that maintains independence from the rest of the organization can enhance structural flexibility. This unit enables organizations to conduct experiments, learn quickly, and avoid conflicts, allowing the rest of the organization to remain stable. (Vial, 2019)

Digital functional area transformation is also important, implying increased reliance on IT and analytical functions. The IT function itself needs to evolve from a line function focused on enabling communication or data flows into a proactive and orchestrating role supportive of digital value creation via fast and explorative responses. (Peter C. Verhoef, 2021)

Defining flexible roles and responsibilities encourages fluidity in roles, allowing employees to contribute beyond their defined job descriptions. Introducing new positions such as Chief Digital Officer (CDO) and innovation manager can drive strategic and communication aspects of digital transformation. (Mihu, 2023)

The process of redesigning an organization's structure involves aligning it with its overarching strategies, ensuring that the structural adjustments support and facilitate the strategic objectives set forth by the organization. This alignment is crucial for the success of the restructuring efforts as it ensures that the organization's structure is conducive to achieving its goals and objectives effectively. (Rajan Ranjith Kumar, 2021) Moreover, flexible leadership, strategy, and business model are essential components that contribute to the success of structure reconfiguration (Daradkeh FM, 2023). Furthermore, the redesigning of an organization's structure is not a one-size-fits-all effort; it depends on factors such as the organization's size, industry, market position, and specific business objectives. Tailoring the restructuring efforts to fit the unique context and requirements of the organization ensures that the resulting structure effectively supports its strategic direction and enhances its overall performance and competitiveness. (Saihi, 2022)

Based on those theories, a conceptual model of the system of organizational structure, as shown in Figure 10, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

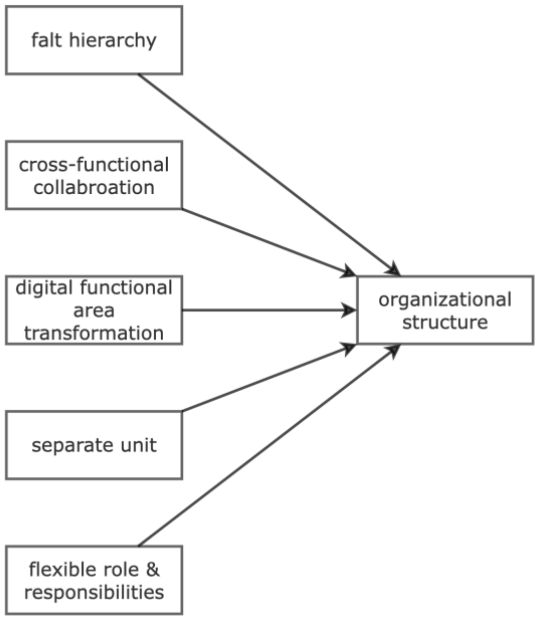

Figure 10 Conceptual Model of Organizational Structure

2.2.5 Process

To understand what role organizations' process plays in their digital transformation and the influencing factors involved in the process, this section reviews the relevant theories on processes related to digital transformation.

Processes, defined as the structured and organized actions, workflows, and mechanisms that drive organizational activities, form the backbone of operations (Bruna Felippes, 2023). Digital transformation impacts both business processes, which connect customers to value chains, and organizational processes, which govern resource allocation and management decisions. Adapting processes is crucial for fostering cultural change, refining strategy, fostering innovation, and ultimately determining the success of digital initiatives (Rajan Ranjith Kumar, 2021).

A digital transformation brings changes to organizations' processes at all levels (Suwanda, 2022). Appropriate processes matter for reforming culture, redesigning strategy, creating innovation, delivering value, and thus determining the success of digital transformation (Konopik, 2022). Therefore, organizations need to understand how digital transformation will affect their processes and what actions they can take to adapt to the changes successfully.

Efforts to digitize and optimize processes play a key role in enhancing organizational efficiency (Mihu, 2023). Automation, for instance, streamlines repetitive tasks, reduces operational costs, and empowers employees to focus on more strategic endeavors (Agostino, 2022). Integration

of processes across different business lines facilitates data centralization and decentralized decision-making, promoting agility and responsiveness (Konopik, 2022). By analyzing process data, organizations can identify inefficiencies, improve communication, and optimize resource allocation (Mihu, 2023).

Horizontal alignment enables businesses to adapt swiftly to changing market conditions and technological advancements, driving productivity and ensuring business continuity. It ensures that all components of the organization work together seamlessly to achieve common digital goals, ultimately enhancing overall efficiency and effectiveness in pursuing digital initiatives. (Mihu, 2023) Thus, the horizontal alignment of the organizational system is critical to successful digital transformation. This concept entails the coordination and integration of various departments, functions, and processes across the organizational landscape. By aligning processes horizontally, organizations can synchronize their activities, resources, and initiatives, thereby fostering a unified approach to digital transformation. This alignment not only promotes consistency and synergy but also facilitates effective communication and collaboration among different parts of the organization. (Azizan, 2021)

The processes should be managed according to the defined process strategy (Zhang Y, 2021). Also, the processes should be standardized along the information flow, and then be documented and clarified to the entire organization since the standardized workflow facilitates consistency and reliable results (Doerr, 2023). Moreover, good communication is required in all the processes, ensuring ongoing information and knowledge sharing across an organization. This links closely with leadership and policy, as effective leadership and relevant communication policy foster an environment of open communication. (Bruna Felippes, 2023)

Approaches such as business process reengineering and business process management offer systematic frameworks for process adaptation (J, 2020). Additionally, efficient project, performance, change, and risk management practices are critical for navigating the complexities of digital transformation successfully. Thus, organizations should effectively integrate these management practices into their process changes. (Afef Saihi, 2022)

Based on those theories, a conceptual model of process, as shown in Figure 11, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

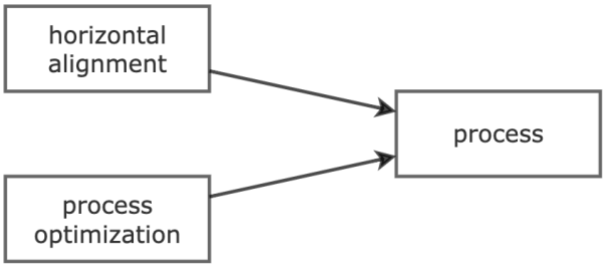

Figure 11 Conceptual Model of Process

2.2.6 Organizational Culture

To be able to understand the influence of an organization's culture on its digital transformation success and the factors influencing an organization's cultural transformation, this section reviews organizational culture theories in the context of digital transformation.

The culture of an organization plays a critical role in its digital transformation journey, as it can either enable or hinder progress (Chih-Wen Huang, 2023). Defined as a complex system of shared values, beliefs, and symbols, organizational culture guides how businesses operate and how employees behave (Bruna Felippes, 2023). This culture permeates across all levels of the organization, shaping employees' sense of identity and influencing their actions (Al-Faihani, 2020). Employees within an organization may simultaneously identify with multiple culture groups, including work and national cultures, which adds to the complexity of organizational culture (Lokuge, 2023).

Adapting the organization's culture to align with its strategy is important, as it influences employee behavior and managerial decisions (Al-Faihani, 2020). Organizations must assess and reform their culture to support, rather than hinder, their defined strategy (Chih-Wen Huang, 2023). Digital transformation necessitates cultural adaptation to foster flexibility in response to evolving internal and external environments (Al-Faihani, 2020). Thus, fostering digital and innovation cultures is critical for organizations to drive successful transformation, as it encourages proactive identification of new opportunities, enhancing digital agility, and maintaining competitiveness (Lokuge, 2021).

The adoption of digital technologies brings changes to organizations' operations and the daily tasks of their employees, necessitating a cultural shift from traditional to digital norms (Al-Faihani, 2020). Developing a digital culture entails shaping organizational behavior and mindset to effectively utilize digital tools, emphasizing traits like empowerment, collaboration, continuous learning, and customer integration (Mihu, 2023). However, people tend to resist changes due to their nature of seeking stability and staying in their comfort zone. Radical digital culture shifts may challenge talent retention (Alrasheedi, 2022).

Organizational culture encompasses a variety of characteristics, as outlined in Cameron and Quinn's Competing Values Culture Model (Kim S. Cameron, 2011), which delineates four sub-cultures: Hierarchy, Clan, Adhocracy, and Market. Organizations often exhibit characteristics of multiple culture types, and this framework helps to identify dominant and secondary cultures. The Competing Values Framework enables leaders to comprehend cultural preferences, identifying areas for improvement or alignment with strategic goals.

- *Hierarchy Culture* prioritizes stability, control, and efficiency, epitomized by clear structures, rules, and processes. Effective in inward-focused, stable environments, hierarchies promote control and efficiency but may hinder responsiveness to market demands.

- *Clan Culture* fosters collaboration, teamwork, and a sense of community, valuing cohesion and employee development. With a focus on internal outcomes and responsiveness, clans may prioritize engagement over external results.

- *Adhocracy Culture* champions innovation, creativity, and adaptability, encouraging risk-taking and flexibility to respond to market changes swiftly. While promoting growth, adhocracies may struggle with operational control and nurturing environments.

- *Market Culture* emphasizes competition, achievement, and results orientation, focusing on external market dynamics and customer needs. While driving competitiveness, market-focused organizations may lack forward-thinking responsiveness.

Each culture type offers unique strengths and challenges, influencing organizational dynamics and strategic orientation. Understanding and leveraging these cultural nuances are integral to fostering a cohesive and effective organizational culture.

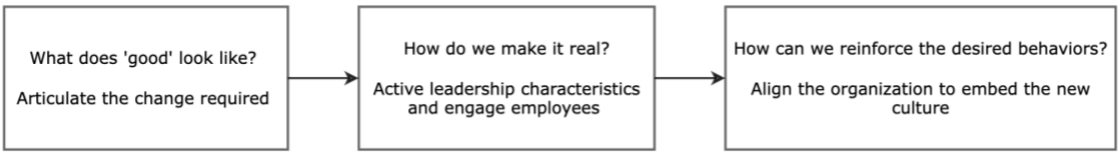

Figure 12 Three-Step Model of Embedding a Digital Culture

Aligning with the Three Stage Change Management Model, Hemerling (2018) introduced a three-step methodology for organizations to integrate a digital culture as illustrated in Figure 12.

The initial step entails articulating the requisite change. This begins by identifying the traits of the desired digital culture and preparing a culture strategy, aligning them with the organization's overarching strategy, goals, and mission. It's important to translate these cultural attributes into specific behavioral examples and assess the variance between current and desired behaviors based on an evaluation of the existing culture. (R. Mulyana, 2021)

The subsequent step revolves around activating the leadership in both top management and middle management and involving employees in nurturing the target digital culture. Creating a positive digital workplace environment, including policies supporting digital-friendly practices like remote work, is essential (Bruna Felippes, 2023). Leaders must exemplify these behaviors as role models and initiate actions to positively influence the organization. This could involve coaching teams, empowering team members, or addressing individuals whose conduct conflicts with the new culture. Activating leadership qualities is pivotal for fostering employee engagement, particularly in a digital culture that stresses autonomy, judgment, customer focus, and an entrepreneurial mindset. Furthermore, fostering knowledge sharing and collaboration across all levels promotes employee involvement and generates new ideas, highlighting the significance of knowledge over mere skills (Konopik, 2022).

In the final phase, the organization aligns its contextual elements to embed the new culture. This often entails implementing changes at the systemic, procedural, and operational levels to integrate and sustain new behaviors across the organization. As the new culture may initially be cultivated in a pilot program, aligning the organizational context ensures the proliferation and consolidation of desired behaviors throughout the organization. (Hemerling, 2018)

Thus, this methodology provides a structured approach to embedding digital culture within an organization, as it highlights the systematic process of cultural transformation, demonstrating

the importance of leadership, communication, and alignment with broader strategic goals. Understanding and applying such systematic methodologies ensures that the digital culture is not only implemented but also sustained, contributing to the overall success of digital transformation.

Based on those theories, a conceptual model of culture, as shown in Figure 13, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

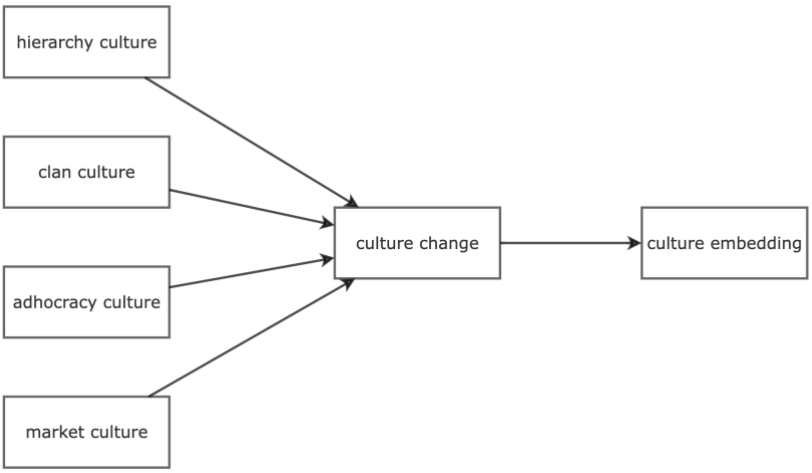

Figure 13 Conceptual Model of Culture

2.2.7 People

To understand the role that people play in organizational digital transformation and the factors influencing people's behavior toward digital transformation, this section reviews the theories on people in the context of digital transformation.

People, rather than technology, constitute the primary asset of digital transformation. Despite substantial investments in cutting-edge technologies, it is ultimately the human element that harnesses and leverages these advancements (Gkrimpizi, 2022). Hence, employees are a vital resource and a key influencer in an organization's digital transformation journey. Human capital and its readiness play a key role in determining the success of such initiatives. (Mihu, 2023)

The success of digital transformation depends on the availability of skilled employees and their attitude toward change (Doerr, 2023). Introducing new technologies necessitates acquiring new skills. Therefore, employees must possess both hard skills, such as technical competencies, and soft skills, including communication, collaboration, creativity, and adaptability, to effectively implement projects and adapt to evolving circumstances. Soft skills might be prioritized over hard skills. Hard skills are specific and temporary as they are constantly changing. This means employees should have the motivation and awareness to keep learning and developing themselves which must be supported by soft skills. (Marcel, 2023) Moreover, a positive attitude and perception toward digital transformation are critical for its success. Employees need to recognize the necessity and important role of digital transformation, requiring a shift in mindset and overcoming resistance to change. (Doerr, 2023)

However, transitioning to a digital culture can be challenging for employees, leading to job insecurity, learning anxiety, and technology anxiety (Mićić, 2022). Learning anxiety emerges when individuals are acquiring skills for new tasks or roles. It stems from a blend of avoidance of learning and the struggle to find time for essential training among existing responsibilities. Technology anxiety, on the other hand, results from the vast amount of information from digital devices, insufficient knowledge and experience, complexities in user interfaces, and the lack of expertise, guidance, or support, which is sometimes even exacerbated by learning anxiety. (Eickemeyer SC, 2021) To address these concerns, organizations must invest in human resource development through reskilling and upskilling initiatives (Marcel, 2023).

Training plays a critical role in equipping employees with the necessary skills and mindset for digital transformation (Bruna Felippes, 2023). Before embarking on training programs, organizations should assess employees' current skills and competencies to tailor training effectively (Phiri, 2023). Additionally, organizations may need to recruit external talents or collaborate with external partners such as universities and consulting agencies to supplement internal skill gaps. However, the competition for IT or digital specialists is very high in the market, making it difficult to recruit qualified people. (Lammers, 2019) Organizations must retain their talents as much as they can (Afef Saihi, 2022).

Furthermore, employee engagement and commitment are important for driving organizational transformation (Papathomas, 2023). Engaged employees play a key role in driving mindset changes, culture reform, and organizational performance (Azizan, 2021). Managers play a vital role in promoting employee engagement by sharing knowledge, promoting a rewarding mechanism, and creating a positive employee experience (Pettersson, 2022). A positive experience includes a nice physical working environment, clear and coherent strategy, good leadership, availability of resources, and so on (Gheidar, 2020). This contributes to the retention of employees as well. Despite organizational efforts to ensure human capital readiness, individual factors such as emotional state, experience, personality, and age also affect learning, acceptance, and engagement (Marx, 2023). Therefore, organizations must personalize management approaches based on their employees' characteristics.

The Theory of Planned Behavior (TPB), developed by Icek Ajzen (1991) , is one of the most influential models for understanding and predicting human behavior across disciplines. Illustrated in Figure 14, TPB posits that individuals' behaviors are primarily driven by their intentions and secondarily by perceived behavioral control. Behavioral intentions are shaped by three key factors: attitudes, subjective norms, and perceived behavioral control, all of which interact with each other in a mutually influential manner.

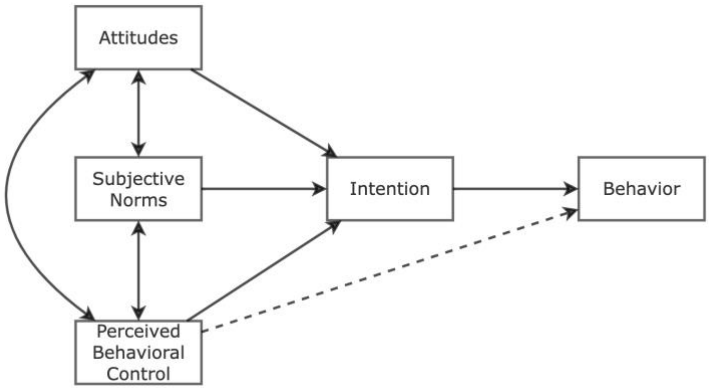

Figure 14 The Theory of Planned Behavior

Attitudes refer to individuals' overall evaluation of a behavior, reflecting their beliefs about the outcomes associated with performing that behavior and the extent to which they perceive these outcomes as favorable or unfavorable. Subjective norms capture the perceived social pressure to engage or refrain from a particular behavior, shaped by individuals' perceptions of others' expectations and their desire to conform to these expectations. Perceived behavioral control reflects individuals' perceptions of their ability to perform the behavior successfully, taking into account both internal factors, such as skills, and external factors such as time and resources. Besides, those three factors influence each other as well. (Ajzen, 1991)

The Technology Acceptance Model, shown in Figure 15, is another widely adopted framework for studying the behavior in acceptance and usage of technology. Similar to the Theory of Planned Behavior, TAM also presents that an individual's intention to use a particular technology is determined by their attitudes toward using such technology. The two primary factors, perceived usefulness and perceived ease of use, directly influence an individual's attitude toward using the technology. Perceived usefulness refers to the degree to which a person believes that using a specific technology will enhance their job performance and productivity, while perceived ease of use relates to the extent to which a person believes that using the technology will be free of effort. Moreover, external factors, such as social influences, training, and support, can also influence these perceptions and, consequently, influence technology adoption. (Davis, 1989)

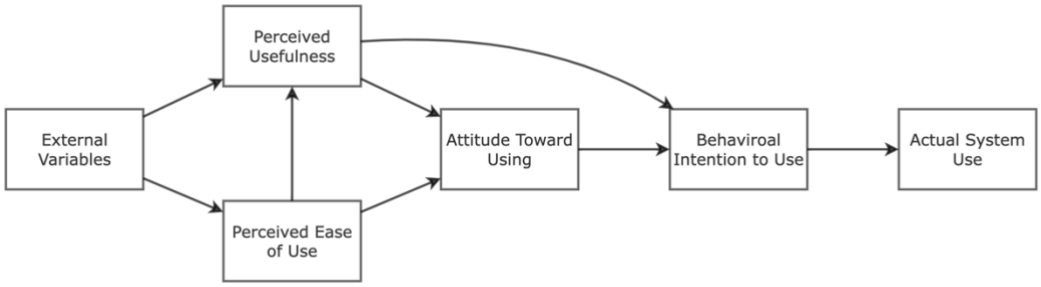

Figure 15 Technology Acceptance Model

Employees' behaviors are also influenced by other internal and external factors. A supportive organizational culture and strong leadership commitment to digital initiatives foster innovation and continuous learning among employees (Gheidar, 2020). Effective change management and communication strategies highlighting the benefits of digital transformation aid in developing an open and adaptive digital mindset (Oakland, Successful Change Management, 2007). Positive peer influence and collaborative work environments promote knowledge sharing and teamwork, shaping employees' digital mindset positively (Marx, 2023). User-friendly digital tools and supportive digital infrastructure simplify tasks, enhance productivity, and foster a proactive digital mindset among employees (R. Mulyana, 2021).

By considering and addressing these influences, organizations can effectively cultivate a digital mindset among employees, fostering a culture of digital innovation, adaptability, and continuous improvement.

Based on those theories, a conceptual model of people, as shown in Figure 16, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

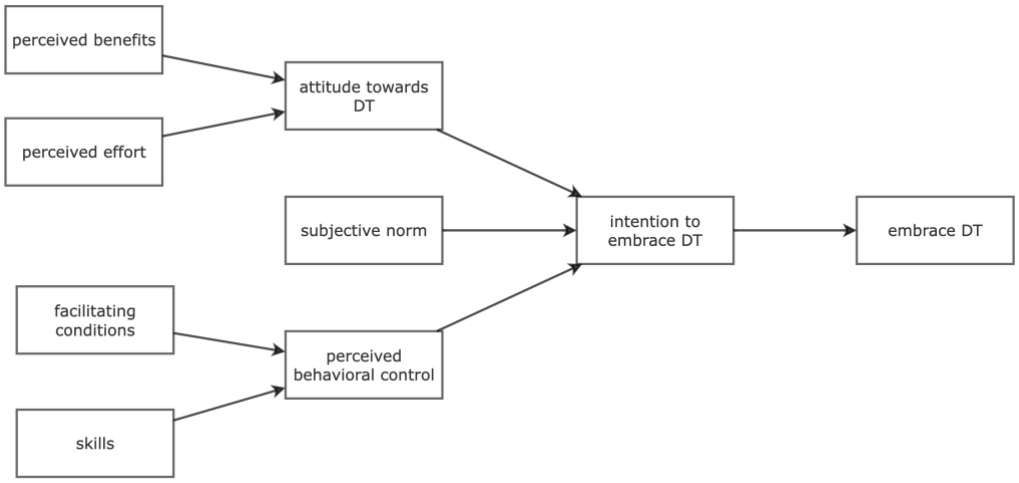

Figure 16 Conceptual Model of People

2.3 Technological Factors of Digital Transformation

To understand and identify the key technological factors that contribute to organizations' digital transformation success, this section reviews the theories in terms of the technological aspects of organizational digital transformation. According to the previous topic research, the implementation of technologies and the utilization of data are the key issues in digital transformation.

As the primary trigger of digital transformation, technology theories will be reviewed first. This is followed by data theories.

2.3.1 Technology

Technology serves as the foundation of a digital transformation, triggering and driving a digital transformation and enabling its success. Technology is one of the ways of value delivery in modern organizations where all products and services are, to some degree, enabled by technology. (Gkrimpizi, 2022) Therefore, the adoption of new technologies derives from not only the need for an organization to interact with its external touchpoints but also the need to improve the internal processes that shape the organization's digital value chain (Tsiavos, 2022). Usually, many technologies are involved in a digital transformation and the adoption of a single technology is not enough to be successful as it might be dependent on other technologies. Thus, it is wise for organizations to jointly implement complementary technologies to achieve their goals. (Henderikx, 2022)

Critical to this process is the assessment of technology availability and readiness, guiding investments in technologies and IT infrastructures based on their cost-benefit analyses (Yang, 2022). These costs encompass both initial expenditures and ongoing maintenance, translating into improved business performance (Sewpersadh, 2023). Given the dynamic nature of digital technologies, organizations must continuously adapt and evolve their IT infrastructure to support integration during transformational endeavors (Trevisan, 2023). Additionally, establishing robust technical support mechanisms fosters employee trust and proficiency in utilizing digital technologies within their work environments (Bayu Rima Aditya, 2021).

Central to an organization's IT infrastructure are various components working harmoniously to support its technological operations (Favoretto, 2021). Hardware forms the physical foundation, encompassing servers, computers, networking equipment, storage devices, and peripherals. Software, including operating systems and application programs, empowers users to perform tasks and manipulate data. Networks provide pathways for data transfer and connectivity, facilitating communication between devices. Data centers serve as vital facilities for managing IT infrastructure, ensuring data storage, processing, and management with reliability and redundancy. Cloud services offer scalable resources and services over the internet, enabling dynamic access to computing power, storage, and applications. Security systems safeguard against unauthorized access, data breaches, and cyber threats, encompassing firewalls, encryption, antivirus software, and access controls. Complemented by effective IT support, these components collectively form a resilient and efficient IT infrastructure foundation. (Prokosch, 2010)

Once the IT infrastructure is sufficient, the adoption of new service technologies or platforms can commence. Rather than outright displacing existing digital components, new technologies enhance and interconnect with the organization's current infrastructure (Russo Spena, 2022). Achieving interoperability among these systems is essential for coherent functionality (Trevisan, 2023). Despite the potential benefits, organizations may delay digital transformation due to apprehensions regarding technology risks and compatibility (Petzolt, 2022). To mitigate these risks, organizations can adhere to IT standards, protocols, and models promoting compatibility and interoperability, while seeking external assistance and selecting technologies aligned with their IT strategy and business model (Abdul Karim Feroz, 2023). The technologies adopted should fit the real needs of an organization and must be within the organization’s potential capabilities for its acceptance and use after implementation (Tsiavos, 2022).

2.3.2 Data

Moreover, leveraging data emerges as a key resource for digital transformation, enabling informed decision-making, market transparency, and process optimization (Doerr, 2023). However, effective data management presents multifaceted challenges, including collection, storage, analysis, cybersecurity, privacy, and trust, underscoring the need for robust infrastructure, skilled personnel, and strict adherence to data standards and regulations (Bruna Felippes, 2023).

Organizations must possess the necessary capabilities to utilize data effectively and extract value (Kempeneer, 2023), requiring modern IT infrastructure, often cloud-based, for data collection, storage, and analysis (Tsiavos, 2022). Outdated systems risk data leaks and diminished quality, highlighting the importance of relevant expertise, including data analysis models, algorithms, data scientists, and analysts (Kempeneer, 2023). However, organizations often encounter challenges due to the fragmentation and diversity of data, stored in separate systems without interlinkages, hindering data sharing across departments or agencies (Gkrimpizi, 2022). To address this, organizations must integrate their IT systems and establish data standards dictating collection, storage, and organization protocols (Saihi, 2022).

Besides, the increasing amount of data and information flow poses concerns l regarding data security, privacy, and trust (Weerabahu, 2022). Distinguishing between security and privacy is essential, with security focusing on safeguarding data from vulnerabilities and external attacks, while privacy concerns confidentiality breaches (Shrivastava, 2022). Data security measures

involve the development, planning, and implementation of procedures to prevent breaches and leaks, with risks borne by IT systems, personnel, and other factors. The adoption of standards like ISO/IEC 27001 guides the implementation of Information Security Management Systems (ISMS), although careful planning is essential to avoid operational burdens. Additionally, organizations must adhere to data protection regulations such as GDPR to safeguard customer privacy. (Tsiavos, 2022) Clarifying data ownership prior to collection builds trust among customers, facilitating easier data collection processes (Doerr, 2023).

Based on those theories, a conceptual model of technology and data, as shown in Figure 17, is made to summarize and represent this sub-system. This conceptual model will be used in the model specification as a guidance.

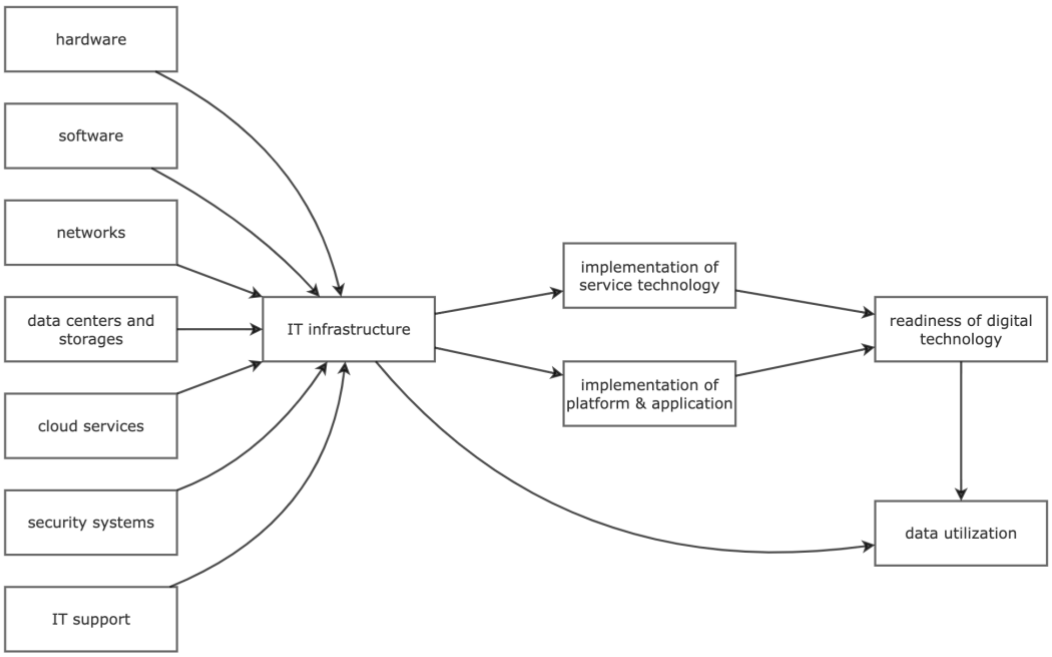

Figure 17 Conceptual Model of Technology and Data

2.4 Change Management

In this context, change management becomes critical for organizations to navigate the complexities inherent in digital transformation. To gain a deeper understanding of change management and its positive impact on digital change, this section reviews the relevant theories of change management.

Defined as "a systematic approach to dealing with the transition or transformation of an organization's goals, processes, and technologies", change management serves as a strategic compass orchestrating the transition from traditional paradigms to dynamic and digitally enabled ecosystems. (Moran, 2001)

Today's business environment is constantly changing, with rapidly evolving technology, changing stakeholder needs, and increasing economic pressures. However, experience has shown that many change initiatives fail to work. They do not always lead to total failure, but

rather to stagnation, misdirection, or only partial realization of the desired outcome. This shows the importance of successful change management (Todnem, 2005).

There are several typologies of change based on different criteria. Based on the underlying causes, organizational change can be categorized into crisis change and chosen change. Crisis change is a reactive approach driven by external factors and fear of failure, while chosen change is more a proactive approach driven by a workforce committed to the success of an organization. (Gerry Johnson K. S., 1999)

Pritchett and Pound (1996) introduced another typology categorizing organizational change into developmental, transitional, or transformational change. Developmental change refers to incremental improvements within existing processes, systems, or structures. Transitional change on the other hand, is a more substantial modification to adapt to new circumstances or opportunities. Transformational change signifies profound reforms involving reinvention of the organization's mission, culture, values, and strategic direction.

Various theoretical frameworks underpin change management practices, providing insights into understanding, implementing, and evaluating organizational change. Lewin's three-stage change management model, which is widely used, divides the change process into three steps - unfreeze, change, and refreeze. Organizations must first unfreeze their current process by analyzing the current business operations and communicating the upcoming change to employees. Organizations then implement the change and support their employees throughout the process. Once the change has been deployed and adjusted based on employee feedback, the organization must consolidate or refreeze the status quo by developing a system to monitor the implementation and evaluate how well the new processes are working. (Cummings, 2016)

For other frameworks, Kotter's (1996) 8-Step Change Model and Bridges' (1991) Transition Model offer additional frameworks for managing change, focusing on creating urgency, building a change team, communicating a vision, removing barriers, and facilitating transitions. These frameworks complement each other, providing valuable perspectives on managing change at different organizational levels.

Various factors influence the planning, preparation, implementation, and outcome of change management. These factors encompass change strategies, organizational culture and climate, leadership styles and behaviors, employee behaviors, and change management processes and systems (Price, 2006). This is closely related to digital transformation factors. Organizations need a deep understanding of how these factors interact and impact the change process. This understanding enables them to anticipate challenges, leverage opportunities, and cultivate an environment conducive to successful change management (Oakland, 2007). Through comprehensive exploration of these factors, organizations can craft tailored change management strategies that effectively address the complexities of their unique contexts, enhancing the likelihood of achieving desired outcomes in organizational transformations.

Many strategies or measures have been proposed to facilitate successful change management. Leadership must be dedicated to identifying the change, setting direction, and propelling its implementation. Communication plays a vital role in promoting transparency, managing change, and addressing employee concerns. Business and organizational process improvement should be aligned with business objectives. (Oakland, 2007) Employee involvement and empowerment can enhance commitment and mitigate resistance, fostering a sense of ownership in the change process. Cross-functional collaboration help breaks down silos and encourages

knowledge sharing. (Vial, 2019) Training and development programs equip employees with the necessary skills and competencies. Additionally, organizational culture alignment, data-driven analysis and decision-making, disciplined project management, and stakeholder management are critical to driving change initiatives forward. (Price, 2006)

2.5 Summary

In summary, organizational digital transformation represents a multifaceted and dynamic process influenced by a variety of interconnected factors. Effective change management is indispensable to steer this transformation journey. To visualize this process, a conceptual model, shown at the beginning of this chapter, has been developed. This model integrates the Three-Step Change Management Model (Cummings, 2016) and divides organizational digital transformation into three distinct phases: unfreeze, change, and freeze.

During the unfreeze phase, organizational leaders strategically respond to both internal and external triggers, setting clear goals and formulating a digital business strategy. Subsequently, a comprehensive digital transformation strategy is developed, with necessary financial resources earmarked to support subsequent phases.

Transitioning to the change phase, both technological and organizational changes are implemented in alignment with the formulated strategies. Technological advancements commence with the enhancement of IT infrastructure to facilitate the adoption of new technologies and maximize data utilization. Simultaneously, organizational changes encompass structural adjustments, process refinement, cultural shifts, leadership enhancements, and workforce development initiatives.

Upon the successful completion of these changes, efforts are directed towards the freeze phase, where the implemented transformations are integrated and embedded within the organizational context. This phase serves as a critical juncture for consolidating the changes and leveraging them to drive tangible impacts across the organization. Overall, this iterative process underscores the importance of strategic alignment, effective resource allocation, and robust change management practices in ensuring the success and sustainability of organizational digital transformation initiatives.

However, while the conceptual model provides a foundational understanding of digital transformation factors and their relationships, it remains static and conceptual in nature. This limits our qualitative and quantitative understanding of these relationships, especially when analyzing multiple factors simultaneously and dynamically rather than the one-to-one correspondence between factors. To study these dynamics in more depth and capture their evolving nature, it is important to include dynamics into the model.

Chapter 3

The System Dynamics Model Specification

Following the Modeling and Simulation Design Cycle, this chapter focuses on the specification part of the system dynamics model tailored to explore the multifaceted dynamics of digital transformation within organizations and present insightful results. The previous chapter identified the key elements of digital transformation and developed an overall conceptual and eight sub-conceptual models. The next step is to include dynamics, which takes the conceptual models made in the previous chapter as input and produces the system dynamics model of digital transformation. This can be done with a system dynamics approach.

Aligned with the structure of the conceptual model, the system dynamics model encompasses eight sub-models, each focusing on delineating the interrelationships among its internal and external factors. Each of those sub-models is presented separately involving its scope, assumptions made, and model behavior. Furthermore, the system dynamics model aims to study and obtain more insights into the dynamics of organizational digital transformation by incorporating time and resource allocation as key factors. To address this, the model also includes a module enabling the division of different transformation phases and the assignment of priority to different digital transformation initiatives. Following the implementation of these executable sub-models, they are integrated into a cohesive system dynamics model that enables digital transformation simulations.

Through the integration of the eight sub-models, the module of phase and priority, and KPIs, the system dynamics model provides a dynamic and concrete framework for analyzing and optimizing digital transformation initiatives. By capturing the nuanced interplay of factors and their impact on organizational outcomes, the model empowers relevant stakeholders to make informed choices, mitigate risks, and drive successful digital transformations in today's rapidly evolving business landscape.

3.1 System Dynamics Approach

The system dynamics approach, introduced by Jay W. Forrester (1961), is a methodology for analyzing and understanding complex dynamic systems. It has five distinguishing features.

First, model structures are built upon relationships between system elements, depicted through causal diagrams. These causal structures always integrate feedback loops, categorized as positive (reinforcing) or negative (balancing), which determine the system's behavior over time. Secondly, system dynamics regards accumulation, delays, and inertia as crucial in delineating real-world dynamics, as every system dynamics model encompasses stocks representing accumulations and flow variables determining changes to these accumulations, offering a realistic sense of path dependence. This perspective differentiates system dynamics from differentiation worldviews in modeling approaches. Thirdly, all variables in a system dynamics model are governed by mathematical equations, describing how they evolve with changing causal influences, connecting the four building blocks of a system dynamics model: stocks, flows, auxiliaries, and constants. Fourthly, system dynamics adopts a relatively realistic concept of time, considering it as continuous and closely monitoring how system behavior evolves over time. Lastly, system dynamics prioritizes feedback analysis, distinguishing itself

from other simulation approaches, such as agent-based modeling, network analysis, and discrete event simulation, providing a structured framework to unravel the intricacies of complex systems and offer valuable insights for decision-making by capturing dynamic interactions and feedback loops. (Asmeret Naugle, 2023)

The application of the system dynamics approach spans fields. In business and management, it models organizational processes, decision-making, market dynamics, and project management (Sterman, 2000). In public policy and governance, it addresses complex social, economic, and environmental issues, enabling informed policymaking and sustainable policies (Meadows, 2008). Environmental science and sustainability leverage system dynamics to model ecosystems, natural resource management, environmental impact assessment, and climate change by capturing human-environment interactions. Furthermore, it is employed in urban planning and transportation to model traffic flows, land use dynamics, infrastructure development, and urban growth, and in education and organizational learning to facilitate the comprehension of complex systems thinking concepts, offering valuable insights for stakeholders. (Railsback, 2011)

Systems dynamics research requires methodological considerations to ensure its rigor, validity, and reliability (Forrester, 1961). Similar to the general simulation design cycle, one important consideration is model development, which involves conceptualizing the system, identifying relevant variables, and defining the relationships and feedback loops among them. The model structure must reflect the underlying dynamics of the system accurately and align with empirical evidence and theoretical frameworks. Validation follows the completion of model development. Validation entails assessing the accuracy and predictive capability of the model by comparing its simulated behaviour with real-world data or expert judgments. This procedure aids in verifying the credibility and reliability of the model. (Cetinkaya, 2011)

Data collection and parameter estimation is another consideration. The selection of techniques may vary based on data availability and quality, including options like historical data analysis, expert elicitation, or simulation-based optimization. Additionally, ensuring transparency and reproducibility is essential. This involves thoroughly documenting modelling assumptions, data sources, and methodology to enable transparency and independent verification of results. (Railsback, 2011)

3.2 Phases of Transformation

In actual digital transformation programs, financial resource constraints and initiative prerequisites often prevent organizations from implementing all initiatives simultaneously (Barthel, 2021). Consequently, organizations must carefully prioritize their initiatives at different stages. To be able to simulate this fact and align with change management stages, the model design incorporates a phase and priority mechanism. The phase & priority mechanism was modelled in the way as shown in Figure 18.

Digital transformation is often seen as a large-scale project with multiple phases (Vial, 2019). The cycle of a large project is around two years on average, rather than one year, as one year is too short for large projects. Also, large projects are usually reviewed biannually (George Westerman, 2014). Therefore, in this model, the simulation time span is 2 years, divided evenly into four phases, each lasting 24 weeks. However, this is only the initial setup of the model. When applied, the simulation durations can be adjusted for different practical situations.

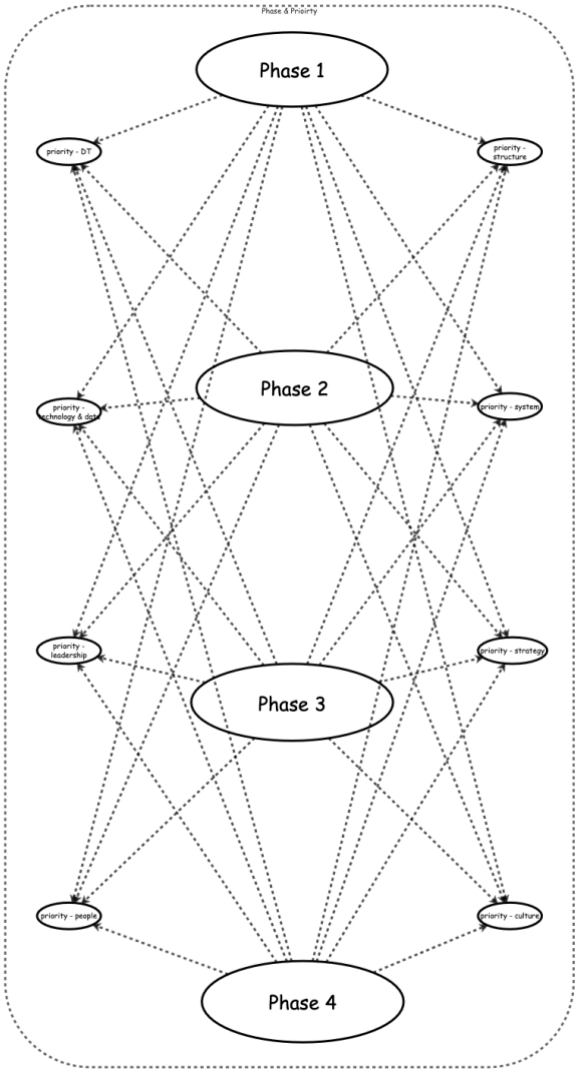

Figure 18 Phases of Transformation

To indicate the priority of the initiatives, each initiative is assigned a priority variable ranging from zero to one, which changes over the phases based on initial data inputs. As a widely used range, zero to one range is consistent with probability theory and weighting methods, making the simulation analysis straightforward and efficient (Rényi, 1970). Also, the uniformity allows for a consistent interpretation across various initiative phases. A priority value of zero indicates the lowest priority, with the organization allocating no resources and taking no action on the initiative. Conversely, a priority value of one signifies the highest priority, with the organization fully maximizing its capacity to implement the initiative. The sum of priorities indicates the total resources allocated to digital transformation.

In addition, the level of commitment to digital transformation tends to vary from one organization to another, depending on factors such as size, type and status of the organization. Larger organizations and those in the technology sector usually tend to allocate a higher proportion of resources to digital transformation initiatives. (Weerabahu, 2022) To represent this fact, the overall digital transformation process is assigned a priority variable as well to reflect the extent to which organizations are devoting internal resources to digital transformation. A priority value of zero signifies that an organization is not allocating resources

and taking any action for digital transformation, whereas a priority value of one indicates that an organization is fully committed to digital transformation efforts.

Based on initial assessment, business goal, and strategic objectives, the priority of each initiative for each phase is entered prior to the simulation run to reflect the importance and urgency of the initiative in a certain situation. The priorities can be adjusted during the simulation to optimize the configuration. The priority value directly influences the speed of initiative implementation and resource allocation. The actual implementation speed of an initiative is equal to the ideal speed multiplied by its priority.

3.3 Strategy Model

This section focuses on the specification of the strategy model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

According to the theories and the strategy conceptual model (Figure 7) in 2.2.1, digital business strategy and digital transformation strategy are the main components of the strategic planning. Thus, this model aims to assess the readiness of an organization's digital business strategy and digital transformation strategy dynamically by transforming the strategy conceptual model into a system dynamics model. To achieve this, it introduces variables such as strategy development, strategy gap, strategy degeneration, and other internal dynamics. The model examines the process of developing digital business strategies and digital transformation strategies, emphasizing the alignment with overarching business objectives and effective navigation of the transformation process.

To be able to realize the specifications of this model, three assumptions were made. Firstly, to simplify the actual system and make the model more implementable, it was assumed that each sub-strategy within an organization evolves and degenerates at a uniform speed. Also, each sub-strategy contributes equally to its overarching strategy. Furthermore, a larger strategy gap implies poorer strategy performance, which accelerates the degeneration of strategy readiness.

Model Operationalization

To achieve the operationalization of the strategy model, the conceptual model of strategy (Figure 7) was translated to a system dynamics model. Based on Collou's (2021) digital business strategy framework and the McKinsey 7-S Model (Suwanda, 2022), five key stocks are identified under digital business strategy: service strategy, platform & application strategy, information & data strategy, infrastructure strategy, and security strategy, and seven stocks are identified under digital transformation strategy: finance strategy, leadership strategy, organizational structure strategy, process strategy, culture strategy, and people strategy. Digital business strategy also contributes to digital transformation strategy as a variable.

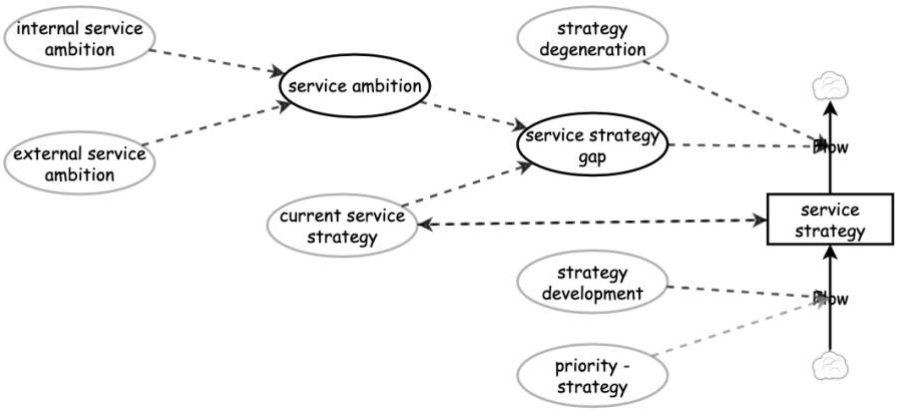

Figure 19 Service Strategy Model

Taking the service strategy in Figure 19 as an example, to simulate the dynamic development process of a strategy, each sub-strategy is directly influenced by four key variables: strategy development, strategy gap, strategy degeneration, and strategy priority. Strategy development signifies the optimal pace at which an organization can formulate strategies, a rate that increases the value of the strategy and varies across different contexts. The actual pace of an organization's strategy development is determined by both its optimal strategy development pace and its current priority on strategy. A strategy gap represents the difference between the organization's ambitions on this strategy and its current status with this strategy. A larger gap accelerates the decrease of the strategy's value. Moreover, strategies inherently degenerate in quality over time, necessitating ongoing maintenance efforts to ensure alignment with goals and sustained effectiveness (Gerry Johnson K. S., 2008). Even in the absence of an obvious gap, this inherent degradation makes the ongoing allocation of resources for strategy maintenance still imperative.

To identify a certain strategy gap, an organization must first define its ambitions in this strategy, internally and externally. Internally, this involves evaluating competencies and benchmarking performance against industry standards. Externally, market, competitor, and customer analyses are essential for gauging external ambitions. (Lokuge, 2021) Subsequently, assessing the quality of the current strategy and comparing it with the ambitions allow for pinpointing the existing gap and informing further strategic decision-making. When operating the model, organizations should assign a value ranging from zero to one to both internal and external service ambitions based on the outcomes of their ambition identification process. A value of zero indicates extremely low ambition, while a value of one indicates extremely high ambition.

INTEG is used as a synonym for "integrate" and it indicates that at any moment in time the stock is equal to the sum of all inflow minus the sum of all outflows plus the initial value. Hence, the equations about service strategy are:

*service strategy = INTEG (strategy development*priority-strategy – service strategy gap – strategy degeneration)*

service ambition = (internal service ambition + external service ambition)/2

service strategy gap = service ambition – current service strategy

This principle extends to the development of any sub-strategy of digital business strategy. Consequently, the equations for the remaining four stocks adhere to the same pattern and will be presented in the Appendix 2.

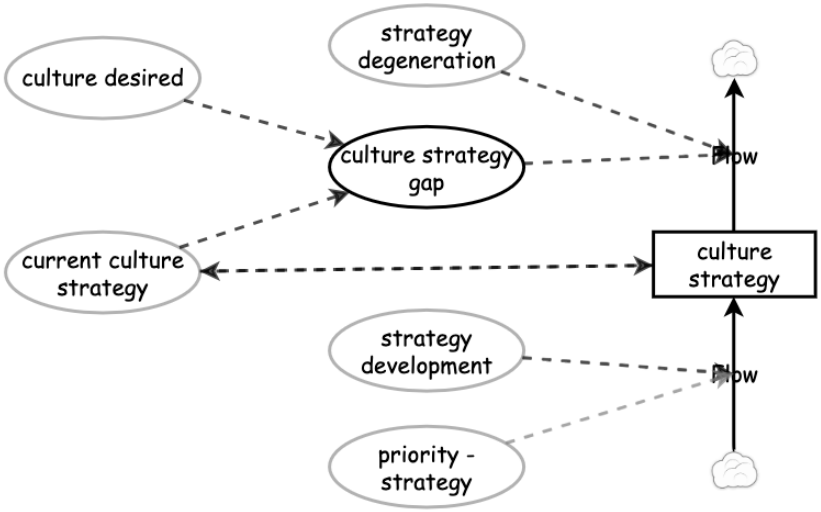

Figure 20 Culture Strategy Model

The development process of the sub-strategies of digital transformation has a similar pattern. Taking the culture strategy model in Figure 20 as an example, the only difference is that the desired state is solely identified internally to facilitate the changes identified within the digital business strategy. Thus, the equations about culture strategy can be formulated as:

*structure strategy = INTEG (strategy development*priority-strategy – structure strategy gap – strategy degeneration)*

structure strategy gap = structure desired – current structure strategy

This principle also extends to the development of any sub-strategy of digital transformation strategy. As a result, the equations about the remaining six stocks follow the same pattern and are presented in the Appendix.

Integrating all sub-strategies modules according to the strategy conceptual model, the strategy system dynamic model was formed which is illustrated in Figure 21. The model has two primary factors – digital business strategy and digital transformation strategy. The value of those two variables scales from zero to one indicating the readiness level of the strategies. Following the principles of change management, it is essential for organizations to formulate a digital business strategy at the very beginning of a digital transformation to pinpoint the driving forces behind change and identify potential transformations (Cummings, 2016). Subsequently, as the final desired outcome of the planning phase, a digital transformation strategy should be prepared to evaluate the organization's readiness for change and steer the implementation process effectively.

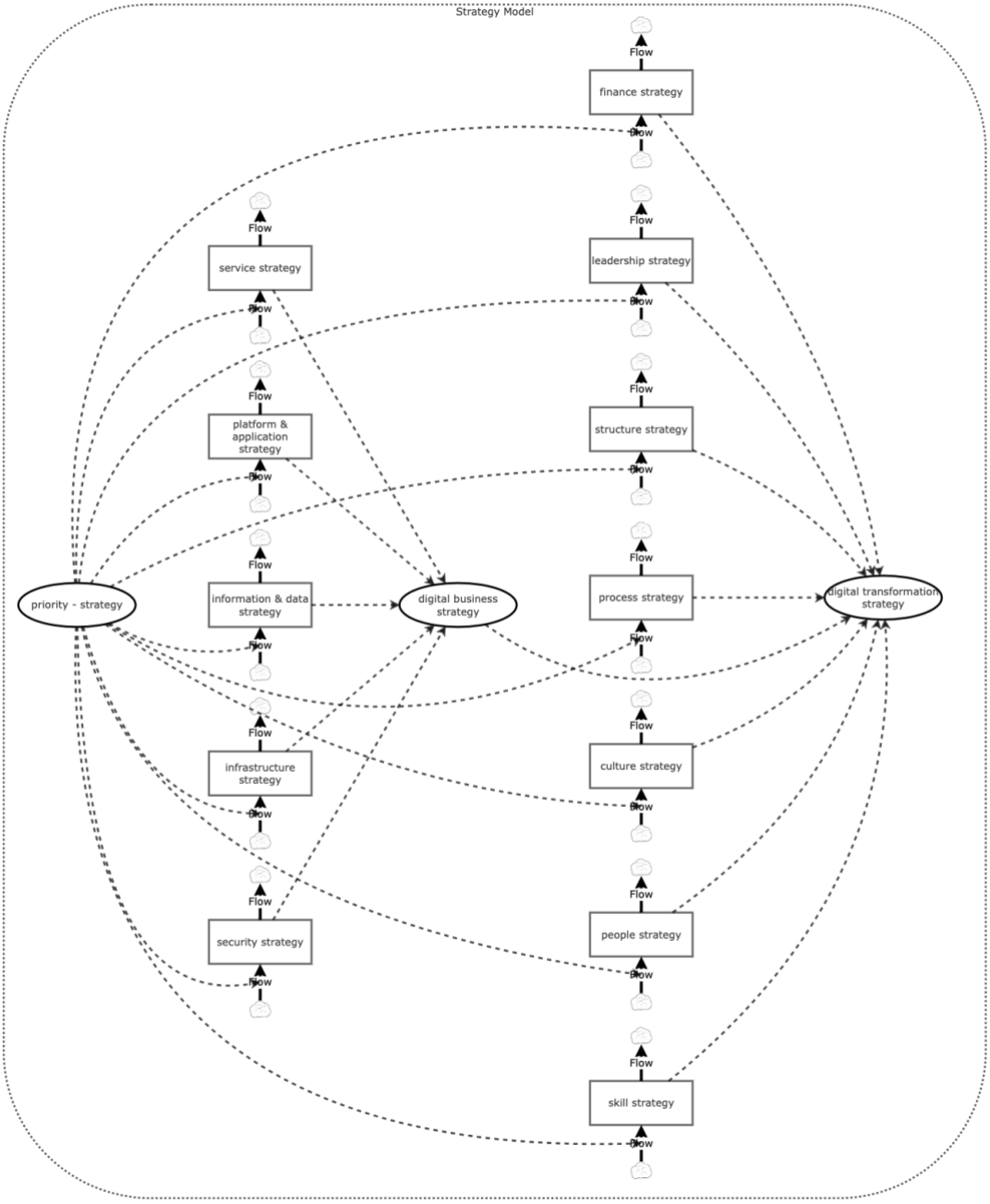

Figure 21 Strategy Model

Thus, based on the relationships shown in the model, the equations about digital business strategy and digital transformation strategy can be formulated as:

digital business strategy = (service strategy + platform & application strategy + information & data strategy + infrastructure strategy + security strategy)/5

digital transformation strategy = (structure strategy + system strategy + culture strategy + skill strategy + staff strategy + styles strategy + culture strategy + finance strategy)/8

3.4 Finance Model

This section focuses on the specification of the finance model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

During digital transformation, an organization's funds flow from source to spend and are therefore constantly dynamic (Weerabahu, 2022). To simulate the financial situation of an organization's digital transformation and capture the dynamics within it, the finance conceptual model was translated into a system dynamic model. Such a model can provide insights regarding resource allocation and prioritization. By evaluating the total funding requirements, available internal resources, and potential external funding sources, the finance model assists organizations in identifying optimal resource allocation strategies to support their digital transformation goals effectively.

To be able to realize the specification of the model, two assumptions were made. To be able to simply represent cost, the priority of a digital transformation initiative corresponds directly to its cost. Thus, the total expense of digital transformation initiatives within a specific phase equals the cumulative value of all initiatives' priorities in that phase and thereby the full funding requirements represent the total cost when all seven initiatives are given the full priority. Moreover, organizations may initially receive external investment as an initial injection of funds for their digital transformation efforts (Mihu, 2023). Subsequently, they will borrow from external entities only if their internal resources are insufficient to cover expenses. Typically, as internal funds become adequate to sustain expenditures, organizations prioritize paying off any external debt incurred.

Model Operationalization

By referring to the finance conceptual model (Figure 8) and Pejic Bach's (2014) credit card usage system dynamics model, the finance system dynamics model, as shown in Figure 22, was operationalized. This model also considers variables such as internal funding, external investments, external funding, and payoff. To be able to represent different types of funds and allow for the accumulation of funds between phases. The model introduces Funds 1 and Funds 2, which change over time. Funds 1, as a stock, represents the amount of funds excluding external contributions, while, although as a variable, funds 2 represents the total funds incorporating both internal and external sources, and it adjusts under changes in Funds 1 and External Fund. Another stock is External Funds which denotes funds sourced from external entities.

Funds 1 is influenced by two primary variables: internal funding infusion as inflows and spending as outflows. Internal funding infusion is determined by the available internal funds within each phase and the phase duration, calculated as a ratio of the internal funds and the value of the phase duration. Internal funds represent an organization's internal investment in digital transformation during certain phases. Thus, internal funds are determined by the total funding requirements and the priority of digital transformation for each phase. Spending, on the other hand, is determined by the total cost incurred across all initiatives within a phase. The total cost of digital transformation initiatives within a specific phase equals the sum value of all initiatives' priorities in that phase.

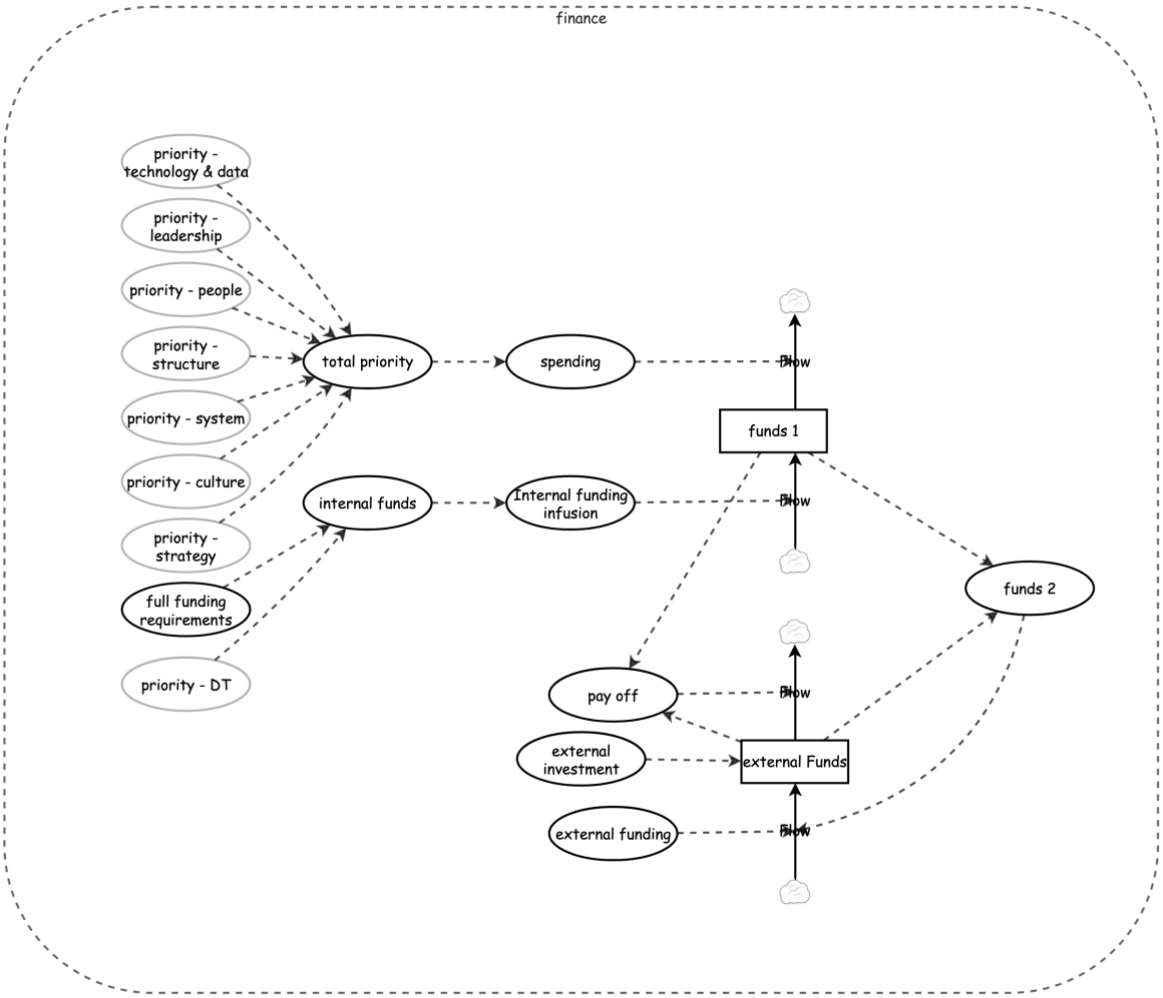

Figure 22 Finance Model

Thus, the model's equations can be formulated as:

$$fund\ 1 = INTEG\ (internal\ funding\ infusion - spending)$$

$$internal\ funding = internal\ funds/24$$

$$external\ funding = total\ priority/24$$

$$internal\ funds = full\ funding\ requirements*priority\text{-}DT = 7*priority\ DT$$

$$external\ funds = external\ investments + INTEG\ (external\ funding - pay\ off)$$

$$funds\ 2 = funds\ 1 + external\ funds$$

3.5 Leadership Model

This section focuses on the specification of the leadership model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

As the readiness of an organization's leadership for digital transformation along the process, this model specification aims to translate the leadership conceptual model (Figure 9) to a system dynamics model that can simulate this dynamic and assess leadership readiness. This can provide insights into an organization's current leadership performance and areas for improvement.

To achieve this model specification, three assumptions were made. Firstly, to deal with the influence of organizational-level leadership and individual-level leadership in a general and simple way, it is assumed that both contribute equally to digital leadership readiness. Similarly, it is assumed that leadership styles, skills, and roles equally contribute to digital leadership transformation. to avoid adding further complexity to the model, each training program has a uniform duration, meaning that leadership styles and leadership skills improve at the same rate over time.

Model Operationalization

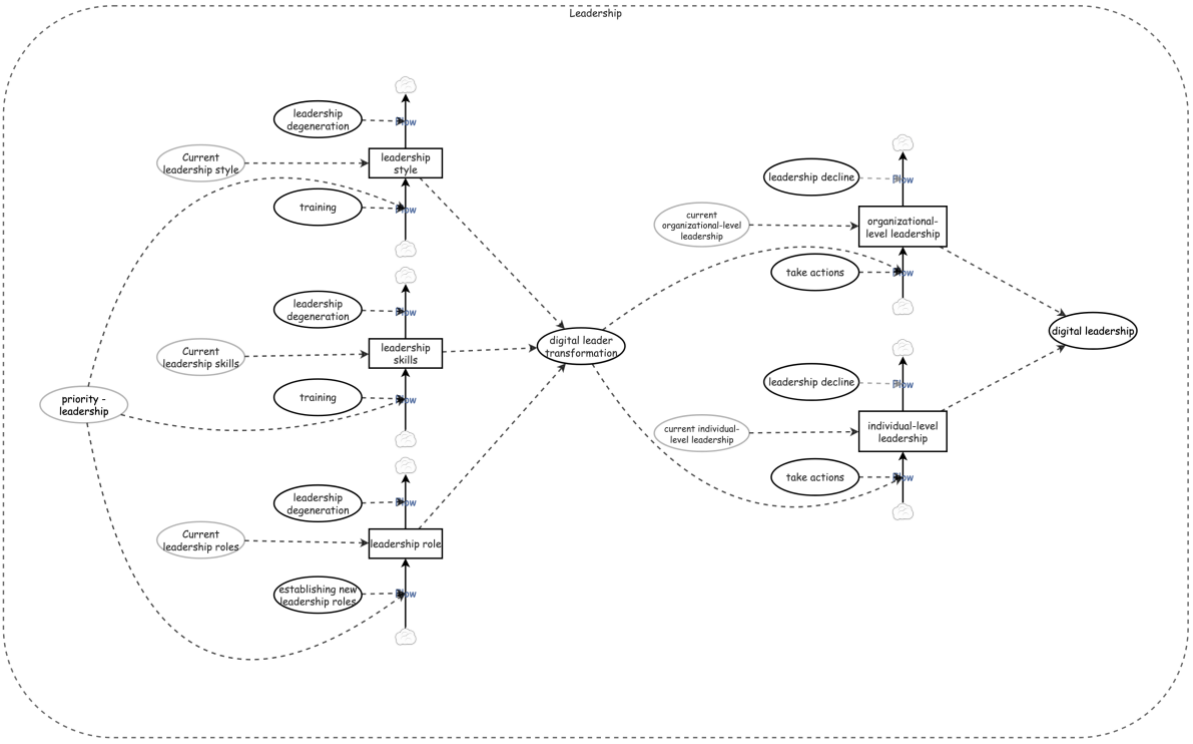

Figure 23 Leadership Model

Following the leadership conceptual model (Figure 9), the leadership system dynamics model was specified as shown in Figure 23. The leadership system dynamic model is a behavioral model to assess if organizations' leadership actively and effectively engages in digital transformation initiatives including both organizational aspects and individuals. Organizational-level leadership and individual-level leadership are identified as two stocks that determine the value of the final variable 'digital leadership' together. Thus, the equation of digital leadership is:

digital leadership = (organizational-level leadership + individual-level leadership)/2

The stock 'organizational-level leadership' reflects how involved and impactful an organization's leaders are in driving its organizational initiatives, with values ranging from zero to one. A value of zero signifies no engagement in organizational initiatives, while a value of one indicates leaders fully embody ideal engagement. Users need to input the current level of organizational-level leadership as an initial value, based on leadership evaluation outcomes and the leadership goals outlined in the strategy. To improve organizational-level leadership, leaders must proactively take action in engaging digital transformation initiatives and makeshift to digital leaders (Thekkoote, 2022). Conversely, organizational-level leadership declines over time if there is no action taken. Thus, taking action and digital leader transformation are the two inflow variables for organizational-level leadership, while leadership decline is the outflow variable. Then, the equation of organizational-level leadership can be formulated as:

organizational-level leadership = current organizational-level leadership + INTEG (take actions + digital leader transformation – leadership decline)

Similarly, the stock 'individual-level leadership' reflects how involved and effective an organization's leaders engage with individuals, with values ranging from zero to one. The equation of individual-level leadership can be formulated as:

individual-level leadership = current individual-level leadership + INTEG (take actions + digital leader transformation – leadership decline)

Digital leader transformation involves equipping leaders with the requisite skills, mindset, tools, and roles to excel in a digitally evolving environment (Azizan, 2021). Thus, the three key factors – leadership style, leadership skills, and leadership role – collectively and equally determine the completeness of digital leadership transformation. Those three factors are identified as stocks that change over time.

The "leadership style" stock reflects the performance of the leader's style compared to the ideal state, with values ranging from 0 to 1. A value of zero suggests a full lack of defined styles, while a value of one indicates attainment of the ideal state. To transform or develop leadership styles, training & learning programs play an important role (Bruna Felippes, 2023). Thus, training was identified as an inflow variable for leadership style. Furthermore, leadership style degenerates due to personal or external factors. To simplify this fact, leadership degeneration was used as the outflow variable for leadership style. When applying, users should input the current leadership style value based on the style evaluation results and the outlined style goals in the leadership strategy. However, digital leader transformation is not a necessary condition, and sometimes leadership can still perform well without undergoing any transformation (Hoessler, 2023). Therefore, organizations should decide whether to undergo digital leadership transformation based on their current leadership performance.

Similarly, the "leadership skills" stock assesses leaders' skill performance, representing progress towards the ideal state with values ranging from zero to one. A value of zero indicates a complete lack of skills, while a value of one indicates full proficiency. Leadership skills are also improved through training & learning programs and naturally degenerate over time (Bruna Felippes, 2023). Thus, training and leadership degeneration were the inflow variable and outflow variable for leadership skills. Users should also input the current leadership skill value based on leadership skill evaluation outcomes and predetermined skill goals in leadership strategy.

The ‘leadership role’ stock represents the progress of establishing new leadership roles with values ranging from zero to one. A value of zero indicates no required leadership roles have been established, while a value of one indicates that required leadership roles are fully established as planned in strategy. To drive this process, proactive establishment or adjustment of roles is essential (Abdul Karim Feroz, 2023). Furthermore, minor adjustments may be necessary based on evolving practices, making leadership roles degenerate over time. Thus, establishing new leadership roles and leadership degeneration were the inflow and outflow variables for leadership roles. Users should also input an initial value for leadership roles based on the current progress in establishing roles.

Therefore, the equations about digital leader transformation can be formulated as:

digital leader transformation = (leadership style + leadership skill + leadership role)/3

leadership style = current leadership style + INTEG (leadership style training – decline)

leadership skill = current leadership skill + INTEG (leadership skill training – decline)

leadership role = current leadership roles + INTEG (establish new leadership role – decline)

3.6 Organizational Structure Model

This section focuses on the specification of the organizational structure model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

An organization’s structure is constantly being dynamically adapted to the demands of digital transformation (Vial, 2019). To simulate this dynamic process and assess the readiness of organizational structure for digital transformation, the organizational structure conceptual model (Figure 10) was translated into a system dynamics model. By examining various dimensions of organizational structure design, including hierarchy, workflow, collaboration channels, and decision-making processes, the model aims to offer insights into the alignment between organizational structure and digital transformation goals, helping organizations identify areas for improvement and implement structural changes to support other transformation initiatives. Simulating and assessing the performance and impacts of different structural configurations enables organizations to design and implement the most suitable organizational structure that fosters innovation, agility, and sustainable growth in the digital era.

According to the organizational structure conceptual model, five key characteristics determine the optimal organizational structure for successful digital transformation: flat hierarchy, cross-functional collaboration, transformation of digital functional areas, separate units, and flexible roles and responsibilities. Those five characteristics tend to impact an organization’s structure differently, thus the importance of the five characteristics varies among organizations.

Model Operationalization

Following the organizational structure conceptual model (Figure 10), the organizational structure system dynamics model was developed as shown in Figure 24. The five key

characteristics of organizational structure for successful digital transformation: flat hierarchy, cross-functional collaboration, transformation of digital functional areas, separate units, and flexible roles and responsibilities, were identified as stocks that change from a value of zero to one over time. A value of zero indicates extremely poor performance that is completely inconsistent with the ideal state, while a value of one indicates extremely good performance that is completely consistent with the ideal state. Those five stocks determine the organizational structure readiness collectively.

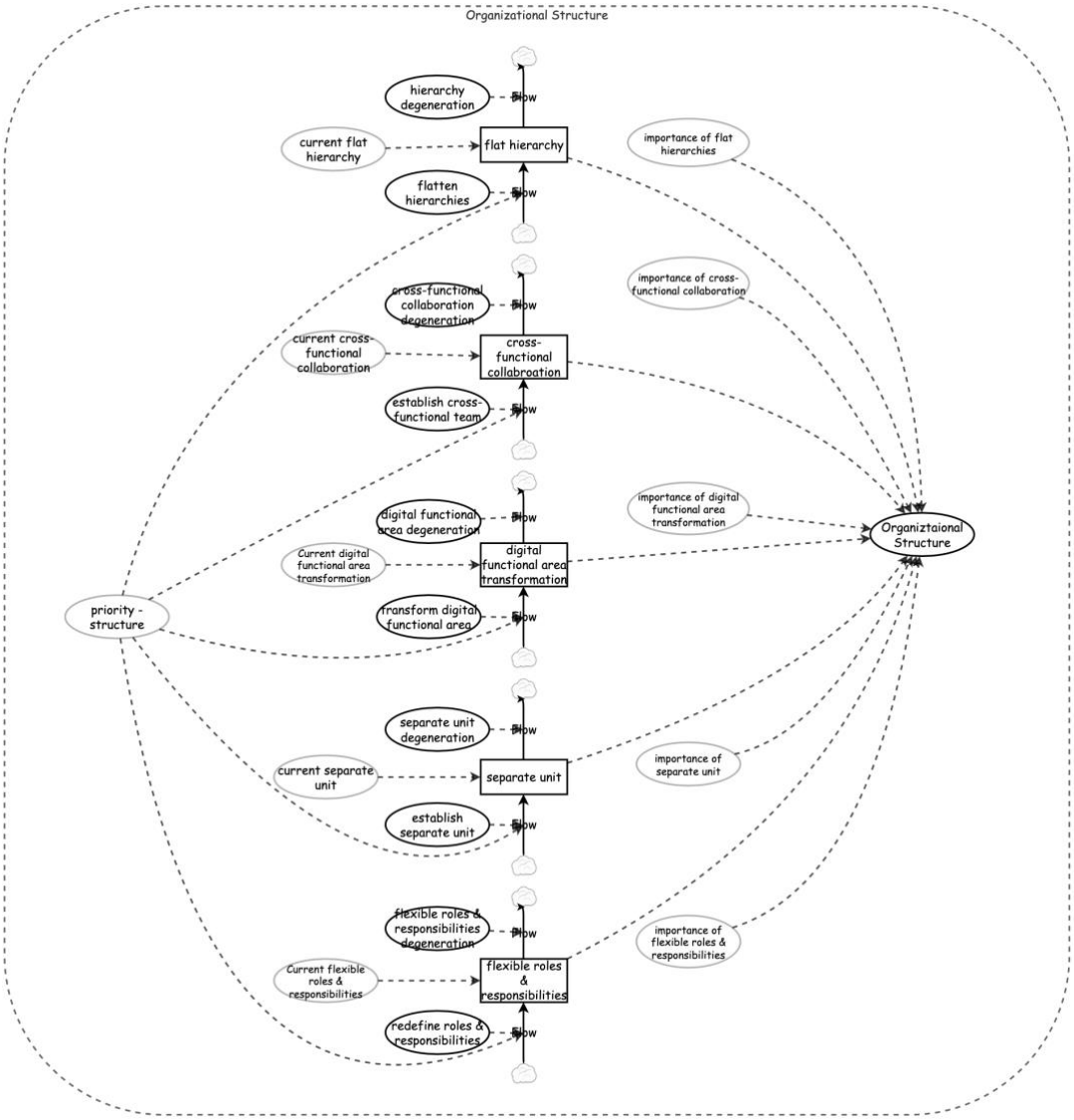

Figure 24 Organizational Structure Model

To improve those five characteristics, organizations need to take relevant measures (Peter C. Verhoef, 2021). Thus, flattening hierarchies, establishing cross-functional teams, transforming digital functional areas, establishing separate units, and redefining roles and responsibilities are the inflow variables for those five stocks respectively. Flattening hierarchy is a rate that indicates the speed at which an organization's hierarchy flattens when there are absolutely sufficient resources and no other obstacles. Similarly, establishing cross-functional teams, transforming digital functional areas, establishing separate units, redefine roles &

responsibilities respectively indicate their speed with sufficient resources and no obstacles. Those optimal rates and the priority assigned to organizational structure together determine the actual inflow.

Furthermore, the quality of those five characteristics degenerates inherently at different rates over time due to their distinct nature (Lawrence, 1967). For instance, roles, responsibilities, and separate units typically remain stable over the long term after their establishment, exhibiting a slow rate of degeneration. In contrast, cross-functional collaboration tends to degrade more quickly due to ongoing resistance factors. Thus, every stock has its degeneration rate as its outflow variable.

Organizations should set an initial value for each characteristic based on the organization's current level and the desired level of the characteristic. This drives organizations to evaluate their organizational structure characteristics and establish goals before embarking on restructuring work. INTEG is used as a synonym for "integrate" and it indicates that at any moment in time, the stock is equal to the sum of all inflow minus the sum of all outflows plus the initial value. The equations for those five stocks can be formulated as:

*flat hierarchy = INTEG (current flat hierarchy + flatten hierarchy*priority-structure – hierarchy degeneration)*

cross-functional collaboration =INTEG (current cross-functional collaboration + establish cross-functional team priority-structure – cross-functional collaboration degeneration)*

digital functional area transformation = INTEG (current digital functional area transformation + transform digital functional area priority-structure – digital functional area degeneration)*

separate unit = INTEG (current separate unit + establish separate unit priority-structure – separate unit degeneration)*

flexible roles & responsibilities = INTEG (current flexible roles & responsibilities + redefine roles & responsibilities priority-structure – flexible roles & responsibilities degeneration)*

While all five characteristics are key to digital transformation success, organizations tend to place different levels of importance and prioritization on each characteristic, which can have different impacts on the organizational structure (Barthel, 2021). To account for this variability, five variables are employed to indicate the importance of each characteristic. The sum of these variables should equal one, reflecting the proportional weighting of importance across the characteristics. Thus, the equation of organizational structure can be formulated as:

*organizational structure = flat hierarchy*importance of flat hierarchy + cross-functional collaboration*importance of cross-functional collaboration +digital functional area transformation*importance of digital functional area transformation +separate unit *importance of separate unit + flexible roles & responsibilities*Importance of flexible roles & responsibilities*

3.7 Process Model

This section focuses on the specification of the process model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

An organization continuously adjusts its process and improves the process readiness for digital transformation (Suwanda, 2022). To be able to simulate this dynamic and assess an organization's process readiness, therefore, the process conceptual model (Figure 11) was translated to a system dynamic model. It provides insights into an organization's performance in terms of process and facilitates continuous monitoring and adjustment of processes to ensure ongoing alignment with digital transformation goals, ultimately driving organizational efficiency and agility.

Horizontal alignment and process optimization are the two main focuses of this model. To simplify the model, it is assumed that horizontal alignment and process optimization equally contribute to organizations' process readiness.

Model Operationalization

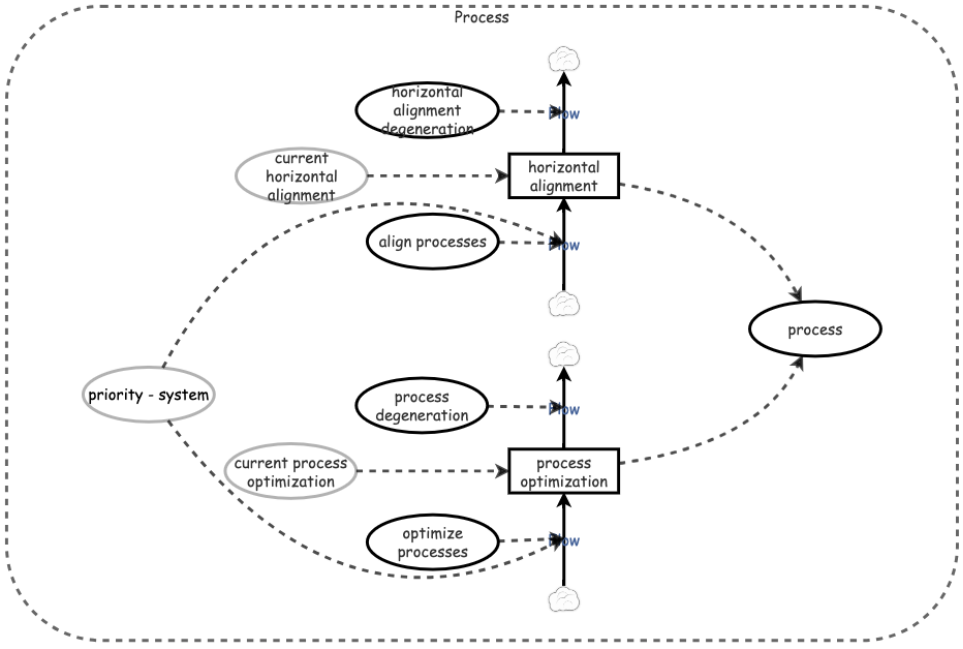

Figure 25 Process Model

Based on the process conceptual model (Figure 11), the process system dynamic model was developed, as shown in Figure 25. Horizontal alignment and process optimization were identified as the two stocks in the model. Horizontal alignment indicates the extent to which processes across various functions and departments of an organization are aligned, with values ranging from zero to one. On the other hand, process optimization reflects the extent to which the organization's processes are aligned with its desired state in terms of efficiency and

effectiveness, with values ranging from zero to one. Since these two factors equally contribute to organizations' process readiness, the equation of process can be formulated as:

process = (horizontal alignment + optimization of the process)/2

To improve an organization's horizontal alignment, the organization needs to take relevant measures to align its processes (Mihu, 2023). Also, a good organizational structure facilitates the alignment of processes. Organizational structure plays a vital role in horizontal alignment by providing the framework within which different functions and departments interact and collaborate (Rajan Ranjith Kumar, 2021). Thus, the inflow variables of horizontal alignment are 'aligning processes' and 'organizational structure'. 'Aligning processes' represents the rate at which an organization can harmonize its processes across different functions and departments under optimal resource and condition settings, derived from all relevant measures. This optimal rate and the priority of the process together determine the actual process alignment speed. Process priority, as previously discussed, determines the allocation of resources to process initiatives, thus impacting their progress. Furthermore, an organization's horizontal alignment inherently degenerates over time. Thus, 'horizontal alignment degeneration' is the outflow variable of horizontal alignment.

Through implementing relevant measures, an organization can drive its process optimization (Agostino, 2022). Hence, the inflow variable of process optimization is generalized as 'optimizing process'. 'Optimizing processes' represents the rate at which an organization can enhance the quality of its processes under optimal resource and condition settings. Similar to horizontal alignment, process priority also impacts the progress of process optimization, and the quality of an organization's processes inherently degenerates over time as well. Also, process optimization degenerates inherently over time. Thus, 'process degeneration' was identified as the outflow variable of 'process optimization'.

Before starting a simulation, Organizations need to determine the initial value of their horizontal alignment and process optimization based on evaluations and the goals outlined in the process strategy. The equations of these two stocks can be formulated as:

*horizontal alignment = INTEG (current horizontal alignment + align process*organizational structure*priority-system – horizontal alignment degeneration)*

*process optimization = INTEG (current process optimization + optimize process*priority-system – process degeneration)*

3.8 Organizational Culture Model

This section focuses on the specification of the culture model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

As illustrated in the culture conceptual model (Figure 13), the culture of an organization needs to be adapted and embedded to adapt to and facilitate digital transformation. To be able to capture the dynamics in the process of cultural change and cultural embedding, the culture conceptual model was translated into a system dynamics model. The system dynamics model also focuses on four key sub-cultures: hierarchy culture, clan culture, adhocracy culture, and

market culture. The model simulates the process of cultural change and evaluates the integration of the new culture into the organizational context. By utilizing the model, organizations can proactively reshape culture, bridge existing gaps, and embed the new culture effectively, ultimately facilitating successful digital transformation initiatives.

To simplify the model, it is assumed that each type of sub-culture within an organization changes at the same pace, implying a consistent rate of transformation across all four cultural dimensions. Besides, an organization typically can only embed a new culture after completing the process of cultural change, suggesting a sequential approach to cultural transformation and integration.

Model Specification

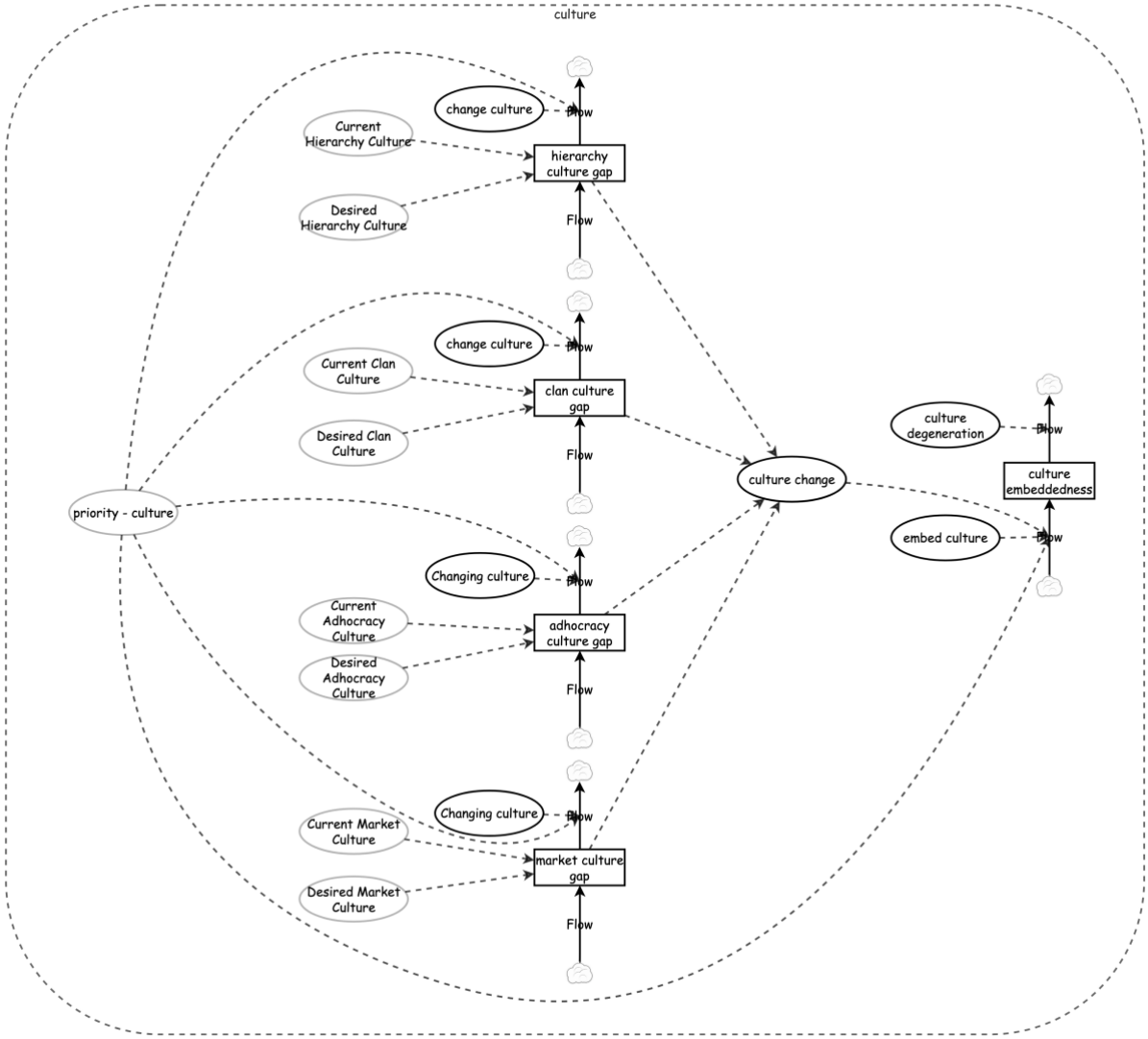

Figure 26 Culture Model

Based on the culture conceptual model (Figure 13), the culture system dynamics model was developed, as illustrated in Figure 26. As discussed in Chapter 2, an organization's culture comprises four sub-cultures, each with a certain proportion. Organizations can dynamically configure these four sub-cultures based on their context to form the most suitable

organizational culture. Hence, organizations typically do not aim to attain an optimal state for a specific sub-culture but adjust these four sub-cultures at the same time. (Kim S. Cameron, 2011) To represent and simulate this phenomenon, the concept of a 'culture gap' was introduced to the culture system dynamics model, representing the deviation of each sub-culture from its desired state, either lower or higher. Thus, the hierarchy culture gap, clan culture gap, adhocracy gap, and market gap were identified as stocks in this model. Each of those stocks has a value ranging from zero to one to represent the degree of deviation. To identify the culture gap and give the stocks an initial value, an organization must set a clear desired state and evaluate the current state of each sub-culture. To bridge the culture gaps, an organization must proactively take relevant measures to reshape its culture. Thus, 'changing culture' was identified as the outflow variable for all the sub-culture gap stock, reflecting the optimal pace for an organization to transform specific subcultures. Yet, the actual pace is also determined by cultural priorities, as previously discussed. Therefore, the equations for the four stocks of the sub-culture gap can be formulated as:

*hierarchy culture gap = INTEG (desired hierarchy culture – current hierarchy gap – change culture*culture priority)*

*clan culture gap =INTEG (desired clan culture – current clan culture – change culture*culture priority)*

*adhocracy culture gap = INTEG (desired adhocracy culture – current adhocracy culture – change culture*culture priority)*

market culture gap = INTEG (desired market culture – current market culture – change culture)

Those four sub-culture gaps together determine the variable 'culture change' which represents the extent to which the new culture has been established with values from one to zero. Thus, the equation of culture change can be formulated as:

culture change = 1 - (hierarchy culture gap + clan culture gap + adhocracy culture gap + market culture gap)/4

Following the completion of the culture change, the new culture must be integrated and embedded into the organizational context (Hemerling, 2018). This dynamic process is identified as a stock 'culture embeddedness' to represent the degree to which the new culture is ingrained in the organization, with values ranging from zero to one. A value of zero indicates minimal integration, while a value of one indicates complete integration. To enhance culture embeddedness, an organization must proactively take relevant measures to integrate its culture (Hemerling, 2018). Thus, 'embedding culture' was identified as the inflow variable for 'culture embeddedness', representing the optimal rate an organization can have to integrate its culture. Furthermore, the culture embedding process may hindered by degenerative factors (Bruna Felippes, 2023), which was generalized as 'culture degeneration' to become the outflow variable of 'culture embeddedness' representing the rate of potential decline.

Also, the culture embedding process is influenced by factors including employee behavior, leadership, organizational structure, and processes (Al-Faihani, 2020; Gheidar, 2020; J, 2020; Hoessler, 2023). Notably, desired employee behavior and effective leadership play significant

roles, exerting greater influence on the overall outcome. Therefore, the equations for culture change and culture embeddedness can be formulated as:

*culture embeddedness = INTEG (embed culture*culture priority*(0.4*embracing DT + 0.3*digital leadership + 0.2* organizational structure + 0.1* process) – culture degeneration)*

3.9 People Model

This section focuses on the specification of the people model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

The behaviors and attitudes of an organization's employees towards digital transformation will change throughout the transformation process (Gkrimpizi, 2022). The people model aims to capture the dynamics of employee behavior and assess employees' readiness and willingness to embrace digital transformation within an organization. Referring to the people conceptual model (Figure 16), the people system dynamics model focuses on three key factors: attitudes toward digital transformation, subjective norms, and perceived behavioral control. These factors collectively determine the intention to embrace digital transformation, which ultimately influences employee behavior. The model simulates the evolution of these factors over time and provides insights into resource allocation priorities for people-related initiatives, such as reward systems and skill development programs, to enhance employees' readiness for digital transformation.

The ultimate desired behavior for employees within an organization during digital transformation is to fully embrace digital transformation, meaning proactive adaptation and enthusiastic incorporation of digital initiatives. To keep the model generic, it is assumed that attitudes towards digital transformation, subjective norms, and perceived behavior control equally contribute to the intention to embrace digital transformation.

Model Specification

Based on the people conceptual model (Figure 16), the people system dynamics model was developed, as shown in Figure 27. As embracing digital transformation is the ultimate desired behavior for employees (Doerr, 2023), 'embrace digital transformation' or 'intention to embrace digital transformation' is identified as the final variable of this model. The intention to embrace digital transformation is determined by three factors collectively: 'attitudes toward digital transformation' and 'perceived behavior control', and 'subjective norm'. Thus, the equation of 'intention to embrace digital transformation' can be formulated as:

intention to embrace DT = (attitudes towards DT + subjective norm + perceived behavioral control)/3

embrace DT = intention to embrace DT

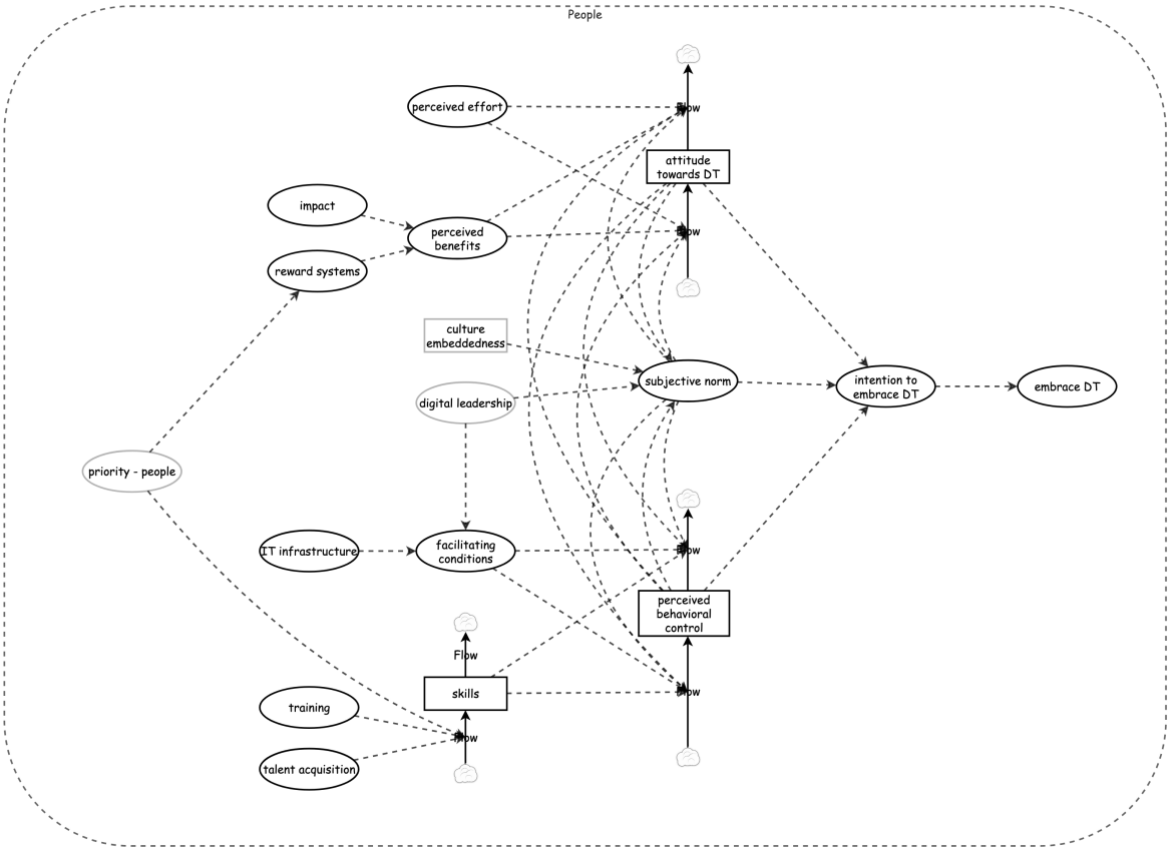

Figure 27 People Model

To capture the dynamics in people's attitudes, the factor 'attitudes towards digital transformation' is identified as a stock and represents the attitude score that ranges from zero to one. A score of zero indicates an extremely negative attitude, while a score of one indicates an extremely positive attitude. According to the Technology Acceptance Model (Davis, 1989), individuals' attitudes toward using a certain technology are determined by their perception of its usefulness and the effort required. Thus, people's attitude toward embracing digital transformation in organizations is influenced by two key variables: 'perceived benefits' and 'perceived effort'. Above-average perceived benefits positively influence people's attitudes, while below-average benefits have a negative impact. Similarly, above-average perceived efforts positively affect attitudes, whereas below-average efforts yield negative impacts.

'Perceived benefits', ranging from zero to one, represents the extent to which people perceive the usefulness or benefits brought about by digital transformation. These perceptions might derive from factors such as promotion opportunities, enhanced work experience, reward systems, and more (Oakland, 2007). On the other hand, 'perceived effort', also ranging from zero to one, represents the extent to which people perceive the additional effort brought about by digital transformation. This perception is often linked to the complexity and scale of digital transformation initiatives (Marcel, 2023). Furthermore, positive subjective norms and above-average perceived behavior control contribute to the formation of positive attitudes, while negative norms and control lead to negative attitudes. Therefore, the equations about the attitude towards DT are:

attitude towards DT = INTEG (perceived benefits, perceived effort, subjective norm, perceived behavior control)

perceived benefits = DT impact + reward system

The factor 'subjective norm' is identified as an intermediate variable since the subject norm is the perceived behavior deriving from leadership behavior and cultural norms (Ajzen, 1991). The value of 'subjective norm', ranging from zero to one, is associated with digital leadership and culture embeddedness. Since organizational culture has a greater impact than digital leadership regarding subjective norms, culture embeddedness contributes 70% value of 'subjective norm' and digital leadership contributes the rest (Bozkus, 2023). Besides, the subjective norm is impacted by attitude towards DT and perceived behavioral control equally. Hence, the equation of subjective norm is:

*subjective norm = (0.3*digital leadership + 0.7*culture embeddedness)*(0.5*attitude towards DT + 0.5*perceived behavioral control)*

To capture the dynamics within the factor 'perceived behavioral control', it is identified as a stock, ranging from zero to one, representing the extent to which individuals perceive the ability to perform the behavior successfully (Ajzen, 1991). A value of zero shows that people do not perceive such ability at all, while a value of one indicates people perceive such ability completely. Such perception typically derives from factors such as skills and facilitating conditions (Marcel, 2023). Hence, skills and facilitating conditions were identified as the two influencing factors of perceived behavior control. Above-average skills and facilitating conditions positively influence this perception, while below-average ones diminish it. Furthermore, positive attitudes and subjective norms have a positive impact on this perception, whereas negative attitudes and norms lead to negative impacts.

As an organization's overall skill level changes constantly (Doerr, 2023), 'skills' was identified as a stock ranging from zero to one to represent the readiness of organizations' people for digital transformation-related skills. To improve skill readiness, an organization needs to provide relevant training programs to its employees or recruit to acquire the talent needed (Marcel, 2023). Thus, 'training' and 'talent acquisition' were identified as the inflow variables for 'skills'. Besides, as people's skills degenerate over time due to the continuous update of technologies (Doerr, 2023), 'skill degeneration' was identified as the outflow variable for 'skills'. 'Facilitating conditions' was identified as an intermediate variable representing the accumulation of digital leadership and IT infrastructure.

People priority determines the resource allocation to people related initiatives. In this model, it directly influences the reward system and skill development. Hence, the equations related to 'perceived behavioral control' can be formulated as:

perceived behavioral control = INTEG (skills, facilitating conditions, attitudes towards DT, subjective norm)

*skills = INTEG ((training + talent acquisition)*priority-people)*

facilitating conditions = (digital leadership + IT infrastructure)/2

3.10 Technology & Data Model

This section focuses on the specification of the technology & data model. A description of the model, including its objectives, scope, and assumptions, will be performed first. Subsequently, the operationalization of the model will be presented.

To be able to capture the dynamics of the IT infrastructure readiness, the implementation progress of digital technologies within organizations, and the performance of data utilization, the technology & data conceptual model (Figure 17) was translated into a system dynamics model. The model enables organizations to assess their technological status and optimize their IT infrastructure and digital technology implementation to drive digital transformation effectively, ensuring efficient data utilization to derive insights for business operations and transformation initiatives.

To simplify the model specification, it is assumed that all the seven elements of IT infrastructure equally contribute to IT infrastructure readiness and deteriorate at a uniform rate. Besides, the categories of service technology and application and platform equally influence an organization's overall digital technology progress.

Model Specification

Based on the technology & data conceptual model (Figure 17), the technology & data system dynamics model was developed as shown in Figure 28. To be able to capture the dynamics of every aspect of IT infrastructure, this model identifies the seven key components of IT infrastructure as the stock, collectively and equally determining the readiness of IT infrastructure. These stocks encompass hardware, software, network, data storage, cloud services, security systems, and IT support (Prokosch, 2010).

Each of these stocks represents the adequacy of its corresponding component, with values ranging from zero to one. A value of zero signifies complete insufficiency, while a value of one indicates full adequacy. Improvement of each component can be achieved through relevant implementation projects, while natural wear and tear and external renewal need to contribute to their gradual deterioration over time (Sewpersadh, 2023). The improvement speed is associated with an organization's priority on technology and data.

The current adequacy score of each component should be determined based on the results of IT infrastructure assessments and aligned with the goals established in the IT infrastructure strategy. Thus, the equations about IT infrastructure can be formulated as follows:

$$IT\ infrastructure = (hardware + software + network + data\ storage + cloud\ services + security\ systems + IT\ support)/7$$

$$hardware = current\ hardware + INTEG\ (implement\ hardware * priority\text{-}technology\ \&\ data - infrastructure\ deterioration)$$

$$software = current\ software + INTEG\ (implement\ software * priority\text{-}technology\ \&\ data - infrastructure\ deterioration)$$

$$network = current\ network + INTEG\ (implement\ network * priority\text{-}technology\ \&\ data - infrastructure\ deterioration)$$

data centers = current data centers + INTEG (implement data centers priority-technology & data – infrastructure deterioration)*

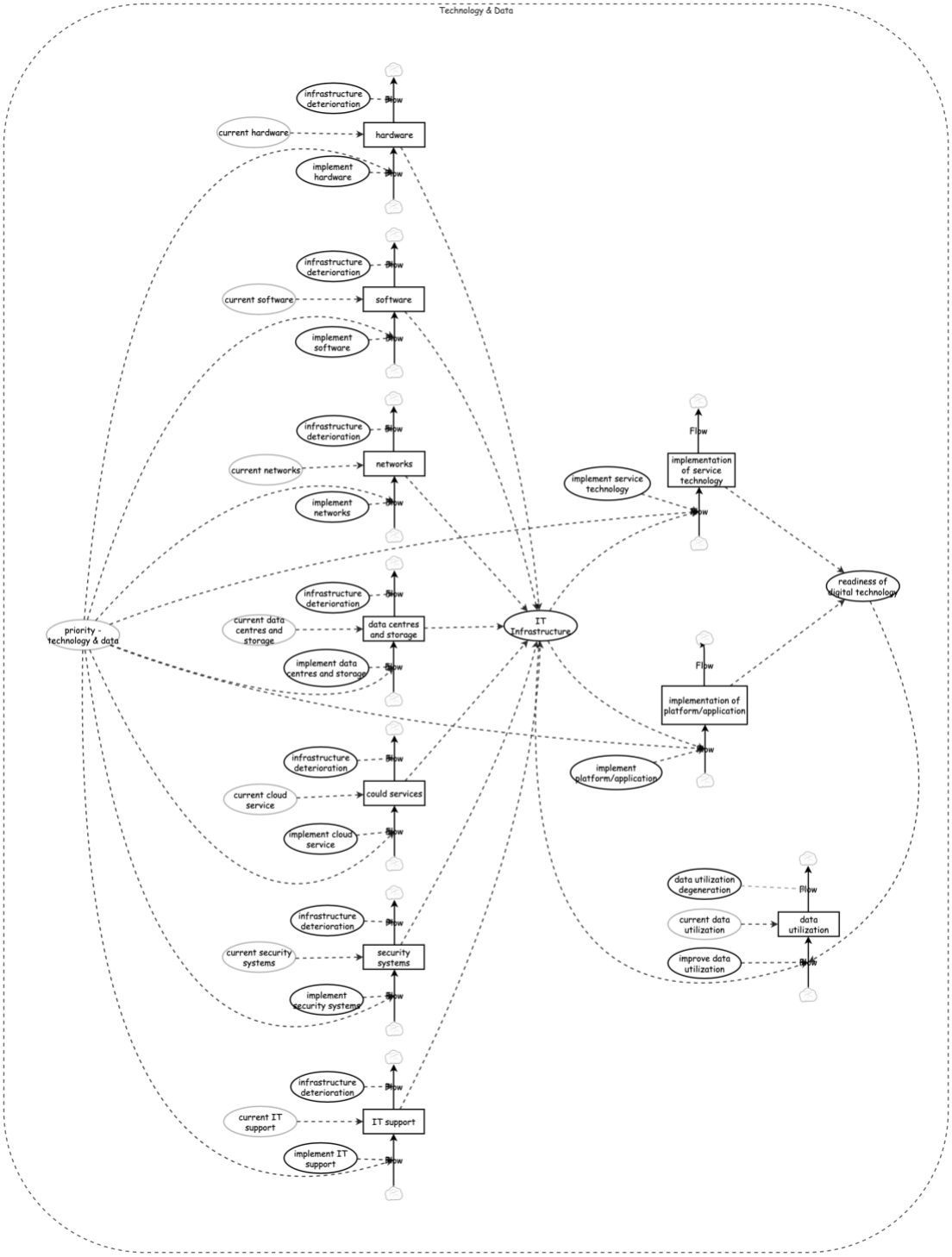

Figure 28 Technology & Data Model

clod services = current cloud services + INTEG (implement cloud services priority-technology & data – infrastructure deterioration)*

security systems = current security systems + INTEG (implement security systems priority-technology & data – infrastructure deterioration)*

IT support = current IT support + INTEG (implement IT support priority-technology & data – infrastructure deterioration)*

As highlighted in section 2.3, organizations should ensure the sufficiency of their IT infrastructure before adopting new technologies. Once the IT infrastructure reaches sufficiency, organizations can begin adopting new technologies. (Russo Spena, 2022) These technologies can be categorized into two types: those aimed at creating new services to expand the business model, and applications or platforms designed to enhance efficiency and productivity (Collou, 2021). To be able to represent the dynamic implementation of those two types of technology, 'implementation of service technology' and 'implementation of application and platform' were identified as two stocks. Each stock represents the progress of implementing its respective technology, with values ranging from zero to one. A score of zero indicates that implementation has not commenced, while a score of one signifies the completion of implementation. The progress of implementation is propelled by active engagement in the process and is influenced by the organization's priority on technology and data. Thus, 'implement service technology' and 'implement application and platform' are the inflow variables for those two stocks. The advancement of these two types of technology implementations collectively determines the readiness of digital technology. The equations about digital technologies can be formulated as:

readiness of digital technology = (implementation of service technology + implementation of application and platform)/2

implementation of service technology = INTEG (implement service technology priority-technology & data)*

implementation of application and platform = INTEG (implement application and platform priority-technology & data)*

The implementation and utilization of digital technologies result in the generation of vast amounts of data (Weerabahu, 2022). Harnessing this data effectively can yield continuous insights for both the digital transformation process and the overall business operations of organizations (Doerr, 2023). Therefore, data utilization is recognized as a critical factor and is identified as a stock.

The stock 'data utilization' measures an organization's capacity to leverage data, with values ranging from zero to one. A score of zero indicates no data utilization capacity, while a score of one denotes ideal data utilization. Several factors positively influence data utilization capacity. A clearly defined data strategy, the presence of relevant skills, and a robust data infrastructure majorly impact an organization's capacity for data utilization (Collou, 2021; Kempeneer, 2023; Marcel, 2023). Besides, a culture that values data-driven decision-making and the implementation of data-driven processes also contributes to the ability to utilize data (Mihu, 2023). Yet, organizations' data utilization capacity inherently declines over time due to constantly renewed needs, necessitating ongoing maintenance (Bruna Felippes, 2023). Thus, 'data utilization degeneration' was identified as the outflow variable.

Organizations should assess their current data utilization status and align it with the objectives outlined in their information and data strategy. Based on this evaluation, an initial value for data utilization should be determined.

Hence, the equation for data utilization can be formulated as follows:

*data utilization = current data utilization + INTEG (improve data utilization * (0.3*data strategy + 0.25*skills + 0.25*IT infrastructure + 0.1*culture embeddedness + 0.1*processes) – data utilization degeneration)*

3.11 Model Integration

The integration of the executable sub-models into a cohesive system dynamics model marks a key step in comprehensively understanding and optimizing digital transformation within organizations. By combining the separately developed sub-models, this process takes the executable sub-models as input and produces the integrated simulation model as a finished product. At its core, the integrated model serves as a dynamic simulation platform, facilitating the exploration of interdependencies and feedback loops among various organizational elements. It allows users to simulate scenarios, identify leverage points, and optimize strategies to accelerate digital transformation effectively.

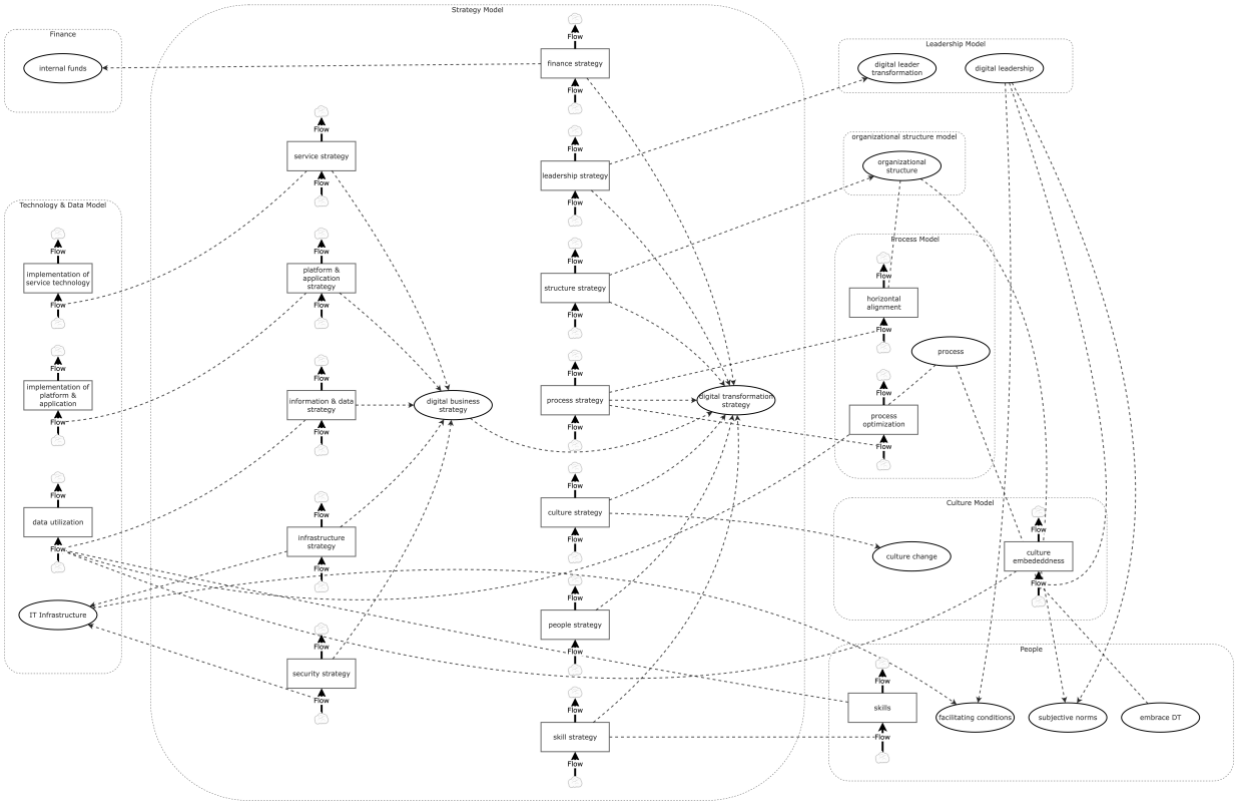

Figure 29 System Dynamics Model Integration

To be able to integrate the eight sub-system dynamics models, the sub-models were interconnected through cross-model relationships between their internal variables. Figure 29 presents the simplification of the integration. To present the final integrated model in a feasible way, only these cross-model relationships were retained in the Figure.

According to the overall conceptual model, digital transformation unfolds across three phases - unfreezing, transforming, and freezing - demonstrating the fundamental cause-and-effect relationship between strategic planning and digital transformation initiatives. These initiatives must unfold chronologically, with each initiative being launched when its corresponding strategy reaches the necessary level. This sequential alignment between strategy and plan ensures the coherence and effectiveness of the transformation journey. During the change stage, digital transformation initiatives interact with each other, either catalyzing or impeding progress. Those interactions were discussed in each sub-model section. For instance, in the people model, subjective norms are shaped by digital leadership and cultural embeddedness, while facilitating conditions stem from digital leadership and IT infrastructure. Similarly, data utilization is facilitated by skills, processes, and culture, whereas culture embeddedness is driven by processes, digital leadership, and organizational structure.

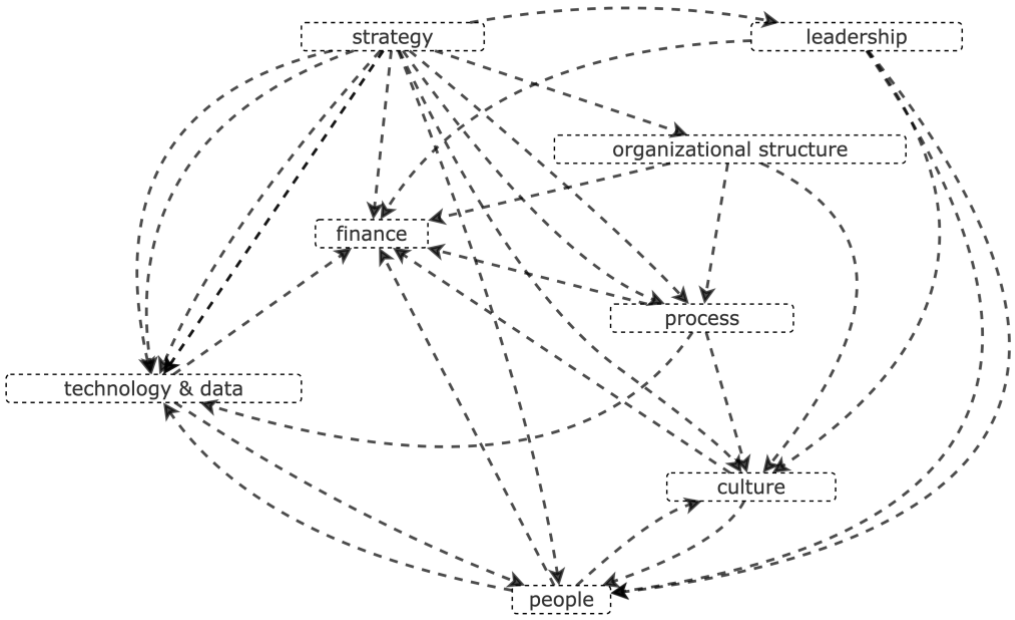

Figure 30 folded system dynamics model

To better demonstrate the relationship between those eight elements of digital transformation, each sub-model was folded, and the cross-model relationships were manifested only between the eight high-level elements. Figure 30 presents the integrated system dynamics model with the sub-models folded, showing the high-level relationships between the digital transformation factors. This corresponds with the initial overall conceptual model and further reflects the complex relationships among the eight digital transformation factors.

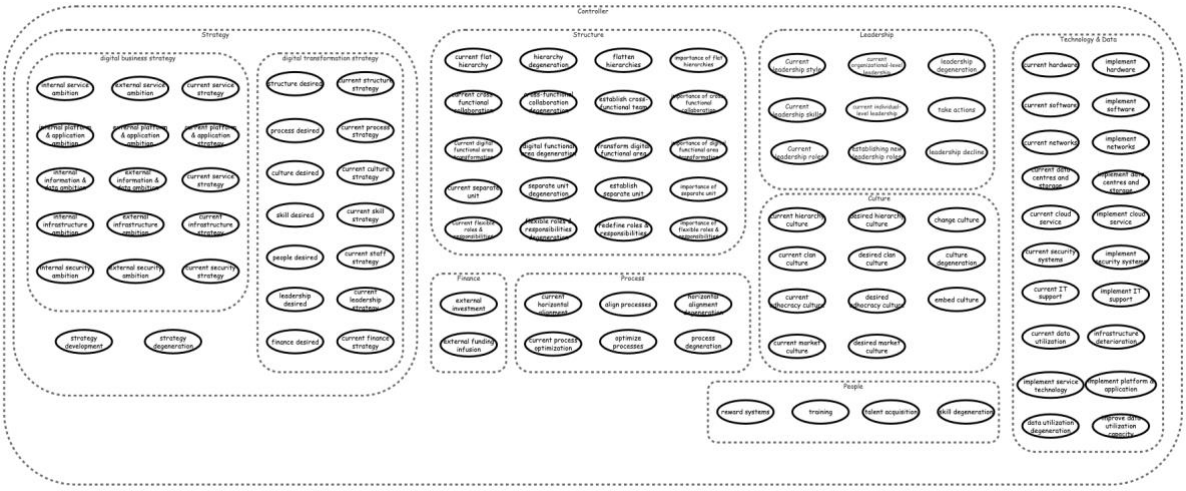

Figure 31 Model Controller

Furthermore, to be able to bridge the sub-models and the final integrated simulation model, a model controller was made during the model integration. The controller is a component that manages the behavior of the model by adjusting inputs or parameters based on system feedback. The inclusion of a controller serves several purposes: it separates the data input concerns from model logic, enhancing the manageability, comprehension, and maintenance of the model. By dynamically altering model parameters or inputs in response to real-time feedback from simulations, the controller enables the model to adapt to evolving conditions or unexpected events, thereby enhancing accuracy and predictive capabilities. Additionally, the controller empowers users to conduct scenario analysis, exploring the impact of various scenarios or interventions on system behavior. Through input manipulation, users can simulate diverse scenarios, evaluate their consequences, and thus, aid decision-making and strategic planning.

As shown in Figure 31, the controller consists of eight distinct sections, each corresponding to one of the eight sub-models. Within each section, users can modify selected original variables' values. Additionally, ghost variables mirroring these original variables exist within the model; however, they are not editable.

Chapter 4

Expert Validation

This chapter presents the expert validation process for the integrated system dynamics model, including the method used, the results, and the conclusion. The purpose of this validation is threefold: First, this validation checks whether the model aligns correctly with the theoretical and conceptual design outlined during the initial stages of model development, ensuring that the model's structure, equations, and logic represent the target system as described in the conceptual model. Secondly, this validation checks the model's accuracy and precision. Experts can identify potential errors, biases, or inaccuracies in the model, and their domain knowledge allows them to effectively review the assumptions, inputs, and outputs of the model. Lastly, this validation also examines the interpretability and explanation of the model. Experts can help ensure that the model's outputs are interpretable and can be adequately explained to non-expert stakeholders.

4.1 Method

The expert validation process was implemented through expert interviews. To ensure comprehensive and valuable feedback, the procedure of the expert interviews involves several steps including the selection of experts, preparation of interview materials, conducting the interviews, documentation and analysis, and integration of feedback.

Two experts were selected for the interview. One expert specialized in system dynamics modeling and the other in modeling and digital transformation. The selection of two experts can provide in-depth analysis and feedback from diverse perspectives without the process becoming too difficult to manage. The two experts' extensive knowledge in system dynamics modeling and digital transformation theories contribute to a more comprehensive evaluation of the model, ensuring the credibility and reliability of the validation process.

A comprehensive questionnaire (see Appendix 3) was developed to probe the different aspects of the model. This questionnaire consisted of five questions designed to assess the key components of the model. The questions addressed the quality of the overall model design, the quality of the sub-model designs, the effectiveness of phases and priority mechanisms, the functionality of the model controller, and the alignment with the goals.

The interviews were scheduled and conducted with the selected experts. When conducting the interviews, the questionnaire was used as a guide to ensure all key aspects of the model were covered systematically. The interviews were recorded and documented to ensure all the feedback was captured for later analysis.

4.2 Results

Through analyzing the feedback from the two interviews, the results of the expert validation were summarized.

About the quality of the overall model design, the experts criticized the presentation of the model's objectives and the problem it addresses, suggesting the use of enterprise architecture to better define motivations and objectives. Moreover, they noted that the high-level relationships within the model were not fully developed and demonstrated, suggesting a need for more comprehensive integration of sub-models to accurately represent the relationships between digital transformation factors.

Regarding the quality of sub-models, experts considered it necessary to simply the real digital transformation system to avoid over-complexity. However, a balance between simplicity and comprehensiveness should be maintained by ensuring that all key elements are included. Furthermore, experts suggested that the terminology used in the sub-models should be more precise and representative. The experts also suggested adjusting the organizational structure model and refining the linkages between the finance model and other sub-models.

In terms of the effectiveness of phases and priority mechanism, the way in which the mechanism was implemented was considered by the experts to be unconventional but was appreciated for introducing dynamic elements into the model and delivering the desired functionality, which is consistent with the fluctuating nature of digital transformation in the real world.

For the functionality of the controller, the experts confirmed its effectiveness in adjusting input parameters to simulate various scenarios and the independence it brings to the model. This functionality allows for testing the model's robustness and adaptability under different conditions.

Lastly, both experts agreed that the developed system dynamics model is well-equipped to serve its intended purpose of capturing the dynamics of organizational digital transformation. The expert opinioned that despite the complex nature, with appropriate simplification and explanation, the outputs of the model could be interpreted and communicated effectively to non-expert stakeholders.

4.3 Conclusion

The expert validation process has provided insights into the strengths and areas for improvement of the developed system dynamics model. The results confirm that the model meets its initial objectives and effectively captures the dynamics of digital transformation. First, the model was found to align well with the theoretical and conceptual frameworks established. This alignment ensures that the model represents the target system as intended. Next, experts considered the accuracy and precision of the model to be decent and identified specific areas where the model could be improved to enhance its accuracy and precision. Lastly, the interpretability of the model was considered good with appropriate simplification and explanation. Those suggested improvements were incorporated into the system dynamics model and presented in Chapter 3.

Chapter 5

Ecological Validation

This chapter presents the ecological validation process of the developed system dynamics model, including the method used, the results, and the conclusion. Ecological validation in this research refers to the process of ensuring that the system dynamics model accurately represents the real-world organizational digital transformation system that is intended to simulate (Schmuckler, 2001). It aims to examine the extent to which the developed system dynamics model can be able to represent the real-world organizational digital transformation system. This includes determining whether the developed system dynamics model can be effectively applied outside of controlled, theoretical environments, examining the robustness and reliability of the model when exposed to real-world data and conditions, and revealing how well the model maintains predictive power across different organizational contexts. By ensuring ecological validity, the model can become a powerful tool not just for academic purposes but also for practical applications, providing reliable guidance for organizations to navigate digital transformation.

5.1 Method

The method applied in this ecological validation was scenario analysis. It involves a series of structured simulations and evaluations designed to test the model under various operational conditions and scenarios typical of organizational settings. The procedure of the scenario analysis included creating organizational persona and data, running the model for scenario simulations, analyzing results, and documenting the results.

To provide the data required for scenario simulation, two hypothetical organization personas were crafted, drawing on practical experiences and case studies. To test whether the model can be effectively adapted to extreme organizational environments and provide valuable insights thereby testing its robustness, the two personas represent two different types of organizations with radically different characteristics in terms of size, industry, and digital transformation goals. The first persona, organization 1, is described as a legacy dairy production and retail giant embarking on a path to digital transformation. The second, organization 2, represents a dynamic tech start-up keen on leveraging digital capabilities for growth. Detailed descriptions of these organization personas are provided below and are also summarized in a comparative table as shown in Table 1.

Furthermore, key performance indicators (KPIs) were applied to navigate scenario simulations. Key performance indicators (KPIs) are important for effectively measuring and guiding the digital transformation strategy. Organizations must choose KPIs that reflect their strategic goals, covering all relevant aspects of the transformation process (Parida, 2015). In this research, therefore, KPIs were carefully selected to serve as pivotal variables linking the various factors within the system dynamics model. These KPIs offer quantitative insights into critical aspects of successful digital transformation, including the time required for cultural adaptation, the return on digital investments, digital maturity levels, and the availability and reliability of digital resources. Furthermore, metrics such as on-time and on-budget completion

rates shed light on project management efficacy and resource utilization, crucial for ensuring the successful execution of digital initiatives within resource constraints. (Westerman, 2014)

Organization 1 Persona: A Traditional Dairy Production and Retail Giant Embracing Digital Transformation

Organization 1, a large firm in the dairy production and retail sector with over a century of history, is actively embracing digital transformation. This strategic shift aims to integrate digital technologies across all business facets, revolutionizing their operations and enhancing value delivery to customers. Two years ago, their IT infrastructure received significant updates to bolster overall robustness. Now the focus is on introducing advanced software and platforms to boost operational efficiency, improve their data utilization capabilities, and fortify their cybersecurity measures to mitigate potential risks.

While Organization 1 has established robust overarching strategies, certain sub-strategies like platform and security strategy are under review to align with the new goals and the evolving digital landscape. As a large enterprise, they prefer developing long-term strategies rather than frequently changing plans, ensuring stability and foresight in their strategic direction. Despite the vast scale of strategic projects, the company allocates a fixed portion of resources to digital transformation, supported by adequate internal resources.

The company's longstanding organizational structure is traditionally hierarchical, which now is targeted for transformation towards a flatter hierarchy to foster better cross-functional collaboration. Although their processes are well-defined, there is an ongoing initiative to further optimize these processes to enhance operational efficiency.

As a non-tech company transitioning into the digital era, Organization 1 is keen on shedding its traditional culture in favor of a digital culture that aligns with modern technological advancements. This cultural transformation is pivotal in their strategy to fully leverage digital opportunities. The organization has a robust IT department staffed with skilled employees, yet there is a push to recruit additional data talent to enhance data utilization capabilities. Outside of the IT department, other employees face a skill and mindset gap in adapting to digital changes, necessitating targeted training programs.

Leadership within Organization 1 is experienced yet faces the challenge of adopting new leadership styles that are conducive to digital transformation. While leaders are highly committed to organizational initiatives, there is a need for greater focus on individual contributions and empowerment. Furthermore, the introduction of a new leadership role, Chief Digital Officer (CDO), is contemplated to spearhead the digital transformation efforts comprehensively.

In summary, Organization 1 is a traditional company poised at the cusp of a significant digital evolution. By strategically updating their technology, flattening their organizational structure, and cultivating a digital-centric culture, they aim to maintain their industry leadership and adapt to the rapidly changing digital landscape.

Organization 2 Persona: A Dynamic Tech Start-Up

Organization 2 is a technology start-up offering software as a service with 20 employees. Born digital, their primary focus is on scaling up, fostering innovation, and sharpening their technological capabilities to remain competitive and responsive to ever-evolving market

demands. As they scale, they are actively enhancing their IT infrastructure, with significant investments in data centers, cloud services, and security systems to support rapid growth.

Resource allocation is a critical aspect for Organization 2, which dedicates a significant portion of its budget to digital transformation. Given their start-up status, they rely heavily on external investments to supplement their limited internal resources. This dependency is crucial as they navigate the challenges of expanding a business in the competitive tech industry. Yet, the organization aims to achieve net profits and financial self-sufficiency within two years.

Strategically, organization 2 is in a constant state of flux, with strategies frequently adjusted to align with their dynamic service requirements and market conditions. This agility is vital in a sector where technological and customer demands are continuously shifting.

Despite its growing size, organization 2 maintains a relatively flat organizational hierarchy, which enhances collaboration and speeds up decision-making processes. They have embraced a modern workplace with updated digital functions, flexible roles, and responsibilities, fostering an environment conducive to rapid adaptation and innovation.

Currently, the organization's processes are in the development stage, crafted to support swift growth while maintaining operational efficiency and customer satisfaction. The workforce is digitally proficient, exhibiting strong skills and a positive outlook towards digital initiatives, which is essential for a tech-focused company.

However, the organizational culture of Organization 2 is still in its infancy. They are working together to foster an adaptable, innovative, and agile culture that can respond quickly to technological change and business challenges. While their leaders are relatively inexperienced, they are passionate and committed to driving organizational and personal development.

In summary, Organization 2 is a vibrant tech startup, strategically investing in its future with a focus on digital excellence and cultural development to navigate the challenges of a rapidly changing industry landscape.

Table 1 Comparison of the Two Organization Personas

Organization Persona	Organization 1	Organization 2
Type	large dairy production and retail company	tech start-up
Digital Transformation Goal	Integrating digital technology into all business areas, fundamentally changing how they operate and deliver value to customers.	Born digital. Focus on scaling up, innovating, and refining their technological edge to stay competitive and meet evolving market demands.
Strategy	The organization generally has sound strategies in place, with only specific areas requiring strategic changes. It tends to favor long-term strategies.	The organization's strategies are not comprehensive. The rapid growing requires frequent adjustment on strategies.

Finance	The organization tends to allocation medium portion resource to digital transformation. Internal resource is very sufficient.	The organization allocates a significant portion of resources to digital transformation despite having limited internal resources.
Organizational Structure	The organization aims to transition from a hierarchical structure to a flat one, fostering cross-functional collaboration. They seek to transform their digital functions and consider establishing a separate unit.	The organization have a flat hierarchy, fosters strong cross-functional collaboration, maintains an updated digital transformation area, and adopts flexible roles and responsibilities without the need for a separate unit.
Process	The organization aims to improve operation efficiency.	The organization aims building systems and processes that can handle rapid growth without losing efficiency or customer satisfaction.
Culture	The organization aims to transform the old culture into a digital one and embed it into organization.	The organization is in the process of cultivating its culture, striving to nurture an adaptive, innovative, and agile environment capable of swiftly responding to technological shifts and business challenges.
People	Individuals within IT departments possess adequate skills, but employees in other departments may lack the necessary skills and mindset to adapt to changes.	The workforce is largely tech-savvy, possessing commendable technical skills, although there might be challenges related to labor shortages. However, there is a prevailing openness among employees towards embracing digital transformation initiatives.
Leadership	Leaders are experienced but need to adapt to new styles. They are highly dedicated to organizational initiatives but may sometimes overlook individual needs. The presence of a Chief Digital Officer (CDO) could be considered.	The leadership currently lacks maturity, as indicated by the ongoing development of leadership styles, skills, and role establishment. However, despite these evolving aspects, the leaders demonstrate a strong dedication to both organizational initiatives and individual development.

Technology	The IT infrastructure is generally robust, yet there is potential for optimization in specific areas such as software and security systems. While data utilization is satisfactory, there is a desire to further enhance it through the introduction of new technologies.	The IT infrastructure is rapidly expanding, particularly in data centers, cloud services, and security systems. The organization aims to expand both service technology and platforms to further enhance its capabilities. Additionally, it currently demonstrates good data utilization practices.

Based on the two personas, the input data for each variable were mocked, reflecting the two organization's unique attributes and objectives. Those data are presented in Appendix 4. Then, those data were inputted into the model through the model controller to run scenario simulations and generate simulation results. The simulation results were analyzed and documented.

5.2 Results

The simulation results of the two organizational scenarios were summarized and presented in this section. The results are presented separately in terms of the seven sub-models.

5.2.1 Strategy

This part presents the analytical results of the scenario simulation on strategy. The simulation results are displayed in Figure 32 for Organization 1 and Figure 33 for Organization 2.

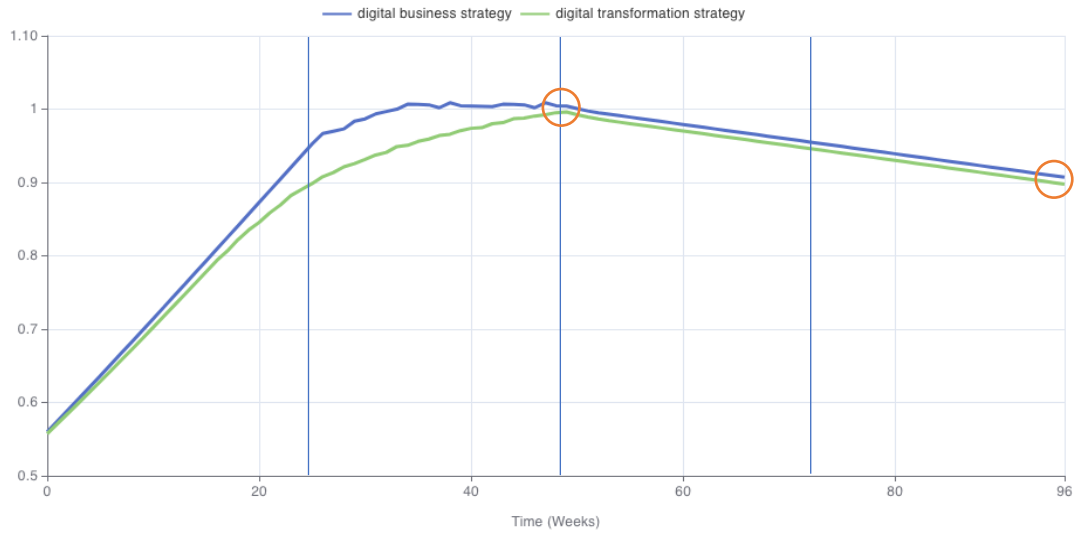

Figure 32 Organization 1 Strategy

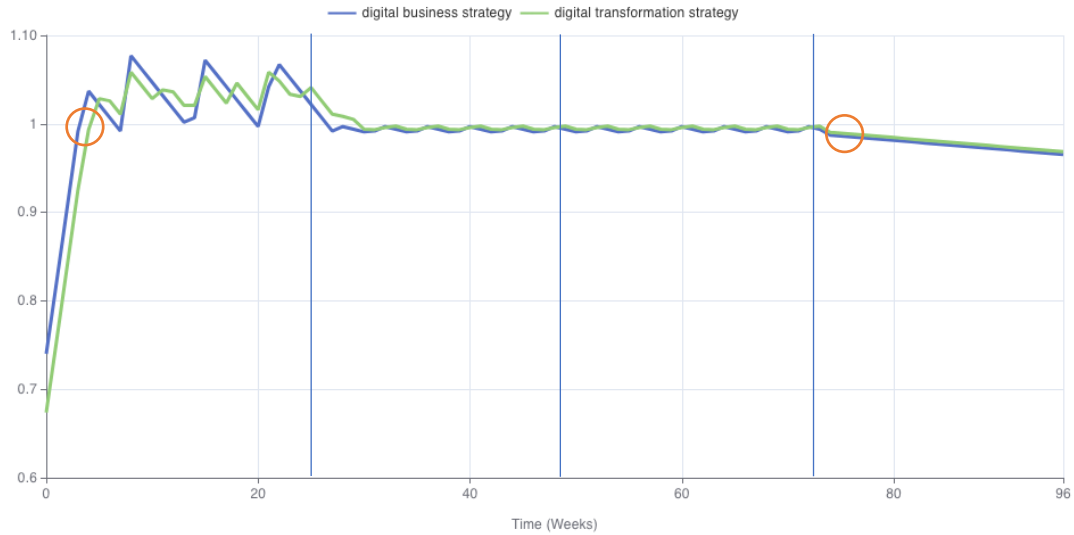

Figure 33 Organization 2 Strategy

The simulation graphs outline the strategic readiness trajectory of each organization over the next two years. These visualizations underscore the distinctive strategic landscapes each organization will navigate, shaped by their unique operational contexts.

For Organization 1, a large enterprise with intricate, long-term strategic planning needs, it is anticipated that achieving full strategic readiness will take approximately one year. Then, this readiness level is expected to hold steady for 13 weeks into the second phase, after which it will gradually decline due to a diminishing focus on strategic updates. By the end of the second year, Organization 1's strategic readiness is predicted to decrease to a still robust 0.9, indicating a slight regression but maintaining substantial strategic integrity.

Conversely, Organization 2, characterized by its agility as a tech start-up, will reach strategic readiness within just one month, due to its small scale and regularly updated strategies. However, this organization will experience more frequent fluctuations in strategic readiness, reflecting its dynamic strategy adjustment practices. Notably, like Organization 1, Organization 2 also exhibits a downward trend in strategic readiness during the third phase, a consequence of reduced financial allocation to strategic development. This pattern highlights the critical need for sustained investment and diligent management of strategic initiatives to maintain and enhance strategic readiness over time.

5.2.2 Finance

This section presents the analytical results of the scenario simulation on Finance. The simulation results are shown in Figure 34 and Figure 35.

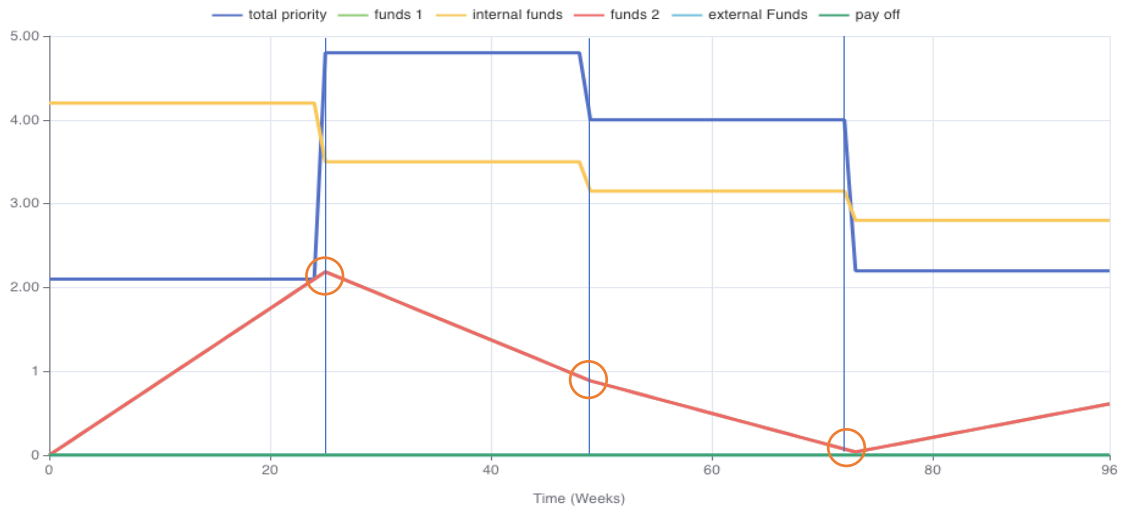

Figure 34 Organization 1 Finance

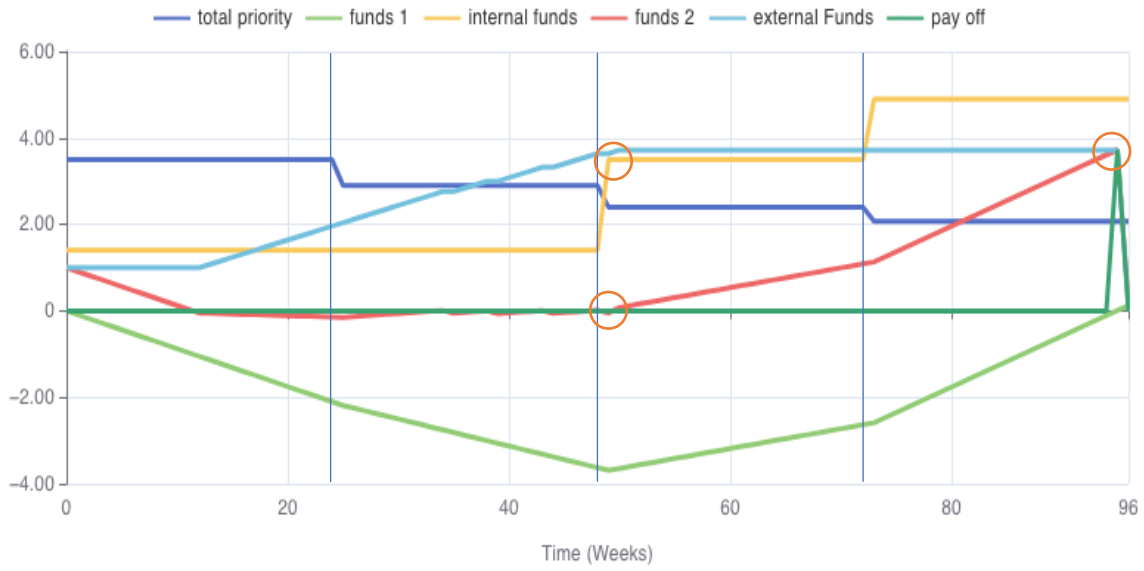

Figure 35 Organization 2 Finance

The results illustrate the financial trajectories of Organization 1 and Organization 2 respectively over the next two years, highlighting their distinct financial strategies and conditions.

For Organization 1, the financial simulation indicates self-sufficiency in funding its digital transformation efforts. As illustrated, no external funding is required, and the financial allocations are internally sourced. During the initial phase, expenditures are relatively low, primarily centered around strategizing for subsequent initiatives with minimal costs allocated towards ongoing operations. The expenditures escalate significantly in the second phase as various digital transformation initiatives kick off following strategic readiness. However, with the maturation of digital leadership and process enhancements in the third phase, there's a slight reduction in costs. By the fourth phase, the focus shifts towards deeply embedding digital culture and maintaining other transformation aspects, leading to another decrease in expenditure. Despite a planned reduction in internal financial allocation across each phase, the

model predicts a substantial surplus by the end of the first phase, which is predicted to deplete by the end of the third phase due to escalating costs.

Conversely, Organization 2's financial outlook presents a different scenario. Initial phases show a reliance on external investment due to limited internal funds. As the simulation progresses, Organization 2 continuously seeks additional external financing to bridge the gap between its growing digital transformation needs and available internal resources. The model forecasts a turning point starting from the third phase, where an increase in profits and a gradual decrease in transformation costs lead to financial surpluses. By the ninety-fifth week, these surpluses are expected to equal the total external funds received, enabling Organization 2 to settle its debts and commence generating a net profit margin.

These simulations provide both organizations with insights into managing their financial resources effectively throughout their digital transformation journeys, ensuring they align their financial strategies with operational needs and long-term objectives.

5.2.3 Leadership

This section demonstrates the analytical results of the scenarios simulation on leadership. The simulation results displayed in Figure 36 and Figure 37 demonstrate the development trajectories of digital leadership for Organization 1 and Organization 2 over the next two years.

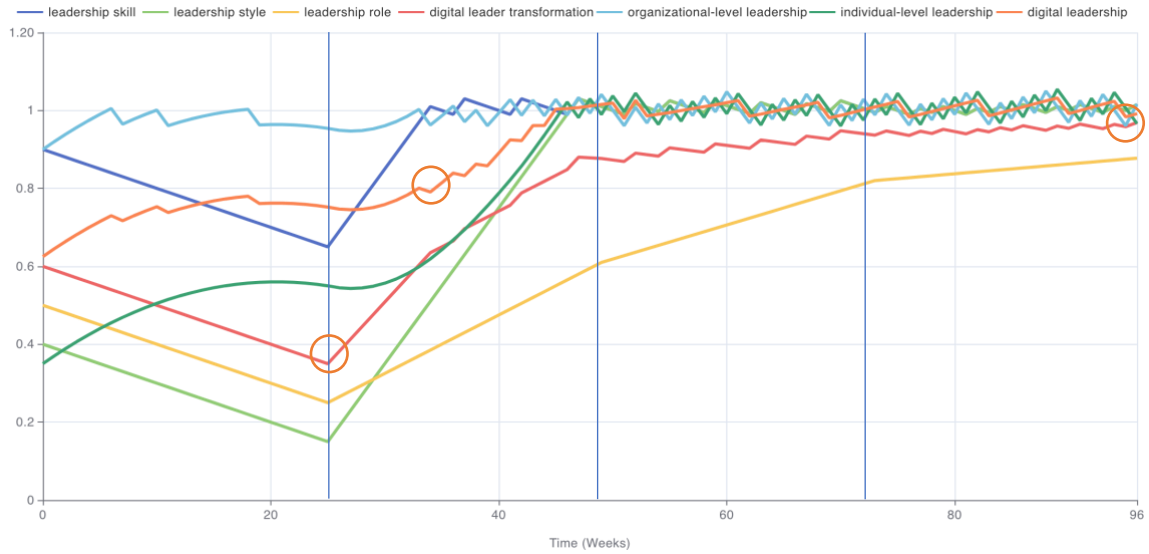

Figure 36 Organization 1 Leadership

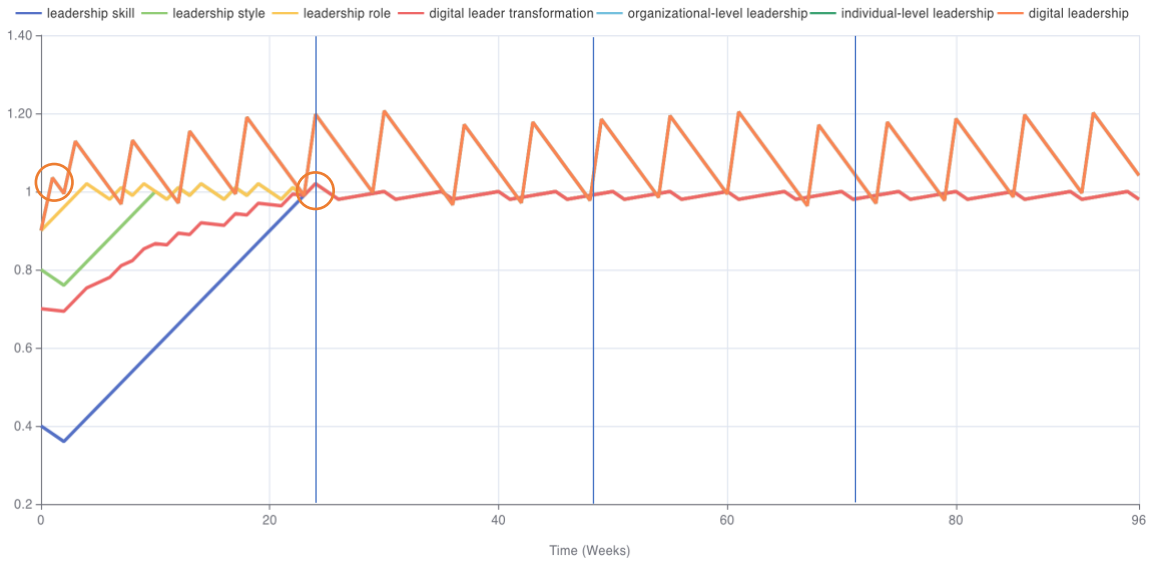

Figure 37 Organization 2 Leadership

For Organization 1, the process of digital leadership transformation experiences an initial decline as the leadership strategy is developed over the first 25 weeks. Following this period, there is a steady increase in digital leadership, peaking at 0.97 by the end of the second year. This growth significantly impacts the achievement of digital leadership, which initially stagnates and slightly declines early on before beginning a steady ascent, achieving stability from week 45 onwards.

Conversely, Organization 2, which already exhibits strong digital leadership performance, rapidly achieves digital leadership readiness in just one week. Despite the digital leadership transformation process not being fully complete, its impact is diminished due to the already high initial level of digital leadership capability, making further transformations less critical in the short term.

5.2.4 Organizational Structure

This section presents the analytical results of the scenario simulation on organizational structure. The simulation results, shown in Figure 38 and Figure 39, detail the trajectories of organizational structure changes for Organization 1 and Organization 2 over the next two years.

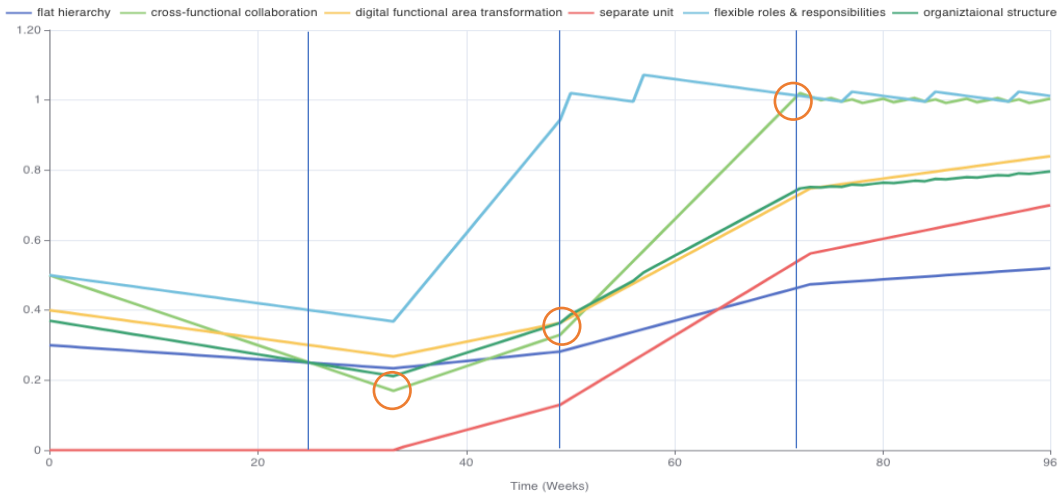

Figure 38 Organization 1 Organizational Structure

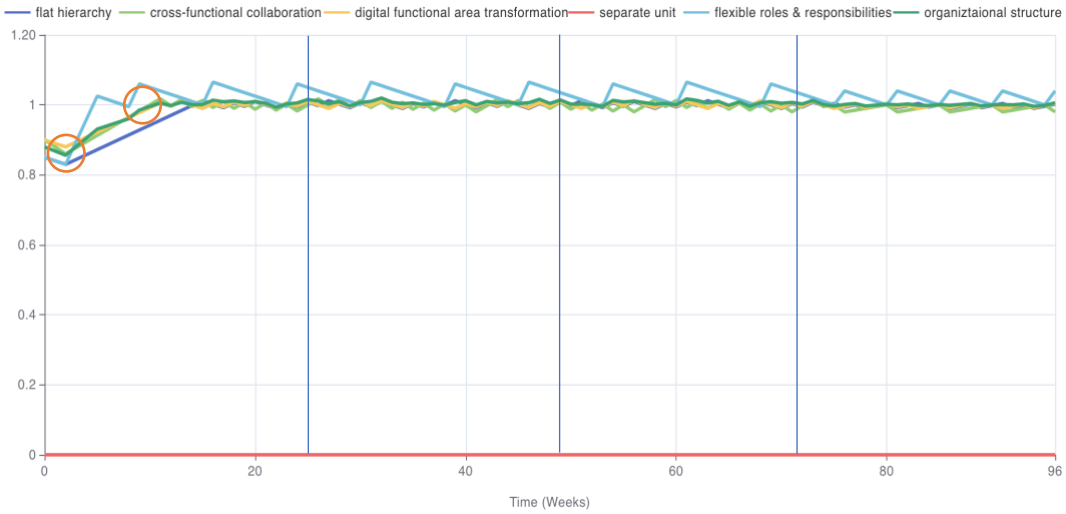

Figure 39 Organization 2 Organizational Structure

For Organization 1, the transformation of its organizational structure unfolds over a substantial period. Initially, the structure will continue to degrade slowly until week 33. Following this, with the strategic readiness for organizational structure achieved, the transformation will commence across the five structural elements. Due to varying priorities assigned to organizational structure across different phases, the speed of transformation fluctuates. In the third phase, a rapid increase is observed, followed by a slower rate of increase, with a total final increase expected to be approximately 0.4.

In contrast, Organization 2 exhibits a robust initial performance in its organizational structure that experiences a minor decline during the first two weeks while its structural strategy is being developed. Unlike Organization 1, Organization 2 quickly achieves structural readiness within just two months, aided by its smaller scale and no need for a separate unit. As the organization grows, continuous investment and flexible adjustments are necessary to maintain structure adequacy, leading to noticeable fluctuations as shown in the figures. This highlights the need for Organization 2 to dynamically manage its structure in response to its scaling operations.

5.2.5 Process

This section presents the analytical results of the scenario simulation on the process. The simulation results, shown in Figure 40 and Figure 41, illustrate the trajectory development for Organization 1 and Organization 2 over the next two years.

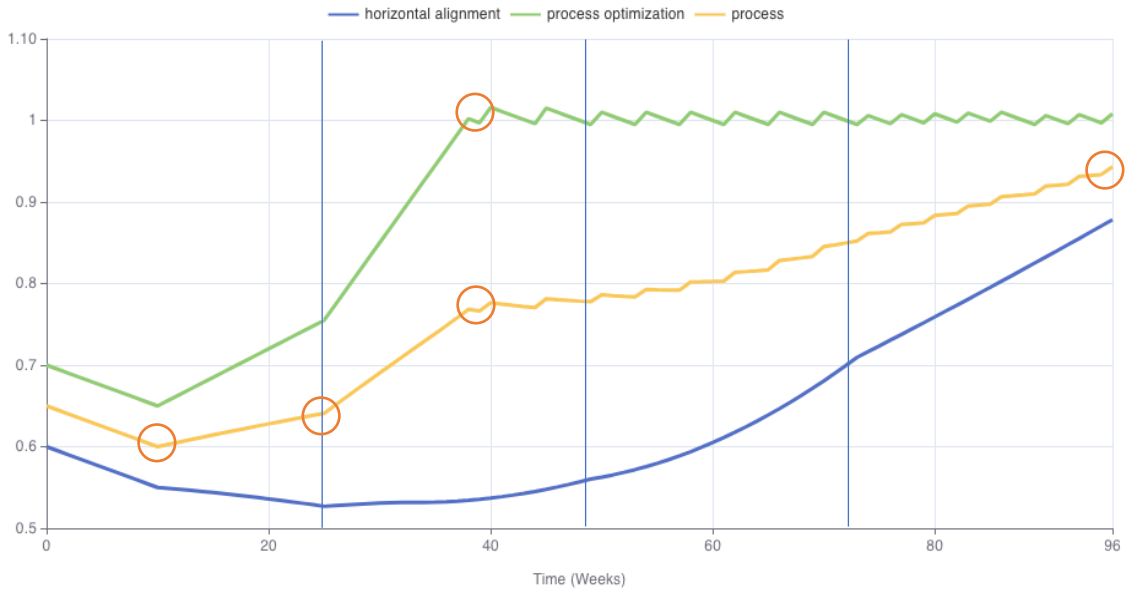

Figure 40 Organization 1 Process

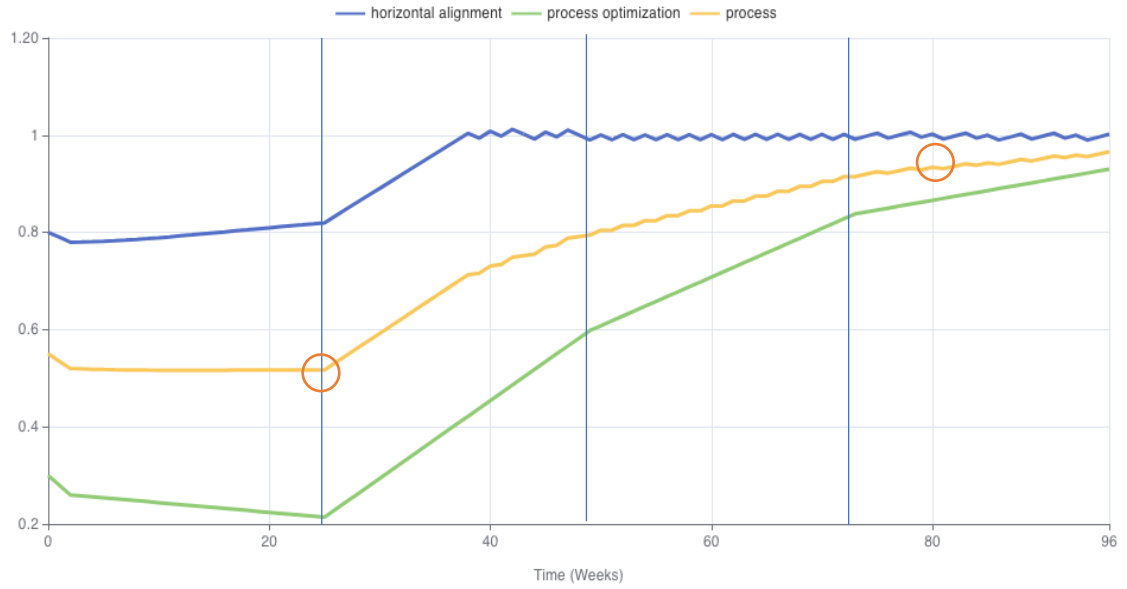

Figure 41 Organization 2 Process

For Organization 1, as the process strategy is being developed during the initial ten weeks, there is a continuous degradation in its processes. Subsequently, process optimization begins to improve, although at varying speeds across different phases due to shifting priorities assigned to process improvement. Despite strategic readiness, horizontal alignment initially continues to decline due to an initially insufficient organizational structure but begins to improve from week 40, associating with organizational structure transformations. As a result,

the overall process score for Organization 1 is predicted to reach 0.94 by the end of the second year, indicating substantial progress yet room for further optimization.

In contrast, the process trajectory for Organization 2 follows a more straightforward pattern. Initiatives aimed at improving horizontal alignment and process optimization commence in the second phase, by which time both the process strategy and organizational structure are deemed adequate. This results in a steady improvement in processes, with Organization 2 achieving a high level of process optimization by week 80, which is then maintained. This reflects Organization 2's effective alignment and optimization of processes, supporting its rapid and sustained growth.

5.2.6 Culture

This section presents the analytical results of the scenario simulation on culture. The simulation results, shown in Figure 42 and Figure 43, detail the cultural transformation trajectories of Organization 1 and Organization 2 over the next two years.

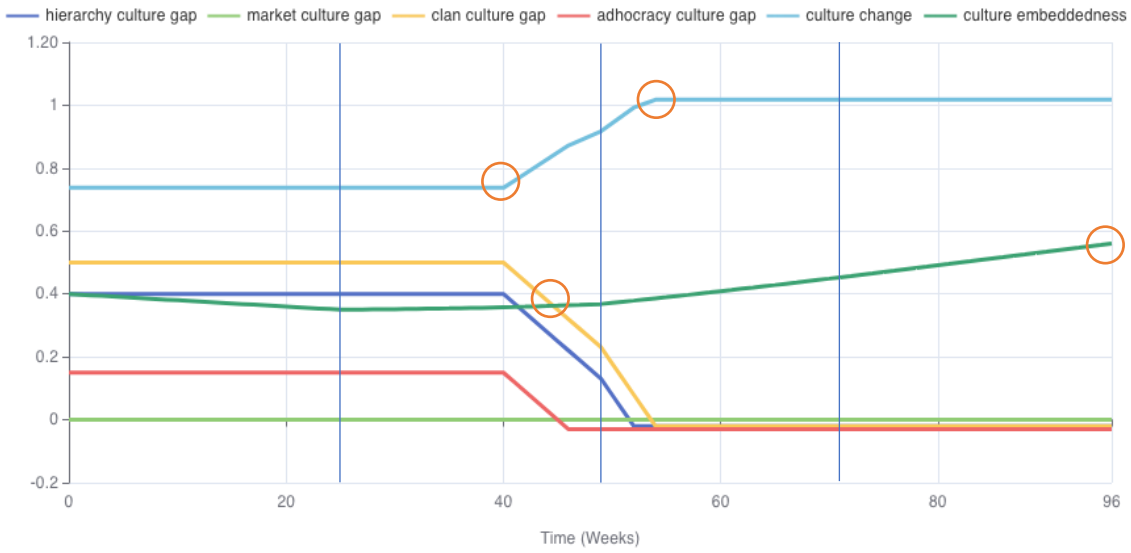

Figure 42 Organization 1 Cultural Adoption

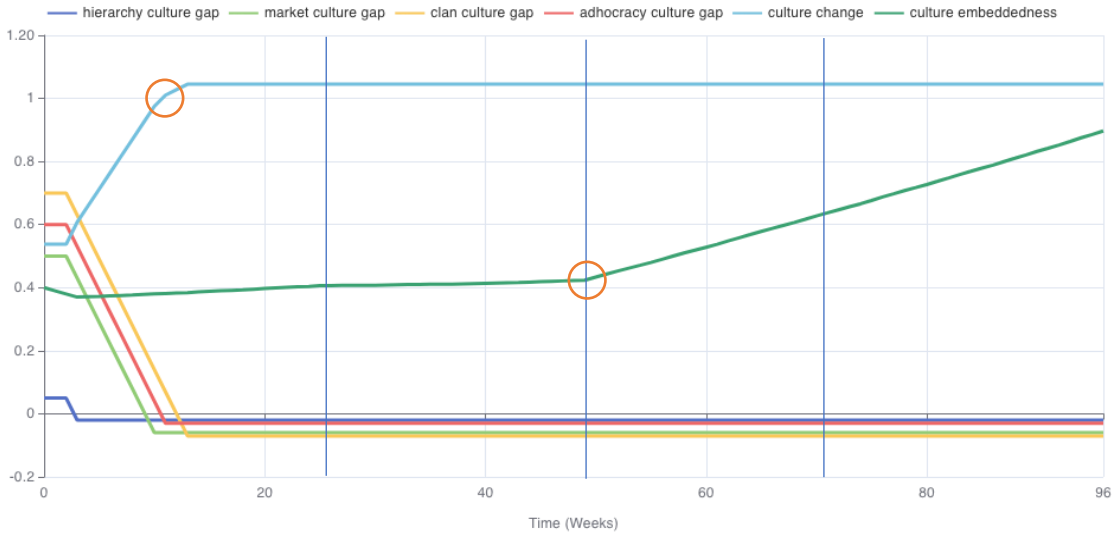

Figure 43 Organization 2 Cultural Adoption

For Organization 1, cultural change initiatives begin at week 40, coinciding with the maturity of its culture strategy, and are predicted to be completed by week 53 as all four sub-culture gaps are effectively addressed. Following this, the culture embeddedness will initially experience a slight decline during the strategic planning phase but will gradually increase, supported by improvements in organizational structure, digital leadership, processes, and employee behavior. The culture embeddedness is expected to rise by 0.16 by the end of the second year, illustrating that cultural transformation in Organization 1 is a gradual and ongoing effort.

Conversely, Organization 2, despite larger initial sub-culture gaps, will undergo its culture change more swiftly, completing the transformation within 12 weeks. This accelerated pace is facilitated by shorter strategic planning periods and more rapid cultural development efforts. Initially, culture embeddedness in Organization 2 will not see significant improvement during the first two phases due to other prioritized initiatives and ongoing enhancements in processes and employee behavior. However, a marked increase in culture embeddedness is anticipated starting from the third phase, as more resources are allocated to cultural aspects and both processes and employee behaviors see significant improvements. By the end of the second year, the culture embeddedness of Organization 2 is expected to reach 0.9, indicating a notable increase of 0.5, which demonstrates a more rapid and effective execution of cultural transformations compared to Organization 1.

5.2.7 People

This section presents the analytical results of the scenarios simulation on people. The simulation results, shown in Figure 44 and Figure 45, illustrate the trajectories of people's behavior for Organization 1 and Organization 2 over the next two years.

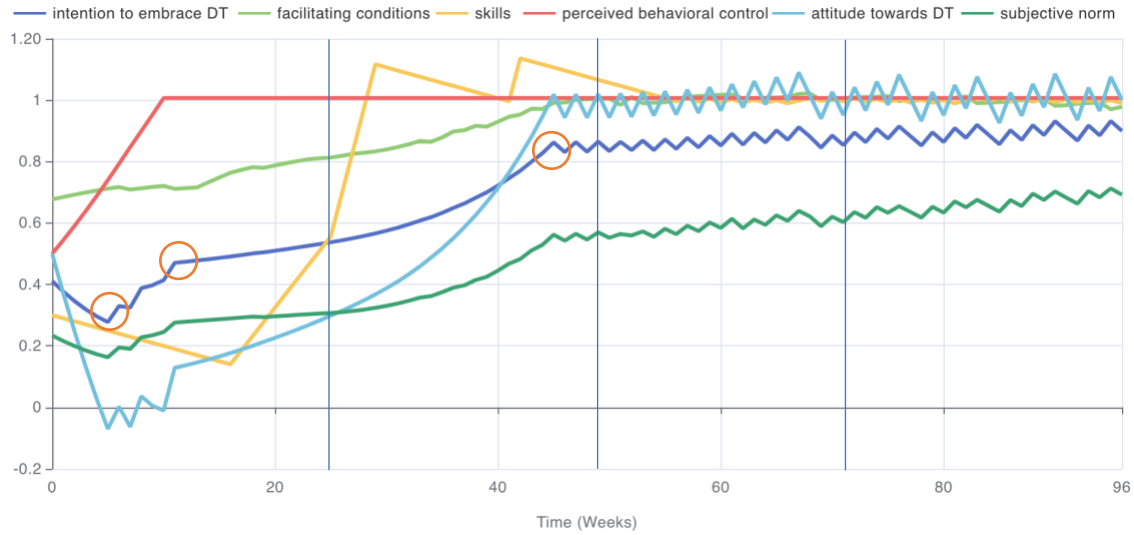

Figure 44 Organization 1 People

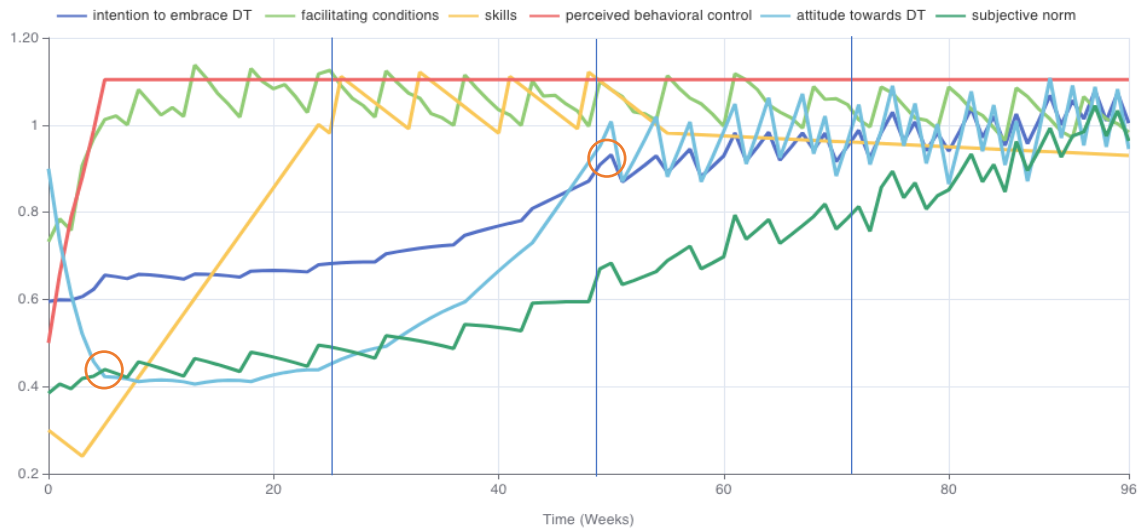

Figure 45 Organization 2 People

For Organization 1, there is an initial decline in employees' intention to embrace digital transformation for the first 5 weeks. This decline is attributed to a temporary decrease in employees' attitudes towards digital transformation, spurred by anticipated increases in workload and uncertainty about the benefits. Following this period, there is a rapid increase in intention up to week 11, primarily fueled by enhanced perceived behavioral control. After this surge, the growth in intention moderates and becomes more gradual, sustained by the developing subjective norms. By week 45, employees' intention to embrace digital transformation stabilizes at a high level, maintaining this peak with minor, frequent fluctuations.

In contrast, Organization 2 starts with a moderately positive intention among its workforce to embrace digital transformation, which consistently rises to a high level by week 50 and continues to rise with some fluctuations. Initially, despite a digital-savvy mindset, there is a significant drop in attitudes towards digital transformation. This decline is likely due to initial financial constraints and inadequate rewards. However, as perceived behavioral control improves, attitudes gradually begin to rebound from their lowest point at 0.4, bolstering the overall intention to embrace digital transformation across the organization.

5.2.8 Technology & Data

This section presents the analytical results of the scenario simulation on technology and data. The simulation results, shown in Figure 46 and Figure 47, provide an insightful comparison of technology adoption and data utilization trajectories for Organization 1 and Organization 2 over the next two years.

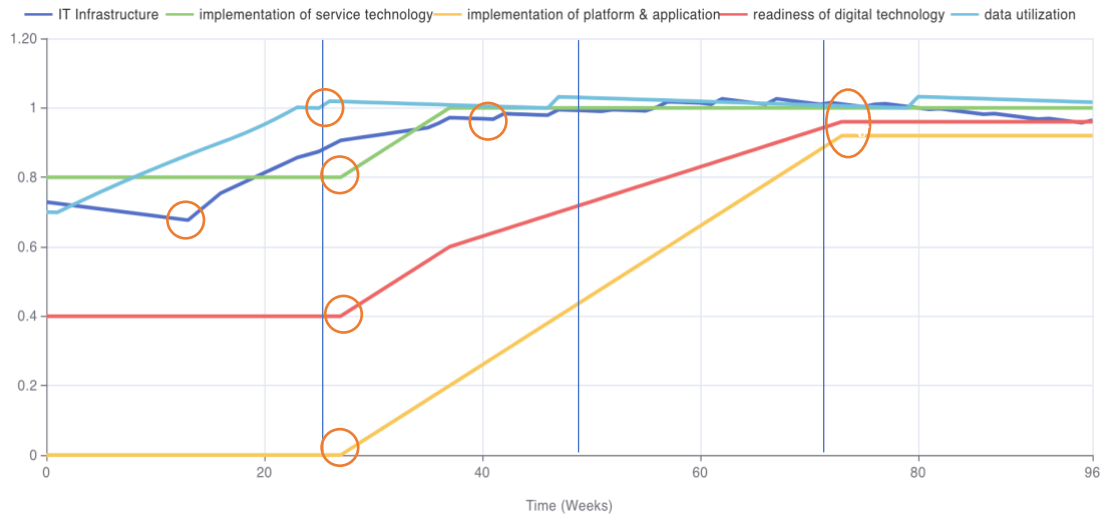

Figure 46 Organization 1 Technology & Data

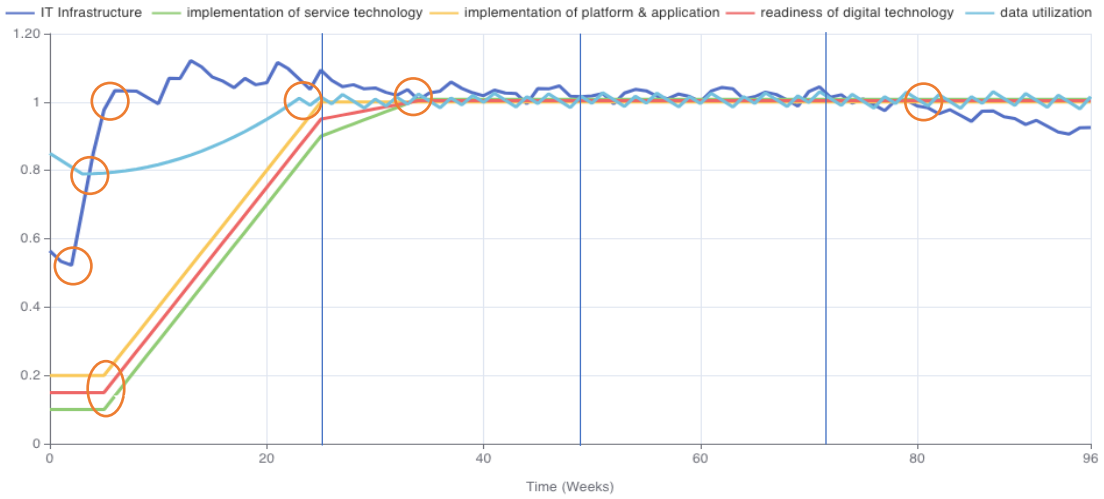

Figure 47 Organization 2 Technology & Data

For Organization 1, the journey towards digital technology readiness is predicted to take about 46 weeks. The readiness of IT infrastructure initially dips slightly until week 13 as the infrastructure strategy is being formulated, then it stabilizes and reaches full readiness by week 40, supported by a robust pre-existing infrastructure. Service technology and platform and application initiatives begin implementation at week 27, following strategic readiness. Service technology, involving minor improvements, is completed swiftly, while the extensive development required for platforms and applications extends its completion to week 73. This marks the point at which digital technology readiness is achieved. Data utilization for Organization 1 is expected to improve steadily and maintain a high level once it peaks.

In contrast, Organization 2 exhibits a faster pace of technology adoption with more pronounced fluctuations, reflecting its dynamic operational environment. Despite a significant initial gap in IT infrastructure, only a slight dip occurs in the first two weeks during strategy formulation, with sufficiency achieved quickly by week 6 due to the organization's smaller scale and streamlined implementation procedure. Fluctuations in IT infrastructure readiness are noted as the organization scales, indicating ongoing needs for investment and updates. The simultaneous implementation of service technology and platforms and applications is forecasted to reach completion within 30 weeks, from week 5 to week 35. Organization 2's technical acumen and smaller-scale projects facilitate rapid technology adoption. Data

utilization starts strong and is expected to further improve dramatically within the first five months as employee skills enhance, maintaining high levels thereafter.

These projections underscore the varied paths that different organizational contexts can take in their digital transformation efforts, highlighting the critical role of strategic planning and resource allocation in achieving technology readiness and optimizing data utilization.

5.2.9 Resource Allocation Optimization

The simulation results reveal that the system dynamics model enables optimal resource allocation through the phase and priority functions, especially in terms of the amount of resources allocated. Figure 48 presents a comparison of Organization 2's IT infrastructure trajectories under two different priority configurations. In simulation 1, the priority assigned to IT infrastructure for the four phases is 1, 0.3, 0.2, and 0.1, while in simulation 2, it is 1, 0.8, 0.8, and 0.8. Both simulations show consistent trajectories, maintaining a very high sufficient level until week 80. However, simulation 1 starts to decline at week 80 due to minimal financial resource allocation to IT infrastructure in phase 4.

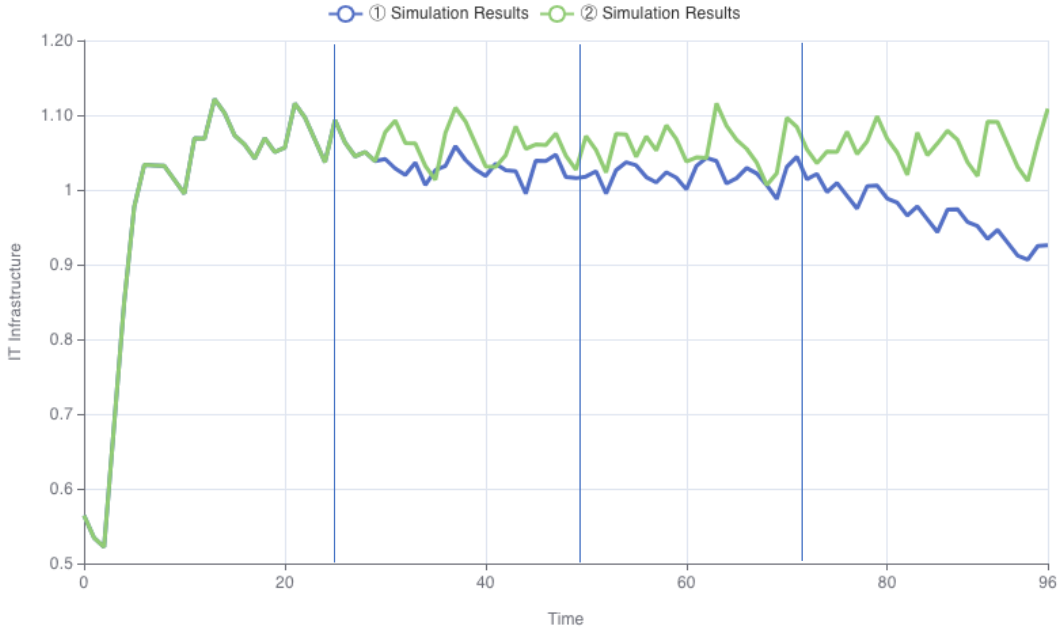

Figure 48 Organization 2 IT Infrastructure Comparison

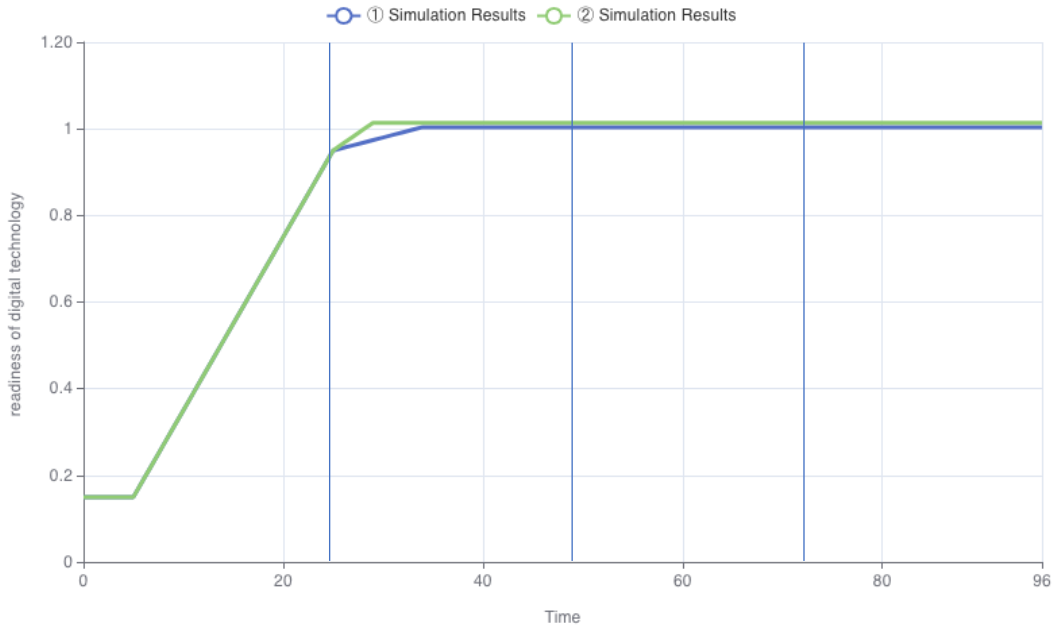

Figure 49 Organization 2 Digital Technology Comparison

Similarly, Figure 48 compares the digital readiness of Organization 2 under the same priority configuration. Simulation 1 achieves digital readiness only 5 weeks later than Simulation 2, albeit with 1.8 fewer financial resources; therefore, the organization could adopt the priority configuration in Simulation 1 but reprioritize phase 4 to 0.2 to maintain its IT infrastructure. This insight highlights the importance of achieving cost efficiencies in resource allocation.

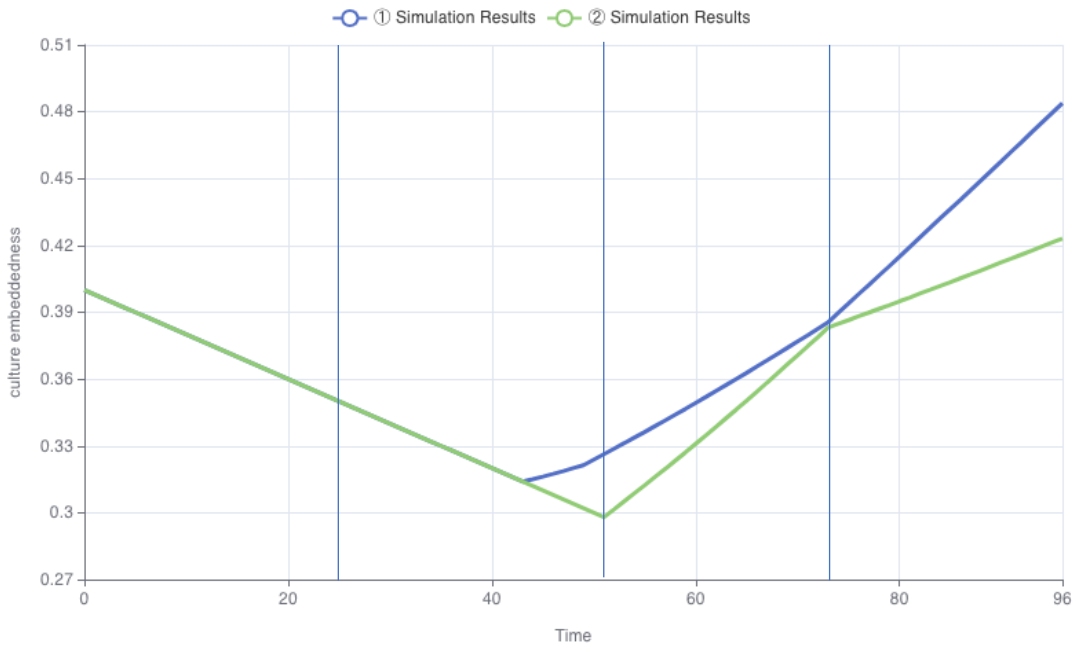

Figure 50 Organization 1 Culture Embeddedness Comparison

The simulation results also provide insights into resource allocation optimization regarding the order in which organizational resources are allocated. Figure 50 presents a comparative analysis of Organization 2's cultural embedding across two different priority configurations. In Simulation 1, priorities are set at 0, 0.6, 0.8, and 1 for the four phases, whereas Simulation 2 assigns the priority as 0.8, 0, 1, and 0.6. Although the resources allocated to culture are the same, differences in the order in which they are allocated lead to different effects. Simulation

1 demonstrates better results than Simulation 2. This is because, in the early stage, prerequisites such as cultural strategy, organizational structure, and digital leadership were not yet in place, making investment in culture less impactful. However, once these prerequisites are established, variations in cultural investment can yield significant effects. Hence, it is important for organizations to figure out the cause-and-effect relationships among various factors and leverage the model to optimize resource allocation effectively.

5.3 Conclusion

Ecological validation of the developed system dynamics model helped to assess its ability to represent realistic digital transformation systems. By employing scenario analysis, the model was tested against operational conditions representative of different organizational contexts. The results of ecological validation confirm that the model has a good ability to represent the real digital transformation system, which not only conforms to the theoretical constructs but also adapts well to practical applications. It demonstrated robust predictive power and maintained its reliability across diverse organizational settings, including both a traditional dairy production firm and a dynamic tech start-up. These findings underscore the model's versatility and its potential utility for organizations undergoing digital transformation. Furthermore, the system dynamics model has proven to be a powerful tool capable of providing valuable insights and guiding strategic decision-making in real-world digital transformation initiatives. It bridges the gap between theoretical frameworks and practical needs, ensuring that the model can be effectively used by organizations to navigate their digital transformation process.

Chapter 6

Conclusion & Discussion

6.1 Conclusion

When undertaking digital transformation, organizations often face challenges to successful completion because of the multifaceted and dynamic nature of digital transformation. This research has developed and implemented a comprehensive system dynamics model to capture the dynamics in organizational digital transformation and so explore the complex and multifaceted phenomenon. By integrating theoretical frameworks with practical validations, the model was able to capture the intricate dynamics involved in digital transformation, providing a robust framework for organizations to navigate their digital transformation process successfully.

A systematic methodology was employed, combining literature review, modeling and simulation design, and validation processes. The Modelling and Simulation Design Cycle ensured the model's theoretical soundness and practical applicability. Verification and validation practices confirmed the model's ability to capture and represent the dynamics of digital transformation accurately and its utility in real-world applications. The practical value of the model was validated through simulated scenarios that reflected real-world conditions. This validation process demonstrated the model's robustness and its ability to provide actionable insights that can guide strategic decision-making. Key performance indicators such as on-time completion rate and on-budget completion rate were used to assess the impact of various digital transformation initiatives, offering stakeholders a clear view of potential outcomes and helping to optimize resource allocation.

This research highlights the key success factors that influence organizational digital transformation through eight sub-models, including strategy, finance, organizational structure, process, culture, people, leadership, and technology & data. By drawing on established theories, these sub-models were crafted, examined, and integrated into a holistic system dynamics model, enabling the capture of the intricate relationships and feedback loops between them over a big picture. The strategy model simulates the readiness of organizations' digital business strategy and digital transformation strategy. The finance model simulates the financial situation of organizations during their digital transformation. The leadership model simulates the readiness of digital leadership in organizations. The organizational structure model simulates the readiness of organizations' structure for digital transformation in terms of five characteristics. The process model simulates organizations' process readiness for digital transformation based on their horizontal alignment and process optimization. The organizational culture model simulates the dynamic process of organizations' cultural change and embedding. The people model simulates people's behavior of embracing digital transformation in organizations. The technology & data model simulates organizations' IT infrastructure readiness, implementation progress of digital technologies within organizations, and performance of data utilization. The model integration allows for a more nuanced understanding of how changes in one aspect of an organization can affect other areas, thereby influencing the overall trajectory of digital transformation. Consequently, the developed model could serve as a valuable tool for

organizations to simulate and analyze these factors, offering insights into the potential outcomes of various digital transformation scenarios.

Overall, this research contributes to the existing body of knowledge by offering a novel approach to studying digital transformation through system dynamics modeling. It provides relevant stakeholders with a practical tool to better understand and manage the complexities of digital transformation, ultimately enhancing the likelihood of successful outcomes.

6.2 Contribution

The research makes significant contributions to both theoretical understanding and practical applications in the field of organizational digital transformation.

The primary theoretical contribution lies in shifting from static conceptual models to a dynamic framework. Existing literature often describes digital transformation as a linear process with fixed stages, but this research introduces a dynamic model that captures the fluid and evolving nature of digital transformation within organizations. By incorporating system dynamics principles, the research offers a nuanced understanding of how various factors interact and influence the trajectory of digital transformation over time. This theoretical advancement fills gaps and provide guidance for relevant academic research.

Beyond its theoretical implications, this research also offers valuable practical applications for organizational decision-making in the context of digital transformation. By developing and validating a dynamic system dynamics model, the research provides actionable insights that can guide strategic planning, resource allocation, and change management efforts within organizations. The model enables stakeholders to simulate different scenarios, assess the impact of strategic decisions, and identify opportunities for optimization in digital transformation initiatives. This practical toolkit empowers organizations to navigate the complexities of digital change more effectively, anticipate challenges, and capitalize on opportunities for innovation and growth. Overall, the research bridges the gap between theory and practice by translating theoretical insights into actionable strategies for real-world digital transformation journeys.

6.3 Limitations

From the theoretical and practical point of view, the research achieved the crucial first step to capture the dynamics of organizational digital transformation. Despite its comprehensive approach and significant contributions, several limitations of this research must be acknowledged.

The system dynamics model developed in this research is based on general principles and factors influencing organizational digital transformation. While it provides a robust framework, the model may not capture all the unique characteristics and nuances of specific organizations or industries. The diversity of organizational contexts and the variability in digital transformation journeys mean that the model may require customization to be fully applicable in different settings. The accuracy and reliability of the model are dependent on the quality and completeness of the data used. In this research, data were primarily derived from mocked data and expert input. While these sources are valuable, they may not fully represent the real-time dynamics and specific challenges faced by organizations. Future research could benefit from

more extensive and diverse data collection, including primary data from a broader range of organizations and industries.

The model and simulation model were based on certain assumptions about the dynamics of organizational behavior. While grounded in theory and expert knowledge, these assumptions may not accurately reflect the actual dynamics within all organizations. The research has provided a theoretical model and initial validation through expert feedback and mock simulations. However, full empirical validation through implementation in real-world scenarios is still needed to make necessary adjustments based on empirical findings to improve the model's accuracy. Furthermore, the complexity of the system dynamics model, with its numerous variables and feedback loops, may pose challenges for its practical application. Organizations may require large-scale initial assessment, training, and expertise to effectively use and interpret the model.

By acknowledging these limitations, this research sets the stage for further improvement. Addressing these limitations through targeted research efforts can enhance the model's robustness, applicability, and value in guiding successful digital transformation initiatives across diverse organizational contexts.

6.4 Future Research

According to the areas highlighted in the limitations, future research should focus on refining the system dynamics model developed in this research through further in-depth study and refinement of the sub-models. While the current model captures a broad spectrum of factors influencing digital transformation, further refinement can improve its precision and utility. Specific areas for refinement include incorporating additional granular factors into each sub-model. These additions can capture more characteristics and provide a more nuanced understanding of how these elements interact. For example, differentiating strategy development and investigating the influencing factors for each type of strategy in the strategy model or investigating the specific aspects of digital transformation impact in the people model. With the incorporation of additional factors, more complex feedback loops will be added, capturing more dynamics of organizational digital transformation, such as the impact of employee resistance to change on the speed of technology adoption or the role of continuous learning and development in sustaining digital transformation efforts.

Applying data from various industries and organization sizes can help in fine-tuning the model to further improve its accuracy and robustness across different contexts. Future research could also conduct in-depth case studies of organizations undergoing or having completed digital transformation initiatives and apply the model to practical organizational context through longitudinal study. This will provide empirical validation for the assumptions made in the model and the outcomes it predicts. Observing real-world digital transformation processes can generate empirical data to validate and adjust the assumptions made in this research. Implementing the model in real-world scenarios with longitudinal study can generate empirical data to validate the model's predictions. Practical insights from these case studies will highlight the challenges, barriers, and enablers of digital transformation that theoretical models may not fully capture, suggesting possible topics for future research.

Furthermore, future research could be integrated with other areas. One interesting topic would be the use of artificial intelligence to generate mocked and predicted data for simulation or automate the simulation processes. Also, based on the general system dynamics model, creating

a digital twin model for specific organizational change would be promising. Finally, creating usable toolkits such as games and dashboards based on this research will further help organizations in practice to achieve successful digital transformation.

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Appendix

Appendix 1 Equations of Stock

Chunks	Stocks	Inflow Equation	Outflow Equation
Strategy	service strategy	IfThenElse([service strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([service strategy]>0, [strategy degeneration]/(1-[service strategy gap]), 0)
	platform & application strategy	IfThenElse([platform & application strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([platform & application strategy]>0, [strategy degeneration]/(1-[platform & application gap]), 0)
	information & data strategy	IfThenElse([information & data strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([information & data strategy]>0,[strategy degeneration]/(1-[information & data gap]), 0)
	infrastructure strategy	IfThenElse([infrastructure strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([infrastructure strategy]>0,[strategy degeneration]/(1-[infrastructure gap]), 0)
	security strategy	IfThenElse([security strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([security strategy]>0,[strategy degeneration]/(1-[security gap]), 0)
	structure strategy	IfThenElse([structure strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([structure strategy]>0,[strategy degeneration]/(1-[structure strategy gap]), 0)
	process strategy	IfThenElse([process strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([process strategy]>0,[strategy degeneration]/(1-[process strategy gap]), 0)
	culture strategy	IfThenElse([culture strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([culture strategy]>0,[strategy degeneration]/(1-[culture strategy gap]), 0)
	skill strategy	IfThenElse([skill strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([skill strategy]>0, [strategy degeneration]/(1-[skill strategy gap]), 0)
	people strategy	IfThenElse([people strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([people strategy]>0, [strategy degeneration]/(1-[people strategy gap]), 0)
	leadership strategy	IfThenElse([leadership strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([leadership strategy]>0,[strategy degeneration]/(1-[leadership strategy gap]), 0)

	finance strategy	IfThenElse([finance strategy]<1, [strategy development]*[priority - strategy], 0)	IfThenElse([finance strategy]>0, [strategy degeneration]/(1-[finance strategy gap]), 0)
Finance	funds 1	[internal funding infusion]	[spending]
	external funds	IfThenElse([funds 2]<0, [external funding infusion], 0)	[pay off]
Organizational Structure	flat hierarchy	IfThenElse([flat hierarchy]<1 and [structure strategy]>0.95, [flatten hierarchies]*[priority - structure], 0)	IfThenElse([flat hierarchy]>0, [hierarchy degeneration], 0)
	cross-functional collaboration	IfThenElse([cross-functional collabroation]<1 and [structure strategy]>0.95, [establish cross-functional team]*[priority - structure], 0)	IfThenElse([cross-functional collaboration]>0, [cross-functional collaboration degeneration], 0)
	digital functional area transformation	IfThenElse([digital functional area transformation]<1 and [structure strategy]>0.95, [transform digital functional area]*[priority - structure], 0)	IfThenElse([digital functional area transformation]>0, [digital functional area degeneration],0)
	separate unit	IfThenElse([separate unit]<1 and [structure strategy]>0.95, [establish separate unit]*[priority - structure], 0)	IfThenElse([separate unit]>0, [separate unit degeneration], 0)
	flexible roles & responsibilities	IfThenElse([flexible roles & responsibilities]<1 and [structure strategy]>0.95, [redefine roles & responsibilities]*[priority - structure], 0)	IfThenElse([flexible roles & responsibilities]>0, [flexible roles & responsibilities degeneration], 0)
Process	horizontal alignment	IfThenElse([horizontal alignment]<1 and [process strategy]>0.95,[organiztaional structure]*[align processes]*[priority - system], 0)	IfThenElse([horizontal alignment]>0, [horizontal alignment degeneration], 0)
	process optimization	IfThenElse([process optimization]<1 and [process strategy]>0.95, [optimize processes]*[priority - system], 0)	IfThenElse([horizontal alignment]>0, [horizontal alignment degeneration], 0)
Culture	hierarchy culture gap		IfThenElse([hierarchy culture gap]>0 and [culture strategy]>0.95 , [change culture]*[priority - culture], 0)
	clan culture gap		IfThenElse([clan culture gap]>0 and [culture strategy]>0.95, [change culture]*[priority - culture], 0)

	adhocracy culture gap		IfThenElse([adhocracy culture gap]>0 and [culture strategy]>0.95, [change culture]*[priority - culture], 0)
	market culture gap		IfThenElse([market culture gap]>0 and [culture strategy]>0.95, [change culture]*[priority - culture], 0)
	culture embeddedness	IfThenElse([culture embeddedness]<1 and [culture change]>0.8, [priority - culture]*[embed culture]*(0.4*[embrace DT]+0.3*[digital leadership]+0.2*[organiztaional structure]+0.1*[process]), 0)	[culture degeneration]
People	skills	IfThenElse([skills]<1 and [skill strategy]>0.9, ([training]+[talent acquisition])*[priority - people], 0)	IfThenElse([skills]>0, [skill degeneration], 0)
	attitude towards DT	(IfThenElse([attitude towards DT]<1 and [perceived benefits]>0.5, [perceived benefits]-0.5, 0) + IfThenElse([attitude towards DT]<1 and [perceived effort]<0.5, 0.5-[perceived effort], 0) + IfThenElse([attitude towards DT]<1 and [subjective norm]>0.5, [subjective norm]-0.5, 0) + IfThenElse([attitude towards DT]<1 and [perceived behavioral control]>0.5, [perceived behavioral control]-0.5, 0))/4	(IfThenElse([attitude towards DT]>0 and [perceived effort]>0.5, ([perceived effort]-0.5), 0)+ IfThenElse([attitude towards DT]>0 and [perceived benefits]<0.5, 0.5-[perceived benefits], 0) + IfThenElse([attitude towards DT]>0 and [subjective norm]<0.5, 0.5-[subjective norm], 0) + IfThenElse([attitude towards DT]>0 and [perceived behavioral control]<0.5, 0.5-[perceived behavioral control], 0))/4
	perceived behavioral control	(IfThenElse([perceived behavioral control]< 1 and [facilitating conditions]>0.5, [facilitating conditions]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and [skills]>0.5, [skills]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and [subjective norm]>0.5, [subjective norm]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and	(IfThenElse([perceived behavioral control]< 1 and [facilitating conditions]>0.5, [facilitating conditions]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and [skills]>0.5, [skills]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and [subjective norm]>0.5, [subjective norm]-0.5, 0) + IfThenElse([perceived behavioral control]< 1 and

		[attitude towards DT]>0.5, [attitude towards DT]-0.5, 0))/4	[attitude towards DT]>0.5, [attitude towards DT]-0.5, 0))/4
Leadership	leadership style	IfThenElse([leadership style]<1 and [leadership strategy]>0.8, [training]*[priority - leadership], 0)	IfThenElse([leadership style]>0, [leadership degeneration], 0)
	leadership skill	IfThenElse([leadership skills]<1 and [leadership strategy]>0.8, [training]*[priority - leadership], 0)	IfThenElse([leadership skills]>0, [leadership degeneration], 0)
	leadership role	IfThenElse([leadership role]<1 and [leadership strategy]>0.6, [establishing new leadership roles]*[priority - leadership], 0)	IfThenElse([leadership role]>0, [leadership degeneration], 0)
	organizational-level leadership	IfThenElse([organizational-level leadership]<1, [digital leader transformation]*[take actions], 0)	IfThenElse([organizational-level leadership]>0, [leadership decline], 0)
	individual-level leadership	IfThenElse([individual-level leadership]<1, [digital leader transformation]*[take actions], 0)	IfThenElse([individual-level leadership]>0, [leadership decline], 0)
Technology & Data	hardware	IfThenElse([hardware]<1 and[infrastructure strategy]>0.6,[implement hardware]*[priority - technology & data], 0)	IfThenElse([hardware]>0, [infrastructure deterioration], 0)
	software	IfThenElse([software]<1 and [infrastructure strategy]>0.6, [implement software]*[priority - technology & data], 0)	IfThenElse([software]>0, [infrastructure deterioration], 0)
	networks	IfThenElse([networks]<1 and [infrastructure strategy]>0.6, [implement networks]*[priority - technology & data], 0)	IfThenElse([networks]>0, [infrastructure deterioration], 0)
	data centers and storage	IfThenElse([data centres and storage]<1 and [infrastructure strategy]>0.6, [implement data centres and storage]*[priority - technology & data], 0)	IfThenElse([data centers and storage]>0, [infrastructure deterioration], 0)
	could service	IfThenElse([could services]<1 and [infrastructure strategy]>0.6, [implement cloud service], 0)	IfThenElse([security systems]>0, [infrastructure deterioration], 0)

	IT support	IfThenElse([IT support]<1 and [infrastructure strategy]>0.6, [implement IT support], 0)	IfThenElse([IT support]>0, [infrastructure deterioration], 0)
	implementation of service technology	IfThenElse([IT Infrastructure]>0.9 and [implementation of service technology]<1 and [service strategy]>0.9, [implement service technology]*[priority - technology & data], 0)	
	implementation of platform & application	IfThenElse([IT Infrastructure]>0.9 and [implementation of platform & application]<1 and [platform & application strategy]>0.9, [implement platform & application]*[priority - technology & data], 0)	
	data utilization		IfThenElse([data utilization]>0, [data utilization degeneration], 0)

Appendix 2 Equations of Sub-strategy

*platform & application strategy = INTEG (strategy development*priority-strategy – platform & application strategy gap – strategy degeneration)*

*information & data strategy = INTEG (strategy development*priority-strategy – information & data strategy gap – strategy degeneration)*

*infrastructure strategy = INTEG (strategy development*priority-strategy – infrastructure strategy gap – strategy degeneration)*

*security strategy = INTEG (strategy development*priority-strategy – security strategy gap – strategy degeneration)*

*process strategy = INTEG (strategy development*priority-strategy – process strategy gap – strategy degeneration)*

*culture strategy = INTEG (strategy development*priority-strategy – culture strategy gap – strategy degeneration)*

*skill strategy = INTEG (strategy development*priority-strategy – skill strategy gap – strategy degeneration)*

*people strategy = INTEG (strategy development*priority-strategy – people strategy gap – strategy degeneration)*

*leadership strategy = INTEG (strategy development*priority-strategy – leadership strategy gap – strategy degeneration)*

*finance strategy = INTEG (strategy development*priority-strategy – finance strategy gap – strategy degeneration)*

Appendix 3 Expert Validation Questionnaire

- To have a good understanding of organizational digital transformation, it has been broken down into 8 building blocks which are Strategy, Finance, Technology & Data, Structure, System, Culture, People, and Leadership. Those building blocks are represented in the model as different chunks/folders to address the high relations among them. Do you agree with it? / Do you think they are represented in a good way?

- More granular components as well as variables of are identified within each chunk to demonstrate more specific causal relations either within or across the building blocks. Users can input initial variables based on their contexts. Do you agree with it? / Do you think they are represented in a good way?

- To better address the dynamics of digital transformation and align with the practices as resources are limited and priority exists, the phase and priority mechanism is introduced. The number and length of the phases, and the priority of each block can be personalized. What do you think of this? / Do you think it addresses the dynamics or involves time in a good manner?

- Besides, a controller is made to separate the value input and the model itself, bringing some independence to the model. What do you think of it? Do you think it is necessary?

- Overall, do you think it fits the purposes that we talked about at the beginning? What do you expect from the outcomes? Do you think it will deviate a bit from my original goal? What is missing or could be added from your perspective?

Appendix 4 Simulation Data

	Organization 1	Organization 2
Priority (Phase 1 – 4)		
digital transformation	0.5, 0.4, 0.4, 0.3	0.2, 0.2, 0.5, 0.7
strategy	1, 0.9, 0.2, 0.2	0.5, 0.1, 0.1, 0.07
technology & data	0.5, 1, 1, 0	1, 0.3, 0.2, 0.1
structure	0, 0.4, 0.8, 0.4	0.3, 0.3, 0.3, 0.2
process	0.3, 0.6, 0.5, 0.4	0.3, 0.6, 0.5, 0.4
culture	0, 0.6, 1, 1	0.7, 0.6, 1, 1
people	0.3, 0.8, 0.1, 0.1	0.3, 0.8, 0.1, 0.1
leadership	0, 0.4, 0.3, 0.2	0.4, 0.2, 0.2, 0.2
Strategy		
internal service ambition	0.5	1

external service ambition	0.3	0.9
current service strategy	0.5	0.7
internal platform & application ambition	0.9	0.7
external platform & application ambition	0.8	0.6
current platform & application strategy	0.5	0.8
internal information and data ambition	0.85	0.9
external information and data ambition	0.75	0.8
current information and data strategy	0.6	0.7
internal infrastructure ambition	0.75	0.8
external infrastructure ambition	0.5	0.8
current infrastructure strategy	0.6	0.7
internal security ambition	0.8	0.6
external security ambition	0.8	0.7
current security strategy	0.6	0.8
structure desired	0.9	0.75
current structure strategy	0.4	0.7
process desired	0.9	0.75
current process strategy	0.75	0.75
culture desired	0.9	0.8
current culture strategy	0.3	0.7
skill desired	0.8	0.9
current skill strategy	0.65	0.7
people desired	0.75	0.85
current people strategy	0.5	0.65
leadership desired	0.9	0.75
current leadership strategy	0.6	0.65
finance desired	0.85	0.6
current finance strategy	0.7	0.5
strategy development	0.02	0.2
strategy degeneration	0.004	0.015
Finance		
external investment	0	1
external funding infusion	0	0.08
Technology & Data		
current hardware	0.9	0.5
implement hardware	0.04	0.2
current software	0.6	0.6
implement software	0.08	0.25
current networks	0.9	0.7
implement networks	0.04	0.5

current data centers and storage	0.8	0.6
implement data centers and storage	0.02	0.25
current cloud service	0.9	0.8
implement cloud service	0.08	0.25
current security systems	0.3	0.45
implement security systems	0.02	0.125
current IT support	0.7	0.5
implement IT support	0.02	0.08
infrastructure deterioration	0.004	0.04
current data utilization	0.7	0.85
improve data utilization capacity	0.04	0.06
data utilization degeneration	0.01	0.02
implement service technology	0.02	0.04
implement platform & application	0.02	0.04
Structure		
current flat hierarchy	0.3	0.85
hierarchy degeneration	0.002	0.01
flatten hierarchies	0.008	0.08
importance of flat hierarchies	0.3	0.2
current cross-functional collaboration	0.5	0.9
cross-functional collaboration degeneration	0.01	0.02
establish cross-functional team	0.04	0.125
importance of cross-functional collaboration	0.3	0.2
current digital functional area transformation	0.4	0.9
digital functional area degeneration	0.004	0.01
transform digital functional area	0.02	0.08
importance of digital functional area transformation	0.2	0.4
current separate unit	0	0
separate unit degeneration	0.002	0
establish separate unit	0.02	0
importance of separate unit	0.1	0
current flexible roles & responsibilities	0.5	0.85

flexible roles & responsibilities degeneration	0.005	0.01
redefine roles & responsibilities	0.08	0.25
importance of flexible roles & responsibilities	0.1	0.2
Process		
current horizontal alignment	0.6	0.8
align processes	0.01	0.04
horizontal alignment degeneration	0.005	0.01
current process optimization	0.7	0.3
optimize processes	0.04	0.06
process degeneration	0.005	0.02
Culture		
current hierarchy culture	0.9	0.05
desired hierarchy culture	0.5	0.1
current clan culture	0.4	0.3
desired clan culture	0.9	1
current adhocracy culture	0.6	0.3
desired adhocracy culture	0.75	0.9
current market culture	0.8	0.2
desired market culture	0.8	0.7
change culture	0.05	0.1
culture degeneration	0.002	0.01
embed culture	0.007	0.02
People		
reward systems	0.8	0.2
training	0.125	0.125
talent acquisition	0.0625	0.0625
skill degeneration	0.01	0.02
Leadership		
current leadership style	0.4	0.8
current leadership skills	0.9	0.4
current leadership roles	0.5	0.9
current organizational-level leadership	0.9	0.9
current individual-level leadership	0.35	0.9
establishing new leadership roles	0.0625	0.125
leadership degeneration	0.01	0.02
take actions	0.1	0.25
leadership decline	0.04	0.04