Understanding Early Stage Evolution of Digital Innovation Units in Manufacturing Companies

Dissertation

To obtain the degree
"Doctor of Philosophy" (Ph.D.)
In the domain of "Information Systems"
(German: "Wirtschaftsinformatik")

submitted to the
Digital Engineering Faculty
University of Potsdam

Annalena Lorson
Potsdam, Germany
December 2023

Supervisor: Prof. Dr. Falk Uebernickel
Research Group: Design Thinking and Innovation Research
Hasso Plattner Institute

Acknowledgment

As I write this, I'm looking back on four exciting, exhausting, intense, rewarding, stressful, and joyful years at the Hasso Plattner Institute as a Ph.D. student at the Chair for Design Thinking and Innovation Research and as a Program Manager at the HPI School of Entrepreneurship. During this time, I have worked, taught, and researched with many remarkable individuals who have made it possible for me to write these words today.

First and foremost, I would like to express my deepest gratitude to my supervisor, Falk Uebernickel, for giving me the opportunity to embark on this Ph.D. journey, providing a great working environment, and supporting me in my development as a scientist.

I would also like to extend a few words of appreciation and gratitude to my colleagues at the Hasso Plattner Institute and beyond, who have enriched my academic journey and with whom I have shared some marvelous moments. Carolin, Vincent, Tobias, Danielly, and Anne, thank you for many valuable conversations and shared experiences inside and outside research. To Selina and Thomas, thank you for being there from the beginning to the last mile through many paper projects and discussions. Your contribution was invaluable. A heartfelt thank you also goes to my academic mentor, Christian Dremel, for your tremendous help through countless hours of collaboration and feedback, organizing my thought process, and introducing me to the world of information systems theory.

In addition, I would like to express my sincere thanks to my boss, Frank Pawlitschek, and the incredible team at the HPI School of Entrepreneurship – David, Max, Clara, Franz, Mona, Tolga, Rebecca, Anna, Willi, and many others. Working with all of you has been an enriching experience, filled with collaborative efforts on numerous programs, events, and lectures. I am grateful for all our laughs, struggles, and triumphs.

To my wonderful family and friends, thank you for your unwavering support and understanding throughout my academic journey and the process of creating this thesis. To my parents, Ingrid and Michael, for always believing in me and lifting me when needed. To my sister, Catharina, for being a source of invaluable advice, positivity, and encouragement, especially in the most challenging moments. Finally, to my better half, Alexander, to whom I owe more gratitude than words can express. Thank you for being there every step of the way, understanding the sacrifices, and celebrating the victories. Your patience, love, and constant support have been the cornerstone of my success.

Thank you all for being part of this journey. I could not have done it without you.

IV

Abstract

The dynamic landscape of digital transformation entails an impact on industrial-age manufacturing companies that goes beyond product offerings, changing operational paradigms, and requiring an organization-wide metamorphosis. An initiative to address the given challenges is the creation of Digital Innovation Units (DIUs) – departments or distinct legal entities that use new structures and practices to develop digital products, services, and business models and support or drive incumbents' digital transformation. With more than 300 units in German-speaking countries alone and an increasing number of scientific publications, DIUs have become a widespread phenomenon in both research and practice.

This dissertation examines the evolution process of DIUs in the manufacturing industry during their first three years of operation, through an extensive longitudinal single-case study and several cross-case syntheses of seven DIUs. Building on the lenses of organizational change and development, time, and socio-technical systems, this research provides insights into the fundamentals, temporal dynamics, socio-technical interactions, and relational dynamics of a DIU's evolution process. Thus, the dissertation promotes a dynamic understanding of DIUs and adds a two-dimensional perspective to the often one-dimensional view of these units and their interactions with the main organization throughout the start-up and growth phases of a DIU.

Furthermore, the dissertation constructs a phase model that depicts the early stages of DIU evolution based on these findings and by incorporating literature from information systems research. As a result, it illustrates the progressive intensification of collaboration between the DIU and the main organization. After being implemented, the DIU sparks initial collaboration and instigates change within (parts of) the main organization. Over time, it adapts to the corporate environment to some extent, responding to changing circumstances in order to contribute to long-term transformation. Temporally, the DIU drives the early phases of cooperation and adaptation in particular, while the main organization triggers the first major evolutionary step and realignment of the DIU.

Overall, the thesis identifies DIUs as malleable organizational structures that are crucial for digital transformation. Moreover, it provides guidance for practitioners on the process of building a new DIU from scratch or optimizing an existing one.

Zusammenfassung

Die digitale Transformation produzierender Unternehmen geht über die bloße Veränderung des Produktangebots hinaus; sie durchdringt operative Paradigmen und erfordert eine umfassende, unternehmensweite Metamorphose. Eine Initiative, den damit verbundenen Herausforderungen zu begegnen, ist der Aufbau einer Digital Innovation Unit (DIU) (zu deutsch: digitale Innovationseinheit) – eine Abteilung oder separate rechtliche Einheit, die neue organisationale Strukturen und Arbeitspraktiken nutzt, um digitale Produkte, Dienstleistungen und Geschäftsmodelle zu entwickeln und die digitale Transformation von etablierten Unternehmen zu unterstützen oder voranzutreiben. Mit mehr als 300 Einheiten allein im deutschsprachigen Raum und einer wachsenden Zahl wissenschaftlicher Publikationen sind DIUs sowohl in der Forschung als auch in der Praxis ein weit verbreitetes Phänomen.

Auf Basis einer umfassenden Längsschnittstudie und mehrerer Querschnittsanalysen von sieben Fertigungsunternehmen und ihren DIUs untersucht diese Dissertation den Entwicklungsprozess von DIUs in den ersten drei Betriebsjahren. Gestützt auf theoretische Perspektiven zu organisatorischem Wandel, Zeit und sozio-technischen Systemen bietet sie Einblicke in die Grundlagen, die zeitlichen Dynamiken, die sozio-technischen Interaktionen und die Beziehungsdynamiken des Entwicklungsprozesses von DIUs. Die Dissertation erweitert somit das dynamische Verständnis von DIUs und fügt der oft eindimensionalen Sichtweise auf diese Einheiten und ihre Interaktionen mit der Hauptorganisation eine zweidimensionale Perspektive entlang der Gründungs- und Wachstumsphasen einer DIU hinzu.

Darüber hinaus konstruiert die Dissertation ein Phasenmodell, das die frühen Phasen der DIU-Entwicklung auf der Grundlage dieser Erkenntnisse und unter Einbeziehung von Literatur aus der Wirtschaftsinformatikforschung abbildet. Es veranschaulicht die schrittweise Intensivierung der Zusammenarbeit zwischen der DIU und der Hauptorganisation. Nach ihrer Implementierung initiiert die DIU die anfängliche Zusammenarbeit und stößt Veränderungen innerhalb (von Teilen) der Hauptorganisation an. Im Laufe der Zeit passt sich die DIU bis zu einem gewissen Grad dem Unternehmensumfeld an und reagiert auf sich verändernde Umstände, um zu einer langfristigen Veränderung beizutragen. Zeitlich gesehen treibt die DIU vor allem die frühen Phasen der Zusammenarbeit und Anpassung voran, während die Hauptorganisation den ersten großen Entwicklungsschritt und die Neuausrichtung der DIU auslöst.

Insgesamt identifiziert die Dissertation DIUs als anpassungsfähige Organisationsstrukturen, die für die digitale Transformation entscheidend sind. Darüber hinaus bietet sie Praktikern einen Leitfaden für den Aufbau einer neuen oder die Optimierung einer bestehenden DIU.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

AC	Adaptive Capacity
AI	Artificial Intelligence
CC	Consultancy Company
CDO	Chief Digital Officer
CDIO	Chief Digital and Information Officer
CEO	Chief Executive Officer
CIO	Chief Information Officer
CRM	Customer Relationship Management
DIU	Digital Innovation Unit
e.g.	For example (Latin: exempli gratia)
ERP	Enterprise Resource Planning
et al.	And others (Latin: et alii)
IS	Information Systems
IT	Information Technology
MVP	Minimum Viable Product
NIH	Not-Invented-Here
PIM	Product Information Management
RASCI	Responsible, accountable, supporting, consulted, informed
R&D	Research and Development
RG	Research Goal
RQ	Research Question
sic	Thus was it written (Latin: sīc erat scriptum)
STS	Socio-technical System

1 Introduction

"Digital transformation has not only affected the product and service offerings of industrial organizations but has also changed the way they operate and, therefore, requires a company-wide transformation programme [sic!] – the digital transformation of organizations." (Imran et al., 2021, p. 2).

Digital Innovation Units (DIU), a holy grail, an all-purpose weapon that harnesses new digital technologies and drives the digital transformation of non-digital incumbent companies – that was the expectation at the beginning of the DIU hype cycle in German-speaking countries in 2015/16 (Sindemann et al., 2021). As a result, more and more incumbents across all industries have established DIUs as innovation forges and an instrument to drive digital transformation (e.g., Fuchs et al., 2019; Raabe et al., 2020b; Sindemann & Ansari, 2017; Sindemann & von Buttlar, 2018).

Today, at the end of 2023, DIUs are a widespread initiative in practice, with more than 300 units in German-speaking countries alone (Lau et al., 2022). Despite the global pandemic, the DIU scene is more vibrant than ever (Sindemann et al., 2021), with many DIUs delivering quantifiable innovation results and making a substantial qualitative contribution to the transformation of the main organization (Sindemann et al., 2020). However, the early days' exaggerated expectations were abandoned through a (sometimes painful) trial-and-error process (Lau et al., 2022). About ten percent of DIUs were closed down (Sindemann et al., 2021) others were sold (Tödtmann, 2020). In particular, scaling business models currently seems to be a substantial challenge, and only about half of DIUs rate the growth of their innovations in the marketplace as high (Ohr, 2020; Sindemann et al., 2021).

The phenomenon of DIUs seems to be a regular business practice of non-digital incumbents that contributes to their digital transformation but also poses various challenges and does not guarantee a sure-fire success. This raises the question of whether DIUs are merely temporary *innovation theaters* (Santarsiero et al., 2021) – i.e., public relations tools or corporate signaling efforts (e.g., Mayer et al., 2021;

Raabe et al., 2020a) – or whether they can make a substantial contribution in the long term.

In the following, the motivation for studying DIUs, particularly the early stages of DIU evolution in the context of non-digital incumbents' digital transformation, is presented, and a specific research gap is identified (Chapter 1.1). Next, the research goal (RG) and research questions (RQ) are derived (Chapter 1.2) before a summary of the contribution to research and practice is provided (Chapter 1.3). Finally, the structure of the dissertation is outlined (Chapter 1.4).

1.1 Motivation and Research Gap

In the last decade, and especially in the previous five years, a stream of literature on DIUs has emerged in academia, particularly in the field of information systems (IS) (e.g., Barthel et al., 2020; Dremel et al., 2017; Holotiuk & Beimborn, 2019; Raabe et al., 2020b; Schumm et al., 2022; Svahn et al., 2017). Since 2014, there has been a steady increase in publications on DIUs that examine the phenomenon from various angles and theoretical lenses (Haskamp et al., 2023) to clarify whether and to what extent DIUs can contribute to incumbent companies' digital transformation.

Digital transformation 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" (Vial, 2019, p. 121). It leads to a new organizational identity (Wessel et al., 2021) and a shift toward malleable institutional designs that are easily influenced, effortlessly changed, and enable continuous adaptation (Hanelt et al., 2020). Digital transformation is a complex topic that affects many or all areas of a company (Hess et al., 2016) and often involves overcoming considerable organizational inertia (Haskamp, Dremel, et al., 2021) and organizational tensions (Svahn et al., 2017).

DIUs are one of several potential initiatives to launch and drive digital transformation (Jöhnk et al., 2020; Matt et al., 2015; Wiesböck & Hess, 2019). Among the few definitions that have been developed, this dissertation follows the conceptualization of Haskamp et al. (2023) as the most recent and comprehensive and defines DIUs as "dedicated organizational units that support and partly drive digital transformation in incumbent firms by leveraging new structures and practices that differ from those existing in the organization, aiming to promote various aspects of digital innovation" (p. 6). They are departments or separate legal entities that address the multi-layered and complex challenges of this journey (Barthel et al., 2020; Fuchs et al., 2019; Raabe et al., 2020a), which requires both the integration of new digital technologies and a thorough digital (transformation) strategy (Bharadwaj et al., 2013; Hess et al., 2016; Matt et al., 2015; Vial, 2019).

DIUs are supposed to break down silos and intensify cross-departmental collaboration and the pooling of competencies, build new digital capabilities, promote a new digital culture, and anchor the digital business (Haskamp et al.,

2023). They leverage digital technologies and develop digital products, services, and business models (Barthel et al., 2020; Ciriello & Richter, 2015; Holotiuk & Beimborn, 2019), but also have to deal with various social aspects of the transformation, such as changing interpersonal relationships, working methods, and organizational practices, structures, and culture (Göbeler et al., 2020; Hellmich et al., 2021; Holotiuk & Beimborn, 2019; Jöhnk et al., 2020; Raabe et al., 2020b). Due to the considerable differences to the main organization in terms of skills, hierarchies, and cultural aspects (social system) as well as in terms of practices, processes, tasks, and technologies (technical system), this thesis understands DIUs as their own socio-technical system (STS).

With their reduced socio-technical complexity, DIUs take advantage of dedicated, smaller structures and faster adaptation within the rest of the organization and consolidate a firm's exploration efforts to enable ambidexterity (managing exploration and exploitation in parallel) (Fuchs et al., 2019; Göbeler et al., 2020; Holotiuk & Beimborn, 2019). This makes them particularly valuable for companies in traditional industries such as retail, manufacturing, automotive, or financial services (Arvidsson & Mønsted, 2018; Chanias et al., 2019; Yoo et al., 2010).

This thesis focuses on the manufacturing industry, which has been identified as particularly relevant for DIU research because it has historically been less responsive to the impact of digital transformation (Hanelt et al., 2015) but is now required to build digital capabilities (Sebastian et al., 2017; Warner & Wäger, 2019; Wiesböck & Hess, 2019). Manufacturing companies traditionally have hierarchical structures and develop and produce their products in a waterfall process with robust timeframes of up to ten years (Dremel & Herterich, 2016; Imran et al., 2021). This contrasts with digital products' agile, iterative, and rapid development and poses a particular challenge to DIUs. In addition, multiple business units, diversified business model portfolios, and complex Information Technology (IT) landscapes within manufacturing organizations create unique organizational challenges (Bilgeri et al., 2017).

Because the approach of leveraging DIUs for digital transformation itself is fraught with challenges (e.g., Non-Invented-Here [NIH] syndrome, unclear objectives, missing skills, and missing top management support (Raabe et al., 2020a)), it is fundamental to understand whether these challenges can be overcome to make DIUs a viable initiative in the long term.

Research on DIUs in the field of IS, however, is currently mostly static, i.e., DIUs are studied from a particular theoretical perspective at a certain point in time regarding their status quo (e.g., Barthel et al., 2020; Fuchs et al., 2019; Holotiuk & Beimborn, 2019; Hund et al., 2019; Raabe et al., 2020a). Only a few publications consider DIUs from a dynamic perspective regarding change or development processes (Raabe, 2021; Raabe et al., 2020b; Schumm, 2023). Therefore, DIU researchers call for studies on the implementation, evolution, and possible reintegration processes of DIUs, including in-depth longitudinal case studies (Barthel et al., 2020; Haskamp et al., 2023; Raabe et al., 2020b). These contribute to a deeper understanding of whether and how DIUs can initiate the necessary

change in organizational structures, processes, and culture to reshape incumbents' value creation and secure their competitiveness in the digital realm. Moreover, it extends the dynamic understanding of DIUs by addressing the issue of whether they can effectively serve as the malleable organizational structures essential for digital transformation (Hanelt et al., 2020).

1.2 Research Goal and Research Questions

This dissertation addresses the research gap of insufficient dynamic understanding of DIUs and examines their evolution process within the first three years of operation. This time frame was chosen because the early years appear to be a critical, make-or-break period for DIUs, as units that closed had an average age of about four years (Sindemann et al., 2021). During this time, the DIU is implemented as a new structure in the main organization, and the most significant changes, adjustments, or rejections are expected to occur. This leads to the following underlying RG:

- *Main Research Goal: Gain a deeper understanding of the early stages of a digital innovation unit's evolution and its contribution to a manufacturing company's digital transformation.*

The RG translates into the following overarching RQ:

- *Main Research Question: How do early-stage digital innovation units evolve to contribute to a manufacturing company's digital transformation journey?*

The main RQ is pursued cumulatively through four sub-questions, answered sequentially. These sub-questions are derived below.

As mentioned above, to date, there is little empirical evidence on the evolution process of a DIU (Barthel et al., 2020), either qualitative or quantitative, leaving us uncertain of a DIU's lasting contribution to the digital transformation of incumbents. The literature provides only general information on how DIUs evolve within a given context (Trischler et al., 2022) but does not give detailed insights into, for example, the dynamics, phases, drivers, success factors, or challenges.

The big picture, i.e., the fundamentals of a DIU's evolution process, will be examined as a starting point. Building on the first indications from the retail and automotive industries that DIUs and their main organization are in a state of constant flux (Raabe et al., 2021) and co-evolve "through continuous and reciprocal alignment" (Schumm, 2023, p. 163), this dissertation aims to unpack how the evolution process unfolds (including dynamics, triggers, characteristics, and outcomes) and how a DIU incorporates the needs and expectations of the main organization. The focus is on the first evolutionary step of the DIU after its initial establishment. Based on a multiple cross-case synthesis with five DIUs from the manufacturing industry, the following sub question is addressed:

- *Sub question 1: How do DIUs evolve over time to meet the needs and expectations of the main organization? (RQ1)*

Since evolution by nature occurs over time, the second sub question focuses specifically on the temporal dynamics in the early stages of a DIU's evolution process. This response to the call of several researchers in the field of IS and beyond to incorporate the dimension of time in research (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001; Conboy et al., 2020; Gerster et al., 2021) and to shift from an actor-centered orientation to a flow-centered approach and vocabulary in the study of socio-technical change in the digital world (Mousavi Baygi et al., 2021). The second sub question reads as follows:

- *Sub question 2: How and what temporal dynamics unfold during the evolution of a DIU? (RQ2)*

As collaboration, alignment, and interrelations with the main organization are essential for the success of a DIU (Haskamp et al., 2023; Holotiuk & Beimborn, 2019; Raabe et al., 2020a) – especially for DIUs that innovate close to the core business – it is also necessary to understand how these emerge along the evolution process of DIUs. So far, the literature considers DIUs generally from the perspective of their contribution to the main organization and with a focus on the influences of their social system on the social system of the main organization (e.g., new digital culture, digital and agile mindset, pooling digital expertise, iterative, customer-centric way of working (Göbeler et al., 2020; Jöhnk et al., 2020; Raabe et al., 2021)). To go beyond this one-dimensional perspective and study the entire variety of interactions between the DIU and the main organization, this thesis applies an STS perspective and seeks to answer the following third sub question:

- *Sub question 3: How do a DIU and its main organization interact at the socio-technical level as the DIU evolves? (RQ3)*

Building on RQ3, the final sub questions delve deeper into the social structures of DIUs and their relational dynamics with the main organization. Since interpersonal relationships and social interactions account for a high proportion of the challenges faced by DIUs (e.g., CDO-CIO conflicts, NIH syndrome, lack of top management support (Raabe et al., 2020a)), it is important to understand how they emerge and what dynamics result from the collaboration with the main organization. Based on an in-depth, longitudinal single-case study, the following fourth sub-question will be addressed:

- *Sub question 4: How do the relational dynamics between the DIU and the main organization unfold during the DIU's evolution? (RQ4)*

The overall intent of the research is explanatory. The first and third RQs are also explanatory. The second RQ is explanatory and predictive. The fourth RQ is descriptive.

In addition to the main RG, four sub-goals were formulated, classified, and a complementary research approach was pursued based on Gregor's (2006) taxonomy of IS theories (Table 1).

The first goal is to explain a DIU's evolution process and how it meets the needs and expectations of the main organization over time, including the evolution's triggers, drivers, processes, and outcomes. The chosen research approach was a multiple cross-case synthesis on the early stage evolution process of five DIUs in the manufacturing industry.

The second goal is to explain and develop testable propositions regarding the temporal dynamics in a DIU's evolution process and how they affect or are affected by DIU activities and outputs. A multiple cross-case synthesis was conducted on the early-stage evolution process of five DIUs in the manufacturing industry to meet this goal.

The third goal is to explain how a DIU and its main organization interact with each other along their socio-technical elements during DIU evolution. A multiple cross-case synthesis was conducted on the early-stage evolution process of seven DIUs in the manufacturing industry.

The fourth goal is to analyze the relational dynamics and the emergence of social structures in DIU evolution. The research approach of choice was a longitudinal, in-depth, single-case study of the early-stage evolution process of a DIU in the manufacturing industry.

Table 1: Research Goals and Research Approach.

Research Goals (RQ, Theory Type)	Research Approach
Explain a DIU evolution process to meet the needs and expectations of the main organization, including triggers, drivers, processes, and outcomes. (RQ1, Explanation)	Multiple cross-case synthesis of the early-stage evolution process of five DIUs in the manufacturing industry
Explain and develop testable propositions of temporal dynamics in DIU activities and outputs. (RQ2, Explanation and Prediction)	Multiple cross-case synthesis of the early-stage evolution process of five DIUs in the manufacturing industry
Explain how a DIU and its main organization interact with each other along their socio-technical elements. (RQ3, Explanation)	Multiple cross-case synthesis of the early-stage evolution process of seven DIUs in the manufacturing industry
Analyze the relational dynamics and the emergence of social structures in DIU evolution. (RQ4, Analysis)	Longitudinal, in-depth, single-case study of the early stage evolution process of a DIU in the manufacturing industry

1.3 Summary of Contributions

This dissertation offers several valuable contributions to IS research and managerial practice by addressing the RG and answering the four RQs presented above.

Overall, the dissertation (1) extends the dynamic understanding of DIUs by focusing on the early stages of DIU evolution in the manufacturing industry, (2) provides various insights into the evolution processes of a DIU, including its fundamentals, temporal dynamics, socio-technical interactions, and relational dynamics, (3) adds a two-dimensional socio-technical perspective to the often one-dimensional view of DIUs and their interactions with the main organization along the DIUs startup and growth phase. In addition, the following five contributions pertain to various aspects of the DIU evolution process that were considered.

Firstly, regarding the fundamentals of DIU evolution, the thesis recognizes and illustrates that DIUs undergo an evolution driven by the interplay between a life-cycle and a dialectical motor of organizational change. Here, ten triggers, in their various combinations, initiate a strategic realignment and reorganization of the DIU as its first substantial evolutionary step. This includes changes in the goals, mandate, governance, team, and processes of the DIU.

Secondly, the dissertation identifies and explains five temporal factors associated with DIU activities and outputs by focusing on the temporal dynamics of DIU evolution. These factors relate to temporal variables such as time allocation, temporal style, or cycle and rhythm. Furthermore, the thesis formulates five propositions regarding the temporal dynamics in DIU activities and outputs, that can be tested in future research. Overall, the thesis identifies DIUs as a fast-paced, short-term, short-cycle temporal zone with a culture of speed (Ancona, Okhuysen, et al., 2001) that improves the organization's ability to meet the temporal demands of digital transformation and extend the connotation of a DIU as an innovation "fast lane" (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b).

Thirdly, the thesis identifies and illustrates various socio-technical interactions between a DIU and the main organization during the first three years of a DIU's operation that lead to their gradual adaptation. Here, a two-phase model visualizes the adjustments in the social system, technical system, environmental system, and outputs throughout the DIU's start-up and growth phases. These findings provide a previously unexplored two-dimensional perspective in the research on DIUs and their interactions with the main organization.

Fourthly, by concentrating on the unfolding relational dynamics in the evolution of DIUs, the dissertation explores the emergence of social structures within DIUs and highlights key characteristics of the initiation, start-up, and growth phases. In so doing, eleven challenges that arose during DIU initiation and evolution are described. Building upwards, downwards, sidewards, and outwards relationships with stakeholders is identified as (part of) the solution to these challenges – here, especially the sidewards challenges are crucial for the DIU's legitimization. Furthermore, the dissertation identifies three mechanisms that unfold during DIU

evolution and collectively favor the emergence and expansion of the organization's adaptive capacity (AC)[1], in addition to increasing the DIU's acceptance in the organization. They overpower five confounding factors that counteract AC emergence and DIU acceptance. These findings include detailed insights into the collaboration between the DIU and the main organization and the way in which their respective interrelationships develop. In particular, the results deepen the knowledge of the DIU type *External Enhancer*[2] (see Chapter 2.2) and its internal ties to the main organization by presenting challenges and solutions, in addition to broadening the comprehension of deploying and using DIUs efficiently.

Fifthly, based on the findings of the DIU evolution process and additional literature from IS research, the thesis develops a phase model to illustrate the intensifying cooperation between the DIU and the main organization within the first three years of DIU operation. The DIU not only initiates change within (parts of) the main organization, it also adapts to the corporate environment to facilitate collaboration and equip incumbents for the digital age. The phase model extends the understanding of new forms of organizational design and their practices implemented for digital transformation and shows that DIUs – at least in their early stages – manifest the malleable organizational structures that is pivotal for digital transformation (Hanelt et al., 2020).

From a practitioner's perspective, the results of this dissertation confirm and underscore that DIUs are a meaningful initiative in the context of incumbents' digital transformation. However, it also becomes clear that building and developing a DIU is neither a foregone conclusion, nor a sure-fire success. So as to support the challenging journey of digital transformation, managers can use the findings to assist in the process of building a new DIU from scratch (greenfield approach) or to optimize an existing one (brownfield approach) (Hopkins & Jenkins, 2008). The dissertation's results create an awareness of the fundamentals and the magnitude of DIU evolution and its impact on established organizational structures. This knowledge empowers managers to make informed decisions and maximize the effectiveness of a DIU in their organizations.

1.4 Structure of the Dissertation

This monographic dissertation is based on five research papers that have been previously submitted and (partially) published at IS conferences, in IS journals, or in preparation for submission. Table 2 provides an overview of these core publications relevant to the dissertation, including their outlets, rankings, and current publication status. All five papers are first authored by the author of this

---

[1] AC is defined as a search process that enhances the "ability to survive in the face of its unalterable features [...][and] the capacity to cope with [...] uncertainty [...] and unpredictable variations" (Parsons, 1964, p. 340). More information in Chapter 4.4.2

[2] This is one of three DIU types defined by Barthel et al. (2020) which is primarily concerned with new products and business models and focuses on innovation in existing businesses and customer groups.

thesis and influence sections or subsections as a whole and/or are closely related to the RQs provided. References to relevant publications are listed at the beginning of each chapter. All substantial parts of the work, including conception, data collection, and analysis, were carried out and led by the author of this thesis. For completeness, Table 2 lists four additional publications on DIUs that were first or co-authored by the author.

Table 2: Publication Overview.

Core Publications for this Dissertation		
No.	**Peer-Reviewed Conference Proceedings**	**VHB Ranking[3]**
1	Lorson, A., Dremel, C., de Paula, D., and Uebernickel, F., 2022. "Beyond the Fast Lane Narrative – A Temporal Perspective on the Unfolding of Digital Innovation in Digital Innovation Units" *European Conference on Information Systems (ECIS).* Timișoara, Romania. Published.	B
2	Lorson, A., Dremel, C., and Uebernickel, F., 2022. "Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change" *International Conference on Information Systems (ICIS).* Copenhagen, Denmark. Published.	A
3	Lorson, A., Dremel, C., and Uebernickel, F., 2023. "Building Adaptive Capacity for Volatile Business Environments: A Longitudinal Study of the Establishment of a Digital Innovation Unit" *European Conference on Information Systems (ECIS).* Kristiansand, Norway. Published.	B
4	Lorson, A., Dremel, C., Haskamp, T., and Uebernickel, F., 2024 "Explaining Socio-technical Convergence: An Analysis of the Interactions between Digital Innovation Units and their Main Organization" *European Conference on Information Systems (ECIS).* Paphos, Cyprus. Submitted.	B
	Peer-Reviewed Journals	
5	Lorson, A., Mayer, S., Dremel, C., and Uebernickel, F. "From Cradle to Cash: The Successful Formation of a Digital Innovation Unit" *MIS Quarterly Executive (MISQE).* In preparation for submission.	B
Further Publications		
6*	Haskamp, T., Lorson, A., de Paula, D. and Uebernickel, F., 2021 "Bridging the Gap – An Analysis of Requirements for Performance Measurement Systems in Digital Innovation Units" *International Conference on Wirtschaftsinformatik (WI).* A Virtual Conference. Published.	C

---

[3] Verband der Hochschullehrerinnen und Hochschullehrer für Betriebswirtschaft e.V. (VHB) (2023), https://vhbonline.org/vhb4you/vhb-jourqual/vhb-jourqual-3/gesamtliste

7*	Haskamp, T., Mayer, S., Lorson, A., and Uebernickel, F., 2021 "Performance Measurement in Digital Innovation Units – An Information Assymetry Perspective" *European Conference on Information Systems (ECIS)*. A Virtual Conference. Published.	B
8*	Haskamp, T., Breitenstein, A., and Lorson, A., 2021 "A Management Control Systems Perspective on Digital Innovation Units" *Americas Conference on Information Systems (AMCIS)*. A Virtual Conference. Published.	D
9	Lorson, A., 2022 "Building Dynamic Capabilities through Digital Innovation Units? – An analysis of their contribution and the spill-over effects to the main organization" *Americas Conference on Information Systems (AMCIS)*. Minneapolis, Minnesota, USA. Published.	D

* The author of this dissertation was not the lead researcher.
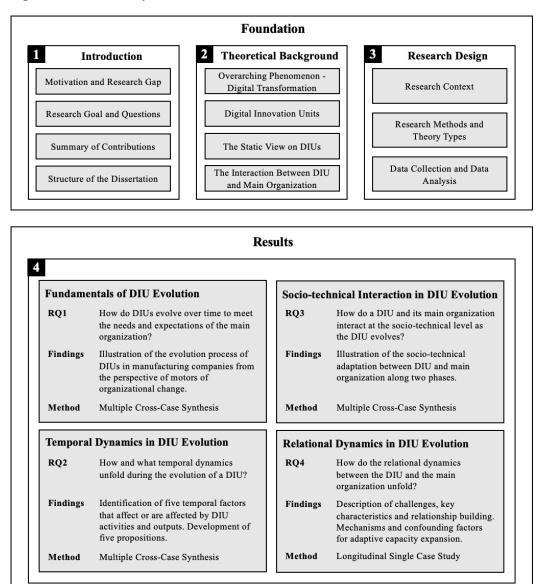
The dissertation consists of eight parts. Chapters 1, 2, and 3 form the foundation, with the first chapter, the Introduction, providing the motivation for this research and the research gap (Chapter 1.1), detailing the research goal and the three RQs (Chapter 1.2), summarizing the contributions (Chapter 1.3), and describing the structure of this thesis (Chapter 1.4). The second chapter, the Theoretical Background, defines the thesis's core concepts and theories. It includes sections on the overarching phenomenon of digital transformation (Chapter 2.1), on DIUs (Chapter 2.2), on the motivation for a dynamic perspective on DIUs (Chapter 2.3), and the interactions between a DIU and its main organization (Chapter 2.4). The third chapter, the Research Design, provides detailed information on the research context (Chapter 3.1), research methods and theory types (Chapter 3.2), and data collection and analysis for the multiple cross-case syntheses and the longitudinal single-case study (Chapter 3.3).
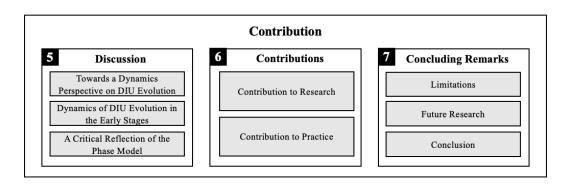
Chapter 4 forms the dissertation's core and describes the findings on the evolution process of a DIU and its contribution to the digital transformation of a non-digital, incumbent manufacturing company. Chapter 4.1 contains an empirical investigation of how DIUs evolve over time to meet the needs and expectations of the main organization. Chapter 4.2 takes a temporal perspective on the unfolding of a DIU's evolution process. Chapter 4.3 examines the interaction and socio-technical adaptation between the DIU and the main organization. Chapter 4.4 studies the relational dynamics between the DIU and the main organization, focusing specifically on social structures and their emergence.

Finally, Chapters 5, 6, and 7 elaborate on the dissertation's contribution. Chapter 5, the Discussion, relates and contrasts the findings of Chapter 4 to the existing DIU literature and, building on this, designs a phase model of the intensification of the cooperation between the DIU and the main organization (Chapter 5.1). It also critically reflects on this model and derives three propositions to inform future research (Chapter 5.2). Chapter 6 summarizes the contributions to research (Chapter 6.1) and practice (Chapter 6.2), while the seventh and final chapter

discusses the limitations (Chapter 7.1) and opportunities for future research (Chapter 7.2) and concludes the dissertation (Chapter 7.3). Figure 1 provides a graphical overview of the structure of this thesis.

Figure 1: Structure of the Dissertation.

Foundation

1 Introduction

- Motivation and Research Gap
- Research Goal and Questions
- Summary of Contributions
- Structure of the Dissertation

2 Theoretical Background

- Overarching Phenomenon - Digital Transformation
- Digital Innovation Units
- The Static View on DIUs
- The Interaction Between DIU and Main Organization

3 Research Design

- Research Context
- Research Methods and Theory Types
- Data Collection and Data Analysis

Results

4

Fundamentals of DIU Evolution

RQ1 — How do DIUs evolve over time to meet the needs and expectations of the main organization?

Findings — Illustration of the evolution process of DIUs in manufacturing companies from the perspective of motors of organizational change.

Method — Multiple Cross-Case Synthesis

Socio-technical Interaction in DIU Evolution

RQ3 — How do a DIU and its main organization interact at the socio-technical level as the DIU evolves?

Findings — Illustration of the socio-technical adaptation between DIU and main organization along two phases.

Method — Multiple Cross-Case Synthesis

Temporal Dynamics in DIU Evolution

RQ2 — How and what temporal dynamics unfold during the evolution of a DIU?

Findings — Identification of five temporal factors that affect or are affected by DIU activities and outputs. Development of five propositions.

Method — Multiple Cross-Case Synthesis

Relational Dynamics in DIU Evolution

RQ4 — How do the relational dynamics between the DIU and the main organization unfold?

Findings — Description of challenges, key characteristics and relationship building. Mechanisms and confounding factors for adaptive capacity expansion.

Method — Longitudinal Single Case Study

Contribution

5 Discussion

- Towards a Dynamics Perspective on DIU Evolution
- Dynamics of DIU Evolution in the Early Stages
- A Critical Reflection of the Phase Model

6 Contributions

- Contribution to Research
- Contribution to Practice

7 Concluding Remarks

- Limitations
- Future Research
- Conclusion

2 Theoretical Background

To respond to the new risks and opportunities posed by exponentially growing and disruptive digital technologies, incumbent companies are undertaking enterprise-wide digital transformation initiatives (Imran et al., 2021). Digital transformation leverages a mix of advanced digital technologies (technical system) and organizational practices (social system) to deliver key business improvements, including better products and services, competitive advantage, improved customer experience, innovative business models, and new business processes (Imran et al., 2021; Ivančić et al., 2019; Singh & Hess, 2020; Vial, 2019). It has not only affected the products and services offered by industrial organizations but has also changed the way they operate (Vial, 2019), necessitating considerable changes within the organization, including structures (Hess et al., 2016; Legner et al., 2017; Matt et al., 2015; Wessel et al., 2021), governance (Legner et al., 2017; Svahn et al., 2017), processes (Legner et al., 2017; Vial, 2019), methods (Legner et al., 2017), culture (Piccinini et al., 2015), and management roles (Singh & Hess, 2020). Digital transformation requires the implementation of malleable organizational designs (Hanelt et al., 2020) to address and implement these profound changes. This has led to several initiatives (e.g., Jöhnk et al., 2020, 2022; Soto Setzke et al., 2020), one of which is the increasingly widespread implementation of DIUs that create the conditions for and generate digital products, services, and business models and initiate, support, or even drive digital transformation (Fuchs et al., 2019; Haskamp et al., 2023; Jöhnk et al., 2020; Schumm & Hanelt, 2021).

This chapter addresses the theoretical underpinnings and relevant research related to DIU in the IS field to provide a theoretical framework for the findings. It begins with positioning within the overarching concept of digital transformation and its characterization before focusing on existing DIU research and the theoretical concepts used to expand the dynamic perspective of DIUs. It draws in part on previously published or submitted research (Lorson, Dremel, de Paula, et al., 2022; Lorson et al., 2024, 2023; Lorson, Dremel, & Uebernickel, 2022) but attempts to minimize redundancy by emphasizing general concepts and themes rather than study-specific findings.

2.1 Overarching Phenomenon – Digital Transformation

DIUs are mainly discussed in the context of, or relation to, two strands of IS literature: digital innovation (e.g., Barthel et al., 2020; Göbeler et al., 2020; Raabe et al., 2021, 2020b; Svahn et al., 2017) and digital transformation (e.g., Dremel et al., 2017; Fuchs et al., 2019; Holotiuk & Moormann, 2023; Jöhnk et al., 2020). Although the efficient use and incorporation of digital technologies are at the core of both phenomena, they are largely discussed and theorized separately – for digital innovation, see, e.g., Kohli & Melville (2019), Nambisan et. al. (2017), Fichman et. al. (2014); for digital transformation see, e.g., Vial (2019), Wessel et. al. (2021), Chanias et. al. (2019), Hanelt et al. (2020). While digital innovation refers to the use of digital technologies to create new products and services, implement new business processes, or operate new business models (Legner et al., 2017; Nambisan et al., 2017), digital transformation constitutes an overarching phenomenon that encompasses significant changes in both society and industry due to the adoption of digital technologies (Agarwal et al., 2010; Majchrzak et al., 2016). As this dissertation seeks to gain a deeper understanding of the early stages of a DIU's evolution and its contribution to a manufacturing company's digital transformation, it more strongly relates to the concept of digital transformation as its overarching phenomenon.

Digital transformation, one of the leading technology-related phenomena of our time, is widely discussed in academic literature and practitioner conversations (Hanelt et al., 2020; Vial, 2019; Wessel et al., 2021). More than 80% of companies (across industries) self-report that they have taken the plunge and started their digital transformation journey (Martin, 2018). Driven by the desire of incumbent companies to become digital, digital transformation aims to create value in the form of digital products, services, processes, and business models, as well as to digitize internal processes to remain successful in today's rapidly changing business environment (Hess et al., 2016; Imran et al., 2021; Ivančić et al., 2019; Singh & Hess, 2017). It is a complex topic that affects many or all company areas (Hess et al. 2016) and changes how a company creates and captures value through digital technologies (Wessel et al., 2021). As a result, a company's value proposition and business model are (re)defined, leading to changes in products or organizational structures (Hanelt et al., 2020; Hess et al., 2016) and a new organizational identity (Wessel et al., 2021). Undertaking digital transformation is not trivial, as it often requires overcoming considerable organizational inertia (Haskamp, Dremel, et al., 2021), resulting in organizational tensions that must be resolved (Svahn et al., 2017).

To properly understand the phenomenon of digital transformation, it is important to clarify the distinction between the often confused terms digitization, digitalization, and digital transformation (Legner et al., 2017; Verhoef et al., 2021). "Digitization is the technical process of converting analog signals into digital form, and ultimately into binary digits" (Legner et al., 2017, p. 301) and has been the core idea of computer scientists since the early days of computers (Legner et al.,

2017; Tilson et al., 2010). Digitalization is a multifaceted socio-technical phenomenon and a process of applying digitizing technologies to broader individual, social, and institutional contexts (Legner et al., 2017; Tilson et al., 2010). Both together are considered prerequisites for digital transformation (Loebbecke & Picot, 2015; Matt et al., 2015; Verhoef et al., 2021), which is a change in how an organization uses digital technologies to develop new digital business models that help create and capture additional value for the organization (Verhoef et al., 2021).

Digital transformation also differs from IT-enabled organizational transformation in that it uses digital technology to (re)define an organization's value proposition, in contrast to merely supporting the existing value proposition. It involves the emergence of a new organizational identity, not the enhancement of an existing one (Wessel et al., 2021)[4]. To render this comprehensive phenomenon and its implications more tangible, Vial (2019) developed a conceptual definition of digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (p.121).

Digital transformation drives organizations into continuous change and reconfiguration to successfully develop and deliver digital products, services, and business models and adapt to digital demands (Hanelt et al., 2020). In particular, incumbent organizations belonging to traditional industries such as retail, manufacturing, automotive, and financial services, which were financially successful in the pre-digital economy (Chanias et al., 2019), are challenged by this. Because value creation in the digital realm has changed considerably compared to the non-digital era (Yoo et al., 2010), digital transformation requires "a new organizational form that differs dramatically from traditional industrial production" (Berente, 2020, p. 92).

Few conceptual and empirical studies have examined how industrial organizations are digitally transformed (Warner & Wäger, 2019). Therefore, the current body of knowledge emphasizes the need to understand new forms of organizational design and their practices (Hanelt et al., 2020; Yoo et al., 2012; Zammuto et al., 2007) and proposes malleable organizational structures as an answer to the challenges of digital transformation (Hanelt et al., 2020). One initiative to initiate and drive this transformation in incumbent organizations is the formation of DIUs (Jöhnk et al., 2020; Matt et al., 2015; Wiesböck & Hess, 2019).

2.2 Digital Innovation Units

As digital transformation is a challenging endeavor for incumbents, they are increasingly deploying dedicated units to support this process, as well as to enhance their digital activities (Fuchs et al., 2019; Holotiuk & Beimborn, 2019; Raabe et

---

[4] Further details in Vial (2019) and Wessel et al. (2021).

al., 2021). Innovation units/labs are not a new phenomenon (Turrin, 2019), as innovation has always been critical to business success (Chiesa, 2000); however, what is unique about the last 25 years of digital advancement is the speed at which innovation is reshaping the world, and these units/labs provide a space for innovation within an organization, increasing the likelihood of survival in the digital era (Turrin, 2019). In practice, there are various names, such as Digital Innovation Hub, Digital Innovation Lab, Digital Unit, Digital Lab, Digital Transformation Initiative, or Digital X Lab. In academia, where there was also a lack of uniform terminology at the beginning, two terms are now increasingly used and seem to have gained acceptance: Digital Innovation Lab (e.g., Göbeler et al., 2020; Holotiuk & Beimborn, 2019; Hund et al., 2019) and Digital Innovation Unit (e.g., Haskamp et al., 2023; Hellmich et al., 2021; Raabe et al., 2021).

This dissertation uses the term Digital Innovation Units and defines them as "dedicated organizational units that support and partly drive digital transformation in incumbent firms by leveraging new structures and practices that differ from those existing in the organization, aiming to promote various aspects of digital innovation" (Haskamp et al., 2023, p. 6). The author understands DIUs as part of the "structural changes" building block of the digital transformation process, which refers to changes in a company's value creation paths enabled by digital technologies (Vial, 2019). This classification is in line with the designations of other researchers who, for example, refer to DIUs as a digital transformation initiative (Jöhnk et al., 2020) or as part of a company's digital transformation strategy (Wiesböck & Hess, 2019). As such, DIUs are viewed – like digital transformation itself – as a socio-technical phenomenon (Imran et al., 2021) that leverages advanced digital technologies (technical systems) and organizational practices (social systems) to develop digital products, services, and business models.

DIUs are departments or separate legal entities that support or even drive digital transformation and consolidate a company's exploration efforts, promoting the journey to become ambidextrous (Fuchs et al., 2019; Holotiuk & Beimborn, 2019; Jöhnk et al., 2020). As a DIU and its main organization differ considerably in terms of skills, hierarchies, and cultural aspects (social system) and concerning practices, processes, tasks, and technologies (technical system), this thesis understands DIUs as their own STS (see Chapter 1.2) built within the existing STS of an incumbent. With their reduced socio-technical complexity, they take advantage of dedicated, smaller structures and faster adaptation within the rest of the organization and can scale the development of digital products and services (Fuchs et al., 2019; Holotiuk & Beimborn, 2019). This makes them highly valuable for companies belonging to traditional industries such as retail, manufacturing, automotive, or financial services (Arvidsson & Mønsted, 2018; Chanias et al., 2019; Yoo et al., 2010) that were not "born digital" (Sebastian et al., 2017, p. 198) such as Amazon, Facebook, Google or Tencent (Chanias et al., 2019; Sebastian et al., 2017).

DIUs are often distinct from the main organization concerning location, mindset, collaboration, and communication. Yet, they maintain connections through knowledge sharing, exchange mechanisms, and personnel transition between the

DIU and departments of the main organization (Holotiuk & Beimborn, 2019). DIUs foster a culture of innovation (Fuchs et al., 2019), create and develop idiosyncratic digital capabilities (Svahn et al., 2017), and carry out digital research and development (Dremel et al., 2017; Svahn et al., 2017) in incumbent firms. They also have reliable financial resources, well-structured organizational integration, high degrees of freedom, and collaborate on projects with one or more units within the main organization (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020b). In addition, DIUs build and leverage digital customer-centric expertise and agile methods and build and maintain innovation ecosystems (Raabe et al., 2021). Establishing a DIU can be understood as an incumbent's effort to change its organizational structure, routines, and culture to become more adaptable to digital environments (Göbeler et al., 2020; Schumm & Hanelt, 2021). The main motivations for this, i.e., the contribution of a DIU to digital transformation, can be summarized as follows: (1) breaking down silos and intensifying cross-departmental collaboration and the pooling of competencies, (2) building new digital capabilities and promoting a new digital culture, (3) developing digital innovations that are fundamentally different from the type and logic of innovation that traditionally prevails in the company, (4) anchoring the digital business, and (5) anchoring the digital transformation strategy (Haskamp et al., 2023).

To better understand and differentiate between DIUs, two main typologies have emerged in recent years (Barthel et al., 2020; Raabe et al., 2020b). Based on a previously published DIU taxonomy (Fuchs et al., 2019), Barthel et al. (2020) differentiate along the dimensions "Objective & Scope" and "Setting & Design" into the DIU types *Internal Facilitator*, *External Enhancer,* and *External Creator*. Raabe et al. (2020b) distinguishes between *Coaching and Screening* and *Center of Excellence* DIUs[5] based on their different focus, modus operandi, and the stage of innovation they address. This dissertation follows the more comprehensive typology of Barthel et al. (2020), which includes both goals and design elements. The *Internal Facilitator* focuses primarily on innovations related to internal organizational aspects, such as business process improvements, and a focus on existing business lines or established business processes. It is usually embedded in the organizational structure as an executive department with little or no external connections (Barthel et al., 2020). The *External Enhancer* primarily concerns new products and business models and focuses on innovation in existing businesses and customer groups. They also transform the current organization, emphasizing market offerings rather than internal processes. Their embedding is mostly as departments in line organizations, sometimes as executive departments, with both internal and external links and collaboration (Barthel et al., 2020). The *External Creator* deals with new products, services, and business models, focuses on innovation in new business areas and customer groups, and covers the entire innovation process up to commercialization. They are usually set up as a separate legal entity (but also as an executive department) and regularly cooperate with external partners. Theoretically, the distance from the core organization is greatest

---

[5] "[Coaching and Screening] unit[s] solely concentrate[...] on the first stage of innovation discovery, while a [Center of Excellence] unit[s] also include[...] development, diffusion in the main organization and impact measuring." (Raabe et al., 2020b, p. 6).

for this type, but the ties to the core organization are still highly relevant (Barthel et al., 2020).

Although different types of DIUs have various characteristics, they all have in common that they intend to incorporate digital technologies (Fuchs et al., 2019), which is a key differentiator between this phenomenon and those studied in other literature streams, such as business incubators (Gassmann and Becker 2006). Because DIUs have strong ties to the main organization, are internally focused on changing existing processes and building digital products for the main organization (*Internal Facilitator* and *External Enhancer*) – such as automotive clouds and infotainment apps (Svahn et al., 2017) – or building products and services that fit into the company's overall ecosystem (*External Creator*), they are also not company builders or accelerators (Raabe et al., 2020b). A company builder is a corporate unit that develops digital business models with internal and external resources from the idea to a startup successfully established in the market (Sindemann & von Buttlar, 2018). They are expected to generate the highest level of innovation, while their contribution to the digital transformation of the main organization is rather secondary (Sindemann & von Buttlar, 2018). Incubators and accelerators are programs that identify, select, and support external startups in developing and scaling novel business ideas (Sindemann & von Buttlar, 2018). However, they differ in their focus and program duration. Incubators provide support over six to 24 months, focusing on developing a business idea, while accelerators aim to accelerate the growth of an existing business model in a three- to six-month program (Velten et al., 2016). Overall, DIUs can coexist with company builders, incubators, and accelerators and with other DIUs, additional digital divisions, or other bimodal IT setups (Raabe et al., 2020b).

DIUs are an increasingly common initiative in the digital transformation of incumbent companies across many different industries and sectors. Since the DIU hype cycle began in the German-speaking region in 2015/2016, new DIUs have been founded yearly (Sindemann et al., 2021). This dissertation focuses on manufacturing companies as representatives of an incumbent industry. The manufacturing industry – machine and plant engineering – was identified as particularly relevant for DIU research because, historically, it has been less responsive to the impact of digital transformation but is now increasingly building such units (Fuchs et al., 2019; Hanelt et al., 2015). These companies have a strong hardware legacy, where development processes and organizational structures are typically adapted and reflected in the physical product (Andreasson et al., 2010). Digital transformation challenges them to combine and work in two different innovation paradigms – classical mechanical engineering and the development of digital products and services (Hylving & Selander, 2012). Thus, they are constantly torn between maintaining their traditional business of designing, producing, and servicing large physical machines and plants and meeting the demands of the digital age in parallel (e.g., software, data analytics, and digital services) (Bilgeri et al., 2017; Hylving & Selander, 2012; Sebastian et al., 2017). Product development and production in manufacturing companies are characterized by robust time frames of up to ten years (Dremel & Herterich, 2016), but they now

need to adapt to the agile and rapid development of digital products, where time and speed play a critical role (Gerster et al., 2020). In addition, they often have multiple "business units, a diversified business model portfolio, and complex IT landscapes including traditional, embedded, and digital IT types" (Bilgeri et al., 2017, p. 1), creating unique organizational challenges. From a DIU perspective, studies have shown that the path from idea to successful innovation is more difficult in industrial companies than in service companies (Sindemann et al., 2021).

In the following, the terms incumbent company and manufacturing company are used interchangeably and always refer to machine and plant engineers. If there is a deviation, it will be specifically mentioned.

2.3 The Static View on DIUs

Research on DIUs has been steadily growing in the field of IS since 2014, as evidenced by a recent publication by Haskamp et al. (2023). In particular, between 2019 and 2021, there was a large increase in DIU or DIU-related publications, with six, eleven, and 16 publications, respectively (Haskamp et al., 2023). In the meantime, DIUs have been studied from different perspectives and theoretical angles, primarily regarding their current status quo. Table 3 shows an excerpt of publications since 2019, with DIUs as the primary focus along the two dimensions "static view" and "dynamic view." Static view means that the study considers a DIU from a specific theoretical angle with regard to its status quo without considering change processes. Dynamic view means that the study focuses on the development and change (processes) of a DIU or initiated by a DIU.

Table 3: Research with Static and Dynamic View on DIUs.

Static view Focus on the DIU status quo from a specific theoretical perspective	**Dynamic View** Focus on DIU development and change processes
• Characterization of DIUs through the development of a taxonomy (Fuchs et al., 2019) • Development of a typology for DIUs from a loose-tight-coupling perspective (Barthel et al., 2020) • Introduction of achieving (temporal) ambidexterity by establishing a DIU. (Göbeler et al., 2020; Holotiuk, 2020; Holotiuk & Beimborn, 2019) • Understanding DIUs from the participant's perspective (Fecher et al., 2020). • Exploration of barriers and enablers of performance measurement systems in mitigating or exacerbating information asymmetry between the	• DIU evolution strategies in a bimodal IT setup (only one part of the study's focus and results) (Raabe et al., 2020b) • Investigation of the path of positioning and implementing a DIU. (Raabe, 2021) • Analysis of DIU survival and growth mechanisms. (Schumm, 2023)

DIU and the main organization. (Haskamp, Mayer, et al., 2021) • Identifying DIU challenges/key barriers and actions to address and overcome them. (Raabe et al., 2020a; Sund et al., 2021) • Identification of seven areas of DIU activity and development of a dual approach of DIUs. (Raabe et al., 2021) • Understanding of digital innovation types and digital trends currently addressed by DIUs and their relation to different DIU setups. (Holsten et al., 2021) • Structured literature review to explore the link between "foundational" and "extensional" dynamic capabilities and DIU. (Hellmich et al., 2021) • Investigation of management control systems in DIUs (Haskamp, Breitenstein, et al., 2021) • Conceptualization of six types of knowledge and how individuals engaged in IT exploration and exploitation through transfer between a DIU and the main organization. (Iho & Missonier, 2021)	

Although Table 3 does not represent an exhaustive compilation of all DIU publications to date, it does allow for an understanding of the current distribution between a static and dynamic view of DIUs in the literature and shows a clear focus on the former. Overall, IS literature currently paints a rather static picture of DIUs, which was also concluded by Haskamp et al (2023) in a recent literature review. However, this means there is insufficient knowledge about whether and how DIUs change and evolve and whether they manifest the malleable structure required for digital transformation (Hanelt et al., 2020). This knowledge is ultimately necessary to determine whether DIUs are a viable long-term initiative for digital transformation. In addition, the favorable effects of DIU outcomes seem to amplify as they become more established, thereby accelerating their effectiveness and gaining internal buy-in (e.g., Chanias et al., 2019; Dremel et al., 2017; Svahn et al., 2017). To use DIUs as efficiently as possible in the future, there is a need to understand better how they become established within the main organization.

The few studies to date that have taken a dynamic, process-oriented view of DIUs show initial indications that a DIU and its main organization are in a state of constant flux (Raabe, 2021) and co-evolve "through continuous and reciprocal alignment" (Schumm, 2023, p. 163), with co-evolution occurring in response to external pressures and internal circumstances (Schumm, 2023). Schumm and Hanelt's (2021) findings also suggest that DIUs can be seen as a step in the overall

shift towards malleable organizational designs that allow for continuous adaptation (Hanelt et al., 2020) by offering a perspective on how to create hybrid organizational structures that are well suited for the digital age.

To expand the dynamic understanding of DIUs, the literature calls for studies of their implementation, evolution, and potential reintegration processes, including in-depth longitudinal case studies (Barthel et al., 2020; Haskamp et al., 2023; Raabe et al., 2020b). As the formation of a DIU can be viewed as an incumbent's effort to change its organizational structure, routines, and culture to become more adaptable to digital environments (Göbeler et al., 2020; Schumm & Hanelt, 2021), a better understanding of how these processes take place and how a DIU evolves to meet the needs and expectations of the main organization is needed. Furthermore, researchers in the field of IS and beyond are generally advocating for greater incorporation of the dimension of time in research (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001; Conboy et al., 2020; Gerster et al., 2021) and a shift from an actor-centered orientation to a flow-centered approach and vocabulary in the study of socio-technical change in the digital world (Mousavi Baygi et al., 2021). Especially in the age of ubiquitous digital technologies that are changing almost every aspect of our society today, making our lives and work more fluid and dynamic, it makes sense to take a temporal perspective to better understand relationships (Mousavi Baygi et al., 2021).

Following these calls and to answer RQ1 and RQ2, this dissertation examines the fundamentals of the evolution processes of a DIU in detail and analyzes the role of temporal factors on DIU activities and outputs in the course of it.

To address the DIU evolution process, the thesis adopts Van de Ven and Poole's (1995) organizational change perspective, which has already been related to digital transformation in previous research (Hanelt et al., 2020). It defines four ideal types of theories of organizational change and development: (1) evolutionary, (2) teleological, (3) life cycle, and (4) dialectic theory. These differ in terms of their cycles and "motors" (or generating mechanism) of change, their unit of analysis – single entity or multiple entities – and their mode of change – prescribed or constructive[6] (Van De Ven & Poole, 1995). Figure 2 overviews the four organizational change and development process theories.

---

[6] A prescriptive mode of change channels the development of entities in a predetermined direction, typically the maintenance and incremental adaptation of their forms in a stable, predictable manner. A constructive mode of change generates novel and unprecedented forms, which, in hindsight, frequently represent discontinuous and unpredictable departures from the past (Van De Ven & Poole, 1995).
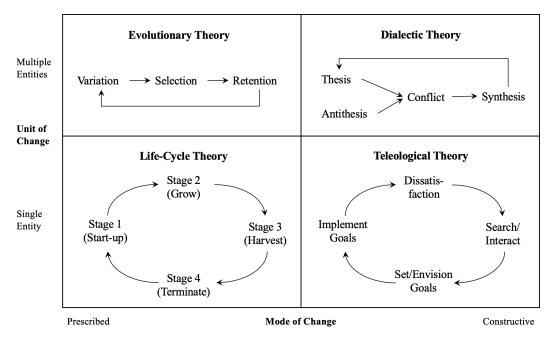
Figure 2: Process Theories of Organizational Change and Development.
Own Representation Based on Van de Van and Poole (1995).

The evolutionary model "consists of a repetitive sequence of variation, selection, and retention events among [multiple] entities in a designated population" (Van De Ven & Poole, 1995, p. 521). Their competition for scarce environmental resources triggers the evolutionary cycle. It represents a prescribed motor of change.

The dialectic model of change also operates on multiple entities and describes change processes as conflicts between two or more entities representing opposing theses and antitheses. As they clash, they generate a synthesis that, over time, becomes the new thesis for the subsequent cycle of dialectical progression. It represents a constructive motor of change.

In a life cycle model, the change process of a single entity is depicted and progresses through a necessary sequence of phases. An institutional, natural, or logical program prescribes the specific content of these phases. The entity can be influenced by its environment and other entities as to how its immanence manifests itself, but the actual impetus for development always comes from within.

The teleological model perceives development as a cyclical process involving goal formulation, implementation, evaluation, and goal modification based on the entity's learning. "This sequence emerges through the purposeful social construction among individuals within the entity" (Van De Ven & Poole, 1995, p. 520).

Knowledge of these four ideal-type motors of change is used to analyze whether the evolution of a DIU can be explained by one or more of them, leading to a better understanding of these units, their development cycles, the triggers, and the outcomes of development. As Chapter 1.2 of the Introduction mentions, a special emphasis is placed on the early stages of DIU evolution, referring to approximately the first three years of their operation, including their first evolution step. This

period was chosen because the DIU is being implemented as a new structure in the main organization, and the most significant changes, adjustments, or rejections are expected to occur. The notion is supported by a study conducted by Sindemann et al. (2021) in German-speaking countries, which shows that closed DIUs typically had an average age of four years at the closure time. Thus, these first years appear to be a crucial stage in the life cycle of a DIU, encompassing a make-or-break point. In addition to improving the understanding of DIUs and their role in the digital transformation of manufacturing companies, this approach offers an opportunity to advance current knowledge on organizational change through digital transformation in general.

To further expand the dynamic understanding of DIUs and to answer RQ2 on the temporal dynamics in DIU evolution, this thesis adopts the temporal framework by Ancona, Okhuysen et al. (2001). So far, DIU research already has an implicit focus on time in the sense of speed, as studies refer to them as "fast lanes" of innovation (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b). This builds on the organizational concept of bimodal IT to transform organizations (primarily IT functions) into an ambidextrous setup with two distinct modes: *Fast IT* and *Slow IT* (Haffke et al., 2017; Horlach et al., 2016/3). *Slow-IT* focuses on the exploitation of what is known (Haffke et al., 2017; Horlach et al., 2016/3) – covered by the existing IT department (Raabe et al., 2020b). *Fast-IT* is optimized for uncertainty using exploration and experimentation to solve new problems (Haffke et al., 2017; Horlach et al., 2016/3) – covered, for example, by a DIU (Raabe et al., 2020b).

However, time has substantially more dimensions and categories to consider than just speed (e.g., Ancona, Okhuysen, et al., 2001; Conboy et al., 2020; Gerster et al., 2021; Mousavi Baygi et al., 2021). Ancona, Okhuysen, et al.'s (2001) temporal framework, for example, encompasses several categories of time, including *conceptions of time, mapping activities to time, actors relating to time*, and *category-spanning variables*. It is a valuable resource for researchers aiming to incorporate a temporal perspective into their study of organizational behavior, facilitating a better understanding and explanation of such phenomena (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001). While tempo or speed is one of the variables considered within this framework, it is not the sole focus. The lens also encompasses other essential aspects such as "timing, cycles, rhythms, flow, temporal orientation, and the cultural meanings of time" (Ancona, Okhuysen, et al., 2001, p. 646). In this way, the framework provides a comprehensive approach to examining time-related dynamics and their impact on organizational behavior.

By using this approach and its additional (temporal) dimensions, it is possible to better understand DIUs, how they work, and their ability to create digital products, services, and business models. The particular focus of this dissertation is on two temporal categories: *mapping activities to time* and *actors relating to time,* as shown in Figure 3. The former, as explained by Ancona, Okhuysen et al. (2001), "directly links organizational work, through activities, to the temporal continuum" (p. 524). This focus allows for a closer examination of the progression of DIU activities and outputs. The latter, which includes the subcategories *temporal perception* and *temporal personality*, provides an opportunity to integrate the

DIU's and/or DIU employees' relationship with time and potentially identify a distinct temporal style of DIUs in the manufacturing industry.

Figure 3: Temporal Framework.
From Lorson, Dremel, de Paula, et al. (2022, p. 4) Based on Ancona, Okhuysen, et al. (2001).

Category	Subcategory	Sample Variables
Mapping activities to time	• Single activity mapping	• Scheduling, rate of completion, duration
	• Repeated activity mapping	• Cycle, rhythm, frequency, interval
	• Single activity transformation mapping	• Life cycles, midpoint transitions, jolts, interrupts, deadline behavior
	• Multiple activity mapping	• Relocation of activities, allocation of time, ordering, synchronizations
Actors relating to time	• Temporal perception	• Experience of time, time passing, time dragging, experience of duration, experience of novelty
	• Temporal personality	• Temporal orientation, temporal style

In addition to the temporal categories, Ancona, Okhuysen, et al. (2001) also propose the concept of structuring an organization based on three distinct "temporal zones" (p. 525). Each zone encompasses activities with common temporal characteristics, such as speed/tempo, cycle duration, and time horizon. In light of this framework and considering that DIUs were previously introduced as *Fast-IT* within a bimodal IT setup (Raabe et al., 2020b), they can be perceived as belonging to the fast-paced, short-term, and short-cycle temporal zone with a culture of speed. Employees in this zone are expected to have a heightened sense of time urgency, a present orientation, and a short-term time horizon. Accordingly, the main organization accommodates the second and third time zones, which operate in medium- and long-term time frames and take a future-oriented view (Ancona, Okhuysen, et al., 2001). This approach allows us to move beyond the exclusive emphasis on IT – characterized as "fast" and "slow" or "traditional" and "agile" in a bimodal setup – and strive for a more holistic approach to organizational design. In addition, the resulting implications for the DIUs and their role in creating digital products, services, and business models can be explored.

2.4 The Interaction between DIU and Main Organization

Not only is the image and understanding of a DIU itself static, but also the knowledge about its interaction with the main organization. Throughout their implementation and evolution, DIUs are expected to, among other things, increase cross-departmental cooperation and anchor an organization's digital transformation strategy (Haskamp et al., 2023). As emphasized in the literature, this requires collaboration, goal alignment (Raabe et al., 2020a), and exchange practices such as the (temporary) transfer of employees between the DIU and the main organization (Holotiuk & Beimborn, 2019). In particular, DIUs that are supposed to innovate close to the core business also rely on various interrelationships with the main organization to access domain expertise and

initiate digital transformation (Göbeler et al., 2020). However, close interaction and coordination are complex to achieve in practice, as evidenced by research on DIUs that have dissolved (Fecher et al., 2020; Sindemann et al., 2021) or are facing various challenges (Raabe et al., 2020a). So far, the details of the interaction between DIU and the main organization and how it evolves to make the cooperation as effective as possible are missing. For example, without further details, Barthel et al.'s (2020) typology only differentiates the DIU's internal ties into *core organization integrated*, *regular liaison*, and *sporadic liaison*. Schumm (2023), therefore, calls for further empirical research to fill the knowledge gap on how they collaborate and develop their interrelationship.

What also plays a role in this context is the fact that DIUs are confronted with the environment and organizational characteristics of incumbent, industrial-age firms (Sandberg et al., 2014) – established IT infrastructure (e.g., Tumbas et al., 2017), traditional, non-digital work culture (e.g., Lucas & Goh, 2009), bureaucratic organizational structures and processes (e.g., Lyytinen et al., 2016) – and are simultaneously responsible for stimulating and triggering change and adaptation in these dimensions (Raabe et al., 2020b). They walk a fine line between being intentionally focused on digital products and services and being sensitive to the demands of a non-digital environment (e.g., Hylving & Schultze, 2020; Svahn et al., 2017). For the automotive industry, for example, Svahn et al. (2017) find that to deliver novel capabilities and digital outcomes to their main organizations, DIUs must ensure a minimum level of applicability and integration with the main organization (Svahn et al., 2017) to ensure survival and growth (Chanias et al., 2019; Raabe et al., 2021; Schumm, 2023). However, the question of how to strike the right balance between integration and degrees of freedom in the interaction between the DIU and the main organization remains unanswered.

Overall, the interaction is mostly studied in a one-dimensional way: Either from the DIU's perspective that the main organization is struggling with digital technologies and how to incorporate them (e.g., Svahn et al., 2017) or from the main organization's perspective that the DIU is not delivering the expected value (e.g., Mayer et al., 2021; Raabe et al., 2020a). Since collaboration, alignment, and interrelationships are essential to the DIU's success (Haskamp et al., 2023; Holotiuk & Beimborn, 2019; Raabe et al., 2020a), it is necessary to move beyond the one-dimensionality and link these two perspectives.

To create a two-dimensional perspective and answer RQ3 and RQ4, this dissertation intends to unpack the elements, characteristics, and relational dynamics of the interaction between the DIU and the main organization and how it develops during the first three years of DIU operation. The focus is on the two entities' social and technical systems and their interaction.

As mentioned above, this thesis understands DIUs as STSs with distinct structures, processes, actors, cultures, values, tools, etc. This perspective allows one to adopt a systemic perception and analyze the DIU's social and technical systems and its internal and external influences. As a result, the interaction between the DIU and

the main organization can be studied along its socio-technical elements, and insights into the optimization and effective use of the DIU can be gained.

The underlying socio-technical paradigm is crucial as one of the foundational paradigms in the IS research field (Sarker et al., 2019). It "assumes that an organization or organizational work system, such as a department, can be described as a socio-technical system" (Bostrom & Heinen, 1977, p. 17), which consists of two interrelated systems that are interdependent yet distinct: the technical system and the social system (Bostrom & Heinen, 1977). The social system encompasses the attributes of individuals, including attitudes, skills, knowledge, values, and interpersonal relationships. It also includes reward systems and authority structures (Bostrom & Heinen, 1977). The technical system comprises the processes, tasks, tools, and technologies necessary for converting inputs into outputs (Bostrom & Heinen, 1977). "It is assumed that the outputs of the work system are the result of joint interactions between these two systems" (Bostrom & Heinen, 1977, p. 17). Over time, the environment (customers, suppliers, society in general, etc.) of an STS, which is referred to as the environmental system, has also been increasingly included in the consideration (Appelbaum, 1997).

STSs are inherently dynamic, evolving through a recursive design of social constructs and technical infrastructure (Orlikowski, 2000; Orlikowski & Scott, 2008). During digital transformation and integration of digital technologies, an organization undergoes socio-technical changes that require continuous reconfiguration (Vial, 2019; Wessel et al., 2021) to effectively create and deliver digital products, services, and business models.

In the current literature, DIUs can only be implicitly linked to an STS perspective, as various findings on DIUs can be understood as contributing to socio-technical change. Through a comprehensive review of the DIU literature, the author maps existing knowledge on DIUs along the four socio-technical elements: social system, technical system, environmental system, and outputs. Table 4 provides an overview.

Table 4: Excerpt of DIU Literature along Four Socio-technical Elements.
From Lorson et al. (2024, p. 3).

Socio-technical Element	References in Literature
Social System	• DIUs inspire a new organizational culture in the main organization (embrace learning from failure, motivate employee innovation, foster a digital and agile mindset, and improve employee communication) (Göbeler et al., 2020; Jöhnk et al., 2020; Raabe et al., 2021) – *Influence of the DIU on main organization.* • DIUs pool digital expertise (Raabe et al., 2021) – *Influence of the DIU on the main organization.* • DIUs build dynamic capabilities within the organization (Lorson, 2022) – *Influence of the DIU on the main organization.* • DIUs enable ambidextrous settings within and across organizations (Göbeler et al., 2020; Holotiuk & Beimborn, 2019;

	Raabe et al., 2021) – *Influence of the DIU on the main organization.*
	• DIUs break up silos and enable cross-departmental cooperation and a combination of competencies (Haskamp et al., 2023) – *Influence of the DIU on the main organization.*
	• Employees move back and forth between the DIU and the main organization to promote the exchange of knowledge and insights and achieve (temporal) ambidexterity (Holotiuk & Beimborn, 2019) – *Mutual influence between the DIU and the main organization.*
	• Main organization rejects innovations developed in the DIU, including managerial (in)action, lack of appreciation, lobbying, rejection, delay, etc. (NIH syndrome) (Raabe et al., 2020a) – *Attitude of the main organization towards the DIU.*
Technical System	• DIUs introduce new processes: Workshops and mentoring sessions for the main organization in agile methodologies (Design Thinking, Lean Startup, Personas, Customer Journey, or Scrum) (Raabe et al., 2020b) – *Influence of the DIU on the main organization.*
	• DIUs discover, select, develop, and diffuse digital technologies (Barthel et al., 2020; Holotiuk & Beimborn, 2019; Raabe et al., 2021) – *Influence of the DIU on the main organization.*
	• DIUs provide digital tools and IT infrastructure (Raabe et al., 2021) – *Influence of the DIU on the main organization.*
Environmental System	• DIU participates and cooperates in innovation ecosystems (Raabe et al., 2021) – *Influence of the DIU on the main organization.*
Outputs	• DIU develops business process innovations, new digital products, services, and business models (Barthel et al., 2020) – *Influence of the DIU on the main organization.*

Looking at Table 4, two aspects stand out: 1) the majority of findings on DIUs concern their social system, 2) DIUs are often viewed from the perspective of their contribution to the main organization, i.e., there is predominantly an influence from the DIU in the direction of the main organization. The social system shows two exceptions, one being a mutual influence between the two STS (employees moving back and forth between the DIU and the main organization to promote knowledge exchange), the other being a negative attitude of the main organization towards the DIU (NIH syndrome).
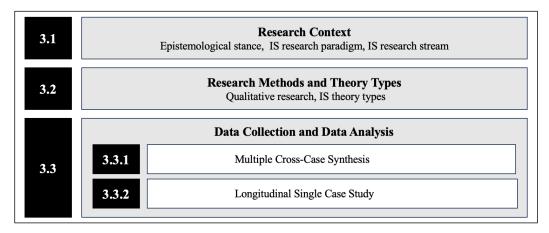
The dissertation aims to obtain a two-dimensional view of the interaction between the DIU and the main organization and its implications along the four socio-technical elements. The focus is on the first three years of the DIU's operation. In addition to enriching DIU research, this broadens the scope of the STS literature, which has historically emphasized optimal design (Cherns, 1976; Mumford, 1995) with limited exploration of the interactions among STS during digital transformation. Thus, the DIU offers a unique opportunity to explore this process and its transformative consequences.

3 Research Design

This chapter lays the methodological foundation for the dissertation by describing the chosen research design, including its aim, method, boundary, setting, timing, outcome, and ambition (Recker, 2021). To answer the main RQ and the four sub questions (RQ1-RQ4), this thesis follows a qualitative research approach in the form of seven case studies with DIUs from the manufacturing industry – i.e., in the field – as a representative of an incumbent industry. Both cross-sectional and longitudinal case studies were conducted to explain the evolution process of a DIU and its contribution to the digital transformation of a manufacturing company. The results lie on the spectrum between descriptive and causal, as they describe these processes and characteristics, identifying the underlying mechanisms and explaining why they manifest themselves without making causal statements. Finally, the ambition was to analyze and explain, as the thesis does not design a solution or a novel artifact but rather build a deeper understanding of DIUs.

The research design is detailed below. Chapter 3.1 presents the research context, Chapter 3.2 illustrates the research methods used and the types of the theory developed, and Chapter 3.3 explains the data collection and analysis for the longitudinal single-case study and the multiple cross-case syntheses. Figure 4 provides an outline of this chapter.

Figure 4: Research Design Chapter Overview.

3.1	**Research Context** Epistemological stance, IS research paradigm, IS research stream
3.2	**Research Methods and Theory Types** Qualitative research, IS theory types

3.3	**Data Collection and Data Analysis**	
	3.3.1	Multiple Cross-Case Synthesis
	3.3.2	Longitudinal Single Case Study

3.1 Research Context

IS research is "primarily concerned with socio-technical systems that comprise individuals and collectives that deploy digital information and communication technology for tasks in business, private, or social settings." (Recker, 2021, p. 3). It examines the interaction between information technologies and human organizations (Grover & Lyytinen, 2015) and is intended to guide both academics and professionals in understanding, interpreting, adapting to, and skillfully overseeing established and currently used technologies, as well as emerging technologies whose effects are just beginning to manifest (Banker & Kauffman, 2004). As such, the field belongs to the social sciences (Bhattacherjee, 2012) and builds on and is influenced by an interdisciplinary foundation of several related disciplines, such as computer science, management science, organizational science, psychology, and sociology (Gregor, 2006). In the following, the general research context of this dissertation is clarified, including the epistemological stance (Orlikowski & Baroudi, 1991), the IS research paradigm (Hevner et al., 2004), and the IS research stream (Banker & Kauffman, 2004).

Epistemology, "the theory of knowledge and understanding, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion" (Oxford University Press, n.d.), differentiates three distinct research paradigms: positivism, interpretivism, and critical realism (Gregor, 2006; Orlikowski & Baroudi, 1991). Positivism is largely concerned with testing, confirming, falsifying, and predicting generalizable theories about an objective, easily grasped reality (Wynn & Williams, 2012). It consists of phenomena with relationships that are fixed a priori and can be made amenable to general theorizing (Orlikowski & Baroudi, 1991; Wynn & Williams, 2012). From a positivist perspective, theories are only truly valid if they can be proven by actual observations, even if they are initially conceived through reasoning (Bhattacherjee, 2012). Interpretivism emphasizes that individuals and their interactions shape reality and reject the idea of objective reality (Orlikowski & Baroudi, 1991; Wynn & Williams, 2012). Interpretivists focus on understanding participants' subjective

meanings of a particular phenomenon in a unique context, considering their subjective realities, interpretations, and behaviors (Bhattacherjee, 2012). Critical realism recognizes the role of the subjective knowledge of social actors in a given situation and the existence of independent structures that compel and enable those actors to pursue certain actions in a given environment (Wynn & Williams, 2012). Theories that emerge from scientific research "must revolve around the independent reality that comprises the world, even though humans are usually unable to fully understand or observe this reality, and that our knowledge of reality is fallible" (Wynn & Williams, 2012, p. 789). This dissertation adopts the research paradigm of interpretivism as it explores DIUs in their real-world context without preconceived notions. The author assumes that social reality is subjective and shaped by human actions and interactions. Organizations, groups, and social systems such as DIUs are intertwined with humans, making objective or universal capture, characterization, and measurement impossible.

Hevner et al. (2004) additionally present two fundamental research paradigms for IS research: behavioral science and design science. Design science is a problem-solving paradigm aiming to effectively and efficiently design, create, and deploy useful information systems to alleviate organizational problems and improve current practices (Hevner et al., 2004; Wilde & Hess, 2009). It is rooted in engineering and the sciences of the artificial (Simon, 1996) and approaches topics in their real-world contexts (Kuechler & Vaishnavi, 2008). In contrast, the behavioral science paradigm has its roots in the research methods of the natural sciences (Hevner et al., 2004). It seeks to formulate and substantiate theories "that explain or predict organizational and human phenomena surrounding the analysis, design, implementation, management, and use of information systems" (Hevner et al., 2004, p. 76). As this research focuses on how DIUs contribute to the digital transformation of manufacturing companies, it is closely related to the goals of behavioral science and is mainly related to this research paradigm.

In terms of research streams in the field of IS, Banker & Kauffman (2004) distinguish five different streams: (1) decision support and design science, (2) human-computer systems interaction, (3) value of information, (4) IS organization and strategy, and (5) economics of IS. Since this thesis examines how incumbent manufacturing firms respond organizationally and strategically to the new challenges posed by digital technologies by building a DIU, it falls thematically within the IS organization and strategy research stream.

3.2 Research Methods and Theory Types

To examine the early stages of a DIU's evolution process and their contribution to the digital transformation of manufacturing companies, this dissertation conducts qualitative research designed to help researchers understand phenomena in their real-world context (Recker, 2021). Qualitative research often focuses on the "why" and "how" of things within a small case or sample (Recker, 2021) and is useful when the object of study cannot be readily characterized by statistical or

quantifiable data (Strauss & Corbin, 1998). Yilmaz (2013) defines qualitative research as an "emergent, inductive, interpretive and naturalistic approach to the study of people, cases, phenomena, social situations and processes in their natural settings in order to reveal in descriptive terms the meanings that people attach to their experiences of the world" (2013, p. 312). It is appropriate for answering research questions that focus on people's experiences that can best be expressed in words. Qualitative methods seek to understand a phenomenon "through direct observation, communication with participants, or analysis of texts, and may stress contextual subjective accuracy over generality" (Recker, 2021, p. 115).

The present dissertation on the early stage of the DIU evolution process adheres to the seven principles of qualitative methods summarized by Recker (2021). By conducting interviews with DIU staff, observing their meetings, interacting face-to-face, and collecting internal and external data about the case, the author performs research on DIUs in their real-world context and follows the principles of "natural setting", "researcher as a key instrument", and "multiple sources of data" (Recker, 2021, p. 115). Typical of qualitative research, an inductive coding method is used (see Chapter 3.3) to analyze the data, building patterns, themes, and concepts from the bottom up, e.g., on the evolution process of DIUs. The focus is on the emergent meaning of behaviors, opinions, or views that DIU employees and employees from the main organization have about the unit (Recker, 2021). The research process also follows an "evolutionary design" (Recker, 2021, p. 115) in that several phases of data collection alternated with independent phases of analysis and theory building. Finally, as the thesis looks at DIU evolution from a variety of theoretical perspectives, such as organizational change theory, time as a research lens, and STS theory to develop a comprehensive, detailed picture, it adheres to the principle of holism and contextuality (Recker, 2021).

Edmondson and McManus (2007) outlined three archetypes of methodological adaptation in field research: the nascent, the emerging, and the mature state of research. When dealing with a nascent status characterized by limited existing theory and research, as in the case of DIUs, the authors emphasized the usefulness of conducting open-ended inquiries about the phenomenon. This includes collecting qualitative data through open-ended interviews and observations and obtaining materials relevant to the phenomenon (Edmondson & McManus, 2007). In line with this, case study research was selected as the qualitative method of choice, "an empirical method that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident." (Yin, 2018, p. 45). Case study research is a commonly used qualitative method in IS and involves intensively studying a phenomenon – such as DIUs – in its real-life context over time (Recker, 2021). It is typically used to answer *how* and *why* questions and is designed for situations where the number of variables of interest is greater than the number of data points (Recker, 2021; Yin, 2018). To enhance the credibility of case study research, it draws on multiple sources of evidence (interviews, observations, documentation, secondary data) for triangulation (Recker, 2021; Yin, 2018). For this dissertation, case studies are used for exploratory purposes to support theory

building (Recker, 2021), and both single and multiple case studies, both cross-sectional and longitudinal, are conducted with DIUs of manufacturing firms. The research objective was always explanatory, as the author asked *how* questions and sought to understand the practices, mechanisms, and relationships at work within a DIU. Since the DIU is the only unit of analysis that the research focuses on, all case studies are holistic cases (Recker, 2021).

To elaborate on the theoretical contribution of this dissertation, the findings are related to three of the five types of theories in IS research (Gregor, 2006): theory of analysis, theory of explanation, and theory of explanation and prediction. Chapter 4.4 develops theory for analysis, stating "what is" (Gregor, 2006, p. 620) by describing the relational dynamics and the emergence of social structures in DIU evolution. Analytical approaches are appropriate here because they are necessary "when little is known about some phenomenon" (Gregor, 2006, p. 624), which is true for the relational dynamics in the evolution process of a DIU, which have not been studied before. They provide analytical and descriptive insights into the unit of analysis by illustrating the challenges, characteristics, and implications of this process and the AC that emerges along the way. Chapters 4.1 and 4.3 develop theory for explaining (Gregor, 2006). Chapter 4.1 answers *how a DIU evolves to meet the needs and expectations of the main organization* and contributes to its digital transformation. From an organizational change perspective, it provides insights into the process of DIU evolution in incumbent manufacturing companies. Chapter 4.3. explains how a DIU and its main organization influence and gradually adapt to each other in terms of their social system, technical system, environmental system, and outputs as a DIU evolves. Case studies, such as the one conducted here, are a common method for developing theories or conjectures to explain something that was previously poorly or incompletely understood (Gregor, 2006). In this case, it is the evolution process of DIUs and the associated interaction and adaptation of two STS – DIU and main organization – that influence and change each other, including an explanation of how and why this happens. Finally, 4.2. present theory for explanation and prediction, as it explains and develops testable propositions (Gregor, 2006) on the unfolding of temporal dynamics and their influence on DIU activities and outputs along the evolution process of a DIU. The multiple cross-case synthesis used as a research method in this chapter is appropriate for this type of theory because it provides an "understanding of underlying causes and predictions, as well as a description of theoretical constructs and the relationships among them" (Gregor, 2006, p. 626). The contribution to theory building is the impact of time on DIU activities and outputs in the early stages of DIU evolution.

3.3 Data Collection and Data Analysis

As mentioned above, a longitudinal single-case study and multiple cross-case syntheses were conducted in the context of this dissertation. During two and a half years, 61 interviews were completed in seven cases. In addition, there are 34 hours of direct observation of DIU meetings in Case F and 63 internal and 29 external

documents across all scenarios. The author of this dissertation performed all data collection.

Due to the novelty of the DIU phenomenon and the lack of existing research on the areas of interest, the thesis applies a grounded theory approach for data analysis to develop theory inductively from rich empirical data for both the single and multiple case studies (Corbin & Strauss, 1990; Gioia et al., 2013; Strauss & Corbin, 1998). The first step was to create first-order codes from the transcripts, attempting to "adhere faithfully to the informant terms," as Gioia et al. (2013, p. 20) suggested. This first step resembled an open coding step (Strauss & Corbin, 1998). The first-order codes were then distilled into second-order codes before aggregated dimensions were developed as a final coding step (Gioia et al., 2013). The initial coding of the first and second order was done by the author of this dissertation, followed by discussion and validation within the authoring team. The same procedure was used to create the aggregated dimensions.

The following chapters describe the research methods and the process of data collection and analysis in detail. It uses information from the following five papers:

- *"Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change"* (Lorson, Dremel, & Uebernickel, 2022) – published.
- *"Beyond the Fast Lane Narrative – A Temporal Perspective on the Unfolding of Digital Innovation in Digital Innovation Units*" (Lorson, Dremel, de Paula, et al., 2022) – published.
- *"Explaining Socio-technical Convergence: An Analysis of the Interactions between Digital Innovation Units and their Main Organization"* (Lorson et al., 2024) – submitted.
- *"From Cradle to Cash: The Successful Formation of a Digital Innovation Unit"* (Lorson et al., n.d.) – in preparation for submission.
- "*Building Adaptive Capacity for Volatile Business Environments: A Longitudinal Study of the Establishment of a Digital Innovation Unit."* (Lorson et al., 2023) – published.

3.3.1 Multiple Cross-Case Syntheses

Working with multiple cases increases the generalizability of findings, eliminates single-case bias, and is therefore considered more persuasive and robust (Recker, 2021; Yin, 2018). To answer RQ1, RQ2, and RQ3, holistic, multiple, cross-case syntheses with seven DIUs from manufacturing companies in Germany and Switzerland were conducted. This allowed the identification of both within-case patterns and recurring patterns across the seven cases in terms of the evolutionary processes of the DIU (RQ1), the unfolding of temporal dynamics (RQ2), and the interactions between the DIU and the main organization (RQ3) along this process.

Replication Logic and Case Description

To select the cases, the research team used a literal replication logic for the first four cases and a theoretical replication logic for the remaining three to search for

manufacturing companies that have implemented a DIU as part of their organizational digital transformation (Yin, 2018). Each of the seven companies is in the manufacturing industry as a representative of an incumbent industry, specifically machine and plant engineering and raw material production systems. They are non-digital natives with a business-to-business focus, were founded at least 50 years ago, and currently employ more than 2,500 people. Given their age and size, it can be inferred that the organization's current structures, IT systems, and processes have a considerable degree of complexity. The seven DIUs established by Case A-G have between seven and 130 employees, are similar in age, and their activities extend beyond conceptualization (Yin, 2018). About half are organized as a separate legal entity, while the other half is a department (or division in Case D) within the main organization. Table 5 gives an overview of the seven cases.

Table 5: Case Overview – Multiple Cross-Case Syntheses.

ID	Main Org. Size	Main Org. Est. In	Country	DIU Size	DIU Est. in
Case A	> 20,000	1867	GER	17	2018
Case B	> 38,000	1932	GER	40	2018
Case C	> 11,000	1850	GER	60	2018
Case D	> 10,000	1946	GER	130	2018
Case E	> 11,000	1906	CH	25	2019
Case F	> 2,500	1844	CH	7	2020
Case G	> 18,000	1881	GER	30	2022

All seven DIUs have a core business-related mandate and focus on innovation "around the machine". This includes developing digital products, services, and business models that enhance and expand the current scope of the business (e.g., remote support offerings, predictive maintenance solutions, or the development of e-commerce platforms for spare parts). Based on the typology of Barthel et al. (2020), the case DIUs correspond to the DIU type *External Enhancer* (introduced in Chapter 2.2.), albeit in slightly different forms (Case D is an exception because it evolves into an *External Creator*).

To provide detailed insights into the seven DIUs, Tables 6 and 7 show the characteristics on which the typology is based and their respective manifestations in each DIUs. Table 6 covers the category *Objectives and Scope* with the dimensions *Innovation Orientation, Market Focus,* and *Scope of Innovation*. Table 7 includes the category *Setting and Design* with the dimensions *Embedding, External Collaboration, Internal Ties, Project Selection,* and *Location* (Barthel et al., 2020). Since all DIUs except Case G have undergone an evolution step described in detail in Chapter 4, both tables include information on changes in characteristics before and after the evolution step, if any.

Table 6: Objective and Scope of Case DIUs.

Own Representation Based on Typology by Barthel et al.(2020)*.*

ID	Innovation Orientation	Market Focus of Innovation	Scope of Innovation Process
Case A	Primarily External	Primarily Existing Business Areas	Idea Generation, Idea Selection, Innovation Development After evolution, Idea Selection, Innovation Development, and Implementation
Case B	Primarily External	Primarily Existing Business Areas	Idea Selection, Innovation Development After evolution, additionally Innovation Implementation, and Commercialization
Case C	Primarily External	Primarily Existing Business Areas	Idea Selection, Innovation Development, Implementation, Commercialization
Case D*	Purely External	Existing Business Areas After evolution, both Existing and Novel Business Areas	Idea Generation, Idea Selection, Innovation Development, Implementation, and Commercialization
Case E	Primarily External	Primarily Existing Business Areas	Innovation Development and Implementation After evolution, additionally Idea Selection
Case F	Purely External	Primarily Existing Business Areas	Idea Generation, Idea Selection, Innovation Development, (partly Innovation Implementation)
Case G	Primarily External	Primarily Existing Business Areas	Idea Selection, Innovation Development, and Implementation

* Case D is unique since it is called a company builder after the development step but strongly resembles an *External Creator* according to Barthel's (2020) typology.

Table 7: Setting and Design of Case DIUs.

Own Representation Based on Typology by Barthel et al.(2020)*.*

ID	Embedding	External Collab.	Internal Ties	Project Selection	Location
Case A	Separate Legal Entity	Irregular	Sporadic Liaison After evolution, Core Org. Integrated	Autonomously After evolution, Order	Offsite
Case B	Separate Legal Entity	Irregular	Sporadic Liaison	Autonomously	Offsite After evolution,

			After evolution, Core Org. Integrated	After evolution, Order	also Onsite Location
Case C	Separate Legal Entity After evolution, Line Organization	Irregular	Regular Liaison	Mixed	Onsite
Case D	Separate Legal Entity	Irregular	Regular Liaison	Mixed	Offsite
Case E	Executive Department	Irregular	Core Organization Integrated - Regular Liaison	Mixed	Offsite
Case F	Executive Department After evolution, Line Organization	Irregular	Core Organization Integrated	Mixed	Onsite
Case G	Line Organization	Irregular	Core Organization Integrated	Mixed	Onsite

Data Collection

Between January 2021 and July 2022, 61 interviews were conducted – 43 with the staff of the DIUs and 18 with the staff from the main organizations. The average interview length is 54.47 minutes, totaling 3,258 minutes across all interviews. All interviews were conducted via video call (due to COVID-19 restrictions) by the author of this dissertation and were audio recorded and transcribed. Employees with different roles and hierarchical levels within the DIU and at least one representative from the main organization were interviewed to get a realistic picture of the DIU. A snowball sampling technique was used to select the interviewees (Myers & Newman, 2007). Table 8 overviews the number and average length of interviews and the interviewee positions for the multiple cross-case syntheses.

Table 8: Overview of Interviews – Multiple Cross-Case Syntheses.

ID	# of interviews (DIU/ main org.)	Ø Length	Interviewee Positions (# of interviews, if >1)
Case A	4 (3/1)	54.00	Managing Director DIU, Senior Consultant Strategic Design, Principal Consultant, Vice President Digital of one division (main org.)
Case B	6 (4/2)	53.33	Director of Digital Transformation, Interim Head of Digital Customer Interaction, Head of Technology and Architecture, Product Manager, Product Portfolio Manager, Head of Digital Excellence of one division (main org.)
Case C	7 (5/2)	55.86	COO and Head of Digital Innovation & Data Science (2), Head of Data Science, Product Owner, Head of Data Integrations & Digital Innovation (main org.) & Head of Application Development & Platforms (DIU), Innovation Manager, Global Head of Sales & Marketing (main org.) & Managing Director DIU
Case D	6 (5/1)	56.50	Chief Executive Officer (CEO) & Managing Director DIU, Head of Innovation, Digital Ideation and Innovation Manager (main org.), Product Design and Strategic Innovation, Senior Venture Architect, Digital Project Lead
Case E	5 (4/1)	64.60	Head of Operations, Global Head of DIU, Senior Program Manager Digital Sales, Program Manager Operations, COO (main org.)
Case F	25 (17/8)*	52.52	Chief Digital and Information Officer (DIU and main org) (4), Director Global IT Governance and Digital Transformation (DIU and main org) (4), Digital Ambassador (4), Consultant in Consultancy Company (4), Partner in Consultancy Company (3), Head of Global Digital Business Operations (2), Head of Sales Italy i.a. Service Division and Global Key Account Manager (1), Data Scientist (1), Senior Consultant in Consultancy Company (1)
Case G	8 (5/3)	44.50	Chief Digital Officer, Head of Digital Hub, Digital Unit Head Division 1, Digital Unit Head Division 2, Part of Digital Unit for Division Liquid & Powder Technologies, Chapter Lead IIot und Data Science (Digital Hub), Part of Digital Unit for Division 3, Digital Unit Head Division 4
Total	61 (43/18)	54.47	

The interviews were conducted in four rounds with nine different people. The number of interviews tends to increase as the DIU team grows. Three interviewees are part of a consulting firm supporting the DIU; two others work in the DIU and the main organization.

The interviews were conducted in four phases. Phase 1, from January 2021 to August 2021, included 39 interviews with Cases A-F. Some of the data from the longitudinal case study that will be presented in the next Chapter 3.3.2 were also used in the multiple case studies. In the first phase of data collection for the multiple case study, two rounds of interviews for the longitudinal case study took place – January/February 2021 and July/August 2021. In Phase 2, in January and February 2022, the interviews with Case G and the third round with Case F – a total of 13 interviews – were conducted. Finally, in Phase 3, the fourth and final round of interviews with Case F took place with nine interviews.

In parallel with the interviews, the research team collected additional secondary data in the form of direct observation of meetings, internal documents (e.g., management reports and presentations), and publicly available external information (e.g., company website, press releases) for data triangulation (Recker, 2021; Yin, 2018). All data was collected, stored, and analyzed using ATLAS.ti, a qualitative data analysis tool. Figure 5 provides an overview of the data collection process.

Figure 5: Data Collection Process – Multiple Cross-Case Syntheses.

Phase 1	Phase 2	Phase 3
January 2021 – August 2021	January & February 2022	July 2022
39 interviews Cases A, B, C, D, E, F	13 interviews Cases F & G	9 interviews Case F

Weekly Meeting Observations, January 2021 – September 2022
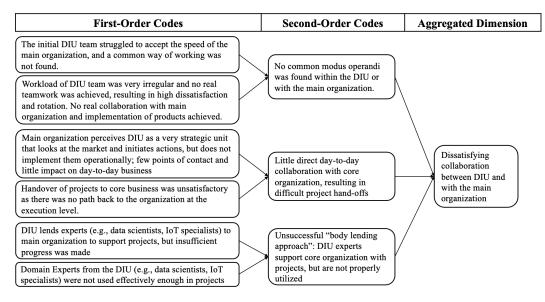
Ongoing collection of secondary data (internal and external material), September 2020 – March 2023

Data Analysis

To answer RQ1 – *how do DIUs evolve over time to meet the needs and expectations of the main organization?* – the author first created 642 first-order codes and distilled them into 295 second-order codes. The organizational change lens guided this step and allowed theoretical dimensions to be specified. Three main categories of codes were derived from the research framework. First, the original DIU setup and the post-evolution setup characteristics were examined: goals, mandate, governance, team, and processes. Second, the research team sought to identify active and passive internal and external triggers that initiated the evolutionary process. Third, the evolution process was coded to understand what steps were required. Based on the data structure and with a "focus on our ultimate goal of building a vibrant inductive model that is grounded in the data" (Gioia et al., 2013, p. 22), the research team incorporated its background knowledge of theories related to digital transformation, DIUs, and organizational change. With particular influence from the ideal-typical motors of change defined by Van De Ven and Poole (1995), a conceptual model that explains the evolution of a DIU was derived. Regarding the characteristics and the evolution process, the research team decided
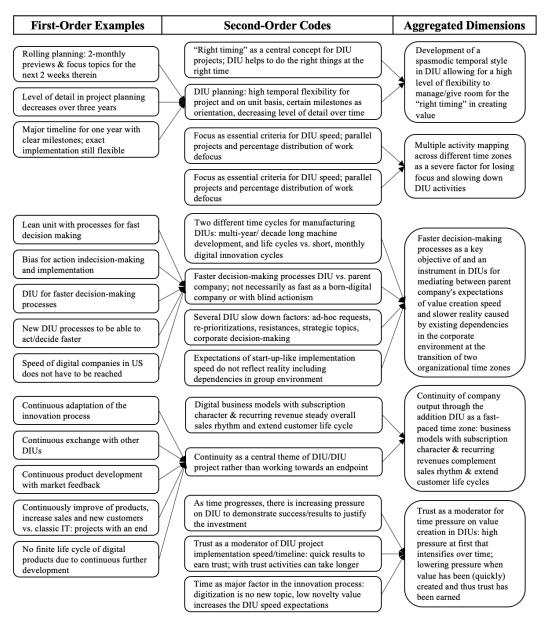
to base the results on the second-order codes to represent these aspects in sufficient detail on a case-by-case basis. For the evolution triggers, ten aggregated dimensions were created based on the second-order codes to compare all five cases and identify recurring patterns. Each aggregate dimension is grounded in the statements of at least three different DIUs to ensure that they provide a sufficient basis for the findings. Figure 6 shows an excerpt of the data structure for RQ1.

Figure 6: Selected Excerpt of the Data Structure for RQ1.

First-Order Codes	**Second-Order Codes**	**Aggregated Dimension**

The initial DIU team struggled to accept the speed of the main organization, and a common way of working was not found.

Workload of DIU team was very irregular and no real teamwork was achieved, resulting in high dissatisfaction and rotation. No real collaboration with main organization and implementation of products achieved.

No common modus operandi was found within the DIU or with the main organization.

Main organization perceives DIU as a very strategic unit that looks at the market and initiates actions, but does not implement them operationally; few points of contact and little impact on day-to-day business

Handover of projects to core business was unsatisfactory as there was no path back to the organization at the execution level.

Little direct day-to-day collaboration with core organization, resulting in difficult project hand-offs

Dissatisfying collaboration between DIU and with the main organization

DIU lends experts (e.g., data scientists, IoT specialists) to main organization to support projects, but insufficient progress was made

Domain Experts from the DIU (e.g., data scientists, IoT specialists) were not used effectively enough in projects

Unsuccessful "body lending approach": DIU experts support core organization with projects, but are not properly utilized

For RQ2 – *how and what temporal dynamics unfold during the evolution of a DIU?* – the first-order coding resulted in 347 codes, from which the research team composed 59 second-order codes. The temporal research lens guided this step, allowing theoretical dimensions to be specified. Based on the following three criteria, the 13 most interesting and relevant second-order codes were selected through discussion within the authoring team. First, each code had to be directly related to the perception and role of time in the context of the DIU. Second, given the review of the existing body of knowledge, the research team aimed to include only novel themes and findings. Third, each code must be able to clarify how time uniquely affects the DIU activities. Based on the selected second-order codes, five aggregated dimensions were developed. Each is grounded in the statements from at least three DIUs to ensure they provide the foundation for the findings that build upon them. Figure 7 shows the data structure associated with RQ2 with selected examples of first-order codes, all second-order codes, and all aggregated dimensions.

Figure 7: Selected Excerpt of the Data Structure for RQ2.
Own Representation Based on Lorson, Dremel, de Paula, et al.(2022, p. 7).

First-Order Examples	Second-Order Codes	Aggregated Dimensions
Rolling planning: 2-monthly previews & focus topics for the next 2 weeks therein	"Right timing" as a central concept for DIU projects; DIU helps to do the right things at the right time	Development of a spasmodic temporal style in DIU allowing for a high level of flexibility to manage/give room for the "right timing" in creating value
Level of detail in project planning decreases over three years	DIU planning: high temporal flexibility for project and on unit basis, certain milestones as orientation, decreasing level of detail over time	
Major timeline for one year with clear milestones; exact implementation still flexible	Focus as essential criteria for DIU speed; parallel projects and percentage distribution of work defocus	Multiple activity mapping across different time zones as a severe factor for losing focus and slowing down DIU activities
	Focus as essential criteria for DIU speed; parallel projects and percentage distribution of work defocus	
Lean unit with processes for fast decision making	Two different time cycles for manufacturing DIUs: multi-year/ decade long machine development, and life cycles vs. short, monthly digital innovation cycles	Faster decision-making processes as a key objective of and an instrument in DIUs for mediating between parent company's expectations of value creation speed and slower reality caused by existing dependencies in the corporate environment at the transition of two organizational time zones
Bias for action indecision-making and implementation	Faster decision-making processes DIU vs. parent company; not necessarily as fast as a born-digital company or with blind actionism	
DIU for faster decision-making processes	Several DIU slow down factors: ad-hoc requests, re-prioritizations, resistances, strategic topics, corporate decision-making	
New DIU processes to be able to act/decide faster	Expectations of start-up-like implementation speed do not reflect reality including dependencies in group environment	
Speed of digital companies in US does not have to be reached		
Continuous adaptation of the innovation process	Digital business models with subscription character & recurring revenue steady overall sales rhythm and extend customer life cycle	Continuity of company output through the addition DIU as a fast-paced time zone: business models with subscription character & recurring revenues complement sales rhythm & extend customer life cycles
Continuous exchange with other DIUs	Continuity as a central theme of DIU/DIU project rather than working towards an endpoint	
Continuous product development with market feedback		
Continuously improve of products, increase sales and new customers vs. classic IT: projects with an end	As time progresses, there is increasing pressure on DIU to demonstrate success/results to justify the investment	Trust as a moderator for time pressure on value creation in DIUs: high pressure at first that intensifies over time; lowering pressure when value has been (quickly) created and thus trust has been earned
No finite life cycle of digital products due to continuous further development	Trust as a moderator of DIU project implementation speed/timeline: quick results to earn trust; with trust activities can take longer	
	Time as major factor in the innovation process: digitization is no new topic, low novelty value increases the DIU speed expectations	

The first-order coding for RQ3 – *how do a DIU and its main organization interact at the socio-technical level as the DIU evolves?* – resulted in an initial set of 604 first-order codes. Following the general recommendations, the coding process was iterative (Strauss & Corbin, 1998; Urquhart et al., 2009). The research team moved back and forth in the data analysis to allow for appropriate analytical lenses to illuminate the phenomenon of interest. To illustrate, the initial codes showed various aspects of the socio-technical perspective, which led to the decision to review the literature on this topic. With the newly acquired theoretical background, the research team then returned to the data analysis, conducted a test coding of seven interviews – one per case – and discussed the results. Since the test coding looked promising, the data were coded according to the dimensions of STS theory. Each first-order code was assigned to one of four categories adopted from the STS lens: technical system, social system, environmental system, and outputs. The

technical system had the additional subcategories of devices, tasks and tools, and processes; the social system had knowledge, skills, attitudes, values, needs, reward system, and authority structures. Following Gioia et al. (2013), the first-order codes were assembled into 67 second-order codes. A second-order code was only created if the topic appeared in at least three DIUs. The results are presented on a second-order basis for the technical system, environmental system, and outputs because the level of abstraction would have become too high and the individual topics too generalized. Only for the social system, the research team derived twelve aggregate dimensions based on the 39 second-order codes in this category. An excerpt of the resulting data structure is shown in Figure 8.
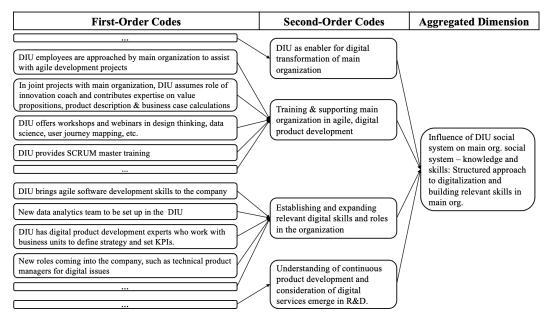
Figure 8: Selected Excerpt of the Data Structure for RQ3.

3.3.2 Longitudinal Single-Case Study

Driven by the goal of understanding *how the relational dynamics between the DIU and the main organization unfold during the DIU's evolution*, an area that remains relatively unexplored, an in-depth, inductive, longitudinal, single-case study was conducted, which is appropriate for the development of grounded theory (Eisenhardt, 1989; Glaser & Strauss, 1967; Van de Ven & Huber, 1990; Yin, 2018). This thesis studies one incumbent organization, Case F, over two and a half years from the initiation and decision to establish a DIU to the finalization of its structure and responsibilities. This case was deliberately selected for its unique ability to provide a comprehensive view of the DIU's evolution journey and its impact on the ongoing digital transformation of an incumbent organization. It is a representative case of a typical situation that incumbents find themselves in due to the emergence of digital technologies and a revelatory case that presents a previously inaccessible opportunity, as DIUs are a recent phenomenon (Recker, 2021). Moreover, the longitudinal case design allows for the exploration of "how specific conditions and their underlying processes evolve over time" (Yin, 2018, p. 87). Case F is well-suited for this purpose because it involves a multi-year, complex digital transformation effort, and its context in the manufacturing industry provides

valuable insights into the challenges of digital transformation for a traditional incumbent company.

While the focus on a single organization imposes some limitations on the broad applicability of the findings, it has facilitated an in-depth exploration of the organization's inner workings. Through this approach, the research team developed a more comprehensive understanding of the relational dynamics in the process of DIU evolution in the context of an incumbent's digital transformation. In addition, it helped uncover mechanisms that favorably influence Case F's AC that has emerged over time, some of which have also changed or intensified.

Case Context

Case F is a nearly 180-year-old international engineering company headquartered in Switzerland. It holds a prestigious position as a global leader in its industry, known for its unwavering reliability and uncompromising standards of excellence, earned by producing machines of enduring quality that provide decades of service. Historically, the development of its products has followed rigid and lengthy cycles, each tailored to a specific machine model, with limited emphasis on integrating digital technologies. Notably, the broader industry remains relatively conservative and is only in the early stages of its digital transformation. However, as the landscape evolves, competitors and native digital companies are increasingly introducing digital solutions to enhance and optimize machine utilization, posing a significant challenge to Case F's market position.

The unit of analysis is Case F's first digital transformation initiative, creating a DIU that is supposed to harmonize previously disparate and uncoordinated innovation efforts and develop digital products, services, and business models along pre-defined strategic areas. The DIU has a core business-related mandate and implements innovations "around the machine," such as predictive maintenance or remote support solutions. The first two years of operation should also be used to analyze and decide how the DIU will ultimately be set up. Pending these deliberations, the unit will function as a virtual entity (not yet a designated department) nested within the main organization's IT department. Case F is supported in its efforts by Consultancy Company (CC, pseudonym), which specializes in customer-centric innovation and the incorporation of digital technologies. Ultimately, the activities of the DIU have highlighted the importance of digital transformation to the main organization, leading to the development of an enterprise-wide digital strategy.

Data Collection

The first contact with Case F was in September 2020, just before the executive board decided to invest in digital transformation and build a DIU as the first initiative. The following month, the research team started collecting the first external data about Case F from their website, press releases, etc., before the official research collaboration was decided in December 2020. As the primary data source, it was decided to conduct exploratory, semi-structured interviews with open-ended questions to ground the discussions in the experiences of the

participants and allow the theory to emerge from the data (Corbin & Strauss, 1990; Gioia et al., 2013; Strauss & Corbin, 1998). Between January 2021 and July 2022, 26 interviews were conducted in four rounds, lasting between 26 and 79 minutes. The research team worked with fixed time intervals (Yin, 2018), interviewing Case F and CC employees involved in building the DIU (mainly the DIU core team) approximately every six months (see Figure 9). The same interviewer – the author of this dissertation – conducted the interviews via video call (due to COVID-19 restrictions), with one person at a time. In addition to the interview data, direct observations of the weekly DIU team meetings were undertaken between January 2021 and September 2022 to gain first-hand experience of any incidents as they occurred (Recker, 2021). Finally, the research team collected additional archival data such as internal materials (e.g., strategy presentations, management reports, market and competitor analysis) and external materials (e.g., annual reports, company website, press releases, and video footage) between September 2020 and March 2023 to triangulate the data (Recker, 2021). Figure 9 provides an overview of the data collection timeline, and Table 9 shows the data sources.

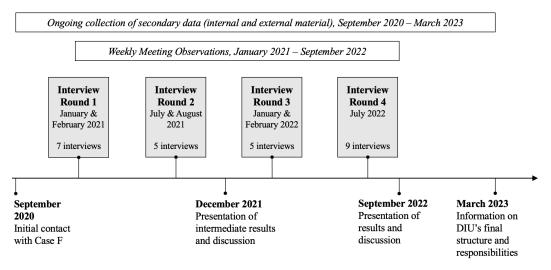*Figure 9: Timeline Data Collection for Longitudinal, Single-Case Study.*

Table 9: Data Sources for Longitudinal, Single-Case Study.
From Lorson et al. (2023, p. 5).

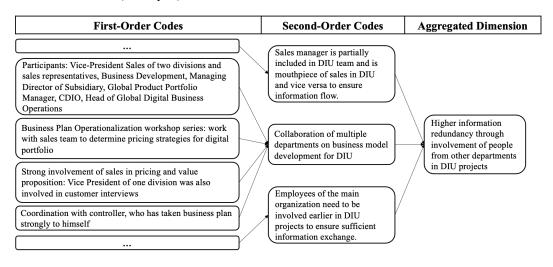| Data	Interview Partner (ID)	# Interviews	Minutes
Primary Data	Chief Digital and Information Officer (CDIO)	4	289
	Director Global IT Governance and Digital Transformation (DITDT)	4	218
	Digital Ambassador (DA)	4	178
	Consultant in Consultancy Company (C1)	4	253
	Partner in Consultancy Company (C2)	3	176
	Head of Global Digital Business Operations (DBO)	2	74

	Head of Sales Italy, i.a., Service Division and Global Key Account Manager (HOS)	1	50
	Data Scientist (DS)	1	49
	Co-founder and member of the board of directors of Consultancy Company (C3)	1	34
	Senior Consultant in Consultancy Company (C4)	1	26
	Total Interviews	26	1347
Secondary Data *Observations*	34 hours of observation of weekly DIU meeting → ∑ 42 pages		
Secondary Data *Internal Material*	51 internal documents such as strategy presentations, management reports, market, and competitor analysis → ∑ 340 slides		
Secondary Data *External Material*	11 external documents such as annual report, website, press releases, and videos from Case F and their partners around the digital transformation journey		

Data Analysis

After completing each interview round, the qualitative interviews were transcribed, and the primary and secondary data analysis was started using the computer-assisted qualitative data analysis software ATLAS.ti. To answer RQ4, the research team created an initial set of 676 first-order codes from the data, which resembled an open coding step (Strauss & Corbin, 1998). With the goal of unpacking the relational dynamics of a DIU's social structures with the main organization, the focus was on potential activities, challenges, characteristics, and implications in the DIU's evolution process for the second-order coding, following Gioia et al. (2013). 127 second-order codes emerged. As the intention was to analyze and explain this process in sufficient detail, the findings are presented in Chapter 4.4.1 based on the second-order codes.

During this first round of second-order coding, the research team found evidence of underlying mechanisms that seemed to play a role in the evolutionary process. In reviewing the literature, the team came across Staber and Sydow's (2002) study of organizational AC, which seemed to be a promising angle from which to explore these mechanisms. The initial 676 first-order codes were reviewed, and a set of 476 first-order codes was extracted based on their relevance to the AC lens. From the extensive compendium of first-order codes, the second-order codes were distilled to 24 (Gioia et al., 2013). Both coding steps were performed by the first author and independently double-checked by a second researcher. The research team developed eight aggregated dimensions from the second-order codes in the final step. In accordance with the grounded theory methodology (Urquhart et al., 2009), the empirical data was systematically collected and analyzed until theoretical saturation was reached. Specifically, the research team iterated until "no new data emerged" (Morse, 2003, p. 1) and a coherent picture of AC over DIU evolution and any confounding factors emerged. Figure 10 shows an example of the data coding.

Figure 10: Coding Example – Longitudinal Single-Case Study.
From Lorson et al. (2023, p. 7)*.*

4 Results

Adaptation is a critical factor for survival in the ever-changing business landscape triggered by the use and diffusion of digital technologies. This is true for both incumbents, who must navigate the constant shifts caused by emerging digital trends (Hinsen et al., 2019) and for the initiatives they undertake to address these changes. Looking at DIU research from this premise, however, one quickly realizes that the vast majority of studies, on the one hand, take a static view of DIUs, referring to their status quo at a given point in time (Chapter 2.3, Table 3), and, on the other hand, adopt a one-dimensional perspective, focusing primarily on the influence and contribution of the DIU to the main organization (Chapter 2.4, Table 4).

To arrive at a more dynamic understanding of DIUs, research calls for an exploration of the processes of change and development that a DIU undergoes (Barthel et al., 2020; Raabe et al., 2020b) and for incorporation of time and temporal factors in research (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001; Conboy et al., 2020; Mousavi Baygi et al., 2021). Barthel et al. (2020) and Raabe et al. (2020b), for example, suggest that the establishment and development of a DIU should be studied, e.g., by conducting in-depth longitudinal case studies to understand how these processes work and how they should be designed in the future to make the most efficient use of the unit.

Furthermore, since cooperation, alignment, and interrelationships with the main organization are essential for the success of a DIU (Haskamp et al., 2023; Holotiuk & Beimborn, 2019; Raabe et al., 2020a), further empirical research is needed to fill the knowledge gap on how DIUs and their main organizations collaborate and develop their interrelationships (Schumm, 2023). Adopting a two-dimensional perspective on the interaction between DIU and the main organization, its evolution, and implications along various social and socio-technical elements promises further insights into the optimization and effective use of DIUs.

By answering the overarching research questions of *how early-stage DIUs evolve to contribute to a manufacturing company's digital transformation journey*, this dissertation aims to create a more dynamic and two-dimensional understanding of

DIUs and their interaction with the main organization. The focus is on the first three years of DIU's operation.

In the following, Chapter 4.1 provides an understanding of the fundamentals of a DIU's evolution process, its triggers, drivers, characteristics, and outcomes. Chapter 4.2 elaborates on the temporal dynamics that accompany the evolution of a DIU and the influence of temporal factors on DIU activities. Chapter 4.3 presents a detailed analysis of the interaction between the DIU and the main organization along four socio-technical elements. Finally, Chapter 4.4 delves deeper into the relational dynamics of the DIUs and the main organization's social structures.

The results in this chapter are based on the following papers:

- *"Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change"* (Lorson, Dremel, & Uebernickel, 2022) – published.
- *"Beyond the Fast Lane Narrative – A Temporal Perspective on the Unfolding of Digital Innovation in Digital Innovation Units*" (Lorson, Dremel, de Paula, et al., 2022) – published.
- *"Explaining Socio-technical Convergence: An Analysis of the Interactions between Digital Innovation Units and their Main Organization"* (Lorson et al., 2024) – submitted.
- *"From Cradle to Cash: The Successful Formation of a Digital Innovation Unit"* (Lorson et al., n.d.) – in preparation for submission.
- "*Building Adaptive Capacity for Volatile Business Environments: A Longitudinal Study of the Establishment of a Digital Innovation Unit.*" (Lorson et al., 2023) – published.
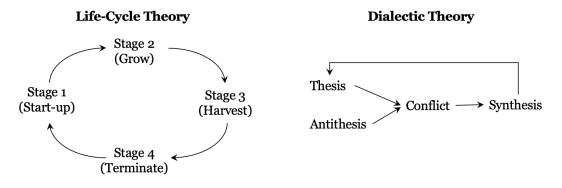
4.1 Fundamentals of DIU Evolution

IS literature calls for research on new forms of organizational design and their practices (Hanelt et al., 2020; Yoo et al., 2012; Zammuto et al., 2007), as digital transformation requires malleable organizational structures that solve its challenges for incumbent organizations (Hanelt et al., 2020). To address this call, this thesis adopts a process narrative to understand the evolution of DIUs – as a potentially malleable structure – and to answer RQ1 on *how DIUs evolve over time to meet the needs and expectations of the main organization*, contributing to or driving its digital transformation. In particular, it focuses on the fundamentals of the first major evolutionary step after the initial setup in the first three years of DIU operation.

As mentioned in Chapter 2.3, the thesis builds on Van de Ven and Poole's (1995) perspective on organizational change and development and distinguishes four ideal types theories of change and development: evolutionary, teleological, life-cycle, and dialectic. During the iterative data collection and analysis, evidence for both life-cycle and dialectic theories emerged across multiple cases, concluding that the

evolution of a DIU is driven by the interplay of these two motors of change. Figure 11 provides an overview of their respective cyclical order.

Figure 11: Life-cycle and Dialectic Theory of Change.
From Lorson, Dremel, & Uebernickel (2022, p. 4) Based on Van De Ven and Poole (1995).

Life-Cycle Theory   **Dialectic Theory**

Stage 2
(Grow)

Stage 1   Stage 3   Thesis
(Start-up)   (Harvest)   Conflict ⟶ Synthesis
                                                            Antithesis
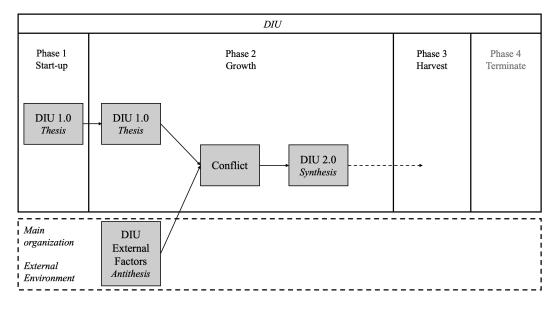Stage 4
(Terminate)

The results presented in this section are based on the publication *"Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change"* (Lorson, Dremel, & Uebernickel, 2022). The underlying database comprises five of the seven case studies – Case A, Case B, Case C, Case D, and Case E – and 27 interviews over seven months (January - July 2021). The data structure resulting from the data analysis consists of 642 first-order codes, 295 second-order codes, and ten aggregated dimensions.

The underlying driver of DIU evolution is the life-cycle motor of change, as the formation of a DIU is regularly planned in three to four phases (Lorson, Dremel, & Uebernickel, 2022). Along these phases, its goals, mandate, and team, for example, are usually expanded. To establish uniformity, the terminology of Van De Ven and Poole (1995) is used as a reference point to name the four foundational phases: *Start-up*, *Growth*, *Harvest* and *Terminate*. This can already illustrate the basic structure of DIU evolution but cannot fully explain it. In addition to the life-cycle motor of change, there is also the influence of the dialectic motor of change in the five cases. The five DIUs had completed the start-up phase and were at some point in the growth phase – some further along, some less so – when the DIU was challenged by external factors, either from the main organization or from the company's external environment. Characteristics of the growth phase are, for example, a familiarization of the team and a settling in of processes and work routines. The conflict resulting from the external challenges had to be resolved and led to a new DIU setup which is called the synthesis following Van de Ven and Poole (1995). Figure 12 summarizes these findings. It shows the life-cycle motor of change as the underlying driver with its *Start-up*, *Growth*, *Harvest,* and *Terminate* phases. The width of the phases has been selected solely for clarity and does not imply the duration of a phase. The final phase, *Terminate*, is presented in a lighter shade, as none of the five cases currently foresees any form of dissolution of their DIU in the medium term. For enhanced comprehensibility, the initial DIU setup, or thesis, is referred to as DIU 1.0, and the setup after the evolutionary process, or synthesis, as DIU 2.0. The dashed arrow after the *synthesis* indicates

the subsequent evolution of the DIU along the life-cycle phases, which is beyond the scope of the data collection (Lorson, Dremel, & Uebernickel, 2022).

Figure 12: DIU Evolution through Life-cycle and Dialectic Motor of Change.
From Lorson, Dremel & Uebernickel (2022, p. 7).

To present the process of DIU evolution in detail, the following chapters will explain how the clash of thesis – DIU 1.0 – and antithesis – DIU external factors – led to conflict and how it was resolved in the form of the synthesis – DIU 2.0. They give an overview of the external factors that form the antitheses and the resolution of the conflict and compare DIU 1.0 and DIU 2.0 to highlight the changes. Here, the narrative moves from the abstract to the concrete, starting with a presentation of the external factors of the DIU – both from the main organization and from the external environment – that form the antitheses. Then, a brief explanation is given of how the conflict between thesis and antithesis leads to synthesis. Both findings – antithesis triggering and conflict resolution – are case agnostic and based on aggregation across all five cases. Finally, the dissertation individually examines the changes observed between DIU 1.0 and DIU 2.0 in all five cases, providing a comprehensive understanding of the possible scope and aspects of the evolution of a DIU. All sections contain sample quotes from the interviews to make the data analysis comprehensible and to substantiate the results.

4.1.1 Antithesis – Triggers for the DIU Evolution Process

Based on the data from the five case studies, the research team has identified ten triggers that initiated the evolution of the DIU from thesis DIU 1.0 to synthesis DIU 2.0, originating from both the main organization and the external environment. Trigger means an event(s) or situation(s) that (collectively) cause(s) (*Cambridge Dictionary*, n.d.) the organization to rethink the initial DIU setup and evolve it to DIU 2.0. Among these triggers, three are active, and seven are passive, collectively forming the antithesis for each case. Active triggers are events directly related to or affecting the DIU, while passive triggers are situations (e.g., outcomes, challenges, interpersonal relationships) indirectly associated with the DIU. Table

10 provides an overview of the ten triggers and indicates whether they are company-internal or -external, positive or negative. For the triggers, the intention was to look for similarities across the five cases to allow for generalizability. The results shown are based on ten aggregated dimensions developed from 43 second-order codes based on an initial set of 96 first-order codes. It is important to note that it is usually not a single trigger but several active and passive triggers that form the antithesis and create the conflict finally resolved in the synthesis (Lorson, Dremel, & Uebernickel, 2022).

Table 10: Antithesis – Triggers DIU Evolution.
Own Representation Based on Lorson, Dremel, & Uebernickel (2022)*.*

	Active Triggers	**Passive Triggers**
Internal Triggers	*Negative* • High-level/c-level management change (4/5 cases) • DIU evolution as a result of a strategic decision or realignment (3/5 cases)	*Negative* • Inappropriate staffing and/or team composition (5/5 cases) • Unsatisfactory results of DIU (supported) projects (4/5 cases) • Unsatisfactory collaboration with the DIU - main organization perspective (3/5 cases) • Insufficient acceptance of DIU (3/5 cases) • Challenges with the DIU's funding approach (2/5 cases) • DIU being half-hearted or actionist, strongly individual-driven initiative (2/5 cases) *Positive* • DIU had fulfilled (parts of) its goals (3/5 cases)
External Triggers	*Negative* • Deterioration in the market conditions of the main organization (2/5 cases)	*No triggers found*

Active Triggers

Starting with the active triggers, two internal and one external were found – all three are negative. In four out of five cases, high-level/c-level management changes played a major role. Either the initiators of DIU 1.0 left the company (Case A and Case C), or individuals with expertise and specific responsibility for digital transformation joined (Case B and Case D) (Lorson, Dremel, & Uebernickel, 2022). Along with the passive triggers, these new hires were instrumental in driving the transformation to DIU 2.0. A quote from Case A exemplifies this: *"The old CEO was in the afterglow of his career, so to speak, and rediscovered the topic of*

digitalization. He bought [digital consultancy], realized two or three huge projects with [consultancy], and initiated the DIU, yes. That was certainly one of the reasons why it died briefly in the meantime because the current acting CEO then made it his own, changed and adapted it."

As a second internal trigger, a strategic decision or realignment of the main organization led to the evolution of the DIU. This was observed in three out of five cases with different characteristics. In Case B, for example, DIU 1.0 underwent evaluation and redesign as part of a strategy project for the main organization's new overall digital transformation strategy: *"As part of or in the run-up to this reorganization [of the DIU], we have now carried out two strategy projects in which we have defined [...] what the plan or priorities are, which products we want to offer. This has now resulted in a roadmap that basically includes three digital products, all of which are more like a platform."* In Case C, the entire company underwent a complete restructuring from a matrix to a product-oriented structure, during which the DIU 1.0 setup was critically reviewed and ultimately transformed into DIU 2.0. Lastly, in Case E, DIU 2.0 assumed responsibility for four new focus projects as a strategic decision by the top management of the main organization (Lorson, Dremel, & Uebernickel, 2022).

The sole external trigger identified is the deterioration of market conditions for the main organization, partly attributed to the impact of COVID-19. In the market where Case C operates, there was a significant collapse of up to 50% in the summer of 2020, necessitating a complete organizational restructuring: *"To be quite honest, we are, of course, operating in a market that has slumped by 20 percent and up to 50 percent last summer, which means that we simply have to tighten our belts quite a bit in some areas, quite frankly."* As a result, the previous level of affordability for the DIU was no longer feasible, leading to the adoption of the new DIU 2.0 setup. In Case E, financial constraints resulting from the COVID-19 pandemic led to the decision to discontinue central funding of the DIU earlier than planned and instead adopt a mixed approach of cost center and central funding (Lorson, Dremel, & Uebernickel, 2022): *"So in terms of funding, we started with [an amount X] for the first two years; we said it was for free, so to speak. 'Use the resources, [...] you can basically call, and you don't have to pay anything.' That lowers the threshold. But now – it wasn't so easy in the Coronavirus year when all the businesses weren't doing so well – we've said: 'Okay, but we have to switch now. We need an internal market. We have to plan projects, and you also have to pay for them."*

Passive Triggers

In terms of passive triggers, seven were identified, all internal to the company, six negative, and one positive. The most common negative trigger in all five cases was inappropriate staffing and/or team composition. These include, for example, a lack of key functions or an incomplete set of skills to create digital products, services, and business models. In Case A, for instance, DIU 1.0 was mainly staffed with business graduates who lacked industry expertise and understanding, which led to negative collaboration experiences for the main organization. One interviewee from Case A describes it as follows: *"That was a first mistake; it was a very closed*

high-talent club. [...] So [with a] good business degree, young guns, motivated people, also very well-paid people who were in the storming phase of their career, who wanted to implement an industrial case quickly and who then also arrived in [headquarters] with a young gun attitude. And they found it incredibly difficult to accept, embrace, and anticipate the speed of [Case A] and then find a different speed for themselves." A similar situation was observed in case B. In Cases D and E, the issue primarily revolved around the lack of expertise in developing digital products, services, and business models. Case D had predominantly designers on the team who did not adequately prioritize economic value creation. In Case E, DIU 1.0 lacked dedicated software developers to implement innovation projects, and data scientists faced unclear roles within the DIU, resulting in unsatisfactory collaboration with the main organization. Additionally, in Case C, two different types of contracts for DIU employees caused administrative burdens and affected team dynamics (Lorson, Dremel, & Uebernickel, 2022).

The second most common negative trigger – observed in four out of five cases – was unsatisfactory results of DIU (supported) projects. Either they were too abstract, remaining at the level of a PowerPoint presentation, without any real implementation of digital products or services *("The result is 150 PowerPoint slides, all of which may be correct in themselves, but are not suitable for [the main organization]. [...] Things that are created there [in the DIU] are very academic, very theoretical and [...] [there are] often ideas that were validated, that were perhaps somehow still comprehensible, but it wasn't a piece of software that was developed"* – Case B), or they lacked sufficient economic potential, resulting in an inadequate impact on the main organization's overall value creation (Case A). Case E faced challenges because DIU 1.0 was working on too many projects concurrently with insufficient staff, resulting in instances where concrete implementation was not feasible. Case D even faced potential dissolution due to output-related issues (Lorson, Dremel, & Uebernickel, 2022).

Moreover, in three of the five cases, the collaboration with the DIU proved unsatisfactory for the main organization. In Case A, a lack of mutual understanding of each other's working methods hindered the establishment of a common way of working. In Case B, there was limited day-to-day cooperation between DIU 1.0 and the main organization, which led to difficulties in handing over innovation projects for implementation and operation. The main organization found itself without the necessary knowledge and expertise in its teams and felt unsupported by the DIU. Case E faced challenges because experts from the DIU team supporting the main organization in its innovation projects were not used effectively: *"What we did initially, in 2020, was the idea of a bit of a, yes, more of a body lending approach. [DIU] Data scientists there, [DIU] IoT architects there, and then 'the business already knows what to do with it,' and, in my view, that has only worked to a limited extent."* The approach of just lending individuals to existing teams was therefore considered unsuccessful (Lorson, Dremel, & Uebernickel, 2022).

Also, in three out of five cases, the main organization's insufficient acceptance of DIU 1.0 serves as another internal trigger. In Case C, the main organization's lack of full acceptance of DIU 1.0 can be attributed to cultural and political reasons. The

works council found it unsatisfactory that it did not have *"access to the employees with a limited liability company contract."* In addition, *"there are few who are really [DIU] fans, but many say, well, 'arrogance, casualness.'"* Its adoption of agile methodologies and interdisciplinary teams, which are essential for developing digital products, services, and business models in modern, new office spaces, was sometimes misunderstood, and seen as "playing around" rather than adding real value in the view of employees of the main organization. In Case E, the lack of buy-in stems from a strained relationship between the main organization and everything "digital" from previous experiences with an underperforming digital venture unit. The preceding DIU team also lacked industry experts, resulting in a poor understanding of the core business for which it was supposed to develop digital products and services. A similar observation applies to Case B (Lorson, Dremel, & Uebernickel, 2022).

The fifth identified trigger was challenges with the DIU's funding approach, observed in two of the five cases. In Case A, DIU 1.0 charged the main organization for its services, leading to dissatisfaction as the results did not meet expectations. Conversely, DIU 1.0 did not charge other departments or divisions for its services in Case D, resulting in financial losses (Lorson, Dremel, & Uebernickel, 2022).

The sixth and final negative trigger, also observed in two of the five cases, was related to the nature of DIU 1.0, which was a half-hearted or actionist, strongly individual-driven initiative. In Case A, the company's digital transformation, including DIU 1.0, was initiated by the then-CEO toward the end of his career. However, he left the company soon after, leaving the initiative without a strong advocate. In Case D, the creation of DIU 1.0 was perceived as a rather half-hearted attempt to kick-start the company's digital transformation with innovation projects that, from today's perspective, looked more like feature developments than new business models: *"[Within the innovation process] you are supposed to explain that it's a new product or a new business model or a new something and 'How much revenue potential does this have?' But it wasn't like that. So effectively, it was more like features for existing products."* (Lorson, Dremel, & Uebernickel, 2022).

As mentioned above, one positive trigger for the evolution to DIU 2.0 was that DIU 1.0 had achieved parts of its goals. In Case B, DIU 1.0 had its first Minimum Viable Products (MVPs) in the market, demonstrating progress, but faced challenges in scaling without access to the main organization's IT infrastructure. Reaching this milestone necessitated a new mandate for the DIU, leading to DIU 2.0: *"It was a natural process where we said that as soon as we hit this glass floor, we would have to look at how we deal with the issues. [...] And we got to the point where we had MVPs in the first markets that were now finished [...]. We would now like to make it bigger, put it on a technical foundation, but that wasn't possible. [...] We have to change something, and that's how it all started: new leadership and a clear need to change the mandate."* In Case C, establishing the DIU as a limited liability company to attract digital talent became unnecessary as the brand was now well-established in the labor market. In Case E, DIU 1.0 convinced the main

organization of its value and qualified it for greater responsibilities (Lorson, Dremel, & Uebernickel, 2022).

No external passive triggers were identified in the data set.

4.1.2 Conflict and Transition to the Synthesis

During the second year of operation (after an average of 18 months), the clash between thesis and antithesis led to a conflict resolved similarly in the synthesis in all five cases. The first step was a period of strategic realignment specific to the DIU (Cases A, D, E) or company-wide (Cases B and C) and varied in scope and duration. For example, Cases A and B had a strategic project lasting approximately six months, during which the new DIU 2.0 setup was decided and designed, followed by a reorganization phase of around three months. In Cases C and D, the strategic realignment was much shorter, lasting about two months. Case C involved a nine-month merger project as the DIU was legally reintegrated into the main organization. Case D underwent a reorganization phase lasting three to four months. Case E experienced the least overall change among all five cases. They dynamically developed the new DIU 2.0 tasks, mandates, and processes, as well as team additions and restructurings over seven to eight months (Lorson, Dremel, & Uebernickel, 2022).

The resolution of the conflict and development of the new DIU 2.0 setup did not involve the original DIU team in Cases A and D and only partially in Case B. In these cases, an external consulting firm or the new DIU management took charge of this task in consultation with the main organization's management. Conversely, in Cases C and E, the responsibility for these activities rested with the DIU management, with partial involvement from other individuals within the DIU team (Lorson, Dremel, & Uebernickel, 2022).

Overall, two positive changes were observed, namely the expansion of the goals and responsibilities of the DIU in Cases B and E. The work of the DIU 1.0 emphasized the need to address digital transformation seriously and on a larger scale, leading to an expansion of the DIU's role and contributing significantly to this effort. In these cases, the DIU changed according to the phase logic originally conceived, aligning with the life-cycle motor of change. In Case B, for instance, the DIU was in the second of three development phases, referred to by the company as the professionalization phase, when the reorganization occurred. It is now moving into the third phase, the impact phase: *"So we had that in the old [DIU] setup. We had a wave chart where we said that we had a ramp-up phase, so to speak, year zero. Then we said there was a professionalization phase in which the team was clear about what it was doing that these structures were settling in, and then we called the last phase the impact phase, where the structure was there, topics were clear, and delivery came out. […] [W]e kind of went into this reorganization the moment we professionalized, which means we are still […] in the professionalization phase, which now looks a bit different than originally planned. We will get to this impact phase."* Similarly, in Case E, DIU 2.0 is in the second of four phases, equipped with various characteristics intended for this phase. Conversely, Cases A and D witnessed significant changes in DIU goals,

tasks, processes, and teams due to the main organization's perceived inadequacy of the previous DIU 1.0 setup. Finally, in Case C, the reintegration of the DIU into the main organization was driven by economic and corporate strategy considerations, in addition to fulfilling its role as an employer branding initiative (Lorson, Dremel, & Uebernickel, 2022).

4.1.3 Thesis and Synthesis – Changes from DIU 1.0 to DIU 2.0

Since this dissertation focuses primarily on the first evolutionary step of a DIU, this section will concentrate on the aspects where changes have occurred. As mentioned earlier, the initial setup is DIU 1.0, and the post-evolution state is DIU 2.0. This chapter describes the differences between DIU 1.0 and DIU 2.0 based on five categories: *goal, mandate, governance, team*, and *processes*. These categories are derived from the current DIU literature (Barthel et al., 2020; Fuchs et al., 2019; Holotiuk, 2020) and inspired by the data collection and analysis results.

The results presented in this section are case-specific to provide a sufficiently detailed description of the changes observed between DIU 1.0 and DIU 2.0 and to give an idea of the potential scope and facets of the evolution of a DIU. For this reason, they are based on 218 second-order codes derived from an initial set of 452 first-order codes and then aggregated to the level of individual cases. Below, the major changes between the initial setup and the DIU after the first evolution step are highlighted (Lorson, Dremel, & Uebernickel, 2022). A more detailed version of the changes can be found in tabular form in Appendix A.

Case A

Goal. The original goal of fostering disruptive innovation outside the main organization has shifted to supporting the main organization in generating incremental innovation with a specific focus on the core business (Lorson, Dremel, & Uebernickel, 2022): *"The [DIU] started very differently from how it is currently functioning. And we have certainly gone through a big, well, hype cycle [...][like others] who have tried to [...] create disruption and then perhaps consciously founded outside the parent company [...] then realized: Ideas come out of it, but no business. [...] We are approaching this with this [DIU] team by saying: 'It is an incremental process.' The constant optimization and the constant approach to the market and the ever better understanding of the needs of the contact person – that is, I think, something we could support by accompanying such projects."*. This shift also includes the creation of (IT) infrastructure foundations to enable the development and delivery of digital products and services as complementary offerings alongside machinery and equipment.

Mandate. DIU 1.0 and 2.0 are the main organization's digital transformation initiatives but not the primary driver. While DIU 1.0 served mainly as a catalyst for innovation, rapidly generating and validating ideas for investment decisions, DIU 2.0 takes a different approach. It executes tangible projects that serve as prototypes to illustrate an alternative path to business growth through digital offerings to the main organization. The core activities of DIU 2.0 include exploring the potential

of ideas, supporting the main organization in developing digital products and services (including user research, business modeling, agile project management, etc.), cultivating partnership networks and ecosystems, and providing educational resources and methodological support.

Governance. The legal entity created for DIU 1.0 remains on paper but is effectively overseen by a consulting firm specializing in digital business modeling acquired by the main organization. In addition, DIU 2.0 establishes *"a [quarterly] Steer-Co [steering committee], which includes the CEO of the digital department and the Managing Director seconded by the [Case A] Management Board"* and the head of the DIU 2.0 to make strategic decisions. This transition from DIU 1.0 to DIU 2.0 includes a change in funding strategy from DIU 1.0, which charged other departments for its services, to centralized funding for DIU 2.0. Finally, DIU 2.0 continues to operate as part of the "Innovation & Technology" division and maintains separate offices in a different city from the main organization.

Team. All employees of DIU 1.0 (approximately 15-20 people) voluntarily resigned after the new structure was announced, paving the way for a comprehensive restructuring. In its current form, DIU 2.0 has no permanent staff. Instead, it receives an annual budget of about 17 full-time positions to hire individuals from the acquired consultancy or from its network of freelancers to work on DIU projects. In addition, DIU 2.0 projects now predominantly involve individuals familiar with the main organization's operational environment and can bridge the gap between the technical and digital domains: *"Domain know-how is essential for us; it has to be there. We don't do anything without market access and in-depth expertise from the divisions [...][–]it can only be done by cross-functional teams."* This was necessary because collaboration between the DIU 1.0 team, which consisted primarily of business graduates with no specific industry expertise, and the main organization was challenging. In addition, all DIU 2.0 project teams include at least one representative from the main organization to ensure domain expertise.

Processes. DIU 1.0 adhered to a structured design thinking approach that focused on rapidly validating ideas and making investment decisions for individual projects one at a time. In contrast, DIU 2.0 has adopted and currently follows a five-phase innovation process, from idea generation to developing a minimum viable product, while managing multiple projects simultaneously. DIU 2.0 actively participates in the innovation process from the beginning, supporting the main organization in user research, visual design, and business modeling. In addition, DIU 2.0 staff commit to projects for extended periods, increasing team stability and facilitating a seamless handover to the main organization for ongoing operations. The steering committee now selects projects quarterly.

Case B

Goal. The goal of the DIU has shifted from its initial experimental and exploratory phase as DIU 1.0, which defined strategic priorities, explored new areas of innovation for the main organization, and conducted pilot projects, to its current role as DIU 2.0, which focuses on implementation: *"So [DIU] was [...] an internal*

digital incubator, an explorer. [...]It [a project/an idea] comes from the business, goes in, goes through a flow heater, and then goes back again. [...] [Now] we have gained implementation competence. In other words, we are building a tech delivery unit to build things outside of IT. And not just prototypes that can do a few features, but can penetrate the core systems SAP, CRM [Customer Relationship Management], and PIM [Product Information Management] system." DIU 2.0 takes previously identified projects and scales them globally. Its primary innovation focuses on digital products, services, and business models around machines to establish digital offerings as a complementary growth driver to the core business. In addition, there is a concerted effort on digital products and services with customer interfaces, strengthening the link between "digital" and sales.

Mandate. DIU 1.0 decomposed digital transformation into smaller components and created, tested, and validated new digital products, services, and business models in a liberated environment before reintegrating them into the main organization. Conversely, DIU 2.0 now plays an integral role in shaping the main organization's new digital transformation strategy and executing projects outlined in the predefined global roadmap. In addition, substantial groundwork is being done to establish the company's digital presence. This includes building a unified IT infrastructure, digitizing existing processes, and fostering employees' understanding of the digital domain. From its role as a facilitator of innovative ideas tailored to individual markets and customer needs, the DIU has evolved into a unit responsible for the global implementation of scalable digital products, services, and business models.

Governance. The legal entity of DIU 1.0 also serves as the organizational container for DIU 2.0, but the distinct digital brand has been dissolved, so there is no longer a clear declaration as a separate legal entity. In addition, DIU 2.0 has established a second office location at the company's headquarters to increase proximity to the core business: *"As part of the reorganization, we have added a second location, I would call it, in [City], where our headquarters are located. [There] we naturally have very good access to various top decision-makers [...], and it is therefore not so bad to be there regularly because if a few operations are based there, you also have a bit more, shall I say, exposure."* In essence, DIU 2.0 has moved to operate at the Group level concerning its activities and integration, functioning as a global entity and reporting to the Group Commercial Officer. Within DIU 2.0, four newly formed departments include a large business-oriented team focused on digital customer interaction, a technology-oriented team, and a Global Digital Steering Committee that meets quarterly to make strategic decisions on the project portfolio and roadmap.

Team. The DIU 1.0 team of approximately 20 to 25 members consisted primarily of individuals with backgrounds in business, economics, or related fields. However, as DIU 2.0 evolved into an implementation-oriented unit, the need for an additional IT team with in-house software developers to complement the existing skills and form interdisciplinary project teams became apparent. As a result, in addition to the DIU 1.0 staff, several new hires were brought on board,

along with selected individuals and departments from the main organization with digital and customer-facing roles (e.g., the DIU *"integrated the former 'Group Marketing' department, which was responsible for the entire topic of CRM on a global level and brand on a global level. […] Then we incorporated a department in the [Case B] Group that dealt with the topic of PIM, Product Information Management, which has now also become part of this digital organization."*), to form the DIU 2.0 team. The target size for DIU 2.0 is now approximately 100 people.

Processes. DIU 1.0 and 2.0 follow an agile, customer-centric approach to developing digital products, services, and business models. DIU 1.0 enjoyed considerable autonomy in project selection and end-to-end responsibility from concept to minimum viable product. In contrast, DIU 2.0 operates within a clearly defined project portfolio and associated roadmap. However, DIU 2.0 takes full responsibility for innovation projects, overseeing them from development through implementation to ongoing operations. Workflows have become more deliberate, as digital products and services are no longer rapidly experimented with in a standardized three-step innovation process to create products of streamlined complexity for specific markets. Instead, these innovations are implemented on a global scale. In addition, the collaboration between DIU 2.0 and various departments within the main organization, such as core IT, marketing, or sales, has become closer.

Case C

Goal*.* The original goals of DIU 1.0 are not expected to change under the new structure. These goals include developing data-driven digital business models closely linked to the core business, generating recurring revenues to complement machine sales, attracting digital talent, and transitioning from a product-centric to a user-centric company. However, the feasibility of the latter goal has become uncertain due to the reintegration into the main organization, as expressed by an interviewee: *"[T]he original approach of turning a product-centric company into a user-centric company is now dead. […] So, the mission may still be the same, but the difficulty, so to speak, of creating this in an existing organization geared towards a different mission is very difficult. So, in this respect, the approach of full integration, as it is happening now, is not helpful; on the contrary, it is counterproductive to the goals that the [DIU] has."* In addition, DIU 2.0 focuses on strengthening ecosystem cooperation between DIU and the main organization.

Mandate. DIU 2.0 continues to be instrumental in advancing the main organization's digital transformation efforts, focusing on driving comprehensive digital marketing initiatives, building, and maintaining a digital ecosystem, and developing and implementing digital products, services, and business models. It also retains its role in building competencies related to creating digital user experiences, coupled with the autonomy to drive innovation efforts with a degree of independence. In addition, DIU 2.0 assumes responsibility for all external communications on behalf of the main organization and takes control of certain IT systems previously managed by the core IT. It is also given an expanded mandate

to offer a variety of subscription models and drive the overarching data-driven sales approach.

Governance. The decision was made to abandon the approach of maintaining a separate legal entity and to fully reintegrate DIU 2.0 into the global sales and marketing organization of the main organization. In the process, certain members of the DIU 1.0 team were transferred to other departments within the main organization with expanded responsibilities. The unit's original purpose remains intact, centered on employer branding to attract digital talents and provide them with industry-standard contracts. The digital brand *"will continue to exist as an image with its own website."* In addition, the original office space in a newly renovated building on the main organization's campus, the modern work environment characterized by a people-centric management approach, and the practice of agile collaboration in cross-functional teams will be maintained, preserving the ethos and culture established by DIU 1.0: *"[T]here is now a change in labor law for the people, they now all have stock corporation contracts, and [...] are now all members who are represented by the works council, [...]. But for the working environment and daily cooperation and life in our beautiful [DIU] hall, it has no effect at all, no influence."*

Team. The team remains relatively unchanged, although certain segments of the DIU 1.0 team have been reassigned to other departments within the main organization, as discussed earlier. However, of the 60 employees of DIU 1.0, approximately two-thirds were employed directly by the main organization, while the remaining one-third held contracts with the limited liability company. With the elimination of the separate legal entity, all DIU 2.0 employees are now under new contracts with the main organization.

Processes. All existing workflows, procedures, and established routines from DIU 1.0 will be maintained. This includes assessing performance against annual goals and monthly evaluations using the "Objectives and Key Results" methodology, adhering to a four-phase innovation process for implementing and continuously improving digital products, services, and business models, and working closely with the main organization throughout its processes. Nevertheless, since the announcement of the reintegration, there has been a noticeable increase in requests for collaborative projects involving DIU 2.0 from the main organization: *"So what we are also seeing now is that one positive aspect of the merger is that we are having more impact in the [main organization], that we are seen less as a foreign body. After three years, one project says: maybe that's not so bad. So [name], my innovation manager, is now being booked as a practitioner for design thinking."*

Case D

Goal. While DIU 1.0 operated as a traditional corporate innovation lab, primarily aimed at developing MVPs and catalyzing cultural change as a precursor to the company's digital transformation journey, DIU 2.0 assumes the role of an *External Creator* (self-designation as a company builder): *"[DIU started] as a classic corporate innovation lab, and then [...] I've reorganized it quite a bit. Originally, it was just a classic MVP lab, mainly driven by cultural transformation and change.*

I've reorganized it a lot in the direction of a company builder." Its primary focus is to nurture independent, industrial software-as-a-service companies, emphasizing user-centric, machine-agnostic, AI-powered software solutions tailored to manufacturing companies with a revenue potential of over €50 million. The current focus is on digital products, services, and business models relevant to core business processes within the main organization's value chain. In particular, while it still supports the overarching digital transformation efforts and seeks to drive cultural change within the organization, these objectives have taken a secondary position, at least for now.

Mandate. DIU 1.0 was primarily designed to generate various ideas, initiate innovation projects, and support other departments in their projects. In addition, it should spark enthusiasm for digital topics among employees. In contrast, DIU 2.0 is expected to create one to two new digital ventures annually and acquire manufacturing startups to bolster its portfolio. The innovation team will no longer support other divisions with innovation projects unless they are intended to become standalone ventures; a new, separate software development hub will be responsible for this. Learning formats such as webinars, workshops, and agency support for the main organization are still secondary tasks: *"Even though we focus on venture building, we have these educational offerings and [...] that's why we also offer agency support when we're not on ventures. For example, if our business areas need help with design, a UI/UX design, or need to validate a project."*

Governance. DIU 2.0 remains a separate legal entity and division of the main organization, with offices in a city different from the headquarters. However, it has undergone substantial structural changes, including establishing a dedicated innovation team that owns the innovation process led by a new Head of Digital Innovation. In addition, DIU 2.0 has established its software development infrastructure through the aforementioned hub. Financially, DIU 2.0 aims to become a profit center and has initiated charging other divisions for its services, a departure from the previous model that resulted in losses for DIU 1.0. Finally, any spin-offs created within DIU 2.*0 "are separate companies that are wholly owned subsidiaries of [DIU 2.0], which are effectively the Business Area."*

Team. *"The organizational structure [of DIU 1.0] was driven by designers who simply didn't understand this basic issue that your user is not your customer,"* which led to a focus on consumer-oriented and design-centric innovation projects rather than emphasizing economic value creation. In addition, there was a lack of in-house software developers to implement digital products, services, and business models. As a result, DIU 2.0 underwent a major restructuring. This restructuring included hiring experts with experience building independent businesses, such as venture architects and innovation managers, to give the unit a stronger business orientation. At the same time, a dedicated software development team was established. As a result, DIU 2.0 now has an interdisciplinary team led by a new Head of Digital Innovation, and the innovation project teams themselves are also interdisciplinary.

Processes. Many ideas that entered the DIU 1.0 stage-gate innovation process lacked strong financial potential and often represented incremental feature developments rather than fully-fledged, stand-alone digital products or services. In addition, none of the projects made it past the fourth of the six available stages because the Innovation Committee always decided on a case-by-case basis rather than selecting the best of all the projects presented for the next stage. In contrast, the innovation process within DIU 2.0 has been lengthened and now spans approximately one year, compared to the previous duration of six months. This revised process has been streamlined to include only three phases and is subject to ongoing refinement. In addition, the DIU 2.0 team actively collaborates with other divisions through joint workshop sessions to stimulate idea generation and select projects with robust spin-off potential: *"[We had] workshops last year, which started with identifying problems. We did this with every business unit last year. This year, we want to focus more on future states and start workshops. But in any case, we are helping to generate the ideas. Then a pitch is created, and a decision is made [...] Yes, it's a stage-gate process. The phases have changed a bit. So, in the beginning, we didn't have Idea Discovery. Now we have that included."* Furthermore, each project team should have a co-development partner, either from the main organization or externally, and hold weekly sparring sessions with the DIU CEO to ensure alignment with management objectives.

Case E

Goal. For DIU 2.0, the goals of DIU 1.0 have been refined and now include four primary focus areas: 1) *"support the various business units and business lines that exist at [Case E] in developing and marketing digital products and services,"* 2) *"advance the topic of digital sales and e-commerce,"* 3) *"digital manufacturing, i.e., digitalizing internal processes at [Case E] in the production area,"* 4) *"digital administration, in other words, when it comes to using process automation to help simplify and accelerate processes in the areas of finance or administration."* What remains constant is the DIU's responsibility to develop and implement digital products and services in close alignment with and for the core business and to digitize internal processes. It also aims *"to support this process of cultural change"* integral to digital transformation and to build and aggregate digital capabilities that can be leveraged across the organization.

Mandate. In parallel with the goals, there are only minor changes to the mandate of DIU 2.0. Two key adjustments decided by the top management include: 1) DIU 2.0 focuses primarily on and takes full responsibility for the four designated focus areas, 2) virtually all projects to develop digital products, services, or business models are now routed through the leadership of DIU 2.0, ensuring a continuous exchange with the main organization. Its overarching role in the digital initiative, which aims to strengthen and extend global market leadership and embed digital expertise and agile methodologies within the main organization, remains unchanged.

Governance. DIU 2.0 retains its office space and continues to integrate seamlessly with the main organization's overarching governance model. This integration

includes common elements such as a unified code of ethics and standardized travel expense policies. At the same time, DIU 2.0 retains its distinctive culture, characterized by a spirit of experimentation, agile working methods, and interdisciplinary teams that take significant ownership of projects. However, DIU 2.0 is establishing its governance structures, including dedicated program management. It is also transitioning its funding approach from central funding to a partially implemented hybrid cost center model, where some departments are already being charged for their services: "*In the first phase, we had central funding [...]. In the current phase, we charge for projects and are a cost center. And in the future phase, we will become more of a profit center and charge for certain digitalization services based on the benefit for the internal customer rather than the hours worked.*"

Team. In addition to the initial interdisciplinary team of DIU 1.0, DIU 2.0 has brought on board dedicated software developers to implement solutions and create tangible value effectively. Moreover, each project within DIU 2.0 now requires the involvement of two key individuals: a business owner from the main organization to ensure alignment with market needs (*"[Y]ou always need someone in the business line to give you access to the customer and so on. And that's why this business owner is always necessary and must always be in place."*), and a C-level sponsor from the division's board of directors to provide critical support, including budget allocation and resource backing, to drive the project forward (*"There is also the CXO sponsor, i.e., the sponsor from the management board of one of the decisions. The CXO sponsor has his [business owner's] back and makes sure that the business owner can keep the promises that are made."*).

Processes. While DIU 1.0 did not engage in project selection but rather offered support to the main organization in various capacities to enhance reputation and credibility (*"The first phase was to build reputation, to earn trust. We simply did everything we were asked to do. We did that [...] for a year."*), DIU 2.0 has now adopted a well-defined six-phase stage-gate innovation process. Within this framework, four key focus areas have been identified and are currently being executed with dedicated project teams, a clear strategy, and defined key performance indicators (*"We now want to do significant projects, we want to have overall responsibility for projects, and we now have about 80% of the resources on four core projects. These are four major projects, and two projects are in conjunction with the Corporate Strategy department.*") DIU 2.0 has the flexibility to lead or support projects and uses an agile product development methodology that follows a SCRUM-based approach. This shift has led to closer collaboration with core IT, ensuring alignment with enterprise architecture standards and the smooth operation of implemented digital products, services, and business models, including customer support and service.

In summary, responding to the call of several authors on new forms of organizational design and their practices (Hanelt et al., 2020; Yoo et al., 2012; Zammuto et al., 2007), this chapter explored the fundamentals of DIU evolution, i.e., *how DIUs evolve over time to meet the needs and expectations of the main*

organization (RQ1). They are observed to evolve naturally rather than by design, driven by the convergence of dialectic and life-cycle motors of change (Lorson, Dremel, & Uebernickel, 2022). In this way, DIUs leverage their greater malleability to adapt to the antitheses they encounter, using a mechanism of conflict resolution that leads to a new DIU design, synthesis. Building on the work of Van De Ven and Poole (1995), this chapter provides empirical insights into the nature of DIU evolution through a multiple case study of five real-world cases. It informs theory-building about continuous organizational design change during digital transformation. In addition, it establishes a foundation for research on DIUs that views these units as dynamically evolving to meet the needs and requirements of the main organization, thereby making a lasting contribution to its digital transformation (Lorson, Dremel, & Uebernickel, 2022).

4.2 Temporal Dynamics in DIU Evolution

Since change and adaptation inherently occur over time, it is imperative to adopt a temporal perspective when studying STS and their evolution to understand the influence of temporal factors in this process. Various authors therefore advocate using time as a research lens (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001) – or have already heeded this call (Conboy et al., 2020; Gerster et al., 2021) – and shifting from an actor-centered orientation to a flow-oriented approach and vocabulary when studying socio-technical change in the digital world (Mousavi Baygi et al., 2021).

To build on the previous chapter's results and extend the dynamic understanding of DIUs, this dissertation adopts the temporal framework of Ancona, Okhuysen, et al. (2001). The goal is to gain a deeper understanding of *how and what temporal dynamics unfold during the evolution of a DIU* (RQ2) and the influence of temporal factors on DIU activities. This perspective is particularly relevant in light of the chosen manufacturing industry, which is constantly challenged between maintaining its traditional business of building large, physical machines and plants and meeting the demands of the digital age in parallel (Hylving & Selander, 2012). Product development and production are known for having extended time frames lasting up to a decade (Dremel & Herterich, 2016). Conversely, developing digital products, services, and business models appears to prioritize time and speed, as highlighted by Gerster et al. (2020). For instance, utilizing the "fast lane" narrative for DIUs (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b) exemplifies this focus on rapid progress.

The results presented in this chapter are based on the publication *"Beyond the Fast Lane Narrative – A Temporal Perspective in the Unfolding of Digital Innovation in Digital Innovation Units"* (Lorson, Dremel, de Paula, et al., 2022). The underlying database comprises five of the seven case studies –Case B, Case C, Case D, Case E, and Case F – and 30 interviews over seven months (January – July 2021). The data structure resulting from the data analysis consists of 347 first-order codes, 59 second-order codes – from which 13 particularly interesting and relevant

second-order codes were selected – and five aggregated dimensions (Chapter 3.3.1).

4.2.1 Temporal Factors in DIU Activities and Outputs

Moving beyond the one-dimensional understanding of DIUs as innovation "fast lanes" (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b), i.e., from a perspective of speed, the role of time in DIU activities and outputs is presented by illustrating five key themes and their links to innovation practices in DIUs. These themes are based on five aggregated dimensions derived in a three-step coding process for data analysis following Gioia et al. (2013), which was explained in Chapter 3.3.1 and read as follows (Lorson, Dremel, de Paula, et al., 2022):

1) Spasmodic temporal style allowing flexibility and "the right timing,"
2) Multiple activity mapping leads to loss of focus and speed,
3) Faster DIU decision-making; objective and mediator between speed expectations and reality,
4) Steadiness of company outputs through DIU business models with subscription character and recurring revenues,
5) Trust as a moderator for the intensity of time pressure on DIU activities and outputs.

Building on these and further generalizing the findings, this chapter develops five propositions to inform future research, drawing on Gioia et al.'s (2013). An explanation of how these were derived from the key themes is presented below. Any quotes from the case studies merely illustrate each theme to make the results more tangible and comprehensible.

Spasmodic temporal style allowing flexibility and "the right timing"

I don't even know if time is the primary variable. [...] I think flexibility and freedom, perhaps are the even more important variables", responded one of the interviewees from Case E when asked about the significance of time in the DIU and its innovation process. However, the time category *actors relating to time* show that these aspects are not mutually exclusive and can, in fact, be directly interconnected. Ancona, Okhuysen et al. (2001) provide an example of the so-called *spasmodic style*, a temporal style that might be adopted by "an organization in a more unpredictable industry [...], recognizing that the past is not tightly linked to the future. In a spasmodic style, managers influence the pace of change to make it faster or slower through innovation, which provides freedom for a broader range of action" (p. 519). It contrasts with a clock-time temporal style, which may be adopted by an organization operating in a slow-moving and predictable industry, where the organization's history is well understood, and the connection between the past and the future is evident (Ancona, Okhuysen, et al., 2001).

Both temporal styles fall into the subcategory of *temporal personality*, which is defined as "the characteristic way in which an actor perceives, interprets, uses, allocates, or otherwise interacts with time" (Ancona, Okhuysen, et al., 2001, p. 519; Sherman, 2001). The spasmodic temporal style aligns well with the structure of the

DIU as an environment designed to foster value creation in the form of digital products, services, and business models (Fuchs et al., 2019). This alignment is particularly evident in the workflows and planning horizons of a DIU's innovation process, which strongly emphasizes flexibility, especially concerning time. The planning process is primarily content-driven, often focused on events such as the launch of an MVP at a fixed date. From this milestone, subsequent planning is typically done on a rolling basis, following a SCRUM approach with quarterly cycles and two-week sprints. Over time, the level of planning detail decreases and extends beyond the innovation process to the entire planning horizon of the DIU. Goals are clearly defined annually but tend to become more generalized over the next two to three years, with only a few significant milestones as reference points. By adopting this approach, the DIU builds flexibility into its processes to effectively respond to customer feedback, environmental influences, and other factors. This allows the DIU to consistently incorporate these inputs into its planning, facilitating adaptability and responsiveness. The flexibility and freedom and the continuous exchange of feedback with customers throughout the innovation process play a critical role in helping the DIU determine the "right timing" for various activities. This includes decisions such as market entry, further investment in specific products or services, and overall value creation, as highlighted by one interviewee in Case B: "*And then you can see that if we do this planning, then you have to support it accordingly because then our products are also placed there accordingly. So, there is a lot of communication with the different customer groups, I would say. That helps us to do the right thing at the right time.*" Another person from Case B assigns an even greater significance to the unit concerning "right timing" and considers this ability as a crucial complement to the main organization's capabilities in terms of value creation beyond the innovation process: "*But in the meantime, and especially in the constellation with [the DIU] [...], we have made it our mission to develop things in the right order, centered on the user. [...] And this should ensure that we don't take the third step before the first and address the most important issues from the customer's perspective. And I believe that this is a capability that [DIU B] [...] has had for a long time, and that is good for the core organization because I don't think they have it there.*"

The DIU's spasmodic temporal style and human-centered approach facilitate the flexibility and freedom needed to develop and implement digital products, services, and business models. This approach complements the clock time temporal style of the main organization, resulting in an enhanced approach to value creation for the entire organization and harnessing the capability of "right timing." Time, timing, flexibility, and freedom are intricately intertwined and interdependent regarding DIUs, establishing them as a valuable additional source of value creation for manufacturing companies. This leads to the following *Proposition 1* (illustrated by arrow 1 in Figure 13): "*By adopting a spasmodic temporal style, DIUs create the necessary flexibility and space to sense the 'right timing' required to [develop and implement digital products, services, and business models], thus becoming an essential, additional source of value creation.*" (Lorson, Dremel, de Paula, et al., 2022, p. 8)

Multiple activity mapping leads to loss of focus and, thus, speed

In all five cases, DIU project team members faced the challenge of engaging in *multiple activity mapping* across various temporal zones within the organization. This contrasts with previous findings, such as in a cross-industry case study by Holotiuk and Beimborn (2019), where individuals moved temporarily between the DIU and their department, allowing them to focus exclusively on exploration in the DIU for a certain period each year (usually between two and four months) while devoting the rest of their time to exploitation in their department. In the five cases considered, however, the interviewees had to allocate their working time daily or weekly, either between several DIU projects or between DIU projects and their routine business tasks for the main organization. With this percentage distribution, there is a risk of losing focus quickly, potentially slowing DIU activities and outputs. A quote from Case F illustrates the issue: *"Another challenge-, I would say- the biggest one is the daily business. The workload. It's a reality that none of us [...][has] fifty percent time. So, we ha[ve] to find time. But there is also day-to-day. [...] That means this balance can be found between new tasks in the [DIU F]. But there is a [n existing] world, and it has to go on. That's this workload"*.

In addition, employees involved in DIU projects and the regular operations of the main organization face the challenge of allocating their time between two different temporal zones. "On the one hand, there is the DIU, the fast-paced, short-term, short-cycle organizational temporal zone with a culture of speed. On the other hand, there is the main organization, which operates with medium- and long-term time horizons" (Lorson, Dremel, de Paula, et al., 2022, p. 9). Employees who navigate these two temporal zones simultaneously should adjust to their respective paces, cycles, and time horizons. This requirement calls for temporal coordination mechanisms because, as Ancona, Okhuysen, et al. (2001) observe, many managers who move from a stable industry to a more dynamic one often find it difficult to keep up with the change in pace. So far, these mechanisms have not been implemented, as evidenced by the following quote from Case D: *"Last year, we staffed the teams in such a way that we said, okay, we need 60 percent a product manager. We need 40 percent a designer [...] and so on. And with these percentages, that just doesn't work, [...] or didn't work for us, because the team just becomes incredibly slow when they're still doing their daily business on the side. And that's where we are now or are currently in a bit of a struggle, to say, okay, we'd rather have a small team, we don't need five people, we'd rather have two or three people who can work full time. Because that leads to focus."* The quote also highlights that instead of implementing temporal coordination mechanisms, current solutions aim to avoid splitting the working time between the DIU and the main organization. This approach is taken to prevent simultaneous involvement in two different temporal zones, ultimately reducing defocus and slowing down of DIU activities. Clearly, focus plays a central role in DIU's activities and outputs and requires a significant investment of working time at the individual and team levels.

These findings validate the existing body of knowledge from (innovation) project management, highlighting the importance of time investment for maintaining

focus, as demonstrated by studies such as Kerzner (2019), especially in the context of DIUs in the manufacturing industry. It is noteworthy, however, that despite this knowledge, the five companies under consideration (continue to) engage in *multiple activity ma*pping across different temporal zones within the same timeframe. This observation also contrasts with previous research on DIUs by Holotiuk and Beimborn (2019). Therefore, this thesis would like to reiterate the significant importance of maintaining focus, especially regarding the unfolding of DIU value creation in the form of digital products, services, and business models, which leads to *Proposition 2* (illustrated with arrow 2 in Figure 13): "*To ensure sufficient focus and thus facilitate DIU [...][activities], a division of employees' time capacities on a daily or weekly basis – especially between DIU and main organization – should be avoided.*" (Lorson, Dremel, de Paula, et al., 2022, p. 9).

Faster DIU decision making; objective and mediator between speed expectations and reality

As discussed in the exploration of Proposition 2, DIUs and their main organizations represent two complementary temporal zones within the overall organizational context. On the one hand, there is the fast-paced, short-term, short-cycle DIU, which emphasizes speed. On the other hand, the main organization operates with medium- and long-term time horizons. Nevertheless, in the context of the five DIUs analyzed in manufacturing companies, there are robust dependencies of the DIUs on their main organization that go beyond the challenge of employees engaging in *multiple activity mapping* across temporal zones mentioned earlier. Given that all five DIUs focus their efforts on the products of the main organization and operate close to the core business to develop digital products, services, and business models "around the machine," the innovation teams rely heavily on the expertise and customer access of the main organization. In addition, they face ad-hoc requests, strategic planning expectations, resistance from other business units to the DIU, and meeting delays, which makes it difficult to meet the main organization's expectations for rapid implementation. However, these dependencies are well recognized and either desired or must be accepted due to the core business-related mandate of the DIU. As a result, statements from all five cases emphasize that a DIU is primarily perceived as an agile, lean, and decision-friendly unit, characterized by considerably faster decision-making processes than in the main organization: *"[...] there is, so to speak, a need for action and a field of action that we definitely take care of and where we then also frequently ensure that quick decisions are made. In other words, as quickly as is necessary for such digital topics"* (Case E). *"In theory, the DIU should be faster. I mean, there are many reasons why we have set up this DIU. [...] And one of those reasons- many others- but one of those reasons is to work outside of the official processes. That doesn't mean having the same decision-making process as all the other processes. Because those are usually very slow."* (Case F).

As a result, prioritizing faster decision-making processes becomes a critical goal for DIUs from a process perspective. These accelerated decision-making processes mediate between the main organization's ambitious expectations for rapid value creation and the comparatively slower pace caused by dependencies within the

corporate environment during the transition between two organizational time zones. This leads to *Proposition 3* (represented by arrow 3 in Figure 13): *Regarding speed, DIUs operating in high-dependency environments should focus on rapid decision-making to meet the main organizations' expectations concerning speed of implementation* (Lorson, Dremel, de Paula, et al., 2022).

Consistent company outputs through DIU business models with subscription character and recurring revenues

Focusing on DIUs in the manufacturing industry, known for its traditional machine sales and extended sales cycles, has also led to industry-specific insights related to temporality. Creating a DIU allows manufacturing companies to transform their entire sales and customer lifecycle. With the introduction of digital services around or in addition to machines, such as online spare parts stores, predictive maintenance solutions, or remote assistance services, the main organization creates entirely new business models. These innovations reshape how the company operates and interacts with customers, leading to transformational opportunities in manufacturing. Because these services are typically provided on a subscription model with recurring revenue, they serve as a valuable complement to the main organization's existing sales cycles. This effectively reduces the historically high peaks in the machine sales timeline, resulting in a more stable and consistent revenue stream for the company as a whole: *"[I]f you classically sell plants or machinery, it's a transactional business with [...] a large deal size. You sell it [to someone] for three million [...] [, it] lasts 15 years, and then maybe after ten years, he buys a new machine. That means [...], on the timeline, you have huge peaks [...] and that has to be made permanent [...] so that it becomes a continuous business. And that is the core of the [...] [DIU C]: Finding new business models that don't have this transactional character, but that have a subscription character [...] so basically recurrent revenues."* (Case C). Furthermore, the DIU's potential to extend the customer lifecycle is evident when, for example, customers purchase spare parts from the DIU's online shop rather than from another supplier. DIU can also leverage these benefits in other industries with similar business models, such as construction and real estate, and to a lesser extent, the automotive industry or the sale of major household appliances.

Besides generating more consistent revenues, DIU activities primarily revolve around continuity. Their agile approach involves continuous improvement of their products or services rather than working on projects with a specific endpoint, which can be seen in contrast to the core IT operations of the main organization. As an interviewee in Case E articulated: *"[W]e want to work in an agile way, and we want to improve a product continuously, continuously gain more revenue and more customers, and not do any projects that have an end. For me, that's also kind of the core difference between classic IT and what we do."* This leads to *Proposition 4*, illustrated with arrow 4 in Figure 13: *DIUs create new subscription-based business modes with recurring revenues that complement the sales cycle of manufacturing companies, stabilize overall business performance, and extend customer lifecycles* (Lorson, Dremel, de Paula, et al., 2022).

Trust as a moderator for the intensity of time pressure on DIU value creation

Finally, this thesis identified trust as a critical aspect of DIUs, particularly as a moderator of time pressure on DIU activities and outputs. Since DIUs are established as the fast-paced temporal zone within an organization, higher speed is expected, leading to increased time pressure on activities and outputs. The longer it takes to achieve substantial results, the greater the pressure. Consequently, one of the most important goals of the DIU is to achieve initial results quickly, as an interviewee from Case D emphasized: *"I think that's the most important thing for everyone, to generate a quick win as soon as possible that has a relevant success. When people can say a statement like 'That works, they know what they're doing. And that's very successful.' And that is, I think, the most important thing. And if you don't manage to do that in a certain amount of time, then I think you've lost."* When tangible results can be demonstrated, the trust and acceptance of the DIU within the main organization grows, as indicated by arrow 5a in Figure 13.

As trust grows, the time pressure on the DIU to deliver outputs does not intensify further; it may even decrease. This allows certain projects to extend beyond their original timelines, giving the DIU greater flexibility to ensure the best possible outcomes: *"We still have a bit of a leap of faith that if you say, 'okay, this is complicated now' or 'it's going to take longer,' that's fine."* (Case E). Arrow 5b in Figure 13 expresses this relationship.
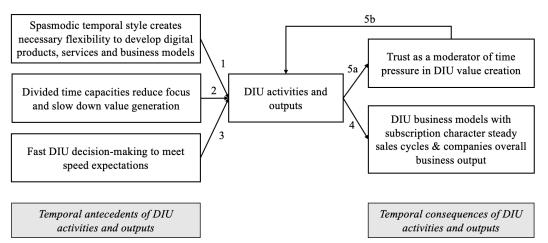
This observation underscores that while DIUs are designed to deliver (initial) results quickly, the focus is on developing digital products, services, and business models, not just on speed. The faster decision-making and implementation speed compared to the main organization should be seen as a means to an end to enable the generation of digital products, services, and business models through a fast, cyclical, and iterative way of working without adhering to traditional waterfall project planning. These findings are consistent regardless of who is in charge of the DIU. Case C, Case E, and Case F leaders are well-known and respected individuals who have worked within the main organization for several years. On the other hand, the current head of Case B was hired specifically to focus on digital transformation, and the head of Case D joined the company shortly before taking on the role of DIU head. However, no notable differences in the expectations placed on the DIUs could be found across the five cases considered.

In summary, trust plays a key role in the time pressure on DIU activities and outputs, as its growth can alleviate some of the tension. This leads to *Proposition 5*, represented by arrows 5a and 5b in Figure 13: "*Earning the main organization's trust is a central goal for DIUs, as it moderates the intensity of the time pressure [...][to create outputs]. Initially, time pressure is high and increases over time [...][without visible outputs] 5a). Through (rapid) [output] creation, trust [is built] vis-à-vis, which keeps the time pressure stable or [even] reduces it 5b)."* (Lorson, Dremel, de Paula, et al., 2022, p. 11).

4.2.2 Temporal Influences on and by DIU Activities and Outputs

Out of the five propositions, Propositions 1, 2, and 3 suggest antecedents of or facilitators for the unfolding of DIU activities and creating digital products, services, and business models, while Propositions 4 and 5 can be seen as consequences of these innovations. Figure 13 provides a graphical summary and gives an impression of the complex construct of the interconnectedness of time and the emergence of DIU activities and outputs. The arrangement and direction of the arrows are intended to illustrate the relationship between the propositions and "DIU activities and outputs." On the left, the antecedents (propositions 1-3) influence the development of digital products, services, and business models, while their development influences the consequences (propositions 4 and 5) on the right. Proposition 5 takes on a special role as it facilitates DIU activities in a second step. To connect with the DIU evolution process and its phase logic examined in Chapter 4.1, it can be said that the antecedents were mostly created in the start-up phase, while the consequences tended to become visible in the growth phase.

Figure 13: Temporal Influences on DIU Activities and Outputs.
Own Representation Based on Lorson, Dremel, de Paula et al. (2022, p. 11).

Although the concept of time in terms of speed and a ticking clock is certainly relevant, as shown in propositions 3 and 5, it plays a more substantial role than the narrative of the innovation fast-lane implies. Different speed forms are important for DIU activities and output creation, such as rapid decision-making processes and using speed to achieve certain outcomes, such as building trust. These aspects can be integrated into the broader context of organizational time zones. In addition, propositions 1, 2, and 4 shed light on temporal considerations associated with DIU activities that are not solely related to speed. Instead, they relate to other temporal variables such as time allocation (part of the *multiple activity mapping* subcategory), temporal style (part of the *temporal personality* subcategory), or cycle and rhythm (part of the *repeated activity mapping* subcategory). These temporal factors either influence or are influenced by the development of digital products, services, and business models.

4.3 Socio-technical Interaction in DIU Evolution

As stated in Chapter 2.3 and 2.4, the current literature provides a static picture of DIUs and a one-dimensional view of their interaction with the main organization. It either takes the perspective of the DIU that the main organization is struggling with digital technologies and how to incorporate digital products, services, and business models (e.g., Svahn et al., 2017) or the perspective of the main organization that the DIU is not delivering the expected value (e.g., Mayer et al., 2021; Raabe et al., 2020a). This dissertation combines these two perspectives and examines *how a DIU and its main organization interact at the socio-technical level as the DIU evolves*. It should clarify whether DIUs are a manifestation of the malleable organizational structures required for digital transformation (Hanelt et al., 2020).

Because of their considerable socio-technical differences, the author sees the DIU and the main organization as two initially distinct STSs that interact, influence, and change each other, potentially merging into a single system, with the DIU becoming a socio-technical unit within the main organization. This understanding aligns with the general view of STSs as inherently dynamic and subject to continuous evolution through recursive design processes involving social constructs and technical infrastructure (Orlikowski, 2000; Orlikowski & Scott, 2008). When organizations adopt new technologies, it often leads to changes in their social systems, such as the emergence of new roles, alterations in organizational structures, and shifts in cultural norms (Dremel et al., 2020). As a result, an STS is continuously subject to incremental and punctuated changes in one or more of its socio-technical units (Lyytinen & Newman, 2008). Especially for a DIU with a core business-related mandate, the DIU and the main organization must find common ground to ensure a successful digital transformation.

The results presented in this section are based on the paper *"Explaining Socio-Technical Convergence: An Analysis of the Interactions between Digital Innovation Units and Their Main Organization"* (Lorson et al., 2024) – submitted. The underlying database comprises all seven case studies – namely Cases A, B, C, D, E, F, and G – 61 interviews over 20 months (January 2021 - August 2022) and secondary data for triangulation.

Based on a data structure of 604 first-order codes, 67 second-order codes, and 39 aggregated dimensions (see Chapter 3.3.1), the data analysis reveals that the DIU and the main organization interact, influence, and change each other, leading to a gradual mutual adaptation over time. The DIU shapes (parts of) the main organization's technical system, social system, environmental system, and outputs. Surprisingly, the main organization also influences the DIU's technical system and social system. These influences and adaptive responses are described and analyzed below, with sample quotes from the interviews to enrich the findings' presentation and link them to the underlying data (Lorson et al., 2024).

4.3.1 Changes in the Main Organization Influenced by the DIU

The influence of the DIU as one STS on the main organization as the other is diverse and can be categorized into four types (Lorson et al., 2024):
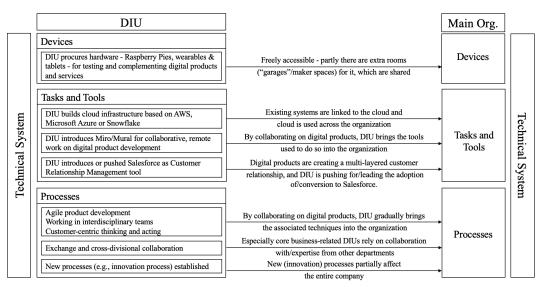
- The DIU's technical system influences the technical system of the main organization.
- The DIU's social system influences the social system of the main organization.
- The DIU's environmental system influences the main organization's environmental system.
- The DIU's outputs influence the main organization's outputs.

To illustrate these interactions and influences, a summary figure is shown, followed by a detailed discussion of each element of the respective system.

Influence of the DIU's technical system on the main organization's technical system

Figure 14 presents a summary of seven aspects of the technical system of the DIU that interact with, influence, and change (parts of) the technical system of the main organization. These aspects can be found along the three subcategories of *devices, tasks and tools*, and *processes* (Lorson et al., 2024). The analysis shows how the technical system of the DIU influences and changes the technological landscape of the main organization, contributing to the overall digital transformation process.

Figure 14: Influence of DIU's on Main Organization's Technical System.
From Lorson et al. (2024, p. 7).

Devices. The DIU's technical system includes various hardware *devices*, such as Raspberry Pies, wearables, or tablets, used to test digital applications while developing digital products or services. Some of these devices, e.g., tablets for remote support solutions, are integral parts of the services themselves. In addition, these devices are made available to the main organization, which in turn influences

its technical system. Some DIUs even provide a dedicated space for experimentation and testing used by the main organization, as one of the interviewees in Case 4 points out: *"That's when someone comes up with an idea, wants to try something out. That's why we have this concept of the digital garage [...] It often happens [...] that the R&D [Research and Development] people come to us and ask our R&D specialist: 'Say, we could build a sensor for the printer here, can't we even-?' And then quite quickly, [...] they're in the lab, and we're trying something out, and that's how it should be."*

Tasks and Tools. Five of the seven DIUs are involved in building the company's cloud infrastructure. Most use Amazon Web Services, but some use Microsoft Azure or Snowflake. To effectively leverage the capabilities of the cloud infrastructure, the DIUs work closely with the main organizations' IT departments to establish connections between the various existing systems within the organization and the cloud, facilitating the seamless flow of data necessary for digital transformation: *"Of course, the cloud data warehouse, the snowflake, is central [...]. I already mentioned that data flows from ERP [Enterprise Resource Planning], i.e., SAP. Data flows from the CRM [...][-] whether this is Microsoft CRM or Salesforce.com [...][-] so that cross-sectional analyses can be performed. [...] We have, of course, the sensor and machine data [...] of the connected machines."* (Case C). As a result of this collaboration and integration with the DIU, there have been considerable changes in the main organization's technical system.

The DIU's introduction of visual collaboration platforms such as Miro or Mural has also influenced the main organization's technical system. As the two entities work together to develop digital products, services, and business models, employees from the main organization encounter and gradually adopt these new tools: *"Miro is important because we also do the workshops [with the main organization] in there and people also use that themselves in their projects."* (Case D).

In three cases, the DIU took the initiative to implement or advocate for adopting Salesforce as a CRM tool due to the increasing complexity of customer relationships and the need for unified data management. This implementation also proved beneficial to the main organization, which now also uses Salesforce for its CRM needs, according to an interviewee in Case B: *"But there is also the [Commercial Excellence] project, [...] they mainly drive the [...] Salesforce rollout [...]. And they also do a lot of training and change. [...] Today, some customer data is stored somewhere in Excel. And they [sales managers] don't have a history of what was said to them or anything else. That all changes with Salesforce. Because one has a complete history [...] and knows what was discussed with the customer, what they wanted, what didn't work."*

Processes. The DIUs have introduced key techniques to the main organization, including agile, digital product development, working in interdisciplinary teams, and customer-centric thinking and acting. As the DIU and the main organization work together on digital product and service development, the broader workforce gradually adopts these techniques. This shift in working practices is evident in the

quotes from both Case A and Case E: *"I would say that in my role [...] I tend to be more methodical or bring speed into it. So away from the classic project approach, perhaps also a little more to: 'start small, then become larger and then with speed,' so that is this thinking to carry into the organization."* (Case A). *"[A]nd that we [Sales and DIU], together with the R&D department, have thought about what is needed, what the market [and] the customer wants [...]. The DIU has intensified [...] that internal departments like R&D work more with the business side [...]."* (Case E).
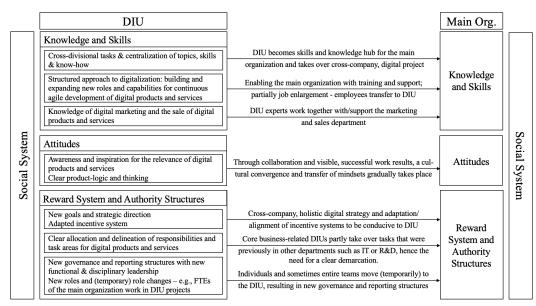
The overall level of sharing and cross-functional or cross-departmental collaboration also increases because the DIU needs the expertise of the main organization to develop digital products and services: *"[T]he core organization, [...] [is] now much more involved in this development of the digital customer interaction platform, [because] their knowledge is also needed, their expertise is needed."* (Case B).

Finally, in five of the seven case studies, the DIU has introduced new processes, primarily focused on digital product development, that also affect the main organization: *"The DIU has given us an evaluation format on how to evaluate all our digital products. [...] And I think it's a very good one, which evaluates according to the three strong criteria of desirability, viability, and feasibility."* (Case A). *"We have set up a portfolio process where new demands can come in from the individual markets. [...] Either they are already on the roadmap anyway [...] or, if we conclude that that is a topic, which is now more important than other things that are on the roadmap [it is prioritized accordingly]."* (Case B).

Influence of the DIU's social system on the main organization's social system

The social system includes employees and their knowledge, skills, attitudes, values, and needs in the work environment, and the organization's reward system and authority structures (Bostrom and Heinen 1977). The data analysis provides valuable insights into various aspects of the social system along the subcategories of *knowledge and skills, attitudes*, and the *reward system and authority structures*, which will be presented accordingly (Lorson et al., 2024). Figure 15 gives an overview of seven aspects of the DIU's social system that influence and impact the main organization's social system, focusing on these three key elements.

Figure 15: Influence of DIU's on Main Organization's Social System.
From Lorson, et al. (2024, p. 8).

Knowledge and Skills. The multiple cross-case syntheses found that four out of seven DIUs perform cross-divisional tasks, such as building platforms like a customer portal shared across the organization. In addition, DIUs serve as *knowledge and skills* hubs for the main organization, providing expertise in various areas such as *"IoT, data science, customer engagement, i.e., customer portal applications and digital change, agile methodology and design thinking"* (Case G), which are delivered as shared services. The DIU is basically *"a nucleus within [...][Case E] that can build up certain competencies and skills that were not initially available in the normal business areas and where it would have been difficult for the business areas to recruit these skills [...]. [With the DIU] there is one place where the threads come together a bit, and the know-how is also bundled"* (Case E).

In all seven cases, the DIU acts as a regulatory element, taking a structured approach to the digital transformation of the main organization. It plays a key role in identifying, analyzing, and prioritizing existing digital initiatives and building the necessary roles and capabilities to address them efficiently. With the DIU, roles such as *"data engineering and then data analytics and science [...][as well as] product owner"* (Case F) come into the organization, and skills such as *"digital product building, market understanding, software and services, IoT logic, thought processes, methodology"* (Case A), digital business models development, trend analysis, etc. are built. The DIU plays a critical enabler role for the main organization, supporting employees in their digital projects and providing education and training in relevant digital skills. As a result, there are opportunities for job expansion for employees as some of them move to the DIU and take on new responsibilities. For example, the DIU in Case E has *"integrated the former 'Group Marketing' department, which was responsible for the entire topic of CRM [...] and branding at a global level [...]. And [...][the DIU was able] to win over a few employees who had previously been active in the markets [subsidiaries] and had*

driven digital projects there. Who have, so to speak, switched – internal development, internal role change."

Finally, the DIU's expertise in digital marketing and the marketing and sale of digital products and services is an important aspect of its contribution to the digital transformation of the main organization. This expertise covers various areas such as online marketing, social media communications, digital product brand strategy, tradeshow appearances, digital product business models, pricing, and contract design. In Case C, the DIU is integrated into the global sales and marketing department, further emphasizing its role in driving digital initiatives. In addition, the DIU actively shares its knowledge with the marketing and sales teams of the main organization through workshops, training sessions, and collaborative efforts: *"I also have the topic of social media located there [in the DIU]. I think my colleagues have done a pretty good job of educating the communications department."* (Case E). In Case F, the DIU supports sales managers during customer meetings for digital products and services, providing specialized knowledge to improve the sales process and customer interactions.

Attitudes. One of the most prominent attitudinal shifts introduced by the DIU is a strong emphasis on product-centric thinking and action. In traditional manufacturing organizations, the dominant project logic often follows a waterfall development model. However, the DIU recognizes that this approach is inappropriate for digital products *"[b]ecause it's an illusion that you release a project and say, 'I'm done now. Now, the software works. Now I'm not doing anything.' [...] [P]roject teams are product teams [-] you come together, and that is also an ongoing task normally. [Therefore,] what we [the DIU team] are trying to do - and that's maybe a shift – is that we're moving more from classic project management into a product owner organization – product accountability."* (Case G). In addition, because of collaborating with the DIU and witnessing its visible and successful outcomes, *"many more people see this topic of digitization as an opportunity. And, as a risk, if we don't do it [...] that we'll end up as a component supplier or something for pure hardware."* (Case F). Consequently, a cultural adaptation occurs, with a gradual transfer of mentality and attitudes from the DIU to the main organization, leading to significant changes in its social system.

Reward System and Authority Structure. By establishing a DIU, companies are pursuing new digital transformation goals. In three of the seven cases, the overall business strategy is adjusted, and after a period, management develops a comprehensive digital strategy: *"We started clearly at the beginning with the vision, 'we build digital products' [...]. In the meantime, the Board of Directors and the Executive Board have expressed the desire to take a closer look at this [digitalization] internally and to define an overall digital strategy."* (Case F). At the same time, companies need to adjust and align their existing incentive systems with the DIUs to ensure that departments are motivated to contribute to the goals of the DIU.
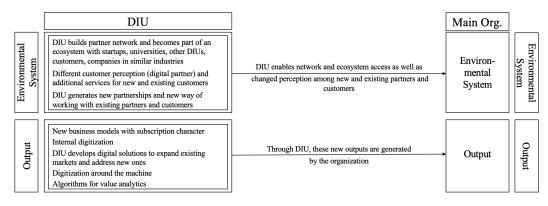
In addition, tasks that other departments previously handled may now be found within the DIU. Therefore, a clear allocation and delineation of responsibilities is

necessary both within the DIU and between the DIU and the main organization to avoid confusion and ensure smooth operations. Case B, for example, was *"in this transformation process that corporate IT is handing over some things – in terms of responsibility – such as for a product information management system [...] [o]r a content management system [...] over to us [the DIU]. [...]That was a long journey to define where this intersection is."*

Concerning *authority structures*, four cases introduced an "innovation board" as a new body that includes key executives such as the CEO, CIO, CTO, CDO, and, in some cases, external experts. *"[A]t the global level [...][the board] agree[s] on the portfolio [and] on the roadmap"* (Case B) and/or decides which innovation projects are to be pursued further. Furthermore, there are changes in governance or reporting structures when individuals or even entire teams (temporarily) move to the DIU, as in Case C, for example, where some DIU employees originally come from *"IT [...], or they were in 'Global Technology,' which is a central staff department for engineering."* Through this process, the governance structures of the DIU are formed, and at the same time, changes are made to the governance structures of the main organization.

Influence of the DIU's environmental system and outputs on the main organization's environmental system and outputs

In addition to internal adaptations, changes in the external environment (environmental system) and the outputs of the case study partners triggered by their DIUs could be observed (Lorson et al., 2024). Figure 16 provides an overview of these findings.

Figure 16: DIU Influence on Environmental System and Outputs.
From Lorson et al. (2024, p. 9).

Environmental System. All seven DIUs considered have a specific mandate to establish and build a partner network that includes startups, universities, other DIUs, customers, and suppliers. The goal is to become part of an ecosystem that facilitates knowledge sharing about technologies and digital trends and, in some cases, collaboration: *"So that was the second important aspect in terms of reputation, in terms of building a partner network. That we spent a lot of time just understanding the ecosystem, yes. Who is doing similar things? Who can we learn from? [...] And what are possible partners in future projects where we can work together?"* (Case E). The partner network established by the DIUs is directly
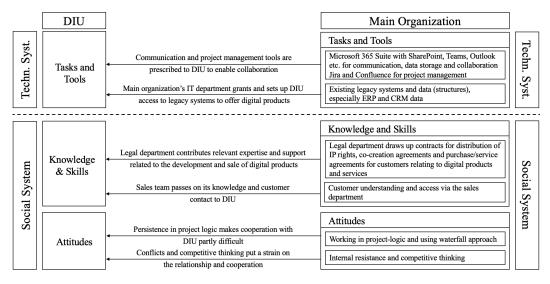
accessible to the main organization, especially for DIUs that work closely with the core business. Respondents also mentioned that *"there are definitely customers who perceive us in a new and different way, i.e., who really take digitization seriously, who are driving this forward."* (Case F). The DIU's efforts have led to a growing perception of the company as a digital partner, allowing it to reposition itself in the market.

Outputs. The DIU generates several new outputs for the company, including subscription-based business models, algorithms for value analysis, digital products, services, and business models around the machines, and internal digitization. These digital solutions expand existing markets and open up new opportunities. As an integral part of the main organization, the DIU ensures that these outputs benefit the entire company.

4.3.2 Changes in the DIU Influenced by the Main Organization

Although the DIU's overall influence on the main organization's STS is greater, there is also interaction and impact in the opposite direction. The technical system of the main organization partly influences the *tools* used in the DIU. In addition, the social system of the main organization impacts its counterparts in the DIU through its *knowledge, skills,* and *attitudes* (Lorson et al., 2024). Figure 17 summarizes the two influences on the technical system of the DIU and the four influences on its social system.

Figure 17: Influence of the Main Organization on the DIU.
From Lorson et al. (2024, p. 10).

Influence of the main organization's technical system on the DIU's technical system

Generally, a DIU has considerable freedom in choosing its software tools. However, the main organization usually dictates the primary communication and data management tool, often the Microsoft 365 suite with Teams, Outlook, Office, OneDrive, etc. In addition, Atlassian products such as Jira and Confluence,

commonly used in the main organization, are often adopted by the DIU. This ensures efficient collaboration between the two STSs, especially for DIUs that are closely involved in the core business. As mentioned, the DIU's cloud infrastructure relies on access to the main organization's legacy systems and data structures for its effectiveness. Consequently, the IT department of the main organization provides and configures this access, allowing the DIU to build its digital products and services on top of it, as described by an interviewee in Case B: *"[W]e're building a tech delivery unit right now that can build things outside of IT as well. And not just prototypes that somehow can do a few features, but pierces through to the core systems SAP, CRM, PIM."*

Influence of the main organization's social system on the DIU's social system

Knowledge and Skills. Regarding *knowledge and skills*, the main organization influences the DIU in two ways: (1) The legal department of the main organization supports the DIU with relevant expertise related to the development and sale of digital products. This includes intellectual property distribution agreements, co-creation agreements, and customer purchase/service agreements. (2) The sales team shares its knowledge and access to customers with the DIU to ensure that digital product development is aligned with user needs and to avoid creating products that do not meet customer requirements. A quote from Case B describes Sales' involvement in DIU activities: *"[T]he sales and marketing structures in the markets these are the most important contacts. In the end, of course, the whole thing must be carried through the marketing channels and sales landscapes to the customer. And we get the best feedback from these structures. What the customer wants/needs, what their interests are."*

Attitudes. Despite the numerous positive influences between the DIU and the main organization, there are also negative influences, especially regarding *attitudes*. On the one hand, the main organization resists transitioning from the traditional project logic common in classical machine and plant engineering to the product logic required for digital products and services. This persistence can lead to frustrating collaboration experiences for the DIU and strain the relationship, as the DIU relies on the domain expertise and involvement of the main organization, as mentioned by an interviewee from Case F: *"I think the objective summary is that R&D thinks very project-driven and not product-driven. That is, they have a project here, and if they fulfill their project, it is a success for them, regardless of whether the thing effectively brings something to anyone. [...]. And I think that clashes very strongly, [...] a clash that the organization has not yet understood, especially when you move away from the classic R&D topics to more digital product topics."* On the other hand, the competitive mindset emanating from the main organization and the resulting conflicts strain the relationship and cooperation with the DIU. One reason for this is the classic defensive attitude driven by the fear of losing one's position due to the growing strength of the DIU: *"I think there are a few people who are very good at these political games to, yes, fulfill their own goals and I think that is the big problem in this current situation."* (Case F). Another is that some departments fear being disrupted by DIU's digital offerings: *"And then they [the departments] don't have it in their hands anymore. In which direction does that*

go? Is this now perhaps even taking customers away from us? In principle, it is inherent that we find business models that ultimately disrupt ourselves. And if we find software that makes our machines 30 percent more efficient, then one in four devices will no longer be needed. So that would also destroy our sales, so to speak, a little bit." (Case D). DIU employees know this defensive attitude, which strains cooperation with the main organization in some areas.

4.3.3 Process of Two-phased Socio-technical Adaptation

From the two-dimensional perspective of the DIU and the main organization, several interactions can be observed between the two parties, which are increasingly adapting to each other over time. Overall, the DIU exerts influence – sometimes stronger, sometimes weaker – on the main organization's social, technical, and environmental system, and outputs. Conversely, the main organization brings about changes in *tasks and tools* (technical system), *knowledge and skills*, and *attitudes* (social system) in the DIU. Building on the phase structure of the DIU life-cycle described in Chapter 4.1, the adaptation is illustrated along two phases – the start-up and the growth phase – that the case study DIUs had gone through or were going through. This is also in line with the evidence of a similar underlying phase logic in the formation and evolution process of the seven DIUs – directly expressed and explained in Cases B, E, F, and G and more subtly applied in Cases A, C, and D (Lorson et al., 2024). Again, the initial phase, covering the first year of the DIU's existence, is named the start-up phase, the subsequent phase, covering roughly the second and third years, is called the growth phase. Across these two phases, there are various interactions, changes, and adaptations in the technical, social, and environmental systems of the DIU and the main organization, as well as changes in the outputs of the company. Figure 18 provides a visual representation of the two phases of socio-technical adaptation (Lorson et al., 2024).

Figure 18: Two-Phased Socio-technical Adaptation.
From Lorson et al. (2024, p. 11).

Start-up Phase. After the formation of the DIU, the first push towards adaptation came from the DIU's technical system. It introduces several novel *processes* for agile, customer-centric, cross-departmental digital product development and *tools* for collaborative remote work. These changes are implemented within the DIU and then gradually extended to the main organization. Almost simultaneously, a corresponding resonance occurs within the social system, with the DIU sharing *knowledge and skills* related to agile digital product development with the main organization through training, workshops, or joint projects. In turn, the main organization's technical system influences the DIU by introducing standard communication and project management *tools*. Concerning their *attitudes*, the two STSs partly take opposing positions. There is a contrast between the focus on product logic (DIU) versus project logic (main organization) and the recognition of digital product potential (DIU) versus a competitive mindset (main organization). These differences can create complexity in their relationship and hinder adaptation to some extent. Finally, there is a unidirectional influence, as the DIU usually establishes an initial partner network (*environmental system*) and launches the first pilot projects (*outputs*), which positively impacts the external perception of the company (Lorson et al., 2024).

Growth Phase. During the growth phase, the main organization increasingly encountered hardware *devices* acquired by the DIU for testing and improving digital products. In addition, there was a growing interdependency between the two technical systems, facilitated by the DIU's newly established cloud infrastructure and integration with the main organization's existing IT systems. As for the social system, it is worth noting that it is adapting to the changes in the technical system by implementing new governance and reporting structures. This involves introducing new roles, adjusting existing ones, and clarifying responsibilities between the DIU and the main organization. In addition, as a direct result of the DIU's initiatives, the main organization is formulating new goals, developing a comprehensive digital strategy, and establishing an appropriate *reward system*. Conversely, during this phase, the main organization contributes its legal *skills* and leverages its access to and *knowledge* of customers in its collaboration with the DIU. Regarding the environmental system and outputs, the DIU is expanding its network and gaining greater access to the ecosystem, leading to the first sales of digital products (Lorson et al., 2024).

In a nutshell, to overcome the one-dimensional view of DIUs, this chapter combines the perspectives of the DIU and the main organization and examines how they interact at the socio-technical level as a DIU evolves. Drawing on STS theory (Bostrom & Heinen, 1977), it identifies various processes of influence and change that lead to increasing adaptation between the two STSs along the DIU's start-up and growth phases (Lorson et al., 2024). By proposing a phase logic of STS adaptation, it also informs theory building on continuous organizational design change and malleable organizational structures (Hanelt et al., 2020) in the context of digital transformation (Lorson et al., 2024).

4.4 Relational Dynamics in DIU Evolution

As the findings in Chapter 4.3 and the existing literature on DIUs (Table 4) show, social structures and their interactions and adaptations play a key role in incumbents' digital transformation. To realize digital transformation, the (majority of the) workforce must be on board, but it is often interpersonal relationships and social interactions that lead to challenges in this context – e.g., NIH syndrome (Raabe et al., 2020a), persistence in existing structures and product logic, competitive thinking (Chapter 4.3).

To specify and deepen the analysis of the socio-technical interactions between the DIU and the main organization from Chapter 4.3, the social structures are now examined in more detail. This chapter seeks to answer RQ4, which asks *how the relational dynamics between the DIU and the main organization unfold during the evolution of the DIU*. It also extends the knowledge of the fundamentals of the DIU evolution process from Chapter 4.1.

As social structures emerge and change over time, the phase logic from Chapters 4.1 - 4.3 is used again to consider a DIU's evolution process along the start-up and growth phases. The analysis concentrates on how the DIU emerges as a new STS, what dynamics are triggered in the process, what challenges are involved, how they are addressed, and what the outcome is. The specific focus is on how the social structures of the DIU are created and what relational dynamics result from this. In addition to a more detailed consideration of the social system of the DIU and its interaction with the main organization, this also contributes to the expansion of the dynamic understanding of DIUs and the processes they go through demanded by research (e.g., Barthel et al., 2020; Haskamp et al., 2023).

The results presented in this section are based on the papers *"From Cradle to Cash: The Successful Formation of a Digital Innovation Unit."* (Lorson et al., n.d.) – in preparation for submission and *"Building Adaptive Capacity for Volatile Business Environments: A Longitudinal Study of the Establishment of a Digital Innovation Unit."* (Lorson et al., 2023) – published. They report on an in-depth, longitudinal case study of a Swiss manufacturing company, Case F, that implemented a DIU to initiate, accompany, and drive its digital transformation, leading to additional revenues through digital products, services, and business models. A variety of primary and secondary data sources such as interviews, observations, and internal and external materials collected between September 2020 and March 2023 were used.

Case F's DIU underwent a 30-month evolution process (encompassing the start-up and most of the growth phase) from November 2020 until the launch of the final setup in April 2023. This process was preceded by an 18-month initiation phase, during which the digital transformation was launched, and the formation of the DIU was set in motion.

In the following, the unfolding of the social structures is described and analyzed in detail, and the resulting relational dynamics will be investigated. The underlying data structure for Chapter 4.4.1 consists of an initial set of 676 first-order codes.

Those were distilled into 127 second-order codes (Lorson et al., n.d.). For Chapter 4.4.2, 476 first-order codes were extracted based on their relevance to the AC lens. Those were distilled into 24 second-order codes, and eight aggregated dimensions were developed (see Chapter 3.3.2, Lorson et al., (2023)). To make the results more tangible and understandable, sample quotes from the interviews enrich the presentation.

4.4.1 The Emergence of Social Structures

In a 30-month process, Case F's DIU and its social structures are being built. As the decision to create this unit was preceded by an 18-month initiation process, this part of the results takes it into account to provide a complete picture of how the DIU was established. Therefore, the initiation phase is also presented in addition to the start-up and growth phases. All three phases were accompanied by substantial changes in the social structures of the DIU and, in part, in the main organization, as well as by important decisions to position the DIU as a new entity (STS). To illustrate the process of initiating and building the DIU, the changes associated with each phase are described and analyzed along five criteria: (1) DIU team and processes, (2) DIU projects/activities, (3) capabilities built by/with the DIU, (4) key strategic decision by the company's executive board, and (5) DIU relationships with internal and external stakeholders.

Overall, eleven challenges of the evolution process were found in Case F. When analyzing the data. It became apparent that the most important attribute, (part of) the answer to every challenge and the key driver of DIU adoption within the organization, was criterion (5), building relationships with relevant stakeholders. This applies to internal relationships with individuals, teams, and departments and external relationships with customers and partners. For that matter, the theoretical angle of stakeholder relationship management is applied, building on the work of Bourne and Walker (2004) and Bourne (2010), who explore stakeholder relationships in project management and identify four key influencing relationships that are critical to manage: (1) *upwards* – managing senior management (especially sponsors) and maintaining organizational commitment, (2) *sidewards* – managing competition and relationships with peers and communities of practice who are considered to be at the same professional level, (3) *downwards* – managing the team (full-time employees, consultants, contractors, or specialists), (4) *outwards* – managing stakeholders outside the team/organization such as end users, customers, suppliers, partners, government, regulators, the public, shareholders, and lobby groups. Since Case F's DIU was a virtual entity – i.e., not yet a designated department, but a team within IT – in the start-up and growth phase (more precisely, the first 30 months of operation), there were strong parallels to a project setup, which makes this distinction appropriate and useful for analyzing the DIU evolution process.

The following, the relational dynamics in the social structures of the DIU and the main organization, are presented along the eleven challenges that emerged in the DIU evolution process (Lorson et al., n.d.). To emphasize the importance of the relationships formed and their fundamental nature in solving the challenges, they

are highlighted by color and location in the overview tables of the key criteria in each phase.

DIU Initiation

In the initiation phase (April 2019 to October 2020), Case F was faced with the need to create awareness of the relevance of digital transformation in the company, which included two challenges: (1) gaining buy-in from key stakeholders and (2) gaining buy-in and approval from the CEO and the executive board for a digital initiative. To tackle these challenges, two levers were used: (1) a strategy workshop series with internal key stakeholders to ensure their acceptance and support and to introduce relevant digital competencies, (2) meetings of the CDIO and the consultancy with the CEO to make key decisions for the digital transformation launch and prepare the digital vision presentation to the executive board (Lorson et al., n.d.).

In April 2019, Case F initiated its digital journey by filling the newly created position of Chief Digital and Information Officer (CDIO) to maintain the company's current position as a global market leader in their field. After the first initiatives to present existing digital projects and their importance to the board and the upper management, testing the technical feasibility of digital prototypes, and building pilots for demonstration, the CDIO decided to hire a Director of Global IT Governance and Digital Transformation and a consulting company (CC) in 2020 to support Case F's digital transformation journey. The following is a description of the two aforementioned challenges faced by this group of people – who would later form the core team of the DIU – during the initiation phase, how they were addressed, and what the outcome was.

Challenge 0.1: Obtaining Key Stakeholder Buy-in. By the summer of 2020, there was insufficient awareness of the necessity of a structured, streamlined approach for digital transformation among Case F's employees, especially among key stakeholders who would be critical to the success of digital transformation: *"The initial question was: 'We [Case F] have a lot of initiatives, pilots and experiments running here on the subject of digitalization and digital offerings. Can we take a structured look at this and consider what we want to do with it? Do we want to invest in this topic? If so, to what extent and then in what form do we organize the whole thing, and what do we perhaps want to focus on because a lot was going on at the same time?'"* (C2, round 1). CC planned a three-part strategy workshop series to ensure key stakeholders' alignment and commitment. Involved in this, besides the CDIO, the Director of Global IT Governance and Digital Transformation, and the CC, were seven key stakeholders: The Presidents of Case F's two divisions, the Vice President of R&D, the Head of Business Development, the Vice President Technical Support, the Managing Director of a subsidiary and the Vice President Sales. On the surface, the goal was to jointly define the potential, the goal, and a plan for Case F's digital transformation, and underneath, to ensure buy-in from key stakeholders: *"We started from the customer side, took a very close look at their needs, conducted interviews and then moved on to matching them with [Case F's] core competencies, things they already have, and what the*

strategic approach should be. And what could a roadmap look like? How could the whole thing be organized?" (C2 round 1). The CEO was deliberately excluded from the workshop series to avoid bias. This process is called building *sidewards stakeholder relationships* because the key stakeholders are at more or less similar hierarchical levels to the CDIO and are, therefore, peers to them and the subsequent DIU team. During the workshop series, key stakeholders were introduced to human-centered design, as some of them, for example, participated in customer interviews conducted by CC. By working with CC, there was also an increased focus on understanding the market and competitors concerning digital products and services, which increased Case F's susceptibility to acquiring and appropriating external knowledge (potential absorptive capacity (Hellmich et al., 2021)).

Challenge 0.2: Obtaining CEO and Executive Board Buy-in and Approval. The second challenge in the initiation phase was to convince the CEO and the executive board to embrace and invest in digital transformation consistently. The CDIO and CC addressed this challenge by meeting with the CEO between strategy workshops to keep him updated on the progress and make key decisions to launch the digital transformation. Furthermore, they worked on and discussed the digital vision that should be presented to the executive board: *"The goal was to get the whole board together and behind this digitalization topic. And to derive the vision and the action areas. [...] There was a top management meeting between workshops one and two. And also, between two and three. And the most important decisions were made."* (C3, round 1). This is identified as *upwards stakeholder management* to build relationships with top management and ensure their buy-in and approval of the proposals for approaching Case F's digital transformation. Based on the workshop results, CC proposed the establishment of a dedicated innovation unit to develop customer-facing digital products and services, which received final approval from the executive board at the end of October 2020. It was decided that a DIU would be established as a virtual unit within Case F's IT department, led by the CDIO. It would have a mandate related to the core business, focusing on products and services "around the machine," and secured funding from the main organization during a two-year ramp-up phase. Exit options/final setup after two years were to be discussed. The DIU would be largely freed from standard processes to be as lean, fast, and decisive as possible. It would claim order and ownership of digital issues and signal internally and externally that Case F is committed to digitization.

Table 11 summarizes the essential characteristics and processes in the initiation phase.

Table 11: DIU Key Characteristics at the End of Initiation Phase.
Own Representation is based on Lorson et al (n.d.).

Team & Processes	Projects/Activities	Capabilities	Key Decision

CDIO appointed Consulting firm conducts workshop series with key stakeholders	Four-part workshop series with key stakeholders to define potential, goal & plan for digital transformation	Market and competitor understanding Human-centered design Potential absorptive capacity	Two-year DIU ramp-up phase to initiate digital projects and define its final setup
Relationships	- Sidewards: Inform and get buy-in from key stakeholders - Upwards: Inform and get buy-in and approval from the CEO and executive board		

DIU Start-up Phase

In the start-up phase (November 2020 to September 2021), Case F faced the situation of positioning the DIU within the workforce, which was accompanied by the challenges of (1) gaining workforce buy-in, (2) countering over-enthusiasm and competitive thinking, (3) managing cultural clashes, and (4) addressing skills gaps in the DIU team. The challenges were addressed with four levers: (1) launch a broad communication initiative and digital branding, (2) personal communication by the CDIO to (key) stakeholders, (3) involve other departments in DIU projects, (4) establish a data science team within the DIU (Lorson et al., n.d.).

Starting in November 2020, the DIU core team, consisting of the CDIO, the Director of Global IT Governance and Digital Transformation, the Digital Ambassador, and two consultants from CC, began its work and was tasked with setting up project management for the implementation of some of the projects defined during the workshops in the initiation phase. In addition, the workforce had to be informed about the existence of a DIU to drive the digital transformation and its exact tasks and goals to ensure that all employees were on board and accepted the new entity. What follows is a description of the four challenges they faced. And how they overcame them.

Challenge 1.1: Gaining workforce buy-in. To ensure that employees were aware of the existence and mission of the DIU, the DIU core team launched a broad communication initiative. This included a company-wide announcement in meetings or via the intranet, a deeper introduction of the DIU to other departments in internal meetings, personal one-on-one interactions (mostly by the CDIO) to inform relevant stakeholders about the DIU's activities, the launch of a digital brand for all digital products and services (*"[W]e worked on building a brand [...] you have to sell yourself to the outside world, and you have to give it a name. [...] First, you take the internal people so that everyone knows about it – so this initiative also has a name"* – CDIO, round 1), and the appointment of a digital ambassador as a point of contact for employees (*"I am the Digital Ambassador. [...] A big part of it [the role] is communication and marketing [...], the interface between the customer and the [Case F] employees, that's me, for example."* – DA, round 1). This communication initiative made the DIU and its projects visible to the workforce. This is another form of *sidewards stakeholder management*, as the

DIU team needs to go beyond the key stakeholders present at the workshops to inform their teams and other potentially relevant people within the workforce about the DIU activities. Since the DIU is to develop digital products and services close to the core business, it is essential to have access to the expertise and support of other departments.

Challenge 1.2: Countering over-enthusiasm and competitive thinking. With the increasing popularity of the DIU through the communication initiative, digital transformation is increasingly perceived as an important topic in the workforce. As a result, innovation projects were created in parallel with DIU activities out of over-enthusiasm but also out of sensitivities and competitive thinking towards the DIU, which arose out of self-interest and fear of losing relevance and status within the company – especially from the R&D team and the subsidiary: *"The submarine projects take place mostly in the R&D department, i.e., Research and Development. They're always tinkering around as they please and invent things that aren't needed. Then, unfortunately, we have [the subsidiary] they're also tinkering around, and I think they see themselves more as competitors. And then they always start tinkering and inventing things that either already exist or are unnecessary."* (DA round 2). To address this challenge, the CDIO became more involved in *sidewards stakeholder management* through personal attention (one-on-one stakeholder communications) and exchanges to resolve conflicts, bring relevant stakeholders on board, and ensure focused collaboration between the DIU and other departments. A quote from the DITDT exemplifies this: *"We try to communicate a lot. We communicate with the Innovation Forum; that's what we do. We have unilateral meetings. We also have meetings with the stakeholders. [The CDIO], for example, has regular appointments, you know, with [President Division 1] and [President Division 2], Vice President Sales and After Sales"* (round 2). Parallel projects were officially discontinued, and competitive thinking was superficially but not eliminated, as became apparent later.

Challenge 1.3: Managing cultural clashes. The DIU introduced an agile, interdisciplinary, customer-centric, product-driven way of working with greater degrees of freedom and a culture of ownership in Case F. They met the waterfall, project-driven, perfection-oriented way of working with clear processes, rules, and corridors of action of the main organization: *"So I think there are enough painful points that can probably all be summarized to the point that we are now coming in from an outside perspective with a very agile, dynamic, explorative way of working and are also encountering a company that is anything but agile in its structures."* (C1, round 1). This was a strong cultural clash that had to be addressed by the DIU team to ensure the progress of the initiatives. One of them was learning by doing and exposure. The DIU continuously involved departments of the main organization in its activities to introduce employees to its way of working and culture and to create an understanding of its relevance. At the same time, the DIU team made some concessions to the original goal of process freedom. For example, the main organization's existing hiring and resource allocation processes were more or less adopted because they had not worked otherwise: *"We said at the beginning that the DIU is process-free, in quotation marks. In other words, it does*

not adhere or does not have to adhere to standard processes to facilitate speed and develop work without bureaucracy. This has only partially worked. Well, as I just said, concerning resources, how do I get people on a project? How do I get time from them? In the end, we made a lot of concessions to the organization and went back to standard processes simply because it turned out that people wouldn't commit resources otherwise." (C2, round 2). Therefore, both *sidewards* and *downwards stakeholder relationships* had to be managed as DIU's peers had to be brought along on the one hand, and the DIU team had to adapt to the circumstances on the other to reconcile different ways of working and cultures. As a result, employees have begun to gradually build capabilities in agile, digital product development, and interdisciplinary teamwork, and they have expanded their human-centeredness and integration of customer needs. In addition, Case F's digital proactiveness increased, which is the use and experimentation with digital technologies that create a supportive climate for adopting and diffusing digital technologies in the organization (Hellmich et al., 2021; Nguyen et al., 2019).

Challenge 1.4: Skills gaps in the DIU team. The fourth challenge in the start-up phase was missing data science skills within the DIU team. The DIU core team quickly realized that the existing workforce did not have sufficient capabilities in data science to develop algorithms for predictive maintenance and value analytics solutions. Therefore, it was decided to create a separate Value Analytics team within the DIU, consisting of three data scientists and one data engineer: *"We are now looking for data engineers, data scientists, data analysts […]. We don't have these skills internally. Someone has to support us in working with the customer on this MVP. We have done the pilot so far in terms of data analysis. But we have reached our limits in terms of skills."* (DITDT, round 1). The first data scientist joined Case F in June 2021. This was identified as a manifestation of *downwards stakeholder management* as it refers to circumstances within the DIU team that are accompanied by the need to form new DIU internal team relationships.

In addition to the relationships that were formed and needed to be managed because of the four challenges, several other *sidewards* and *outwards stakeholder relationships* were created. As the DIU collaborated with other departments on digital initiatives, the following *sidewards stakeholder relationships* developed: The marketing department collaborates with and supports the DIU in its external communication. With the legal department, the DIU works on setting up co-creation agreements for pilot customers. The main organization's product management team gradually overtook the first digital product that the DIU developed. R&D and the subsidiary are involved in several of the DIU's innovation projects – as described in Challenge 1.2; this is a rather tense relationship. Interaction with sales was sporadic in the start-up phase, with individual sales managers providing feedback on DIU projects and informing the team of DIU's progress and its impact on them. Finally, the DIU is organizationally assigned to the IT department, which is also heavily involved in one of the DIU projects. To form *outwards stakeholder relationships*, the DIU approaches existing customers of Case F to initiate pilot projects for digital products and services. These relationships are also presented in the summary Table 12 to give a complete picture.

At the end of the start-up phase, the executive board approved the DIU product portfolio and the proposed business model patterns for digital products and services defined by the DIU team. Table 12 provides an overview of this phase's essential characteristics and processes.

Table 12: DIU Key Characteristics at the End of Start-up Phase.
Own Representation Based on Lorson et al. (n.d.)*.*

Team & Processes	Projects/Activities	Capabilities	Key Decision
Core team and project management in place First data scientist hired Digital ambassador appointed	First pilot project started Digital brand and marketing strategy launched	Agile, digital product development Interdisciplinary teamwork Digital proactiveness Data Science	DIU project portfolio and digital business model patterns approved by the executive board

Relationships	• Sidewards:
	  o Inform and get buy-in from the workforce
	  o Involve IT, R&D, subsidiary, legal, sales, product and marketing
	• Sidewards/downwards: Reconcile different working modes
	• Downwards: build DIU internal team relationships
	• Outwards: Approach pilot customers		

DIU Growth Phase

In the growth phase (October 2021 to March 2023), the DIU team was faced with the need to produce results in the form of first revenues for digital products and services and to position the unit within Case F. Five challenges arose: (1) lack of acceptance of the DIU, ongoing power struggles and dysfunctional cooperation, (2) non-compliance with management decisions, (3) insufficient sales integration, (4) difficulties with digital product transfer to the main organization, (5) Lack of active top management support. The DIU addressed these with three levers: (1) alignment and regular meetings with relevant stakeholders, (2) appointment of a sales representative in the DIU, and (3) appointment of a Head of Global Digital Business Operations. Challenges 2 and 5 became obvious in the growth phase but were not addressed during the data collection (Lorson et al., n.d.).

During the growth phase in February 2022, the DIU earned its first "digital dollar," which was widely communicated throughout the organization. In addition, the DIU grew from six to ten team members, with the first iteration of the Value Analytics team (three data scientists and one data engineer) and a Head of Global Digital Business Operations joining the DIU from the main organization. The DIU team became more aligned and considerably improved the distribution of roles and tasks. With the implementation and sale of the first digital products, the organization realized the ability to develop and manage digital products and generate digital

business models. In addition, the DIU reconfigures and coordinates internal and external resources, redesigns the internal environment for the adoption of digital technologies, and leverages and mobilizes resources, resulting in the organization's digital responsiveness capability (Hellmich et al., 2021; Nguyen et al., 2019). Despite these positive developments, the DIU faced four challenges, discussed in more detail below, including how they were addressed and what they resulted in. All four relate to *sidewards stakeholder relationships*.

Challenge 2.1: Missing acceptance, ongoing power struggles, and dysfunctional collaboration. As indicated in Challenge 1.2 of the previous chapter, the appearance of parallel projects and competitive thinking could not be eliminated by the CDIO's stakeholder management. As a result, the DIU faced a lack of acceptance, ongoing power struggles, and dysfunctional collaboration in Phase 2 – again intensely on the part of the R&D department in the subsidiary – as one of the interviewees described: *"And then there are I think, many, many issues that have come up again, where we thought we had left that behind us. [The CDIO] always uses the word submarines. I don't see it that way. These are competing projects or projects very close to this field, attributed to the DIU."* (C1, round 2). To counteract this, the DIU team engaged in several additional activities of *sidewards stakeholder management* to improve cross-department relationships. First, an alignment meeting was held with all parties involved in the DIU project to share information on progress, the status quo, and the next steps. Second, it instituted regular meetings with the Vice Presidents of the two divisions, as well as with the management and involved staff of R&D, Sales, and the subsidiary to keep everyone in the loop on the current progress, priorities, and how the work of the DIU will impact the other's area of responsibility. Third, CC developed and implemented a RASCI (responsible, accountable, supporting, consulted, informed) matrix for innovation projects to provide stakeholders with an overview of their expected level of engagement: *"The whole of October and November [2021] was actually about creating a RASCI matrix: Who takes on which responsibilities and how the whole thing should work, there is a huge document with a precise breakdown of who takes on which activities and responsibilities and who has to provide support where"* (C1, round 3). Fourth, the DIU Data Science team initiates exchanges and collaborations with other departments – especially with IT, R&D, and the subsidiary – on DIU topics, but also on topics that are helpful to the departments to show how they can support them. In this way, it positions itself as an expert on data science topics.

Challenge 2.2: Noncompliance with management decisions. Challenge 2.2 builds directly on Challenge 2.1, as the RASCI matrix created by the CC is not lived in the organization, even though it has been approved by the CEO and is therefore a clear management directive. The tasks and responsibilities resulting from it are not considered by some of the teams concerned, especially by R&D and the subsidiary: *"So for me, the worst outlier is that in this RASCI matrix, it has been decided that the edge device, i.e., the thing that collects data on the [machine], will no longer be developed by R&D, but by [the subsidiary] [...] that has been working on monitoring issues for a long time. And that the project in R&D is being stopped.*

And a week later, R&D sat on a steering committee and applied for 300,000 Swiss francs to continue developing this edge device." (C1, round 3). This did not result in any immediate action or decision but led to the realization of the DIU team that departments needed to be held more accountable and measured against the results of the DIU. The goal agreements and incentive systems should be adjusted to create clear accountability. This has been considered in developing the final design of the DIU after the ramp-up phase.

Challenge 2.3: Insufficient sales integration. At the beginning of the growth phase, the sales team expressed dissatisfaction that they were not sufficiently informed about and involved in DIU activities, especially as digital products, new business models, pricing strategies, etc., bring about substantial changes for sales. The DIU reacted to this with targeted *sidewards stakeholder management* to strengthen cross-departmental relationships with sales and appointed a sales representative to the DIU team and vice versa. This involved integrating a trusted person within the sales team into DIU meetings and activities to provide the sales perspective. Conversely, the person shares information with the sales team about new digital products or DIU progress in general: *"There is now [a sales manager], who [...] is responsible for DIU sales part-time [...]. This has also come about due to criticism from Sales that there is too little communication."* (C1, round 3), *"They can, of course, give us all the sales-relevant topics in the DIU in advance and support us accordingly and then later communicate what we do in the DIU to the sales community."* (CDIO, round 3). As a result, information flows between the DIU and the sales team are more regular and comprehensive, collaboration is more intense, and the sales perspective is considered from the outset.

Challenge 2.4: Difficulties with product transfer to the main organization. Like Challenge 2.3, Challenge 2.4 refers to a *sidewards relationship* with a specific department –the main organization's product management team. The transition of the first digital product from the DIU to the product management team was bumpy because product management was not brought into the project early enough. An immediate reaction to this was the appointment of a new Head of Global Digital Business Operations, coming from the main organization to the DIU, who would potentially lead a newly formed technical product management team in the DIU. In addition, the DIU team began building a technical product management team by advertising for two product manager positions. The main organization will now be involved more and earlier in projects to shun hard decoupling points at handover. This is another *sidewards stakeholder management* measure to strengthen the cross-departmental relationship with product management.

Challenge 2.5: Lack of active top management support. Against the background of challenges 2.1 and 2.2, it became apparent that the mere support and approval for the DIU and its activities from the top management is insufficient. This thesis calls this *passive top management support*. Passive top management support slows the DIU evolution process, as expressed by the CDIO in Case F: *"[T]op management is just providing passive support. We could go faster. We are also running uphill to a certain extent, and these friction losses are not being addressed. [...] Even if, on the one hand, they're like, 'Wow, you're fast!', [...] if they think it's cool that*

we're fast, they should also remove stumbling blocks from our path. [...] This decree to say: 'Hands off, the DIU is responsible' has not been the culture of [Case F] so far." Active top management support seems to be needed, i.e., the continuous defense of the role and responsibilities of the DIU against the overreach of other departments. Obviously, this is a challenge in the *upwards relationship* of the DIU. Although it became apparent during the growth phase, no direct action was taken. However, as the DIU moves into its final set-up, including new governance structures, the challenge has the potential to be mitigated.

In terms of relationships that did not arise as a result of the challenges, there is an intensified *sidewards stakeholder relationship* with the legal department in the course of working on co-creation agreements for pilot customers and a subsequent amplified *outwards stakeholder relationship* with external partners through co-creation that helps position Case F as a digital partner.

The two key decisions made by the executive board during the growth phase were the development of a holistic digital strategy, which became part of the company-wide five-year strategic plan, and the transition of the former virtual DIU to a newly created "Digital Products and Services" department, established at the corporate level – not part of either division – and reporting to the CDIO. Table 13 includes the essential characteristics and processes in the growth phase.

Table 13: DIU Key Characteristics in the Growth Phase.
Own Representation Based on Lorson et al. (n.d.).

Team & Processes	Projects/Activities	Capabilities	Key Decision
First version of a value analytics team Head of Global Digital Business Operations Improved role and task distribution	**First "digital dollar" earned** Four algorithms for value analytics are developed	Digital business model generation Digital product management capability Digital responsiveness	Development of a holistic digital strategy that becomes part of the company-wide strategic five-year plan DIU will become the "Digital Products and Services" department
Relationships	• Upwards: Lack of active top management support • Sidewards: Improve and strengthen cross-department relationships • Outwards: Intensify collaboration with pilot customers and position as a digital partner		

The data collection for this study officially ended in March 2023 with the information about the planned transition of the former virtual DIU to the newly created "Digital Products and Services" department in April 2023. This means the following information is prospective. The DIU will turn into a separate department with four teams – Business/Sales Development, Product Management, Product Development, and Engineering/ Manufacturing – and will become an integral part

of the organizational chart. It will consist of more than 90 employees, resulting from integrating other teams (mainly the subsidiary, but also some employees from R&D, Technical Engineering, Business Development, and one other department) into the DIU and external hires (two product managers). The mandate remains unchanged for now: developing customer-facing digital products and services (Lorson et al., n.d.).

4.4.2 Building Adaptive Capacity through DIUs

Along the previously presented in-depth evolution process of Case F's DIU, various interpersonal interactions were triggered, and social dynamics were set in motion. To analyze these dynamics between the DIU and the main organization in more detail, this dissertation adopts an AC lens by Staber and Sydow (2002), which builds on Giddens' (1984) structuration theory. AC is defined as a search process that enhances the "ability to survive in the face of its unalterable features [...][and] the capacity to cope with [...] uncertainty [...] and unpredictable variations" (Parsons, 1964, p. 340). Possessing AC refers to an organization's ability to learn and adapt faster than the changes in its environment, which requires breaking old routines and creating new ones (Staber and Sydow, 2002). In the context of the digital transformation of incumbents, which is taking place in an environment characterized by volatility and unpredictability, such capabilities appear highly valuable.

ACs consist of three structural properties: *multiplexity, redundancy*, and *loose coupling* (Staber & Sydow, 2002). "Multiplexity refers to the number and diversity of relations between actors in organizations or interorganizational networks." (Staber & Sydow, 2002, p. 414). It fosters the development of a shared organizational mindset as information spreads through the system, accessible from different perspectives (Morgan, 1997). Redundancy refers to surplus resources, such as excess employees, unused production capacity, or overlapping jurisdictions, that increase the system's resilience and encourage experimentation and risk-taking (Staber & Sydow, 2002). There are three forms of redundancy: *information redundancy, task redundancy*, and *relationship redundancy.* Coupling per se refers to the strength of connections between system elements. *Loose coupling* in (inter-)organizational systems implies relative independence among units, allowing adaptation to changing demands at different rates (Staber & Sydow, 2002). It reduces the risk of repeating mistakes (Masuch, 1985) and escalating commitments (Ross & Staw, 1993), thereby increasing the adaptability of the system in uncertain environments (Staber & Sydow, 2002).

Relating the concept of AC to Giddens' (1984) structuration theory, which deals with the dualism between structure and agency, Staber and Sydow (2002) unpack the influence of the three structural dimensions of *signification, domination*, and *legitimation* (Giddens, 1984) on an organization's AC. For example, if not managed effectively, *multiplexity* can impede or distort the flow of information, thereby limiting adaptive learning. This ties into the *signification* aspects of structuration and is based on the existing rules and how actors interpret and use them to sanction events or behaviors (Staber & Sydow, 2002). In addition, there is a risk that individuals in positions of power may instrumentalize multiplex

relationships in ways that lead to conflict and resistance rather than adaptability, which is related to the *domination* aspects of structuration (Staber & Sydow, 2002).

Building on the theoretical foundations of organizational AC, this thesis deepens the understanding of the relational dynamics in the social structures of a DIU and examines whether and how the formation of a DIU contributes to the emergence of AC and whether these developments are negatively affected by their interactions with structural dimensions of the main organization.

Rooted in the rich empirical data from the longitudinal case study, three mechanisms and five confounding factors emerged along the three structural properties of AC: *multiplexity*, *redundancy*, and *loose coupling* (Lorson et al., 2023). Table 14 provides an overview of the three mechanisms and five confounding factors that emerged during DIU evolution, along with their corresponding impacts on the three dimensions of AC.

Table 14: Mechanisms and Confounding Factors for the Expansion of AC.
Own Representation Based Lorson et al. (2023, p. 7)*.

AC Dimension	Mechanisms with a positive impact on AC dimension	Confounding factors for the expansion of AC dimension
Multiplexity	*Multiplexity enhancement*: Continuous development and expansion of collaborations by DIU with departments and partner companies	*Impairment of multiplexity by signification and legitimation aspects of structure*: Department heads partly withhold information to pursue their interests, and the reward system does not emphasize relations with DIU *Impairment of multiplexity by insufficient conferral of legitimacy*: Hardly any sanctions by management if departments deviate from role and task allocation by DIU for innovation projects
Redundancy	*Information redundancy generation:* Involvement of employees from other departments on a project basis or as official representatives in the DIU expands the level of information and knowledge about the unit and its innovation projects	*Artificial and uncoordinated task redundancy*: Blind actionism and promotion of self-interests by dominant actors lead to parallel projects and defocusing of the DIU team
Loose Coupling	*Decoupling tendency*: Tangible results lead to recognition of competencies and higher acceptance and awareness of the potential of digital products, data science skills, and market and customer orientation	*Persistence in strong coupling*: Silo thinking, inertia, and skepticism of departments about DIU and digital transformation persist *Limited process slack*: DIU's original goal of full process freedom was not achieved; great

		difficulty in deviating from standard processes

To enhance the findings' presentation and to link them to the underlying data, an illustrative quote from the interviews is included for each identified mechanism and confounding factor. In addition, given the importance of temporality in the DIU evolution process, the thesis examines how the effectiveness of these mechanisms and confounding factors evolved over time and along the DIU's start-up and growth phase. The following presents the three mechanisms and five confounding factors for AC emergence along the *multiplexity, redundancy*, and *loose coupling* dimensions.

Multiplexity

The first mechanism identified is the *multiplexity enhancement mechanism*, whereby a company increases the number and variety of relationships between its organizational actors and inter-organizational networks. This, in turn, positively influences its AC. In Case F, this mechanism manifests itself during the evolution process of the DIU and its innovation projects, leading to various new internal and external relationships. Internally, these relationships emerge as the DIU involves other business units directly, integrating them as part of the team or indirectly engaging them as responsible entities for enabler projects related to the DIU's initiatives. By working together on digital products and services, the DIU builds relationships with members of other departments, and those departments also build relationships with each other. As individuals from different departments come together in new constellations and settings, the total number and diversity of relationships within Case F increase, leading to a boost in multiplexity and, thus, an overall expansion of AC. A similar phenomenon was observed in establishing the new data analytics team as part of the DIU. The team initiated regular interactions and internal collaborations with other departments to demonstrate the utility of data analytics, thereby demonstrating the value of the DIU. These positive experiences allowed the DIU to build important relationships within the organization.

In addition, the *multiplexity enhancement mechanism* has an external impact. The work of the DIU introduces new dimensions to the relationships with existing partners and changes their perception of Case F, as described by one of the interviewees: *"[M]any partnerships have existed for a long time and are now simply being given new facets. So [Case F] has been working with [Software Company] to prototype, prepare, think ahead, and so on for quite a while. And, of course, this partnership will be built upon."* (C2, round 1). The new digital product and service offerings allow Case F to establish itself as a valuable partner on digital issues, resulting in requests for products and partnerships from previously unaffiliated companies. From a temporal perspective, the *multiplexity enhancement mechanism* was effective from the beginning (start-up phase) but experienced further growth over time, particularly in the second year of DIU operations (growth phase) (Lorson et al., 2023).

The benefits of increased *multiplexity* could be even greater if it were not for two confounding factors hindering the unfolding of its full potential. *Multiplexity* is impaired by the signification and legitimation aspects of structuration and by a lack of sufficient legitimation, resulting in the following two confounding factors for the expansion of AC (Lorson et al., 2023):

- *Impairment of multiplexity by signification and legitimation aspects of structure*
- *Impairment of multiplexity by insufficient conferral of legitimacy*

The former refers to what Staber and Sydow (2002) describe as the negative influence of structure's *signification* and *legitimation* aspects on AC. For example, in organizations with a history of competition for resources among different subunits, this dynamic may affect the rules in place and how they are interpreted by actors, thereby influencing whether knowledge is shared, manipulated, distorted, or withheld. In addition, the organization's reward system may encourage certain types of relationships, leading actors to question the legitimacy of resource sharing. Both scenarios could be observed in Case F, where some department heads withheld information about the DIU and its projects from their employees out of self-interest. Articulated management decisions about the role and tasks of the DIU that are not welcomed by all employees have led to resistance from some individuals who attempt to pursue their agendas within their departments, ultimately impeding the overall progress of the project. Competitive behavior, political conflicts, and pursuing individual interests contribute to ongoing discussions, substandard results, and unfinished tasks, resulting in considerable delays in innovation projects. In addition, the current reward system does not prioritize the relationship with the DIU, as departments with enabler projects for DIU workstreams can achieve their goals without adhering to DIU requirements: *"[T]he core problem is that R&D and [the subsidiary], who have to deliver an essential part of the product, in the sense of [being an] enabler [project][...] can fulfill their own goals without enabling the DIU to achieve theirs. [...] So, I think there is a conflict of goals."* (C1, round 4).

The second confounding factor for multiplexity, *impairment of multiplexity by insufficient conferral of legitimacy*, is inadequate management sanctions when individuals exploit multiplex relationships for personal gain or create unnecessary task redundancies that hinder overall progress. As mentioned in the previous chapter, the DIU team developed a RASCI matrix to clarify its roles and responsibilities and those of other departments involved in innovation projects. However, in many cases, these guidelines were not followed, and there were no consequences from management for non-compliance. This also highlights the distinction between active and passive management support: Although management supports the DIU, they often fail to take consistent action when other departments do not align with digital transformation principles and do not support DIU projects (see Chapter 4.4.1). Active top management support is therefore essential for smooth progress.

Both confounding factors have been present from the beginning (start-up and growth phase) but are now expected to improve because of the new digital strategy and five-year mid-range plan, together with the revised DIU setup and clear revenue targets (Lorson et al., 2023).

Redundancy

Information redundancy generation is the second mechanism discovered in Case F – a process that increases the number of (unused) opportunities to transmit information, which has advantages for the adaptability of an information-dependent system. Redundant information increases transmission reliability since the failure of one strand of facts can be compensated by another (redundant) strand. As redundancy improves, so does the overall AC. In Case F, this mechanism has manifested itself as follows: The working mode of the DIU, which regularly involves representatives from other departments in its innovation projects, favors disseminating information about these projects and developing digital products and services in general. For example, representatives from sales, product management, and controlling were closely involved in the business model development workstream, which defined business model patterns for digital products and services and calculated the overall business case for the DIU. As a result, the information is no longer limited to the DIU itself but is also available to other parts of the organization, ensuring reliable information access and flow. The DIU team added a sales representative in late 2021/early 2022 to improve information saturation and redundancy regarding digital products and services. This person will act as a liaison between the sales team and the DIU to ensure effective communication (see also Chapter 4.4.1). The primary goal is to incorporate the voice of the customer, as represented by sales, into the development of digital products and services. At the same time, the sales team should be fully informed to effectively market and sell these products and services: *"All in all, I think it is fair to say that the exchange has become much closer, better, and earlier. We at the DIU now have a better understanding of what our sales colleagues are waiting for, what they need, so that they can say, okay, we now dare to go to the customer, announce something, promise something [...]. And conversely, I hear more and more frequently that there is at least a little more transparency about what the DIU is doing and developing. So, things have moved much closer together. I think this also gives us better access to customers."* (C2, round 4).

In other areas, *information redundancy* is also being improved to avoid delays in the handover of digital products and services from the DIU to the main organization, as happened with the first product. After the initial development, the DIU transfers it to the main organization for further development and operation. However, the transition was abrupt in this case, and the new product owner lacked critical information, leading to numerous questions. To avoid such problems in the future, the main organization will be involved much earlier in the development process, ensuring sufficient *information redundancy* and creating a gradual transition phase instead of an abrupt transition point (Lorson et al., 2023).

The *information redundancy generation* mechanism began to show its effects during the growth phase in the second year of DIU operations, when the core team had a clearer understanding of its role, structures, and processes, allowing for better integration of the main organization (Lorson et al., 2023).

The negative factor in the AC dimension of *redundancy* observed during Case F's DIU implementation is *artificial and uncoordinated task redundancy*. "It refers to the influence of the *domination* aspects of structure on *redundancy*, for example, when dominant actors instrumentalize *task redundancy* to advance their personal interests rather than those of the organization." (Lorson et al., 2023, p. 10). In Case F, the rapid emergence of "digital" as a prominent topic in the company attracted the attention of many departments and employees. This led to blind actionism, resulting in uncoordinated parallel initiatives to existing digital projects – i.e., *artificial task redundancy*. As a result, the DIU team had to spend considerable time and effort identifying and collecting these uncoordinated initiatives, which negatively impacted their focus: "*It's still a beauty contest [...]. [T]his digital topic fascinates many people. And when the call to order comes and says, 'the DIU is responsible for this,' not everyone complies. [...] [A] not inconsiderable amount of our time [...] is just to [...] stop these multiple developments, to stop submarine projects. [...] And of course, we must ensure we don't lose our objective.*" (CDIO, round 3). Similarly, dominant organizational actors instrumentalized *artificial task redundancy*, such as launching parallel digital projects, to serve their interests. Despite clear communication from management about respective roles and responsibilities, some individuals pursued their agendas, leading to duplication of effort and conflict within the organization (Lorson et al., (2023), see also Chapter 4.4.1). These tendencies were present in the early stages of the DIU's existence (start-up phase) but became more pronounced and noticeable about six to nine months after the DIU was established (start-up and growth phase) (Lorson et al., 2023).

Loose Coupling

The third mechanism observed in the longitudinal case study is the *decoupling tendency* – a process in which different units strive for greater independence, allowing them to adapt to changing requirements at different speeds. This mechanism positively influences a company's organizational AC. *Decoupling tendencies* represent the first steps towards a loosely coupled system, which is highly valuable in uncertain and volatile business environments such as those encountered during digital transformation. In this context, new system entrants, such as the DIU, who possess valuable information and resources, are less likely to be viewed with suspicion or rejected outright, as might be in a tightly coupled system. In Case F, the efforts of the DIU, especially the first visible results and the growing recognition of its capabilities, gradually loosen the tightly coupled system of the main organization. As a result, there is a growing acceptance of digital transformation and an increased awareness of the potential benefits of digital products, data science capabilities, and customer-centric approaches. The presence of two algorithms, several pilot customers, and initial revenues makes the work of the DIU more tangible to the workforce, effectively convincing various skeptics

that it is a valuable and meaningful initiative: *"I think that DIU has consolidated itself in [Case F]. I mean that the DIU is known, and we have also delivered concrete things, which means we have also become recognized [...]. The people who understand that we exist and that we can deliver. [Product 1], our product, is already on the market [and there is a] co-creation agreement [...] with [...] our pilot customers. [W]e have developed two algorithms [...] that are already tested, and we are already in the validation phase with the customer. [...] And that is something very concrete you can measure."* (DITDT round 4) (Lorson et al., 2023).

The *decoupling tendency* mechanism became evident around July/August 2021 (late start-up phase) and began to show significant results in late 2021/early 2022 (growth phase), coinciding with the successful completion of the first pilots, algorithms, and the generation of revenues (Lorson et al., 2023).

Despite the positive developments, the organization still shows a *persistence to strong coupling* as silo thinking, inertia, and skepticism towards digital transformation activities remain. As a new entrant to the main organization's STS, the DIU is still viewed with suspicion, suggesting that much work remains to be done to establish a culture in which the digital and traditional worlds can coexist (Lorson et al., 2023). Respondent C2, in round 4, alluded to this challenge: *"[I]n general, what strikes me is that the silos are still not broken down between the individual organizational units. The entire collaboration for developing digital products is based on goodwill. And sometimes, things go quite well for a certain phase, and you get the feeling that things seem to fall into place. And then there are just as many backslidings, setbacks, fronts closing again."*

This inertia also affects DIU processes and imposes a second confounding factor on expanding the AC dimension of loose coupling: *limited process slack*. Despite the initial goal of process liberation, the DIU encountered noticeable difficulties in departing from standard processes within the organization, such as faster decision-making – *"[T]hat is one of the reasons you build a Digital Unit: Faster decision-making process and doing things a little differently. That is where I think we have not arrived yet. It is very easy to get back into our normal decision-making process. [...] [F]or this reason [the goal] is not yet fulfilled. [...] We are still linked with the old processes at the company."* (DITDT, round 1) – or hiring new staff – *"So if you want [...] to take degrees of freedom for yourself, you must do that from the very beginning. As soon as you put the first footstep into a standard process or tool, the grinder catches up with you. That is what happened [to the DIU] in the case of recruiting."* (CDIO, round 1). As a result, the main organization remains a rather tightly coupled system with deeply entrenched legitimacy structures and internalized processes, making it difficult for the DIU to exploit the intended degrees of freedom. For example, the new CEO recently decided that the DIU should leverage and accelerate the existing innovation process rather than create its own (Lorson et al., 2023).

Both confounding factors have played a role in the start-up and growth phases since November 2020, with the former – the *persistence of strong coupling* – decreasing slightly over time (Lorson et al., 2023).

5 Discussion

Despite the growing number of publications on DIUs in the field of IS, the findings are predominantly static, as most studies look at DIUs at one point in time rather than over an extended period (e.g., Barthel et al., 2020; Hellmich et al., 2021; Mayer et al., 2021; Schumm et al., 2022), see also Table 3, Chapter 2.3). As a result, there is little knowledge about the processes within a DIU or the processes it goes through, such as the DIU evolution process (Barthel et al., 2020). Initial studies in this area suggest that a DIU and its main organization are in a state of constant flux (Raabe, 2021) and co-evolve "through continuous and reciprocal alignment" (Schumm, 2023, p. 163). However, as about ten percent of DIUs (in the German-speaking region) have already been closed, often because expectations were not met (Sindemann et al., 2021), there is a need to understand better whether they are more than just *innovation theaters* (Santarsiero et al., 2021) and whether they can evolve to make a substantive, ongoing contribution and be a malleable organizational design and structures needed for digital transformation (Hanelt et al., 2020).

The following chapter discusses the dissertation findings in the context of existing literature and how they contribute to a more dynamic understanding of DIUs and their evolutionary process (Chapter 5.1). Subsequently, based on the results of Chapter 4 and the discussion in Chapter 5.1, a conceptual synthesis of the empirical data is developed in the form of a phase model of the intensification of cooperation between DIUs and the main organization to allow for a higher level of abstraction (Chapter 5.2). Finally, the findings and the process model are critically reflected upon, and three propositions are developed to inform future research (Chapter 5.3).

5.1 Towards a Dynamic Perspective on DIU Evolution

Within their first three years of operation, DIUs are found to be malleable entities that evolve naturally in interaction with the main organization and play a critical

role in an incumbent's adaptation to the digital age. Temporal factors, socio-technical adaptation, and relationship and AC building are key facets of this evolution, providing valuable insights for organizations seeking to build a DIU and realize their potential in the digital transformation era. The findings are summarized in Table 15, along with the four sub questions discussed below in the context of existing research.

Table 15: Summary of the Findings.

RQ	Findings
RQ1: How do DIUs evolve over time to meet the needs and expectations of the main organization	• A DIU results from and is driven by the interplay of dialectical and life-cycle motors of organizational change. • After an average of 18 months of DIU operation, there is a major first evolution step along which the DIU's goal, mandate, governance, team, and processes are adapted. • Evolution is triggered by several of the ten identified triggers (active and passive, internal and external). • The new DIU setup (DIU 2.0) was developed during strategic realignment and subsequent reorganization.
RQ2: How and what temporal dynamics unfold during the evolution of a DIU?	• Five temporal factors, including time allocation, temporal style, cycle and rhythm, and speed, influence the unfolding of DIU activities and outputs. • Speed is relevant, but so are flexibility and "right timing," sufficient time capacity to ensure focus and rapid decision-making processes.
RQ3: How do a DIU and its main organization interact at the socio-technical level as the DIU evolves?	• The DIU interacts with and influences the main organization's technical, social, and environmental systems and outputs. • The main organization interacts with and influences the DIU's technical and social system. • The interaction between DIU and the main organization leads to mutual influence and socio-technical adaptation.
RQ4: How do the relational dynamics between the DIU and the main organization unfold during the DIU's evolution?	• The DIU's initiation, startup, and growth phases correspond to distinct attributes, including team dynamics, project and activities, relationships with stakeholders, capabilities, and key decisions by the executive board. • Sidewards relationships with other departments are a critical success factor, especially if a DIU wants to develop digital products, services, and business models close to the core business. • DIU evolution triggers three mechanisms that increase the company's AC: multiplexity enhancement, information redundancy generation, and decoupling tendencies. • The mechanisms outweigh the five confounding factors and positively impact the AC of the organization.

5.1.1 Discussion of the Fundamentals of DIU Evolution

Regarding the evolution process of the DIU in non-digital, incumbent companies, this thesis offers an additional, complementary, and partly contradictory perspective. As presented in Chapter 4.1, it was found that DIUs evolve naturally, not by design, adapting to the needs and expectations of the main organization.

The underlying driver of this evolution is a life-cycle motor of change (Van De Ven & Poole, 1995), as in practice, the implementation and progression of a DIU are planned along certain phases (usually three to four). An expansion of the DIU's goals, mandate, and team typically accompanies these phases. Figure 12 in Chapter 4.1 illustrates this phase logic following the ideal-typical life-cycle motor or change sequence – start-up, growth, harvest, and terminate – (Van De Ven & Poole, 1995). This insight extends the findings of Raabe et al. (2020b), who describe four DIU evolution strategies within a bimodal IT setting along two DIU types – *Coaching and Screening* and *Center of Excellence* DIU (Raabe et al., 2020b), see also Chapter 2.2). However, they do not analyze temporal components, triggers, drivers, or exact phase logic. A second mention of three successive DIU life-cycle stages can be found in Schumm (2023).

In addition to the life-cycle motor of change, there was also an influence of a dialectic motor of change (Van De Ven & Poole, 1995) on the evolution of the DIUs considered. At some point in the growth phase, the DIUs were challenged by external factors from the main organization or the company's external environment. These triggered a conflict with the initial DIU 1.0 setup (thesis) and eventually led to the creation of DIU 2.0 (synthesis), the new setup that differed in terms of goal, mandate, governance, etc. This observation from five manufacturing DIUs – each having one single DIU – complements but also contrasts with a recent study by Schumm (2023) of an incumbent automotive company that had implemented >25 DIUs in three years. Schumm (2023) found that DIUs "co-evolve with their main organization through continuous and reciprocal alignment." (p. 163). On the one hand, there is a consensus with the findings of this dissertation that the development of a DIU is not exclusively self-driven but takes place in interaction with the main organization or with factors external to the DIU (see Chapter 4.1, (Lorson, Dremel, & Uebernickel, 2022; Schumm, 2023)). On the other hand, there are conflicting accounts of how this interaction occurs between the observations of this dissertation (Chapter 4.1) and Schumm (2023). The >25 DIUs in the automotive company that Schumm (2023) examined "need to compete for scarce resources (e.g., attention and funding) with other digital innovation initiatives internally […] to secure their survival and growth" (p. 130). In this context, they describe three evolutionary mechanisms involving constant negotiation and ambiguity (Schumm, 2023). According to Van de Ven and Poole's (1995) ideal-type organizational change theories this corresponds to an evolutionary motor of change. The five manufacturing DIUs considered for this thesis and their evolution differ in two respects: (1) Although they had firmly allocated budgets and resources, they were not competing with other DIUs or digital transformation initiatives, i.e., an evolutionary motor of change was not triggered. (2) Although there was overall increasing cooperation between the DIU

and the main organization, accompanied by some mutual accommodation, the major evolutionary step of the DIU took place abruptly and within a few months, after various external triggers of the DIU had accumulated and been discharged. This shows the influence of a dialectic motor of change. Thus, Schumm's (2023) recognition of an evolutionary motor of change and this dissertation's finding of an interplay between a life-cycle and a dialectic motor of change in the evolution of DIUs contain some similar elements, but are at their core opposed to each other. These differences may be industry-specific (automotive vs. machine and plant engineering), due to the coexistence of multiple DIUs within an organization (one vs. 25), or due to other factors that need to be clarified in future research.

5.1.2 Discussion of Temporal Dynamics in DIU Evolution

In light of the research findings on the role of temporal dynamics in the evolution process of DIUs (Chapter 4.2), it is posited that DIUs should be reevaluated as not only serving as fast lanes of innovation (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b) but rather as additional lanes for the development of digital products, services, and business models. DIUs are embedded in the broader context of three organizational temporal zones and fill the role of the fast-paced, short-term, short-cycle temporal zone (Ancona, Okhuysen, et al., 2001). Time in the sense of speed is part of the narrative but rather a means to an end of DIU activities and outputs. The findings from Chapter 4.2 thus extend previous research that uses the term innovation fast lane primarily focusing on IT (fast IT) (Raabe et al., 2020a, 2020b) to a broader context. In particular, because manufacturing DIUs operate close to the core business with their innovation activities, additional circumstances regarding time or speed, such as focus, flexibility, trust, and consistency, need to be taken into account (see Chapter 4.2, (Lorson, Dremel, de Paula, et al., 2022)). This also raises the question of whether the narrative of an innovation fast-lane might be counterproductive, as it creates certain expectations. For example, Proposition 2 in Chapter 4.2 shows that flexibility is equally crucial to speed, which can be related to the insight of previous publications that DIUs should be equipped with high degrees of freedom (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a).

Based on the findings of cases B, C, D, E, and F, the main objective should, therefore, be to create the conditions for faster implementation of digital products, services, and business models, for which focus, flexibility, and "right timing" as well as efficient decision-making processes are essential. Regarding the importance of focus, it is surprising that in the five manufacturing companies, some employees divide their working time between the DIU and the main organization, i.e., across different temporal zones. A study by Holotiuk and Beimborn (2019) suggests the opposite: developing digital products, services, and business models requires employees to spend their entire working time (at least temporarily) on exploration activities to exploit the potential and quickly acquire the necessary knowledge. Proposition 2 in Chapter 4.2 confirms this suggestion, adding that splitting work time across temporal zones prevents the vital focus for DIU activities and should, therefore, be avoided. This insight has either not yet penetrated the business

practices of manufacturing companies, or it is deliberately accepted at the cost of speed.

5.1.3 Discussion of Interactions in DIU Evolution

In literature, the interaction between the DIU and the main organization is mostly studied one-dimensionally either from the perspective of the DIU, where the main organization struggles with developing and incorporating digital products, services, and business models (e.g., Svahn et al., 2017), or from the perspective of the main organization where the DIU does not deliver the expected value (e.g., Mayer et al., 2021; Raabe et al., 2020a). Adopting an STS perspective to obtain a two-dimensional view of the interaction between the DIU and the main organization increased the knowledge for designing and deploying DIUs more efficiently in the future. The results in Chapter 4.3 show that DIUs have a greater impact on adaptation across the board, triggering various changes within the main organization. Given that their goal is to initiate and drive digital transformation (Barthel et al., 2020; Jöhnk et al., 2020), this is a logical development and a positive sign. Surprisingly, however, the main organization also influences the DIU in its technical and social system in a way that favors adaptation. This seems counterintuitive since incumbents initially built DIUs to exploit their reduced socio-technical organizational complexity and to take advantage of dedicated, smaller structures within the remaining organization to be able to scale the development of at least radical (Raabe et al., 2020b) innovation (Arvidsson & Mønsted, 2018; Holotiuk & Beimborn, 2019). Although collaboration with the main organization is important (Svahn et al., 2017), DIUs should be endowed with high degrees of freedom (Fuchs et al., 2019; Holotiuk & Beimborn, 2019; Raabe et al., 2020a) and "leverage[e] new structures and practices that differ from those existing in the organization" (Haskamp et al., 2023, p. 6).

However, the results in Chapter 4.3 show that DIUs, for example, adopt standard communication tools from the main organization to enable collaboration or administrative structures, concepts, and procedures such as the existing hiring process. This insight from an STS perspective shows similarities with Schumm's (2023) findings, which identify the collaborative cooperation between the DIU and the main organization and the mutual adoption of work practices (especially in the early stages of the DIU) as a way to reduce irritation and friction losses and gain efficiency and legitimacy within the organization. Thus, it appears that the DIU – more or less voluntarily – is giving up some of its initial degrees of freedom for acceptance and legitimacy. From the perspective of digital transformation, which requires malleable organizational structures (Hanelt et al., 2020), the ability of an early-stage DIU to adapt to the needs of the main organization can be viewed positively. The question that now arises, however, is whether they will remain malleable in the future or whether they are now too close to the main organization to be able to fulfill their mandate of bringing about digital transformation and at least radical (Raabe et al., 2020b) innovation (Arvidsson & Mønsted, 2018; Holotiuk & Beimborn, 2019). This question is addressed again in Chapters 6.2 and 6.3.

In addition, the findings of this dissertation on the socio-technical interactions between DIU and the main organization also broaden the scope of the STS literature, which has historically emphasized optimal design (Cherns, 1976; Mumford, 1995) with limited exploration of the interactions among STS during digital transformation. Within the DIU, one could observe the STS's typical inherently dynamic evolution through a recursive design of social constructs and technical infrastructure (Orlikowski, 2000; Orlikowski & Scott, 2008). Changes in the social system were accompanied by a reaction in the technical system and vice versa. Moreover, the findings in section 4.3. extend this knowledge and show that two different STS (DIU and main organization) are also in dynamic interaction and adapt over time. This confirms that DIUs can initiate and drive socio-technical change during the digital transformation, which requires continuous reconfiguration (Vial, 2019; Wessel et al., 2021). As this dissertation focused on the early stages of DIUs within their first three years of operation, future research needs to clarify whether these processes remain continuous.

5.1.4 Discussion of Relational Dynamics in DIU Evolution

Studies by Schumm et al. (2023) and Raabe et al. (2020b) touch on early-stage DIUs but focus primarily on their evolution along different DIU types that they define beforehand. Detailed insights into the relational dynamics, especially in the social structures that led to the gradual legitimization of the DIU and its emergence as an independent department, were previously unknown.

The individual steps taken by Case F, such as building the team and processes, initiating projects and activities, developing digital capabilities, and making keyboard decisions, all contributed to positioning the DIU within the organization. While these steps can be used as an example for other manufacturing companies, it was primarily the relationship building that proved critical in overcoming the challenges of the initiation and evolution process. In contrast to previous research on DIUs, which chiefly emphasized the indispensability of relationships with top management/C-level and their buy-in (upwards relationship) (Lau et al., 2022; Raabe et al., 2020a; Velten et al., 2016), this dissertation finds sidewards relationships with peers and communities of practice (Bourne, 2010; Bourne & Walker, 2004) to be equally crucial. In Case F, these are primarily the heads of the other departments and their teams with whom the DIU works closely, such as R&D, IT, sales, the subsidiary, product management, or marketing. Without their cooperation, the DIU could not fulfill its role. This phenomenon may be specific to the manufacturing industry or DIUs with a core business-related mandate/*External Enhancers*. As the manufacturing industry has typically been slow to respond to the impact of digital transformation, as its mostly non-digital business models are not yet threatened (Fuchs et al., 2019; Hanelt et al., 2015), there is still great potential to develop digital products and services that complement the machine and to build the necessary, unified data management and IT infrastructure. The DIU, therefore, relies on the knowledge and skills of those departments that develop (R&D) and sell the machines, have the proficiency and access to customers (Sales) or manage the IT infrastructure (IT), making *sidewards relationships* essential.

Furthermore, Case F shows that the mere support and approval of top management (*passive top management support*) leads to challenges in the DIU evolution. Thus, this thesis confirms the importance of the *upwards relationship* with the top management highlighted in previous studies (Lau et al., 2022; Raabe et al., 2020a; Velten et al., 2016) but emphasizes the necessity of *active support* from the top management, i.e., the continuous defense of the role and responsibilities of the DIU against the overreach of other departments.

Finally, regarding the AC lens, the results in Chapter 4.4.2 show a positive relationship between the formation of a DIU and the expansion of the companies' AC. In turn, this positively influences the acceptance of the DIU. The DIU initiated and required the three mechanisms identified – *multiplexity enhancement, information redundancy generation,* and *decoupling tendency.* A closer look at the mechanisms reveals that one of the great benefits of a DIU is that it brings the entire enterprise "closer together." It increases the number and variety of relationships within the main organization, leading to greater *multiplexity*. It also contributes to heightened interdepartmental communication and, for example, *information redundancy*. And it paves the way for more *loosely coupled systems* within the main organization. This observation relates to, confirms, and extends existing findings that DIUs can help break down inter- and intra-organizational silos (Haskamp et al., 2023; Holotiuk, 2020; Raabe et al., 2021; Svahn et al., 2017). Ultimately, the DIU enhances the company's overall AC, enabling it to thrive in unstable and uncertain circumstances, a critical factor in digital transformation (Hinings et al., 2018; Vial, 2019). At the same time, the DIU needs to operate in a way that aligns with these dynamics to secure a successful position within the organization or, using the terms of other DIU research, to build acceptance and legitimacy within the organization (Schumm, 2023). In particular, DIUs with a core business mandate – such as in the manufacturing companies observed – depend on input from the main organization. Case F, for example, needs access to customers and the existing IT infrastructure and must interact with the R&D department to develop and launch digital products and services. As a result, it is keen to establish and maintain as many exchange points with the main organization as possible and to share key information about innovation projects to ensure smooth collaboration.

Similarly, the five confounding factors identified are detrimental to AC's development and expansion and the DIU's evolution. Regarding *multiplexity*, the results show the importance of the above-mentioned *active management support –* at all levels – to ensure an adequate reward system and flow of information and the imposition of sanctions when the new structure – in this case, the DIU – is counteracted. Concerning *redundancy*, blind actionism and the pursuit of self-interest by dominant actors are detrimental to the development of both the AC and the DIU. Finally, the inertial forces of the main organization and its tendency toward being a highly coupled system have a detrimental effect on the expansion of the AC and the building of the DIU and its work (see Chapter 4.4, (Lorson et al., 2023)).

5.2 Dynamics of DIU Evolution in the Early Stages

Based on the results of this dissertation and the previous discussion, a conceptual synthesis of the empirical data is now developed to allow for a higher level of abstraction.

As shown in Chapter 4, the evolution process of DIUs within the first three years is divided into two phases: the start-up and the growth phases. To provide a comprehensive understanding of the characteristics in both phases across all findings, Table 16 presents a detailed overview of how the two-phase nature is manifested in the results.

Table 16: Illustration of the Two-phase Nature of the Results.

Topic, RQ, Chapter	Start-up Phase	Growth Phase
Fundamentals of DIU Evolution RQ1 Chapter 4.1	• Initial DIU setup with specific goals, mandate, governance structures, team, processes, (and technology)	• During the growth phase (on average after 18 months), an antithesis consisting of several triggers conflicted with the DIU initial setup (thesis) and led to a restructuring and closer alignment to the main organization (synthesis) across all five cases.
Temporal Dynamics in DIU Evolution RQ2 Chapter 4.2	Temporal antecedents for DIU activities and outputs: • DIU adopts a spasmodic temporal style that creates the necessary flexibility for DIU activities and outputs • Divided time capacities reduce focus and slow down value generation • Fast DIU decision-making to meet speed expectations	Temporal consequence of DIU activities and outputs: • Trust as a moderator for time pressure in DIU activities and outputs • DIU business models with subscription character steady sales cycles and companies' overall business outputs
Socio-technical Interaction and Adaptation in DIU Evolution RQ3 Chapter 4.3	DIU-initiated: • Introduces agile, customer-centric, digital product development, accompanying digital tools and infrastructure (technical system) • Introduces product logic, new organizational culture, ambidexterity digital expertise, and dynamic capabilities (social system)	DIU-initiated: • Introduces hardware devices for testing digital products and builds cloud infrastructure - common data storage and management (technical system), • Pushes for new governance and reporting structures, new goals and strategic direction, and aligned reward systems (social system)

	• Network and ecosystem (environmental system), first digital pilot projects (outputs) Main Organization-initiated: • Introduces standard communication tools in DIU (technical system) • Meets the DIU with persistence, competitive thinking, and NIH-syndrome (social system)	• Expands the network and ecosystem (environmental system) as well as launches first digital products Main Organization-initiated: • Provides access to existing IT infrastructure (technical system) • Supports DIU with legal topics and provides customer access and knowledge (social system)
Relational Dynamics in DIU Evolution RQ4 Chapter 4.4	• Initiation of upwards, sidewards, downwards, and outwards relationships • Implementation of team and processes, first digital pilot projects and digital brand, initiation of digital capabilities	• Expansion and intensification, especially of sidewards and outwards relationships • Enlargement of team and professionalization of processes, first product launched and revenue created, expansion of digital capabilities, development of a holistic digital strategy, and decision on final DIU setup
	AC building mechanisms: • Initiation of multiplexity enhancement mechanism • Initiation of decoupling tendencies mechanism (around month nine to ten)	AC building mechanisms: • Deployment of multiplexity enhancement mechanism • Unfolding of information redundancy generation mechanism • Proper unfolding of decoupling tendencies mechanism
	AC confounding factors: • Impairment of multiplexity by signification and legitimation aspects of structure and by insufficient conferral of legitimacy • Artificial and uncoordinated task redundancy tendencies begin to be visible (after six to nine months) • Strong persistence in strong coupling and limited process slack	AC confounding factors: • Impairment of multiplexity is expected to improve with the new DIU setup • Artificial and uncoordinated task redundancy tendencies remain but are expected to improve with the new DIU setup • Slight decline in persistence in strong coupling and limited process slack

To summarize and synthesize the findings, enriched by insights from the existing DIU literature, the two-phase nature is used to outline the dynamics of DIU

evolution in the early stages and to derive a phase model of intensifying cooperation between the DIU and the main organization. The phase logic of the evolution process in Chapter 4.1, Figure 12, is used as a basis.

The start-up phase encompasses the first year of DIU operation, and the subsequent growth phase encompasses roughly the second and third years. Based on the data, this thesis defines the transition from the start-up to the growth phase as the point at which the DIU team is implemented, processes are in place, and the first pilots or MVPs are launched. The third phase, "maturity," follows the growth phase and covers DIU evolution from around the end of the third/beginning of the fourth year to when the DIU is sufficiently well positioned and established to scale its activities without major adjustments. This phase is about "reaping what one has sown," for example, generating revenue on a larger scale from the developed digital products and services and firmly establishing the company's additional business models. As all cases were at most in their third year of operation at the time of data collection, the maturity phase is shown in a lighter shade of gray, as no data-based statements can be made. The width of the phases has only been chosen for clarity but does not imply how long or short the maturity phase is. The phase model of intensifying cooperation does not include a termination phase because there is no plan to dissolve the DIU, at least in the medium term, in any of the seven cases – this also aligns with other DIU publications (Schumm, 2023).

Figure 19 provides a detailed illustration of the mutual influence and the relationship between the DIU and the main organization and how they intensify their cooperation along two phases. The phase designations at the top of the figure refer to the DIU only. The following explains the phase model of intensifying cooperation in detail.
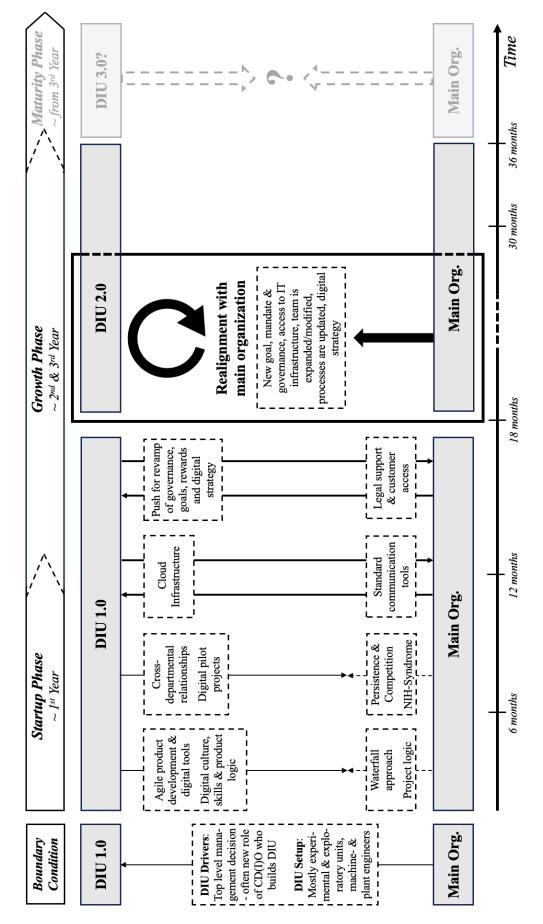
Figure 19: A Phased Model of Intensifying Cooperation.

The model shows a gradual intensification of the cooperation between the DIU and the main organization over roughly three years during the DIU's start-up and growth phase. This reflects the findings of this thesis from the machine and plant engineering industry (see Chapters 4, (Lorson et al., 2024, 2023, n.d.; Lorson, Dremel, & Uebernickel, 2022)) and also resonates with Schumm et al.'s (2023) findings from the automotive industry and Raabe et al' (2021) findings from the retail sector. According to the terminology from Chapter 4.1, the initial setup of the DIU, which was in place for the first 18 months on average, is named DIU 1.0, while the configuration after the realignment with the main organization is named DIU 2.0. For clarity and readability, several key aspects were chosen to roughly depict the sequence of cooperation between DIU and the main organization and how it intensified. The arrows' thickness indicates the intensity of the relationship – the thicker the arrow, the stronger the relationship. This categorization is based on the increasing interlocking between the DIU and the main organization, e.g., more people are involved in projects, more often, or (IT) systems are linked – it was not subject to quantitative analysis. The arrows on the lines represent the direction from which cooperation is initiated, not causation. Since some influences occurred almost simultaneously (such as the first and second aspects) or with a slight time lag in the individual DIUs, they should not be understood as being determined to the nearest month. Nevertheless, the timeline at the bottom of the figure is intended to give the reader a point of reference.

The boundary conditions of the phase model are the criteria DIU Driver and DIU Setup. In all seven cases, the trigger for creating a DIU – called the DIU Driver – is a top-level management decision, often coming from the supervisory board or a new appointment to the supervisory board. This is mostly followed by the assignation of the CD(I)O, who, in turn, decides to create a DIU. Concerning the DIU setup, all DIUs observed were in manufacturing, specifically machine and plant engineering, and were initially set up more as experimental and exploratory units.

Once the decision is made to establish a DIU, the leaders assemble a team, identify projects to work on, build processes and ways of working, and define the work culture. When the first projects are launched, this is often not done in a DIU vacuum but also regularly in collaboration/exchange with the main organization (see also (Barthel et al., 2020; Holotiuk & Beimborn, 2019)). As a result, the main organization becomes familiar with agile, digital product development, digital tools, skills, and culture, as well as thinking in terms of product logic (Göbeler et al., 2020; Haskamp et al., 2023; Holotiuk & Beimborn, 2019; Raabe et al., 2021, 2020b). This process is illustrated with the first dashed box in Figure 19. Although the main organization is familiar with the DIU's ways of working and digital culture, it continues to think more in terms of project logic and approaches product development with a waterfall process (see Chapter 4.3, (Lorson et al., 2024)). While this is still perfectly valid for the development of machines, it creates obstacles to developing digital products and services. A dashed arrow from the main organization towards the DIU expresses these inertial forces. The dashed arrow is used because it is not a case of the main organization influencing the DIU

but rather a case of the main organization opposing how the DIU works and hindering the convergence of the two STSs.

In the further course, increased interdisciplinary collaboration in the form of innovation projects or pilots leads to sidewards, cross-departmental relationships between the DIU and the main organization. This process, often referred to in the literature as breaking down intra-organizational silos (Haskamp et al., 2023; Hund et al., 2019; Raabe et al., 2020b) – which is also one of the goals/motivations behind a DIU (Haskamp et al., 2023) – is slowed down primarily by persistence, competitive thinking and NIH syndrome on the part of the main organization (see Chapters 4.3 and 4.4, (Lorson et al., 2024, n.d.; Raabe et al., 2020a)). These inertial forces – also referred to in the DIU literature as irritation and friction losses which often occur at the beginning of the DIU's existence (Schumm, 2023) – are typical of digital transformation processes (Haskamp, Dremel, et al., 2021) and hinder the increase of the collaboration of the two STSs (see Chapter 4.3, (Lorson et al., 2024)). Again, a dashed arrow is used to visualize them. Over time, however, as the irritations and friction losses diminish and the specific work attitudes, cultural characteristics, and digital skills can be transferred from the DIU to the main organization, there is an overall increase in mutual understanding, collaboration, and convergence (see Chapter 4.3, (Lorson et al., 2024; Schumm, 2023)).

A key aspect of strengthening collaboration – and eliminating friction losses (Schumm, 2023) – is the alignment of infrastructure between the two STSs (see Chapter 4.3, (Lorson et al., 2024)) shown in box three and connected with a thicker arrow. On the DIU side, the focus is on building a cloud infrastructure that will be used across the company. Conversely, the main organization introduces some communication tools in the DIU to enable collaboration. In addition, the DIU more or less voluntarily gives up some of its initial degrees of freedom and adopts some administrative structures, concepts and procedures of the main organization (such as the existing hiring process) in order to gain internal efficiency and legitimacy as mentioned above (see Chapter 4.4, (Lorson et al., 2023; Schumm, 2023)).

As the DIU enters its growth phase, the main organization is familiarizing itself with the new unit, supporting the DIU team with legal matters, for example, or sharing its knowledge and access to customers, which is critical to the DIU's customer-centric approach to product development. Conversely, it becomes increasingly clear that certain structural barriers prevent the unit from realizing its full potential. For example, the existing performance measurement system often does not incentivize departments in the main organization to support the activities of the DIU, or there is no unified digital strategy (see Chapters 4.1 and 4.3, (Lorson et al., 2024; Lorson, Dremel, & Uebernickel, 2022)). As a result, the DIU team increasingly pushes to revise governance structures, goals and reward systems, and the digital strategy, which is ultimately addressed as part of the realignment.

As shown in Figure 19, the "realignment with the main organization" takes place during the growth phase – on average, after 18 months of DIU existence. An accumulation of different circumstances – called triggers in Chapter 4.1 – challenge the initial setup of the DIU (DIU 1.0) and leads to the need for its realignment.

These can be positive circumstances, such as (partially) achieved goals, but also negative circumstances, such as a lack of cooperation with the main organization or insufficient results (see Chapter 4.1). During an average 8.5-month realignment process, the relationship and mode of collaboration between the DIU and the main organization are – in some cases substantially – redefined. The DIU goals are more closely aligned with the core business, and its mandate is focused on implementing digital products, services, and business models, i.e., exploitation, rather than exploring them. Governance structures are changing as some companies abandon the DIU's separate legal entity, or individuals or entire teams become part of the DIU. Furthermore, the DIU gains proper access to the main organization's IT infrastructure, the team is often expanded or modified, and processes are updated. In all cases, the realignment was accompanied by a strategic reorientation as the organization develops or redevelops its digital strategy (see Chapter 4.1, (Lorson, Dremel, & Uebernickel, 2022)). The broad, round arrow from DIU and the broad arrow from the main organization in Figure 19 illustrates that both DIU and the main organization (and, in some cases, also an external consultancy) were involved in the realignment. Following this realignment – after about 26.5 months – six of the DIUs considered to have a (stronger) core business-related mandate and a clear focus on developing digital products and services that complement the machines (Case G was still in the start-up phase at the end of data collection). This new setup is called DIU 2.0 and has an intensified mode of operation with the main organization, as most of the six cases decided, for example, that each innovation team must have a domain expert from the main organization and sometimes even a high-level sponsor. However, the DIU remains its own entity and is not fully integrated into the main organization but is at least a separate department. Conversely, the main organization has not fully adopted the DIU's ways of working, processes, team dynamics, digital culture, etc.

Since the data collection for this thesis ended after the realignment phase, no data-based statements can be made about the subsequent evolution of the DIU and its cooperation with the main organization. There is a possibility that it will remain the same or that it will be intensified or weakened from either side. There is also the possibility that the DIU setup will change considerably again, and there will be a new DIU 3.0 design. Figure 19 illustrates this with a lighter-shaded DIU 3.0 and main organization after the growth phase, and two lighter-shaded dashed arrows with a question mark between them.

Chapter 5.3 now discusses some implications of the phase model of intensifying cooperation and possible implications for the further development of cooperation between the DIU and the main organization.

5.3 A Critical Reflection of the Phase Model

Based on the findings of this dissertation and previous research, creating a DIU is considered a valuable and important initiative in an incumbent's digital transformation, as it leads to change and adaptation in the organization.

Building on the existing mostly static and one-dimensional knowledge of DIUs and their interaction with the main organization, this thesis elaborates on the evolution process of a DIU in the early stages (first three years of DIU operation), including its fundamentals, temporal dynamics, socio-technical interactions, and relational dynamics.

The phase model of intensifying collaboration in Figure 19 illustrates three essential insights of DIU evolution:

1) The evolution is driven by the interaction/relationship of the two STSs – DIU and main organization – which influence each other.
2) The STSs of the DIU and the main organization gradually increased their cooperation during the DIU's start-up and growth phase.
3) Realignment is a decisive process that brings substantial changes, especially for the DIU, and aligns it more strongly with the main organization.

Several implications arise from these findings and the model itself, three of which will be discussed in more detail below and serve as a basis to derive propositions that provide subjects for future research.

First, the question that immediately arises is: does mutual influence and intensification of cooperation between the DIU and the main organization make sense? Looking more closely at the results and the phase model in Figure 19, there is even a change in the narrative from a DIU-driven intensification of cooperation to a main organization-driven intensification of cooperation. Initially, the DIU seeks to establish cooperation with the main organization or bring its way of working and thinking, its tools, and processes to the main organization. During the growth phase, the main organization integrates the DIU more closely. This is particularly evident in the "realignment" triggered by factors external to the DIU (see Chapters 4.1 and 5.2). As already discussed in Chapter 5.1.3, this development is a double-edged sword, as there is a risk that the satellite, the DIU, will get too close to the planet, the main organization, will be retracted and absorbed, and will not be able to initiate the necessary changes for digital transformation. It may no longer be able to fulfill its role as a malleable structure, rendering the entire initiative obsolete. Conversely, however, both the results of this dissertation and those of other authors suggest that the DIU must adapt to the main organization to some extent to enable collaboration, eliminate irritation and friction losses, and gain internal efficiency and legitimacy (see Chapter 4, (Raabe et al., 2020a; Schumm, 2023)). Regarding the results in Chapter 4, one can add that all seven DIUs considered are active in the manufacturing sector and (by now) have a core business mandate. To meet this mandate, most of the main organizations' influence is essential for successful collaboration even though they restrict a DIU's originally planned and required degrees of freedom. For example, the two STSs need a way to communicate and collaborate when working on joint projects. Common communication and project management tools, therefore, make sense. Furthermore, if the DIU's innovations are to impact the core business, it needs access to the existing IT infrastructure, such as ERP or CRM systems, and machine

data. Therefore, these limitations in degrees of freedom are evaluated as a necessary sacrifice to deliver real value to an incumbent digital transformation, which leads to the following proposition:

Proposition 1: In an incumbent company that requires innovation close to the core business, a DIU must initially allow for some level of cooperation/giving up some degrees of freedom to bring about the necessary changes in the main organization and make a relevant contribution to digital transformation.

Second, this dissertation focuses on DIUs in the manufacturing industry as an example of a traditional incumbent industry characterized by robust product development and production timeframes of up to ten years (Dremel & Herterich, 2016). Their representatives increasingly feel the pressure to embrace digital technologies and adapt to the agile and rapid development of digital products and services, where time and speed play a critical role (Gerster et al., 2020). Thus, they are constantly torn between maintaining the traditional business of designing, producing, and servicing large physical machines and plants and meeting the demands of the digital age (e.g., software, data analytics, and digital services) in parallel (Bilgeri et al., 2017; Hylving & Selander, 2012; Sebastian et al., 2017). Looking at the phase model, the "realignment with the main organization" is immediately noticeable because it is a process that involves major changes in the relationship and collaboration between the DIU and the main organization. In all cases that have reached the growth phase (Case A-F), the initial design of the DIU is revised (often substantially) with the result that their activities are more clearly aligned with the core business. This is the result of the preceding gradual approach, which showed that the previous setup could not fully meet the expectations of the main organization. In the early stages of digital transformation and DIU operation (minimum within the first three years), the manufacturing industry seems to need a core business-related DIU to help build the necessary (IT) infrastructure for enterprise-wide digital transformation and to harness the potential of digital products, services, and business models "around the machine." An exploratory DIU that identifies new business opportunities but does not help the main organization lay the groundwork is not the way to go for now. A report by Sindeman et al. (2021) shows the same trends for the DIUs in other industries. In 2021, 90 percent of DIUs addressed core-business related topics – and potentially others (Sindemann et al., 2021). This leads to the following proposition:

Proposition 2: a) A company in its early stages of digital transformation and DIU operation requires a DIU with a core business-related mandate. b) Otherwise, the expectations of the main organization remain unfulfilled, leading to the need for realignment during the DIU's growth phase.

Third, as mentioned in Chapter 5.2, there are different options for the further development of the DIU and its dynamic cooperation with the main organization, especially in the maturity phase. Each of the two STSs can either drive the intensification or the reduction of the cooperation, or it can remain unchanged with DIU 2.0. These options have different implications, advantages, and disadvantages that must be considered, some of which are discussed below.

Suppose the DIU's cooperation with the main organization intensifies further, the question arises whether it can continue to be the satellite that is intentionally designed to be different from the main organization in terms of mindset, collaboration, working methods, communication, and degrees of freedom to enable the creation of digital products, services, and business models (Fuchs et al., 2019; Holotiuk & Beimborn, 2019; Raabe et al., 2020a). The development over the first three years along the start-up and growth phases shows that the DIU fulfills this role (at least to some extent) and that malleable structures are emerging that other authors have identified as crucial for digital transformation (Hanelt et al., 2020; Huang et al., 2017). Thus, the DIU should not give up more degrees of freedom in their work practices to maintain these structures. Conversely, suppose the main organization adopts more of the DIU way of working, tools, and culture; this must also be based on the premise that the organization continues to be capable of both exploration and exploitation activities and is itself ambidextrous (Duncan, 1976) because it is still valid and useful to design and build machines in a waterfall process. Regarding remaining ambidextrous, the development of DIU 2.0 raises slight concerns. Most DIUs under consideration have received a new mandate with the realignment and transition to DIU 2.0, which is focused on implementing the previously developed MVPs (apart from Case D) – i.e., exploitation. It, therefore, seems as if they are now in the role of a product development team rather than an innovation department. Because it can take several years to bring these digital products and services to market and roll them out globally, the prioritization of exploration activities necessary to remain ambidextrous and innovative is currently limited. For companies that have gone through this development, it is, therefore, advisable to develop the DIU or parts of the DIU team in the direction of exploration in the future – as in Case D. Following the naming logic of Chapters 4.1 and 5.2, this subsequent design could be called DIU 3.0. It differs from DIU 2.0 in that most team members remain a permanent part of the DIU, e.g., as innovation managers supporting innovation teams from the main organization. This way, knowledge about developing digital products, services, and business models is permanently available in the DIU and can be transferred to the main organization, thus maintaining exploration and ambidexterity. In addition, the DIU retains its character as a malleable structure. This leads to the following proposition:

Proposition 3: *To maintain the capabilities of a malleable organizational structure, the DIU requires a next evolutionary step toward DIU 3.0, in which the DIU (or part of it) evolves into an innovation enabler that empowers innovation teams from the main organization to develop digital products, services, and business models. This allows the DIU to maintain its role as an exploratory unit and ensures the ambidexterity of the entire organization.*

As none of the seven cases considered plan to dissolve their DIU, at least in the medium term, the phase model does not include a termination phase. In practice, however, it occasionally happens that DIUs are closed or sold (Fecher et al., 2020; Sindemann et al., 2021; Tödtmann, 2020) because they were unable to meet the expectations placed on them. Considering the discussion that leads to *Proposition 3*, it is also conceivable that the DIU could be dissolved because it has fulfilled its

mission and sufficiently transformed the main organization. This case has not yet occurred and has been investigated due to the currently young age of many DIUs. A DIU would thus be a temporary phenomenon, ensuring that the main organization becomes a malleable structure adapting to changing external circumstances. Future research should clarify whether this is the case and how the maturity and termination phases are shaped.

Looking at the phase model of intensifying cooperation and the results of this dissertation in general, one recognizes a high relevance of social factors that both enable and, to some extent, hinder the digital transformation efforts of an incumbent. For example, it is relationship building that strongly shapes the evolution process of a DIU, and personal exchange and collaboration that transfers DIU processes, culture, and ways of working to (parts of) the main organization, but it is also an individual need for recognition and pursuit of own goals that lead to persistence and inertia. To emphasize this social aspect of digital transformation, this thesis advocates for the term "human-digital transformation."

6 Contribution

This dissertation focuses on the emerging phenomenon of DIUs and their early-stage evolution in the manufacturing industry. It offers several valuable contributions to both research and practice. DIUs are considered separate STSs that are built and evolve within the "surrounding" STS of the main organization. In the following, contributions to research on DIUs and DIU evolution in the early stages are presented (Chapter 6.1). Then, the managerial implications of the findings are outlined to provide insights for business practice (Chapter 6.2).

6.1 Contribution to Research

The contribution to IS research is threefold in its core: (1) the dissertation extends the dynamic understanding of DIUs by focusing on the early stages of DIU evolution in the manufacturing industry, (2) it provides various insights into the evolution processes of a DIU including its fundamentals, temporal dynamics, socio-technical interactions, and relational dynamics, (3) it adds a two-dimensional socio-technical perspective to the often one-dimensional view of DIUs and their interactions with the main organization. Additionally, it extends the knowledge of digital transformation in incumbent organizations and the malleable structures they deploy for this process. In the following, each contribution is explained in detail.

This dissertation's RG was to *gain a deeper understanding of the early stages of a DIU's evolution and its contribution to a manufacturing company's digital transformation.* It intends to fill the research gap of a missing dynamic understanding of DIUs, specifically focusing on machine and plant engineers.

The dissertation began with introducing the main RQ, which was to be answered cumulatively through four sub questions (see Chapter 1.2). These research questions were addressed throughout the dissertation (Table 17).

Table 17: Research Question and Research Contribution.

Research Question	Research Contribution
How do DIUs evolve over time to meet the needs and expectations of the main organization?	• Illustration of early-stage DIU evolution process driven by life-cycle and dialectic motor of change • Ten triggers for the first major DIU evolution step • Description of strategic realignment and DIU reorganization • Description of changes between DIU 1.0 and DIU 2.0 setup
How and what temporal dynamics unfold during the evolution of a DIU?	• Identification and illustration of five temporal factors that affect or are affected by DIU activities and outputs • Clustering of the five temporal factors in three temporal antecedents and two temporal consequences of DIU activities and outputs • Five propositions about temporal dynamics in DIU activities and outputs
How do a DIU and its main organization interact at the socio-technical level as the DIU evolves?	• Illustration and analysis of the interaction and influence between the DIU and the main organization along four socio-technical elements • Visualization of the two phases of socio-technical adaptation
How do the relational dynamics between the DIU and the main organization unfold during the DIU's evolution?	• Description of eleven challenges during the initiation and evolution of DIUs. • Presentation of the emergence of key characteristics and social structures of a DIU's initiation, start-up, and growth phase • Description of the emergence and temporality of DIU relationships and identification of the high relevance of sidewards relationships • Identification of three positive mechanisms and five confounding factors for the emergence and expansion of organizational AC

To answer the first RQ, the thesis develops a visual representation of the early stages of the evolution process of a DIU, driven by the interplay of a life cycle and a dialectic motor of organizational change. It also identifies ten triggers – both active and passive, internal and external – some of which, accumulated in different combinations, trigger a DIU's first major evolutionary step. In addition, the thesis provides a detailed explanation of the strategic realignment and reorganization process through which DIU 1.0 was reconfigured into DIU 2.0 to meet the needs and expectations of the main organization. Finally, the changes between DIU 1.0

and DIU 2.0 setup are presented. On the one hand, these findings contribute to the understanding of new forms of organizational design and their practices implemented for digital transformation (Hanelt et al., 2020; Yoo et al., 2012; Zammuto et al., 2007) and show that DIUs are, at least in their first three years, are malleable structures that digital transformation requires (Hanelt et al., 2020). On the other hand, they extend but also contradict Schumm (2023), who identifies an evolutionary driver of change for DIU evolution in reciprocal alignment with the main organization and provides an additional perspective.

The second RQ is addressed in a publication on the temporal dynamics in DIU evolution. It identifies and explains five temporal factors that affect or are affected by DIU activities and outputs. Three temporal factors are antecedents of DIU activities and outputs; the remaining two are consequences. Building on this, the thesis derived five propositions about temporal dynamics in DIU activities and outputs that can be tested in future research. Overall, the DIU takes on the role of a fast-paced, short-term, short-cycle time zone with a culture of speed within the organization that improves its ability to meet the temporal demands of digital transformation. These results extend the connotation of a DIU as an innovation "fast lane" (Fuchs et al., 2019; Hellmich et al., 2021; Raabe et al., 2020a, 2020b), as they find several temporal factors other than speed associated with DIU activities and outputs. Furthermore, they add to the literature stream of temporal research (called upon by several researchers (Ancona, Goodman, et al., 2001; Ancona, Okhuysen, et al., 2001; Mousavi Baygi et al., 2021)) in the field of IS with a specific focus on digital transformation and the evolution of DIUs.

To answer the third RQ, the interactions and influences between the DIU and the main organization are illustrated, analyzed, and explained along four socio-technical elements: social system, technical system, environmental system, and outputs. Based on this, a visualization of the two-phase adaptation between the DIU and the main organization is created to reflect the dynamic evolution and the temporal sequence of this adaptation along a DIU's start-up and growth phase. Thus, the findings of this dissertation add a two-dimensional perspective to the research on DIUs and their interactions with the main organization. Furthermore, it extends the scope of the STS literature with insights into the socio-technical interaction and convergence of two systems throughout the digital transformation of incumbent firms.

Regarding the fourth and final RQ, the dissertation presents how the social structures of the DIU are constructed and how the associated key characteristics unfold in the initiation, start-up, and growth phases. It also describes eleven challenges that arise during the initiation and evolution of DIUs. The majority of these challenges are directly or indirectly related to interpersonal interaction and relationships (i.e., the social system). Furthermore, the emergence and temporality of the DIU's *upwards, downwards, sidewards,* and *outwards relationships* are described as the most fundamental attribute, (part of) the answer to every challenge, and the key driver of DIU adoption. In particular, the *sidewards relationships* with the peers of the DIU are crucial for its legitimization. Finally, the thesis identifies three mechanisms that positively influence the emergence and expansion of

organizational AC, as well as five confounding factors with a negative impact and how they unfold over time. The three mechanisms also work in favor of the acceptance of the DIU within the organization, whereas the five confounding factors are an expression of the inertial forces in incumbent companies during digital transformation (Haskamp, Dremel, et al., 2021).

These findings extend the knowledge of relational dynamics in DIU evolution, describing how DIUs and their main organizations collaborate and develop their interrelationships. In particular, the challenges associated with this process are presented and approaches for overcoming them, to advance the knowledge of how to deploy and utilize DIUs efficiently. Furthermore, the thesis deepens the understanding of the DIU-type *External Enhancer* regarding its internal ties to the main organization (Barthel et al., 2020). It also adds to the evidence of top management support as a key success factor for DIUs (e.g., Raabe et al., 2020a). While top management support is important, it must be *active top management support*, and relationships with the internal peer group are at least as essential.

Overall, the findings from the four RQs and the phase model of intensifying cooperation (see Chapter 5.2) broaden the dynamic understanding of DIUs and their early-stage evolution. As noted above, the thesis identifies DIUs within their first three years of operation as a manifestation of the malleable organizational structures required for digital transformation. They both initiate change in (parts of) the main organization, but they also adapt to the corporate environment and changing circumstances to some extent to contribute and equip incumbents for the digital age. The thesis also confirms Raabe's (2021) statement that the DIU and its main organization are in constant flux. Schumm's (2023) findings that the DIU and the main organization co-evolve through continuous and reciprocal alignment are complemented by the phase model as it shows that the DIU mainly drives the first part of their cooperation and adaptation while the main organization mostly triggers the realignment. This means there are periods when one STS is more active than the other. Finally, the findings reveal the complexity of the phenomenon and the profound changes involved, as well as the levers that can be used to set them in motion. They also highlight the challenges and obstacles that arise and provide insights into possible solutions.

6.2 Contribution to Practice

In addition to the implications for research, the results of this dissertation provide several valuable contributions to managerial practice. Overall, the existing DIU literature and the findings of the studies presented here show that DIUs are a meaningful initiative in the context of the digital transformation of incumbent companies. As shown in the case studies, they are often an important cornerstone for launching digital transformation, creating the conditions for developing digital products, services, and business models and equipping non-digital companies for the digital age. However, the results also show that implementing a DIU is neither

a foregone conclusion nor a sure-fire success, so they should also sensitize managers to potentially difficult situations that may arise and how to navigate them.

Altogether, several managerial implications emerge that can assist practitioners in building a new DIU from scratch (greenfield approach) or optimizing an existing DIU (brownfield approach). The greenfield and brownfield approaches –originally introduced by Hopkins and Jenkins (2008) and popularized by SAP – help companies derive and navigate a DIU strategy.

In the case of a greenfield approach, where a new DIU is to be built, the findings can provide the following:

- A plan for DIU evolution within the organization along its start-up and growth phase. Because DIUs are intended to be malleable organizational structures, managers must be prepared for ongoing adjustments as DIUs adapt to changing needs and expectations. The findings of this thesis can help better plan for DIU evolution, reducing the need for the deep realignment process observed in the case studies (derived from Chapter 4.1).
- An overview of the role of temporal dynamics in DIU evolution. Managers should create an environment that gives DIU employees the freedom and flexibility to identify the "right timing" to develop and implement digital products, services, and business models and ensure that DIU employees have sufficient time and focus to work on DIU projects. In addition, DIU management needs to establish structures (such as budgets and access to decision-makers) to ensure sufficiently fast decision-making processes in the DIU – despite high dependencies on the main organization – to meet the expectations addressed to them (derived from Chapter 4.2).
- An orientation to guide and smooth the socio-technical influence and adaptation trends between the DIU and the main organization. Managers must ensure early access to the main organization's IT infrastructure to lay the foundation for scalable digital products, services, and business models. Continuous and transparent communication and intensive and regular collaboration between the DIU and the main organization is necessary to mitigate the cultural clash. Finally, managers should initiate the development of an enterprise-wide digital strategy early on and align the incentive system accordingly (derived from Chapter 4.3).
- An insight into the activities and challenges of DIU evolution and the critical role of building stakeholder relationships. Since *sidewards relationships* with other departments and their leaders are most important for legitimizing a DIU within the organization, managers should first identify these key stakeholders and then prioritize relationship development to secure support and cooperation for the DIU (derived from Chapter 4.4).
- A guideline to ensure that the three discovered AC building mechanisms can unfold their full potential and that the disturbing factors are eliminated as much as possible. Therefore, managers should expand the DIU's intra- and inter-organizational network to create multiplex relationships and provide the basis for a shared organizational mindset. They should also

involve employees from other departments in innovation projects at an early stage. This way, diverse perspectives are incorporated into product development, and the main organization becomes better acquainted with the DIU's goals, tasks, and working methods. Finally, prominently communicating and showcasing concrete results can help ensure that the DIU's competencies are recognized and lead to greater acceptance and awareness of the potential of digital transformation (derived from Chapter 4.4).

- A basis of argument/support to advocate for building a new DIU in an incumbent company (derived from Chapter 4).

For companies that have already established a DIU, i.e., those that take a brownfield approach, this dissertation can provide managers with the following:

- A roadmap of possible next evolutionary steps to improve the existing DIU and prepare for change (derived from Chapter 4.1).
- An orientation for the transformation of a DIU that is faced with a conflict between the initial DIU setup and the expectations of the main organization or changes in its environment. Managers can use the results as inspiration to design the new DIU setup (derived from Chapter 4.1).
- A reminder that a DIU is intended to be a malleable structure designed to change. Managers should be aware that the DIU is unlikely to remain permanently in its initial design and anticipate that there will be sections with stronger or weaker core business alignment and stronger or weaker contextual or structural ambidexterity (derived from Chapters 4.1 and 4.3).
- An orientation to refining or repositioning an already established DIU. Managers can use the results to assess whether and to what extent their DIU is set up in such a way that (1) the temporal factors that influence DIU activities and outputs can unfold (derived from Chapter 4.2), (2) the socio-technical adaptation of the DIU and the main organization are managed according to the requirements of the DIU (derived from Chapter 4.3), (3) the mechanisms that favor the emergence of AC can reach their full potential and the disruptive factors are largely eliminated (derived from Chapter 4.4).
- Mechanisms to establish sustainable cooperation and collaboration between the DIU and the main organization, especially in light of the balance between sufficient degrees of freedom and adequate value added by the DIU (derived from Chapter 4.3).
- A justification for continuing to invest in a DIU (derived from Chapter 4).

These findings provide managers with valuable information to guide the DIU evolution in digital transformation. Recognizing the phase logic, the importance of (primarily sidewards) stakeholder relationships, temporal factors, AC enhancement mechanisms, and socio-technical adaptation will help managers make informed decisions and maximize the effectiveness of DIUs in their organizations.

Finally, this dissertation contains words of admonition. Driving digital transformation in organizations is a complex, non-linear process not governed by

clear plans or best practices. It requires a long and adaptive journey characterized by uncertainty and ambiguity. For example, as suggested by Proposition 3 in Chapter 5.3 of the Discussion, DIUs have probably not yet reached their final, optimal design and may never do so, as digital transformation requires malleable structures. DIUs in the manufacturing industry are currently in their second stage of development, from which they will have to emancipate themselves to maintain the organization's ambidexterity in the long term. Managers should also promptly explore alternative organizational approaches within their current context to forge new paths for digital products, services, and business models and strengthen their organization's resilience. They should prepare to manage paradoxical situations where simple solutions are rare. Adapting to digital transformation within established, industrial-age organizations may be one of today's most formidable management challenges.

7 Concluding Remarks

This dissertation has limitations, outlined in Chapter 7.1. However, these limitations can also pave the way for future research described in Chapter 7.2. Finally, the dissertation is closed with the conclusion in Chapter 7.3.

7.1 Limitations

Although this dissertation strengthens the dynamic understanding of DIUs and provides diverse insights into DIU evolution in the manufacturing industry, it faces some limitations rooted in the research design, including data collection and analysis, the infancy of the phenomenon, and the practical applicability of the results, which could affect the rigor and relevance of the findings.

First, this dissertation relies on qualitative empirical analysis, which includes inductive coding for analysis, and is subject to personal bias (Galdas, 2017; Thirsk & Clark, 2017). Therefore, the interpretation of the data may be based on the opinions and experiences of the researcher, which limits objectivity. To reduce the risk of personal bias, data analysis was conducted in multiple rounds of coding, with each round including a review and discussion of the codes by study co-authors and other researchers involved in the study. In addition, the study uses a variety of primary and secondary data sources, such as qualitative-empirical interviews, observations, and internal and external materials, to gain a broad understanding of the phenomenon. Although interviewees with different roles and levels within the DIU and at least one representative from the main organization were carefully selected to get a realistic picture of the DIU, the possibility that important voices from within the company were not included cannot be ruled out. Because the seven DIUs have a mandate close to the core business, they work with many different people and departments that could have provided an additional perspective on the unit.

Second, this dissertation focuses on the manufacturing industry, specifically machine and plant engineers, as a representative of an incumbent industry. On the

one hand, this implies that no definitive statements can be made regarding the applicability of the findings to other industries. On the other hand, it cannot be ruled out that certain aspects may be observed across different industries, suggesting that they are not solely specific to manufacturing. The data is geographically limited to DIUs in Germany and Switzerland that were three years old or less at the time of data collection. In addition, due to their young age of up to or just over three years, the thesis only examines DIUs up to and including their growth phase, not beyond. The data collection was also affected by a global pandemic; thus, all interviews and observations were conducted online. Although this facilitated access to the sessions, the lack of face-to-face interaction may undermine the theoretical claims. Regarding Chapter 4.4, it should be noted that while access to the rare long-term data of a DIU implementation process justifies a longitudinal single-case study, further research is needed to confirm the generalizability of the findings.

Third, because DIUs are a relatively new phenomenon, no standardized term has yet been coined. Various names (e.g., Digital Innovation Hub, Digital Innovation Lab, Digital Unit, Digital Lab, Digital Transformation Initiative, or Digital X Lab) can be found in the academic literature, practitioner papers, and corporate practice. While the discourse in the German-speaking world is mostly conducted under the terms Digital Innovation Unit and Digital Innovation Lab, with the former becoming increasingly dominant (e.g., Fuchs et al., 2019; Haskamp, Mayer, et al., 2021; Hellmich et al., 2021; Mayer et al., 2021; Raabe et al., 2020a), this is not necessarily the case in the international context, as a wide range of terms appears in the search queries. This abundance of terms and the description of multiple but only slightly different archetypes can lead to overlooking important findings and relevant studies from IS and other research disciplines, making it difficult to compare results.

Fourth, in assessing the findings of this dissertation, certain additional limitations emerge. While the dissertation presents numerous original and relevant contributions along the phenomenon of DIU evolution, including a detailed analysis of its fundamentals, temporal dynamics, socio-technical interactions, and relational dynamics, as well as a phase model of intensifying cooperation, it's worth noting that none of these have been extensively tested or evaluated in subsequent studies or practical applications. To overcome this limitation and strengthen the robustness of the results, some empirical and preliminary results were presented and discussed with industry experts. Nevertheless, it is important to recognize that these efforts cannot fully address these shortcomings. As a result, the practical applicability of the findings and conclusions of this dissertation remains subject to limitations. Nonetheless, these limitations provide encouraging avenues for future research.

7.2 Future Research

A first promising area for future research is the further evolution of DIUs beyond the growth phase. Most of the data for this dissertation was collected in 2021 and 2022. Therefore, it would be a good opportunity to collect new/subsequent data in three, five, or ten years (and beyond) to see how the units have evolved. This would indicate whether DIUs are just a short-term hype that will deflate in the next few years or a long-term trend that will manifest and spread further in the next decade(s). Furthermore, it allows for a closer look at the maturity phase of a DIU, for example, how it occurs, the implications, and the challenges. In addition, it would be possible to determine if DIUs will ever enter a termination phase and why. This knowledge of the full life-cycle of the DIU can provide the basis for developing a theory of continuous (design) change in incumbent companies throughout digital transformation.

In addition to these temporal factors, future research should also analyze the contextual elements of DIU. For example, the existing literature on DIUs focuses primarily on Europe (Haskamp et al., 2023), prompting an exploration of whether DIUs are a global phenomenon and whether the findings can be extrapolated to other regions. Given that the analysis of this dissertation has focused exclusively on well-established, non-digital-native incumbents with more than 2,500 employees, it would be valuable to consider investigating DIUs operating within small and medium-sized enterprises. In addition, exploring how digital-native firms stimulate radical innovation could provide insightful perspectives. Because this thesis focuses on the manufacturing industry, it cannot make any valid statements about whether the findings apply to other firms, i.e., whether or not they are manufacturing-specific. Future research should, therefore, investigate which aspects may be industry-agnostic and which are manufacturing-specific.

As this dissertation uses qualitative research methods, the author wants to encourage other researchers to evaluate the results with further qualitative and quantitative methods for their generalizability and to test the phase model of intensifying cooperation and the propositions based on it. Furthermore, as this thesis focuses on the manufacturing industry, it should be examined whether the results are transferable to other sectors, whether some aspects are specific to manufacturing or at least play a predominant role there. Since cross-industry studies dominate DIU research, it would be reasonable to proceed on an industry-specific basis and examine other industries in more detail to compare them with the presented findings. This, of course, does not preclude the possibility of looking again at similarities and differences in DIU evolution across industries in the future.

The critical reflection of the phase model of intensifying cooperation in Chapter 5.3 states that most of the DIUs considered in this thesis have evolved into an implementation and delivery unit/product development team rather than remaining an exploratory innovation department. Therefore, it proposes that from this current status onwards, these (manufacturing) DIUs require a next evolutionary step toward a DIU 3.0, in which the DIU (or part of it) evolves into an enabler for digital products, services, and business models that empowers innovation teams from the

main organization. It can preserve its ability to innovate and walk the line between transforming the main organization and having sufficient degrees of freedom. In addition, it retains its role as an exploratory unit to ensure the ambidexterity of the organization and its capabilities as a malleable organizational structure to ensure a long-term contribution to digital transformation. Future research is required to investigate further and validate this proposition.

Finally, from the perspective of the theoretical lenses that this thesis uses to study early-stage DIU evolution, there are three interesting avenues for future research: (1) Using time as a research lens and placing more emphasis on temporal aspects has opened new ways for the author to think about and study the phenomenon of DIUs. Therefore, there is great potential in this perspective for other initiatives related to digital transformation, and this thesis joins the call of other authors for more research with a temporal lens in the field of IS. (2) From the perspective of the socio-technical lens adopted, the author encourages future research to build on the insight on the adaptation between the DIU and the main organization in their socio-technical elements and to study the relationships and interactions of different STSs in the course of digital transformation. (3) Building on the findings in Chapter 4.4.2 of three mechanisms and five confounding factors for building AC through DIUs, future research can identify additional mechanisms and disruptive factors that occur during this or other digital transformation initiatives.

7.3 Conclusion

"*Digital transformation has [...] changed the way [industrial organizations] operate and, therefore, requires a company-wide transformation programme [sic!] – the digital transformation of organizations.*" (Imran et al., 2021, p. 2). As digital technologies proliferate, organizations rooted in the industrial age are under increasing pressure. In response, there is a growing focus on initiatives that promote malleability and enable rapid answers to digital challenges. One such initiative involves deploying DIUs to leverage dedicated structures with reduced socio-technical complexity. DIUs facilitate rapid adaptation and initiate, support, and partially drive digital transformation in incumbent manufacturing organizations, promoting ambidexterity. As such, they make lasting changes to (parts of) the main organization's structures, practices, tools, processes, culture, etc.

The process and dynamics of DIU evolution in the early stages are set in motion with the formation of a DIU and progress in phases. Along these phases, the DIU emerges as an independent STS – its team, processes, governance, mandate, culture, etc. – that builds relationships with and exerts influence on (parts of) the main organization, leading to socio-technical changes, e.g., in structures, working methods, technology, and ways of thinking. The parallel internal change and adaptation of the DIU itself is also planned in a phased logic but has additional elements of dialectical change drivers. As comparatively small STSs within the main organization, DIUs must acknowledge the traditional physical world to

ensure seamless integration and relevance within industrial-age manufacturing companies. Thus, DIU evolution does not occur in a vacuum but is characterized by cooperation and counteraction between the DIU and the main organization, especially during the DIU's growth phase. The challenge is to find the right balance between freedom and adaptation to the main organization. If DIUs are too far removed from the core business, they lack the leverage to make far-reaching changes. If they are too close, i.e., if they adapt too much to the existing structures, they will lose their distinctiveness without advancing digital transformation.

The current status quo in manufacturing companies' DIU evolution is two interrelated, interacting, partially adapted STS that intensified their cooperation within the first three years of DIU operation. The observed evolution from an exploratory initial DIU setup to an implementation and delivery unit was necessary at the time but needs to be revisited and further developed to continue to drive change and remain a malleable structure essential for digital transformation. Thus, DIU evolution resembles a continuous swinging pendulum of adaptation between the DIU and the main organization, reflecting the essence of contemporary organizational transformations in an intrinsically turbulent and dynamic environment. It requires flexibility, communication, commitment, perseverance, and a fundamental rethinking of ideas, structures, strategies, and organizational responsiveness to create a progressive organization for innovation in the digital world.

References

Agarwal, R., Gao, G., DesRoches, C., & Jha, A. K. (2010). The Digital Transformation of Healthcare: Current Status and the Road Ahead. *Information Systems Research*, *21*(4), 796–809.

Ancona, D. G., Goodman, P. S., Lawrence, B. S., & Tushman, M. L. (2001). Time: A New Research Lens. *Academy of Management Review. Academy of Management*, *26*(4), 645–663.

Ancona, D. G., Okhuysen, G. A., & Perlow, L. A. (2001). Taking Time to Integrate Temporal Research. *Academy of Management Review. Academy of Management*, *26*(4), 512–529.

Andreasson, L., Henfridsson, O., & Selander, L. (2010). Design-task Linkages in Digital Innovation: Software Platforms at Globalcarcorp. In *Sprouts: Working Papers on Information Systems* (10 (25)).

Appelbaum, S. H. (1997). Socio-technical systems theory: an intervention strategy for organizational development. *Management Decision*, *35*(6), 452–463.

Arvidsson, V., & Mønsted, T. (2018). Generating innovation potential: How digital entrepreneurs conceal, sequence, anchor, and propagate new technology. *The Journal of Strategic Information Systems*, *27*(4), 369–383.

Banker, R. D., & Kauffman, R. J. (2004). The Evolution of Research on Information Systems: A Fiftieth-Year Survey of the Literature in "Management Science." *Management Science*, *50*(3), 281–298.

Barthel, P., Fuchs, C., Birner, B., & Hess, T. (2020). Embedding Digital Innovations in Organizations: A Typology for Digital Innovation Units. *Proceedings of 15th International Conference on Wirtschaftsinformatik*, 780–795.

Berente, N. (2020). *Agile Development as the Root Metaphor for Strategy in Digital Innovation Handbook of Digital Innovation*. Edward Elgar Publishing.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. *MIS Quarterly*, *37*(2), 471–482.

Bhattacherjee, A. (2012). *Social science research: Principles, methods, and practices*. Textbooks Collection.

Bilgeri, D., Wortmann, F., & Fleisch, E. (2017). How Digital Transformation Affects Large Manufacturing Companies' Organization. *Proceedings of the Thirty Eighth International Conference on Information Systems*. Thirty Eighth International Conference on Information Systems, South Korea.

Bostrom, R. P., & Heinen, J. S. (1977). MIS Problems and Failures: A Socio-Technical Perspective. Part I: The Causes. *MIS Quarterly*, *1*(3), 17–32.

Bourne, L. (2010). *Stakeholder Relationship Management: Using the Stakeholder Circle methodology for more effective stakeholder engagement of senior management*. 7th Project Management National Benchmarking Forum, Rio de Janeiro, Brazil.

Bourne, L., & Walker, D. H. T. (2004). Advancing project management in learning organizations. *The Learning Organization*, *11*(3), 226–243.

Cambridge Dictionary. (n.d.). "Trigger" Definition. Retrieved September 24, 2023, from https://dictionary.cambridge.org/us/dictionary/english/trigger

Chanias, S., Myers, M. D., & Hess, T. (2019). Digital transformation strategy making in pre-digital organizations: The case of a financial services provider. *The Journal of Strategic Information Systems*, *28*(1), 17–33.

Cherns, A. (1976). The Principles of Sociotechnical Design. *Human Relations; Studies towards the Integration of the Social Sciences*, *2*(9), 783–792.

Chiesa, V. (2000). Global R&D Project Management and Organization: A Taxonomy. *Journal of Product Innovation Management*, *17*(5), 341–359.

Ciriello, R. F., & Richter, A. (2015). Idea Hubs as Nexus of Collective Creativity in Digital Innovation. *Proceedings of the Thirty Sixth International Conference on Information Systems*.

Conboy, K., Dennehy, D., & O'Connor, M. (2020). 'Big time': An examination of temporal complexity and business value in analytics. *Information & Management*, *57*(1), 103077.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*.

Davison, R. M., Laumer, S., Tarafdar, M., & Wong, L. H. M. (2023). Pickled eggs: Generative AI as research assistant or co-author? *Information Systems Journal*, *33*(5), 989–994.

Dremel, C., & Herterich, M. (2016). Digitale Cloud-Plattformen als Enabler zur analytischen Nutzung von operativen Produktdaten im Maschinen- und Anlagenbau. *HMD Praxis Der Wirtschaftsinformatik*, *53*(5), 646–661.

Dremel, C., Herterich, M. M., Wulf, J., & vom Brocke, J. (2020). Actualizing Big Data Analytics Affordances: A Revelatory Case Study. *Information & Management*, *57*(1).

Dremel, C., Herterich, M., Wulf, J., & Walter, B. (2017). How AUDI AG Established Big Data Analytics in its Digital Transformation. *MIS Quarterly Executive*, *16:2*, 81–100.

Duncan, R. B. (1976). The Ambidextrous Organization: Designing Dual Structures for Innovation. In R. H. Kilmann, L. R. Pondy, & D. P. Slevin (Eds.), *The Management of Organization Design: Strategies and Implementation* (pp. 167–188). North Holland.

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). Opinion Paper: "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, *71*, 102642.

Edmondson, A. C., & McManus, S. E. (2007). Methodological Fit in Management Field Research. *Academy of Management Review*, *32*(4), 1155–1179.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *Academy of Management Review. Academy of Management*, *14*(4), 532–550.

Fecher, F., Winding, J., Hutter, K., & Füller, J. (2020). Innovation labs from a participants' perspective. *Journal of Business Research*, *110*, 567–576.

Fichman, R. G., Dos Santos, B. L., & Zheng, Z. (2014). Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum. *MIS Quarterly*, *38*(2), 329–343.

Fuchs, C., Barthel, P., Herberg, I., Berger, M., & Hess, T. (2019). Characterizing Approaches to Digital Transformation: Development of a Taxonomy of Digital Units. *Proceedings of the 14th International Conference on Wirtschaftsinformatik.*

Galdas, P. (2017). Revisiting Bias in Qualitative Research: Reflections on Its Relationship With Funding and Impact. *International Journal of Qualitative Methods*, *16*(1), 1609406917748992.

Gerster, D., Dremel, C., Brenner, W., & Kelker, P. (2020). How Enterprises Adopt Agile Forms of Organizational Design: A Multiple-Case Study. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems*, *51*(1), 84–103.

Gerster, D., Dremel, C., Conboy, K., Mayer, R., & vom Brocke, J. (2021). How Fujitsu and Four Fortune 500 Companies Managed Time Complexities Using Organizational Agility. *MIS Quarterly Executive*, *20*(2), 127–150.

Giddens, A. (1984). *The Constitution of Society. Outline of the Theory of Structuration*. University of California Press.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. *Organizational Research Methods*, *16*(1), 15–31.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory*. Aldine.

Göbeler, L., Schaar, D., & Hukal, P. (2020). Initiating Ambidexterity through Digital Innovation Labs. *Proceedings of the 28th European Conference on Information Systems*.

Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly*, *30*(3), 611–642.

Grover, V., & Lyytinen, K. (2015). New State of Play in Information Systems Research: The Push to the Edges. *MIS Quarterly*, *39*(2), 271–296.

Haffke, I., Kalgovas, B., & Benlian, A. (2017). The Transformative Role of Bimodal IT in an Era of Digital Business. *Proceedings of the 50th Hawaii International Conference on System Sciences*.

Hanelt, André, Bohnsack, R., Marz, D., & Antunes Marante, C. (2020). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, *58*(5), 1159–1197.

Hanelt, André, Piccinini, E., Gregory, R. W., Hildebrandt, B., & and Kolbe, L. M. (2015). Digital Transformation of Primarily Physical Industries – Exploring the Impact of Digital Trends on Business Models of Automobile Manufacturers. *Proceedings of the 12th International Conference on Wirtschaftsinformatik*, 1313–1327.

Haskamp, T., Breitenstein, A., & Lorson, A. (2021). A Management Control Systems Perspective on Digital Innovation Units. *Proceedings of the Twenty-Seventh Americas Conference on Information Systems*.

Haskamp, T., Dremel, C., Marx, C., & Uebernickel, F. (2021). Understanding Inertia in Digital Transformation: A Literature Review and Multilevel Research Framework. *Proceedings of the Forty-Second International Conference on Information Systems*.

Haskamp, T., Mayer, S., Lorson, A., & Uebernickel, F. (2021). Performance Measurement in Digital Innovation Units - An Information Assymetry Perspective. *Proceedings of the Twenty-Ninth European Conference on Information Systems*.

Haskamp, T., Raabe, J.-P., Barthel, P., & Schirmer, I. (2023). The Digital Innovation Unit: A Silver Bullet for Managing Digital Transformation? *Proceedings of the Thirty-First European Conference on Information Systems*.

Hellmich, J., Raabe, J.-P., & Schirmer, I. (2021). Towards a Foundational and Extensional Dynamic Capability Perspective on Digital Innovation Units. *Proceeding of the Twenty-Eighth Americas Conference on Information Systems.*

Hess, T., Matt, C., Benlian, A., & Wiesböck, F. (2016). Options for Formulating a Digital Transformation Strategy. *MIS Quarterly Executive*, *15*(2), 123–139.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105.

Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization*, *28*(1), 52–61.

Holotiuk, F. (2020). The Organizational Design of Digital Innovation Labs: Enabling Ambidexterity to Develop Digital Innovation. In N. Gronau, M. Heine, K. Poustcchi, & H. Krasnova (Eds.), *Proceedings of the 15th International Conference on Wirtschaftsinformatik* (pp. 1019–1034). GITO Verlag.

Holotiuk, F., & Beimborn, D. (2019). Temporal Ambidexterity: How Digital Innovation Labs Connect Exploration and Exploitation for Digital Innovation. *Proceedings of Fortieth International Conference on Information Systems*.

Holotiuk, F., & Moormann, J. (2023). Evolution of Digital Innovation Labs – How Organizational Learning Contributes to Digital Transformation. *Proceedings of the Twenty-Ninth Americas Conference on Information Systems*.

Holsten, J., Raabe, J.-P., Gebken, L., & Schirmer, I. (2021). The Status Quo of Digital Innovation Units: "A Day Late and a Dollar Short." *Proceeding of the Twenty-Eighth Americas Conference on Information Systems*.

Hopkins, R., & Jenkins, K. (2008). *Eating the IT Elephant: Moving from Greenfield Development to Brownfield*. IBM Press.

Horlach, B., Drews, P., & Schirmer, I. (2016/3). Bimodal IT: Business-IT Alignment in the Age of Digital Transformation. *Multikonferenz Wirtschaftsinformatik*, 1417–1428.

Huang, J., Henfridsson, O., Liu, M. J., & Newell, S. (2017). Growing on steroids: rapidly scaling the user base of digital ventures through digital innovation. *MIS Quarterly*, *41*(1), 301–314.

Hund, A., Holotiuk, F., Wagner, H.-T., & Beimborn, D. (2019). Knowledge Management in the Digital Era: How digital Innovation Labs Facilitate Knowledge Recombination. *Proceedings of the 27th European Conference on Information Systems*.

Hylving, L., & Schultze, U. (2020). Accomplishing the layered modular architecture in digital innovation: The case of the car's driver information module. *The Journal of Strategic Information Systems*, *29*(3), 101621.

Hylving, L., & Selander, L. (2012). Under the guise of openness: Exploring the digital innovation user interface design. *Proceedings of the 20th European Conference on Information Systems*.

Iho, S., & Missonier, S. (2021). Conceptualizing knowledge in digital innovation labs. *Proceedings of the 54th Hawaii International Conference on System Sciences*. 54th Hawaii International Conference on System Sciences (HICCS), Virtual.

Imran, F., Shahzad, K., Butt, A., & Kantola, J. (2021). Digital Transformation of Industrial Organizations: Toward an Integrated Framework. *Journal of Change Management*, *21*(4), 451–479.

Ivančić, L., Vukšić, V. B., & Spremić, M. (2019). Mastering the Digital Transformation Process: Business Practices and Lessons Learned. *Technology Innovation Management Review*, *9*(2), 36–50.

Jöhnk, J., Ollig, P., Oesterle, S., & Riedel, L.-N. (2020). The Complexity of Digital Transformation – Conceptualizing Multiple Concurrent Initiatives. *Proceedings of 15th International Conference on Wirtschaftsinformatik*, 1051–1066.

Jöhnk, J., Ollig, P., Rövekamp, P., & Oesterle, S. (2022). Managing the complexity of digital transformation—How multiple concurrent initiatives foster hybrid ambidexterity. *Electronic Markets*.

Kerzner, H. (2019). *Innovation Project Management: Methods, Case Studies, and Tools for Managing Innovation Projects*. John Wiley & Sons.

Kohli, R., & Melville, N. P. (2019). Digital innovation: A review and synthesis. *Information Systems Journal*, *29*(1), 200–223.

Kuechler, B., & Vaishnavi, V. (2008). On Theory Development in Design Science Research: Anatomy of a Research Project. *European Journal of Information Systems*, *17*(5), 489–504.

Lau, F., von Buttlar, H., & Münch, L.-T. (2022). *Konzerne auf den Spuren von Startups 2022* (No. 6). Infront Consulting & Management GmbH.

Legner, C., Eymann, T., Hess, T., Matt, C., Böhmann, T., Drews, P., Mädche, A., Urbach, N., & Ahlemann, F. (2017). Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community. *Business & Information Systems Engineering*, *59*(4), 301–308.

Loebbecke, C., & Picot, A. (2015). Reflections on societal and business model transformation arising from digitization and big data analytics: A research agenda. *The Journal of Strategic Information Systems*, *24*(3), 149–157.

Lorson, A. (2022). Building Dynamic Capabilities through Digital Innovation Units? - An analysis of their contribution and the spill-over effects to the main organization. *Proceeding of the Twenty-Eighth Americas Conference on Information Systems*.

Lorson, A., Dremel, C., de Paula, D., & Uebernickel, F. (2022). Beyond the Fast Lane Narrative – A Temporal Perspective in the Unfolding of Digital Innovation in Digital Innovation Units. *Proceedings of the Thirtieth European Conference on Information Systems*.

Lorson, A., Dremel, C., Haskamp, T., & Uebernickel, F. (2024). Explaining Socio-technical Convergence: An Analysis of the Interactions between Digital Innovation Units and their Main Organization. *Proceedings of the Thirty-Second European Conference on Information Systems*.

Lorson, A., Dremel, C., & Uebernickel, F. (2022). Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change. *Proceedings of the Forty-Third International Conference on Information Systems*.

Lorson, A., Dremel, C., & Uebernickel, F. (2023). Building Adaptive Capacity for Volatile Business Environments: A Longitudinal Study of the Establishment of a Digital Innovation Unit. *Proceedings of the Thirty-First European Conference on Information Systems*.

Lorson, A., Mayer, S., Dremel, C., & Uebernickel, F. (n.d.). From Cradle to Cash: The Successful Formation of a Digital Innovation Unit. *MIS Quarterly Executive*.

Lucas, H. C., & Goh, J. M. (2009). Disruptive technology: How Kodak missed the digital photography revolution. *The Journal of Strategic Information Systems*, *18*(1), 46–55.

Lyytinen, K., & Newman, M. (2008). Explaining information systems change: a punctuated socio-technical change model. *European Journal of Information Systems*, *17*(6), 589–613.

Lyytinen, K., Yoo, Y., & Boland, R. J., Jr. (2016). Digital product innovation within four classes of innovation networks. *Information Systems Journal*, *26*(1), 47–75.

Majchrzak, A., Markus, M. L., & Wareham, J. (2016). Designing for digital transformation: Lessons for information systems research from the study of ICT and societal challenges. *MIS Quarterly*, *40*(2), 267–277.

Martin, J.-F. (2018). *Unlocking Success in Digital Transformations*. McKinsey & Company.

Masuch, M. (1985). Vicious circles in organizations. *Administrative Science Quarterly*, *30*, 14–33.

Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business & Information Systems Engineering*, *57*(5), 339–343.

Mayer, S., Haskamp, T., & de Paula, D. (2021). Measuring what Counts: An Exploratory Study about the Key Challenges of Measuring Design Thinking Activities in Digital Innovation Units. *Proceedings of the 54th Hawaii International Conference on System Sciences*.

Morgan, G. (1997). *Images of organization (2nd ed.)*. Sage.

Mousavi Baygi, R., Introna, L. D., & Hultin, L. (2021). Everything Flows: Studying Continuous Socio-Technological Transformation in a Fluid and Dynamic Digital World. *MIS Quarterly*, *45*(1), 423–452.

Mumford, E. (1995). *Effective Systems Design and Requirements Analysis: The ETHICS Approach*. Red Globe Press.

Myers, M. D., & Newman, M. (2007). The qualitative interview in IS research: Examining the craft. *Information and Organization*, *17*(1), 2–26.

Nambisan, S., University of Wisconsin–Milwaukee, Lyytinen, K., Majchrzak, A., Song, M., Case Western Reserve University, University of Southern California, & Xi'an Technological University. (2017). Digital Innovation Management: Reinventing Innovation Management Research in a Digital World. *MIS Quarterly*, *41*(1), 223–238.

Nguyen, D. K., Broekhuizen, T., Dong, J. Q., & Verhoef, P. C. (2019). Digital readiness: construct development and empirical validation. *Proceeding of the Fortieth International Conference on Information Systems*.

Ohr, R.-C. (2020, June 27). *Digital Innovation Units: Setting-Up for Scaling-Up*. Integrative Innovation. https://integrative-innovation.net/?p=2448

Orlikowski, W. J. (2000). Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. *Organization Science*, *11*(4), 404–428.

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research*, *2*(1), 1–28.

Orlikowski, W. J., & Scott, S. V. (2008). 10 sociomateriality: Challenging the separation of technology, work and organization. *The Academy of Management Annals*, *2*(1), 433–474.

Oxford University Press. (n.d.). *Epistemology*. Oxford English Dictionary. Retrieved August 10, 2023, from https://www.oed.com/search/dictionary/?scope=Entries&q=epistemology&tl=true

Piccinini, E., Hanelt, A., Gregory, R. W., & Kolbe, L. M. (2015). Transforming Industrial Business: The Impact of Digital Transformation on Automotive Organizations. *Proceedings of the Thirty Sixth International Conference on Information Systems*.

Raabe, J.-P. (2021). *Digital Innovation Units as a Vehicle for Innovating Incumbent Firms: A Nexus for Digital Innovation Management* [Doctoral degree at the Faculty of Mathematics, Informatics, and Natural Sciences]. Universität Hamburg.

Raabe, J.-P., Drews, P., Horlach, B., & Schirmer, I. (2021). Towards an Intra- and Interorganizational Perspective: Objectives and Areas of Activity of Digital Innovation Units. *Proceedings of the 54th Hawaii International Conference on System Sciences*.

Raabe, J.-P., Horlach, B., Schirmer, I., & Drews, P. (2020a, August). 'Forewarned is Forearmed': Overcoming Multifaceted Challenges of Digital Innovation Units. *Proceedings of the Twenty-Sixth Americas Conference on Information Systems*.

Raabe, J.-P., Horlach, B., Schirmer, I., & Drews, P. (2020b). Digital Innovation Units: Exploring Types, Linking Mechanisms and Evolution Strategies in Bimodal IT Setups. *Proceedings of 15th International Conference on Wirtschaftsinformatik*, 844–858.

Recker, J. (2021). *Scientific Research in Information Systems*. Springer International Publishing.

Ross, J., & Staw, B. M. (1993). Organizational escalation and exit: Lessons from the Shoreham nuclear power plant. *Academy of Management Journal. Academy of Management*, *36*(4), 701–732.

Sandberg, J., Mathiassen, L., & Napier, N. P. (2014). Digital Options Theory for IT Capability Investment. *Journal of the Association for Information Systems*, *15*(7), 422–453.

Santarsiero, F., Lerro, A., Carlucci, D., & Schiuma, G. (2021). Modelling and managing innovation lab as catalyst of digital transformation: theoretical and empirical evidence. *Measuring Business Excellence*, *26*(1), 81–92.

Sarker, S., Chatterjee, S., Xiao, X., & Elbanna, A. (2019). The sociotechnical axis of cohesion for the IS discipline: its historical legacy and its continued relevance. *MIS Quarterly*, *43*(3), 695–720.

Schumm, M. (2023). *Organizing for Digital Innovation. Implications for Organizational Forms, Digital Transformation and Digital Innovation Units* [Doktor der Wirtschafts- und Sozialwissenschaften]. Universität Kassel.

Schumm, M., & Hanelt, A. (2021). Transformational Dynamics – Systemizing the Co-Evolution of Organizational Forms and Information Systems. *Proceedings of the Forty-Second International Conference on Information Systems*.

Schumm, M., Hanelt, A., & Firk, S. (2022). Digital Innovation Units: An Empirical Investigation of Performance Implications. *Proceedings of the Forty-Third International Conference on Information Systems*.

Sebastian, I. M., Ross, J. W., Beath, C., Mocker, M., Moloney, K. G., & Fonstad, N. O. (2017). How Big Old Companies Navigate Digital Transformation. *MIS Quarterly Executive*, *16:3*, 197–213.

Sherman, M. (2001). *Time personalities: How organizations think about, use, and relate in time*.

Simon, H. A. (1996). *The Science of the Artificial*. MIT Press.

Sindemann, T., & Ansari, F. L. (2017). *Konzerne auf den Spuren von Startups 2017*. Infront Consulting & Management GmbH.

Sindemann, T., & von Buttlar, H. (2018). *Konzerne auf den Spuren von Startups 2018*. Infront Consulting & Management.

Sindemann, T., von Buttlar, H., Lau, F., & Münch, L.-T. (2020). *Konzerne auf den Spuren von Startups 2020*. Infront Consulting & Management GmbH.

Sindemann, T., von Buttlar, H., Lau, F., & Münch, L.-T. (2021). *Konzerne auf den Spuren von Startups 2021* (No. 5). Infront Consulting & Management GmbH.

Singh, A., & Hess, T. (2017). How Chief Digital Officers Promote the Digital Transformation of their Companies. *MIS Quarterly Executive*, *16*(1), Article 5.

Singh, A., & Hess, T. (2020). How do chief digital officers pursue digital transformation activities? The role of organization design parameters. *Long Range Planning*, *53*(3), 1–14.

Soto Setzke, D., Opderbeck, L., & Riasanow, T. (2020). Toward a Taxonomy of Digital Transformation Initiatives. *Proceedings of the Twenty-Eighth European Conference on Information Systems*, Research-in-Progress Papers. 15.

Staber, U., & Sydow, J. (2002). Organizational Adaptive Capacity. A Structuration Perspective. *Journal of Management Inquiry*, *11*(4), 408–424.

Strauss, A. L., & Corbin, J. M. (1998). *Basics of qualitative research : techniques and procedures for developing grounded theory*. Sage Publications.

Sund, K. J., Bogers, M. L. A. M., & Sahramaa, M. (2021). Managing business model exploration in incumbent firms: A case study of innovation labs in European banks. *Journal of Business Research*, *128*, 11–19.

Susarla, A., Gopal, R., Thatcher, J. B., & Sarker, S. (2023). The Janus Effect of Generative AI: Charting the Path for Responsible Conduct of Scholarly Activities in Information Systems. *Information Systems Research*, *34*(2), 399–408.

Svahn, F., Mathiassen, L., & Lindgren, R. (2017). Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns. *MIS Quarterly*, *41*(1), 239–253.

Thirsk, L. M., & Clark, A. M. (2017). Using Qualitative Research for Complex Interventions: The Contributions of Hermeneutics. *International Journal of Qualitative Methods*, *16*(1), 1609406917721068.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Digital infrastructures: the missing IS research agenda. *Information Systems Research*, *21*(4), 748–759.

Tödtmann, C. (2020, December 19). *Daimler verkauft Zukunftsprojekt an GFT-Chef*. WirtschaftsWoche. https://www.wiwo.de/unternehmen/auto/lab-1886-daimler-verkauft-zukunftsprojekt-an-gft-chef-/26637470.html

Trischler, M., Bason, C., & Li-Ying, J. (2022). Managing Digital Innovation Units - Life Cycle, Transitions, and Growth Traps. *Research-Technology Management*, *65*(5), 18–28.

Tumbas, S., Berente, N., & vom Brocke, J. (2017). Born Digital: Growth Trajectories of Entrepreneurial Organizations Spanning Institutional Fields. *Proceedings of Thirty Eighth International Conference on Information Systems*.

Turrin, R. (2019). *Innovation Lab Excellence: Digital Transformation From Within*. Authority Publishing.

Urquhart, C., Lehmann, H., & Myers, M. D. (2009). Putting the 'theory' back into grounded theory: guidelines for grounded theory studies in information systems. *Information Systems Journal*, *20*(4), 357–381.

Van de Ven, A. H., & Huber, G. P. (1990). Longitudinal Field Research Methods for Studying Processes of Organizational Change. *Organization Science*, *1*(3), 213–219.

Van De Ven, A. H., & Poole, M. S. (1995). Explaining Development and Change in Organizations. *AMRO*, *20*(3), 510–540.

Velten, C., Michel, J., & Özdem, A. (2016). *Digital Labs – How to build, how to run*. Crisp Research AG.

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889–901.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118–144.

Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326–349.

Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J., & Jensen, T. (2021). Unpacking the difference between digital transformation and IT-enabled organizational transformation. *Journal of Association for Information Systems*, *22*(1), 102–129.

Wiesböck, F., & Hess, T. (2019). Digital innovations. *Electronic Markets*, *30*(1), 75–86.

Wilde, T., & Hess, T. (2009). Forschungsmethoden der Wirtschaftsinformatik Eine empirische Untersuchung. *Wirtschaftsinformatik*, *49*(4), 280–287.

Wynn, D., & Williams, C. K. (2012). Principles for Conducting Critical Realist Case Study Research in Information Systems. *MIS Quarterly*, *36*(3), 787–810.

Yilmaz, K. (2013). Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education*, *48*(2), 311–325.

Yin, R. K. (2018). *Case study research and applications: Design and Methods*. SAGE Publications, Inc.

Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for Innovation in the Digitized World. *Organization Science*, *23*(5), 1398–1408.

Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research*, *21*(4), 724–735.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., & Faraj, S. (2007). Information Technology and the Changing Fabric of Organization. *Organization Science*, *18*(5), 749–762.

Appendix

A. Study 4.1 Appendix

Detailed illustrations of the changes between DIU 1.0 and 2.0 as part of the DIU evolution from Study 4.1 based on the publication *"Evolution of Digital Innovation Units for Digital Transformation – The Convergence of Motors of Change"* (Lorson, Dremel, & Uebernickel, 2022).

Table 18: Case A – Changes from DIU 1.0 to DIU 2.0.

Own Representation Based on Lorson, Dremel, & Uebernickel (2022).

	DIU 1.0	DIU 2.0
Goal	● Generate **disruptive innovation** outside the main organization ● **Capture and understand market and customer need** to support the main organization with digital product and service development and implementation	● Support the main organization to generate **incremental innovation** with a clear **focus on the core business** ● Create **(IT) infrastructure foundations** to build up and offer digital products and services as a complement to machines and plants ● Capture and understand market and customer needs with a **focus on industry-relevant innovations**.
Mandate	● **Initiative** but not the driver **of digital transformation** ● **Flow heater for innovation** to quickly develop ideas and validate them for investment decisions	● **Initiative** but not the driver **of digital transformation** ● **Implement innovation projects** as blueprints to demonstrate alternative paths to business growth through digital offerings – both as a supporter and a driver of projects ● **Core activities**: Exploring idea potential, supporting the main organization with processes, methodologies, and skills for digital product and service development (user research, market analysis, business modeling, agile project management, interface design), building a partnership network and ecosystem, providing education and methodological sparring on agile working methods

Gover-nance	**Separate legal entity** - Managed by the Head of DIU - Funding strategy: **DIU charges the other divisions for its services**. - Affiliation: part of the **"Innovation & Technology" division** - Location: offices in a **different city** than the main organization	- Legal entity continues to exist on paper but, in effect, **becomes the responsibility of a consulting firm previously acquired** by the main organization, which also specializes in digital business modeling and innovation - DIU Management: **Managing Director of consulting firm** **Steering committee** meets quarterly to make strategic decisions. Members: Head of DIU, CEO of the Innovation and Technology division, and seconded Managing Director of the main organization - Funding strategy: **central funding** by the main organization - Affiliation and location are unchanged
Team	**15-20 employees** **Business graduates without specific industry knowledge** - Difficult mutual understanding and cooperation between DIU and the main organization - Works in a very isolated manner	- No permanent staff but **annual budget for approx. 17 full-time equivalents** - Mainly employees from the consultancy but also its freelancer and partner network - People who are **familiar with** the main organization's **work environment** and can mediate between the technical and digital worlds. **Cross-functional project teams** should include at least **one representative from the main organizatio**n to ensure domain expertise.

Processes	**Structured design thinking approach** to quickly validate ideas and derive an investment decision for one **single project at a time** **Strong distribution of individual process steps** among the team members led to **irregular workloads** for employees, and no real teamwork could develop, therefore, **dissatisfaction and a high turnover rate** and the main organization needs to constantly onboard new people. **No adequate handover process** to the main organization and information gets lost. **Innovation projects stem from departments of the main organization** - also in collaboration with the DIU - and from the divisional management.	- Structured **five-phase innovation process** from idea generation until the development of a minimum viable product and its complete handover to the main organization for **several projects simultaneously** - Accompanies the **innovation process from the early stages** and supports the main organization with user research, visual design, and business modeling. - Employees are often **involved in the projects over a longer period,** making the teams more stable. This also **simplifies the handover to the main organization** for permanent operation. - Innovation projects stem from departments of the main organization and are **selected by the steering committee quarterly.**

Table 19: Case B – Changes from DIU 1.0 to DIU 2.0.

Own Representation Based on Lorson, Dremel, & Uebernickel (2022).

	DIU 1.0	DIU 2.0
Goal	**Experimental and explorational DIU** that defines strategic priorities discovers innovation fields for the main organization and implements pilot projects. **No specific innovation focus**	**Implementation DIU** that realizes some of the projects previously identified and scales them globally - Innovation **focuses strongly on digital products and services "around the machine"** to establish digital offerings as the second growth muscle alongside the core business. - Efforts are directed primarily at **digital products and services that interface with the customer** to strengthen the link between "digital" and sales.
Mandate	**Cut the topic of digital transformation into smaller**	**Integral part and driver** for the new **digital transformation**

	pieces and develop, test, and validate new digital products, services, and business models in a restriction-free environment. ● **Return innovation** to the main organization once they have reached a certain level of maturity. ● **Flow heater** for innovative ideas that develop solutions for **individual markets and customers** to test needs	**strategy** and implements projects of the previously defined roadmap globally. ● **Doing groundwork to lay the foundation for the digitization** of the company, e.g., setting up a unified (IT-) infrastructure, digitizing existing processes, and creating an understanding of the topic "digital" among employees ● Implements **globally scalable digital products and services** with a focus on projects with **platform character**
Gover-nance	● **Separate legal entity** ● Location: office in a **different city** than the main organization ● Relatively isolated, locally operating unit **detached from the governance structure of the main organization** ● Funding: **cost center**	● Separate legal entity remains a legal container, but the **"digital" brand disappeared,** i.e., no demarcation as a separate legal entity neither internally nor externally. ● **Additional office location at the headquarters** to enable more proximity to the core business ● **Group-level embedding and activities** to function as a **global entity** and report to the Group Commercial Officer. ● **Four newly created departments**, primarily one large business-oriented team for digital customer interaction and a technology-oriented team. ● New **"Global Digital Steering Committee"** meets quarterly and makes strategic decisions on the project portfolio and the roadmap. ● Funding: **cost center**
Team	● **20-25 employees** ● Mainly employees with a background in **business and economics or related disciplines**	● Approx. **60 employees**; target size by the **end of 2021: 100 employees** ● **Own IT** team with in-house software developers to complement the existing skill set and build interdisciplinary project teams

	DIU 1.0	DIU 2.0
		● **New hires** and **integration of employees and departments** from the main organization with a digital and **customer-focused mandate**
Processes	● **Agile, customer-centric development** approach for digital products and services ● **High degrees of freedom** regarding the selection of projects and ● **End-to-end responsibility** from the idea until the minimum viable product ● **Rapid experimentation** in a standardized three-stage innovation process to develop minimum possible products with **greatly reduced complexity** for individual markets	● **Agile, customer-centric development** approach for digital products and services ● **Reduced degrees of freedom** as it works on a clearly defined project portfolio with a respective roadmap ● **Fully responsible** for innovation projects from development through implementation to **ongoing operation.** Longer planning horizon overall, both at the level of individual projects and the roadmap level. ● **Project workflows are much slower** as innovations are **implemented globally** on a large scale. ● **Closer collaboration** between DIU and the **departments in the main organization**, such as core IT, marketing, or sales

Table 20: Case C – Changes from DIU 1.0 to DIU 2.0.
Own Representation Based on Lorson, Dremel, & Uebernickel (2022).

	DIU 1.0	DIU 2.0
Goal	● Develop **core-business-related, data-driven digital business models** with recurring revenues to complement machine sales. ● Attract **digital talent** ● Turning a product-centric into a **user-centric company**	● Develop **core-business-related, data-driven, digital business models** with recurring revenues to complement machine sales ● Attract **digital talent** ● Turning a product-centric into a **user-centric company** → Uncertainty whether these goals can continue to be pursued after reintegration into the main organization

		● **Strengthen the ecosystem approach** between DIU and the main organization
Mandate	● **Part of and a vehicle for the overall digital transformation** of the main organization. Focus on driving overall digital marketing, establishing and growing a digital ecosystem, and developing and implementing digital products and services. ● Build **competencies to design the digital user experience** ● **Freedom to use an alternative approach** with greater speed and certain independence to develop digital products and services.	● **Remains part of and is a vehicle for digital transformation**. Focus remains unchanged ● Build **competencies to design the digital user experience** ● **Freedom to use an alternative approach** with greater speed and certain independence to develop digital products and services. ● Overtake all **external communications** for the main organization ● **Responsibility for certain IT systems** from core IT and ● Stronger mandate for the **offering of various subscription models** and the overall **data-driven sales approach**
Gover-nance	● **Separate legal entity** ● **No own administrative structures**, but obtained human resource management, controlling, accounting, etc., from the Group as a shared service. ● Location: **Newly renovated building on company premises** ● Funding: **cost center** with annual innovation budget ● **Different contracts**: two-thirds of the team have contracts from the main organization, and one-third has a contract from the limited liability company	● Reintegrated it into the main organization's **global sales and marketing department** ● **"Digital" brand** and dedicated website remain in place ● Location: **Newly renovated building on company premises** ● Funding: **cost center** with annual innovation budget ● All employees receive the **same contract** from the main organization
Team	● **60 employees** ● Several teams: ecommerce, digital marketing, data science, innovation, and customer portal	● **60 employees** ● Several teams: ecommerce, digital marketing, data science, innovation, and customer portal ● Parts of the team are now **assigned to other departments of the main organization** and

		receive a larger mandate for their tasks.
Processes	**Agile working** in interdisciplinary teams **Four-phased innovation process** to implement and continuously further develop digital products and services. - Success measurement against **annual goals** and monthly reviews with the "**Objectives and Key Results**" method **Strong collaboration** with the main organization	Processes are to remain unchanged → Since the announcement of the reintegration, there have been **noticeably more requests for joined projects with DIU** from the main organization.

Table 21: Case D – Changes from DIU 1.0 to DIU 2.0.

Own Representation Based on Lorson, Dremel, & Uebernickel (2022).

	DIU 1.0	**DIU 2.0**
Goal	- Classical **corporate innovation lab** **Develop MVPs** of digital products and services **Drive cultural transformation** to kick off the main organization's digital transformation journey.	**Company builder** with a focus on industrial software as a service companies - Create **commercial value** with user-centric, machine-agnostic, AI-powered software solutions for manufacturing companies with a revenue potential of ≥ €50 million - Current focus on **core business-related digital products and services** along the main organization's value chain **Driving digital transformation** and initiating cultural change became merely a **secondary goal** for the time being
Mandate	- Generate a variety of **ideas and initiate** digital products and service projects. **Support other divisions** with their innovation projects **Spark enthusiasm** for digital topics among the workforce	- Create **one to two new digital ventures per year** **Acquire startups** in the manufacturing sector for its portfolio **Innovation team no longer supports other divisions** with digital products and services projects that are not supposed to become standalone ventures (a

		new separate software development hub within the DIU is now responsible for this) ● **Secondary tasks**: learning formats like webinars and workshops and agency support for the main organization
Gover-nance	● **Separate legal entity** ● **Division of the main organization** ● Location: **different city** than the main organization ● Funding: **cost center**	● **Separate legal entity** ● **Division of the main organization** ● Location: **different city** than the main organization ● Funding: **cost center** ● Specific **innovation team** that owns the innovation process for digital products and services ● New **Head of Digital Innovation** as team lead ● **Own software development structures** with the new hub mentioned above. ● Funding: the goal is to **become a profit center** - DIU 2.0 has begun charging other divisions for its services ● **Spin-offs** created in DIU **become 100% subsidiaries** of DIU limited liability company.
Team	● **Approx. 130 employees** ● Many employees from the **main organization,** personnel of an **acquired company,** and **new hires** ● **Organizational structure** (particularly the innovation team) was **dominated by designers** Innovation projects were heavily focused on the consumer and design rather than economic value creation. ● **Not enough in-house software developers** can implement digital products and services.	● **Approx. 130 employees** ● Recruitment of **experts in building independent businesses** - e.g., venture architects and innovation managers ● **Dedicated software development team** ● **Interdisciplinary teams** in all innovation projects, with certain roles that must always be present
Processes	● **6-phased, stage-gate innovation process of six months.** Many ideas had low financial potential and were feature developments rather	● **Three-phase, one-year innovation process**. Continuously development ● DIU team **supports other divisions** in **joint workshop**

| | than standalone digital products or services.
● Innovation committee always **decided on a case-by-case basis** instead of selecting the best projects presented for the next phase. No project made it past the fourth phase.
● **High degree of freedom** through its administrative structures as a division | **sessions** for idea generation and project selection to ensure that sufficient spin-off potential is available.
● Project teams require a **co-development partner** - within the main organization or external.
● Project teams have **weekly sparring sessions with the DIU's CEO** to ensure management buy-in.
● High degree of freedom through its administrative structures as a division, although this can **vary now depending on the project owner** |

Table 22: Case E – Changes from DIU 1.0 to DIU 2.0.

Own Representation Based on Lorson, Dremel, & Uebernickel (2022).

	DIU 1.0	**DIU 2.0**

Goal	● **Develop and implement digital products and services** close to the core business and other business units.
	● **Digitize internal processes**
	● **Support cultural change** that goes hand in hand with digital transformation
	● Build and bundle **digital competencies**
	● Side effect: make the workplace more attractive for external digital talents
		● **Sharpen the previous goals**
		● **Four new focus areas**:
		  o Support the business units in developing and marketing digital products and services,
		  o Push digital sales and e-commerce,
		  o Digital manufacturing (digitization of internal processes in the production area)
		  o Digital administration (internal process automation for finance, administration, etc.)

Mandate	● Part of the digital initiative to support the maintenance and expansion of global market leadership ● Anchor digital expertise and agile working methods in the main organization	● Previous mandate is expanded ● Primary focus on and overall responsibility for **the four focus areas** ● Almost all **innovation projects now converge at the head of DIU** so that there is a continuous exchange with the main organization

Gover-nance	**Department of a division** of the main organization. **Integrated into the overarching governance model** of the main organization (e.g., common code of ethics, uniform travel expense, and company car regulations) **Own culture** of trial and error, agile working methods, and interdisciplinary teams with a high level of ownership for projects - Location: **different city** than the main organization, - Funding: **central funding**	**Department of a division** **Integrated into the overarching governance model** with **own culture** - Location: **different city** than the main organization **Own governance structures** (e.g., own program management) - Funding: **cost center approach** (currently still hybrid), partly already **charging the other departments for its services**
Team	**Approx. 15 people** **Interdisciplinary team** with technical expertise (e.g., data scientists, IoT experts) and expertise in digital project management and digital marketing	**Approx. 25 people** **Interdisciplinary team** with technical expertise (e.g., data scientists, IoT experts) and expertise in digital project management and digital marketing **Software developers** hired to implement solutions and generate real value-added. - DIU projects need both a **business owner from the main organization** to ensure a market need and a **C-level sponsor from the division's board of directors** to back the project, provide budget and resources, and support the business owner
Processes	**No clear innovation process** in place - DIU supports the main organization with whatever is needed to build reputation and credibility.	**Six-phase, stage-gate, innovation process** **Four focus topics are now being implemented** with a defined project team, a strategy, and key performance indicators. - DIU can be both the **lead or the support on projects** and **Agile product development** process following a SCRUM logic. **Closer coordination with the core IT** to ensure compliance with the enterprise architecture

		and secure the operation for implemented digital products and services, including customer support and service

B. Data Collection and Analysis Repository

Access to the virtual data collection and analysis will be provided to reviewers and may be requested with the author's permission.

C. Statement on the Use of Generative AI Tools

Recent literature has extensively discussed the incorporation of generative Artificial Intelligence (AI) in IS research (Davison et al., 2023; Dwivedi et al., 2023) and provided recommendations for the responsible use of AI-based tools (Susarla et al., 2023). By emphasizing the importance of transparency in the use of generative AI tools for research purposes, these guidelines underscore the need for openness. Consequently, the author presents a comprehensive overview of how generative AI tools have been used according to these guidelines, particularly as outlined by Susarla et al. (2023).

Table 23: Use of Generative AI Tools.

Generative AI Tool	Use in the Context of the Dissertation
DeepL (deepl.com)	Translation of Interview Quotes from German to English Refinement and Optimization of Wording and Sentence Structure Spell Checking
Grammarly (app.grammarly.com)	Spell and Grammar Checking Refinement of Sentence Structure
ChatGPT (chat.openai.com)	Refinement and Optimization of Wording and Sentence Structure

Declaration on Oath / Eidesstattliche Erklärung

I hereby declare that I have independently developed and written this thesis and used only the stated sources and tools. All passages quoted literally or by content from published or unpublished sources are explicitly marked. This thesis has not been submitted in an identical or similar form to any other examining board.

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbstständig und nur unter Benutzung der angegebenen Quellen und Hilfsmittel angefertigt habe. Alle Textstellen, die wörtlich oder sinngemäß aus veröffentlichten oder nicht veröffentlichten Quellen entnommen wurden, sind als solche kenntlich gemacht. Die Arbeit hat in gleicher oder ähnlicher Form keiner anderen Prüfungsbehörde vorgelegen.

_____   _____

(Place, Date/Ort, Datum)   (Signature/Unterschrift)