

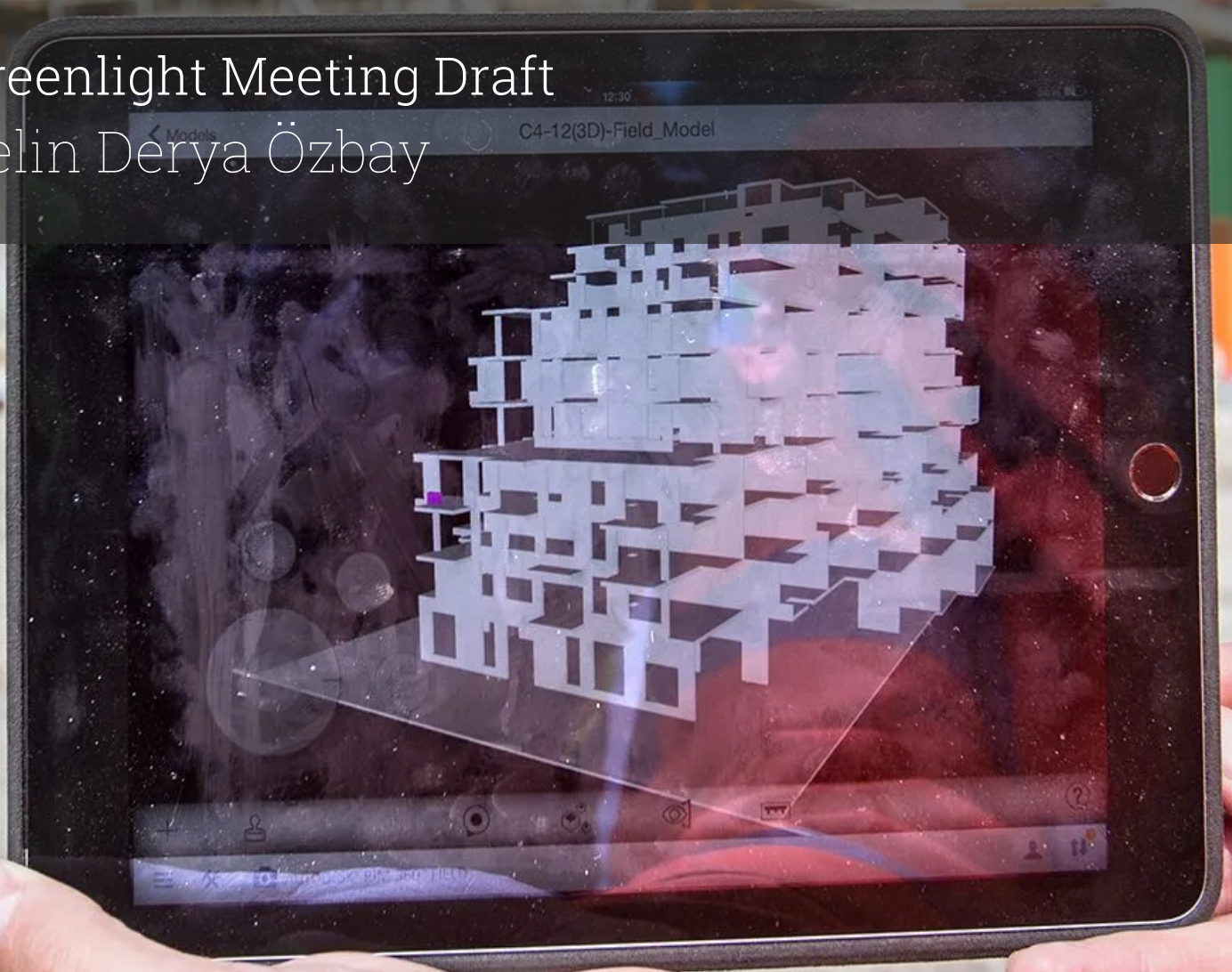
Improving Digitalisation Through Client-Contractor Partnerships in Infrastructure Asset Management

The Case of BAM and Schiphol

Greenlight Meeting Draft

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Improving Digitalisation Through Client-Contractor Partnerships in Infrastructure Asset Management

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by

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to obtain the degree of Master of Science
at the Delft University of Technology,
to be defended publicly on November 28, 2025

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Project duration: April 4, 2025 – November 28, 2025
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This thesis is confidential and cannot be made public until 28-11-2025

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Preface

This thesis marks the end of my academic journey and the completion of my Master's programme in Construction Management and Engineering at TU Delft. It has been an intensive process, but I am proud of the final result that I now have the opportunity to present and share.

The research originated from the complex issue of digitalisation in infrastructure asset management and the practical challenges I observed during my time as a working student at BAM. These experiences motivated me to understand the underlying causes of these challenges and to explore how the partnership with Schiphol can move forward and grow in this aspect. Writing this thesis has allowed me to combine my academic skills with real-world problems, while learning from professionals who face these issues on a daily basis.

I would like to express my sincere gratitude to my entire thesis committee. First, to my chair, Eleni Papadonikolaki, for helping me shape my research problem from the very beginning and for her continuous involvement throughout the process. I am also grateful to my supervisors Ad Straub and Erik-Jan Houwing for their valuable feedback, guidance, and readiness to help and suggest practical improvements.

I am especially thankful to my colleagues at Schiphol and BAM, who shared their expertise and took the time to contribute to my research. In particular, I want to thank Jan Willem Breemhaar, who supervised and supported me throughout the entire process. I would also like to thank Lisanne, Merna, and Rik, who were always willing to help whenever I needed it.

Finally, I want to thank my family and friends for their support and patience during the more stressful periods of this journey.

I hope that this thesis contributes to both academic understanding and practical reflection on how client-contractor partnerships can strengthen digitalisation to create value in infrastructure asset management.

*Selin Derya Özbay
Delft, November 2025*

Executive Summary

0.1. Introduction

In recent years, infrastructure asset management has been shifting from traditional, reactive maintenance towards a more data-driven approach. Data is increasingly used as the main lens for decision-making, helping organisations improve efficiency, safety and asset life cycles. Various digital technologies, such as Building Information Modelling (BIM), IoT sensors, machine learning, cloud computing and interactive dashboards now offer possibilities to collect and analyse data in real time. However, despite this technological progress, many organisations still struggle to translate digital tools into actual improvements in decision-making. Especially in complex, multi-stakeholder settings such as infrastructure, digitalisation is not just a technical challenge but also an organisational one. Success depends on how organisations deal with digital knowledge, both internally and across organisational boundaries.

This challenge is particularly visible in the partnership between Royal Schiphol Group (client) and Royal BAM Group (contractor), responsible for the management of Schiphol's landside infrastructure under the MC2019 contract. The contract follows a Best Value approach, aiming to stimulate trust, transparency and innovation between both partners. While this approach has proven successful for most partnership objectives, digitalisation remains a difficult topic. Schiphol has defined ambitions to become the 'most digital airport', yet how these ambitions should be translated into practice, and what they mean for both organisations, remains unclear. BAM is expected to take a proactive role in achieving this objective, yet the absence of a shared digitalisation strategy or roadmap results in fragmented initiatives and limited alignment. This has created a gap between ambition and implementation, raising the question of how digitalisation can be improved within client-contractor partnerships in infrastructure asset management.

How can clients and contractors improve digitalisation within their partnerships to create shared value in infrastructure asset management?

To address this question, four sub-questions are formulated:

1. How is digitalisation conceptualised in the infrastructure asset management literature?
2. How does the literature explain the role of absorptive capacity in enabling digitalisation?
3. How does the literature describe the influence of strategic interdependence on digitalisation within partnerships?
4. Which mechanisms explain how digitalisation unfolds in practice within the Schiphol-BAM partnership?

0.2. Literature Background

The literature on digitalisation in infrastructure asset management emphasises that progress depends not only on new technologies but also on organisational capabilities and collaboration across actors. Two concepts are particularly relevant: *absorptive capacity*, which explains how organisations recognise, share, and apply new knowledge, and *strategic interdependence*, which describes how partners rely on one another to achieve digital goals. Existing studies rarely examine these mechanisms within client-contractor relationships in IAM, leaving a gap that this research addresses.

0.3. Methodology

The research followed a qualitative, empirically grounded single-case study of the partnership between Schiphol and BAM under the MC2019 contract. A Design Science Research Method (DSRM) was used to structure the study, with the main artefact being a grounded model that explains how digitalisation unfolds in a client-contractor partnership and how it can be improved. A theoretical framework based on

absorptive capacity and strategic interdependence informed the research design and interview guide, while leaving room for context-specific mechanisms to emerge from the data.

Empirical data were collected through 16 semi-structured interviews with employees from both organisations, selected across strategic, tactical, and operational levels. The interview data were analysed inductively using the Gioia Methodology, resulting in a data structure of first-order concepts, second-order themes, and aggregate dimensions, which were synthesised into five propositions. These propositions were triangulated with internal documents and formed the basis of the grounded model and the practical recommendations. The propositions were subsequently validated and refined through a focus group with representatives from Schiphol and BAM. All research activities followed TU Delft's ethical guidelines, with informed consent, anonymisation, and secure data storage.

0.4. Main Findings

The study shows that digitalisation in the Schiphol-BAM partnership develops through the interaction of absorptive capacity, strategic interdependence, and five mechanisms identified in the empirical data. These mechanisms are (1) institutional context, (2) financial alignment, (3) organisational capabilities, (4) relational dynamics, and (5) strategic alignment. Together they form a grounded model that shows how digitalisation develops in client-contractor partnerships in the IAM sector. By addressing each of these mechanisms, this thesis shows how digitalisation can be improved in client-contractor partnerships in IAM.

0.5. Practical Implications

Improving digitalisation requires addressing all five mechanisms of the grounded model. The research results in twelve recommendations: Schiphol should clarify digital expectations, align data requirements and long-term valuation, strengthen governance and expertise, and provide clearer leadership. BAM should scale digital solutions and increase transparency on progress. Jointly, Schiphol and BAM should improve knowledge retention, resolve system and data integration issues, and develop a shared digitalisation roadmap. These actions can support more consistent progress and enhance shared value creation.

0.6. Scientific Contribution

The research extends the framework of Siachou et al. (2021) by showing how absorptive capacity and strategic interdependence operate within a client-contractor partnership in an IAM context. It demonstrates that digitalisation is shaped not only by knowledge processes between partners, but also by institutional, financial, organisational, relational, and strategic factors. The grounded model therefore contributes to a more practice-oriented understanding of digitalisation in infrastructure asset management.

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Nomenclature

Abbreviations

Table 1: List of abbreviations or nomenclature

Abbreviation	Meaning
Contract & Case Context	
BV	Best Value
DDH	Digital Data Hub
DDS	Data Dictionary Schiphol
DMP	Data Management Plan
IAM	Infrastructure Asset Management
IM	Information Management
KPI	Key Performance Indicator
MC	Main Contractor
MC2019	Main Contractors 2019
O&M	Operations and Maintenance
ROK	Raamovereenkomst (Framework agreement)
UTI	Uitnodiging tot Inschrijving (Tender invitation document)
Digitalisation & Technology	
AI	Artificial Intelligence
BIM	Building Information Modelling
ESB	Enterprise Service Bus
GIS	Geographic Information System
IoT	Internet of Things
ISO	International Organization for Standardization
IT	Information Technology
Maximo	Asset and Maintenance Management System used by BAM
SharePoint	Document and information management platform
Theoretical Concepts	
ACAP	Absorptive Capacity
DB	Design-Build
DBB	Design-Bid-Build
PACAP	Potential Absorptive Capacity
RACAP	Realised Absorptive Capacity
RDT	Resource Dependency Theory
Research Methodology	
ATLAS.ti	Qualitative data analysis software
DSRM	Design Science Research Method
HREC	Human Research Ethics Committee
SQ	Sub-question
RQ	Research Question

1

Introduction

In recent years, infrastructure asset owners and managers have shifted from traditional, reactive maintenance towards more data-driven asset management. This reflects a broader change in the sector, where data increasingly becomes the primary basis for decision-making (International Organization for Standardization, 2024). Real-time data is used to gain insights into asset performance and support decisions that improve efficiency, safety, and life-cycle optimisation (Hoosemans, 2023; Rijkswaterstaat, 2025).

To achieve this, various technologies have recently disrupted the infrastructure asset management (IAM) sector, with the rise of technologies ranging from data collection methods to analysis tools that enable data-driven decision making. These include Building Information Modelling (BIM), Internet of Things (IoT) sensors, machine learning and AI algorithms, cloud computing, blockchain, and interactive dashboards. Despite this technological progress however, many organisations still find it challenging to convert raw data into enhanced decision-making, particularly in complex, multi-stakeholder infrastructure settings (Brous et al., 2017; Caldera et al., 2021; Parlikad & Jafari, 2016).

The digitalisation of decision-making processes in the IAM sector is therefore not only a technical challenge, but also an organisational one (Parlikad & Jafari, 2016; Schraven et al., 2011). As a socio-technical process, digitalisation requires not just access to technologies, but also the ability to deal with knowledge on digitalisation (Gradillas & Thomas, 2025; Legner et al., 2017; Vial, 2019). This becomes even more complex in multi-actor contexts such as infrastructure, where asset management responsibilities are increasingly shared between public clients and private contractors (Alexander et al., 2019; Parlikad & Jafari, 2016; Schraven et al., 2011). In such cases, the success of digitalisation efforts depends on more than tools, it relies on the collective ability of organisations to deal with knowledge across organisational boundaries.

1.1. Case Context

This challenge is particularly relevant in the context of large public-private partnerships such as the collaboration between Royal Schiphol Group and Royal BAM Group (BAM). Schiphol Airport is one of Europe's busiest hubs, managing a large and complex network of assets, including runways, taxiways, terminals, roads, and underground systems. To manage this complex and extensive asset base, Schiphol outsources large parts of its asset management through a Best-Value (BV) procurement approach. Because Schiphol is so large and complex, it is outsourced in subdivisions divided by parcels each belonging to a certain asset domain or responsibility, see Table 1.1 (Royal Schiphol Group, 2017). BAM Infra is responsible for Parcel 3 in this contract, the MC2019.

1.1.1. Contractual Responsibilities

Parcel 3 covers the management, maintenance, renovation, and new construction of landside infrastructure assets, which includes assets such as roads, tunnels, bridges, pavements, signage, lighting, drainage systems and greenery. Under the MC2019 contract, BAM Infra is responsible for performing

all operational and tactical asset management activities within this parcel. This includes preventive and corrective maintenance, inspections, repairs, data collection and registration, incident response, and the execution of capital projects within the scope. BAM is also responsible for proposing improvements, managing subcontractors, ensuring safety and continuity, and delivering information and documentation according to Schiphol's standards

Schiphol, as the client, is responsible for the strategic asset management, performance steering, budgeting, long-term planning, and ensuring compliance with aviation and safety regulations. Schiphol sets performance requirements, monitors KPIs, approves yearly plans, and manages interfaces with other parcels. While BAM is responsible for execution, Schiphol remains accountable for asset performance at airport level (Schiphol Nederland B.V. & BAM Infra B.V., 2019)

Table 1.1: Overview of Schiphol parcels and responsibilities

Parcel nr.	Responsibility
Parcel 1	Flight handling
Parcel 2	Aircraft handling
Parcel 3	Landside infrastructure
Parcel 4	Underground infrastructure
Parcel 5a	Terminal 1 & 2
Parcel 5b	Terminal 3
Parcel 6	Fencing and gates
Parcel 7	Landside cleaning

1.1.2. Best-Value Approach

These responsibilities of Parcel 3 are outsourced to BAM via a Best-Value (BV) procurement approach, which is performance-based rather than prescriptive. Under BV, the contractor is expected to take a leading role in demonstrating expertise, proactively identifying risks and opportunities, and continuously improving throughout the contractual period. The nine-year contract is reviewed every three years based on BAM's performance, creating an ongoing cycle of accountability and improvement (Schiphol Nederland B.V. & BAM Infra B.V., 2019)

The BV philosophy shapes how Schiphol and BAM collaborate. Instead of specifying detailed requirements, Schiphol focuses on defining goals and relies on BAM's expertise to determine how these goals should be achieved. According to the internal framework agreement between Schiphol Nederland B.V. and BAM Infra B.V. (2019), via the BV approach, "the client wishes to collaborate with the contractor in a manner where both parties, from their respective roles, make use of each other's expertise, create transparency around performance and risks, and grant each other such a level of trust that both are willing to be vulnerable within the partnership". In their tender document, Schiphol states that they chose this approach for the tender and execution of the contract due to its reduction of risks and maximum utilisation of opportunities (Schiphol Nederland B.V., 2018b).

1.1.3. Systems and Tools

Within the MC2019 contract (Schiphol Nederland B.V. & BAM Infra B.V., 2019), Schiphol has formulated four strategic objectives to support its central ambition of becoming Europe's preferred airport (Figure 1.1):

1. Sustainability and safety
2. Excellent organisation
3. Digitalisation and innovation
4. Optimal asset return

In order to comply with the contractual data requirements and to demonstrate its digitalisation capabilities during the tender, BAM proposed the Digitale Data Hub (DDH) as the central interface for structured data exchange with Schiphol. The DDH brings together asset information from BAM's core systems: Maximo (asset data), GIS (geodata), and SharePoint (documents). These systems are connected



Figure 1.1: Key objectives defined by Schiphol in the MC2019, adapted from Schiphol Nederland B.V. and BAM Infra B.V. (2019)

through the Enterprise Service Bus (ESB), which automatically routes updates to the DDH, where they are converted into Schiphol's required format.

In addition, incident notifications from Schiphol are received in the DDH, translated to BAM's structure, and forwarded to Maximo via the ESB, with status updates returning through the same route. Through this setup, the DDH ensures reliable and contractually compliant data delivery and supports BAM's performance commitments in the MC2019 contract (BAM Infra B.V., 2025b).

1.2. Problem Statement

As mentioned above, Schiphol has defined four main objectives in the MC2019 contract. Most of these objectives, such as sustainability and safety, excellent organisation and optimal asset return, have clear strategies and measurable targets, with no ambiguity in interpretation for the contractor. However, when it comes to the digitalisation objective, this clarity is still lacking. While there are mentions of an ambition for a 'digital twin' and 'data driven asset management', what these terms mean in practice, how they will be operationalised, and who is responsible for what remains ambiguous. Although several digital systems and data-exchange processes are already in place, these foundations have not resulted in the expected digitalisation progress.

At the same time, in accordance with the BV philosophy, BAM is contractually expected to proactively make use of their expertise and determine how the digitalisation objective should be achieved. But, without a clear definition of the goal by Schiphol, such as a shared roadmap or strategy, their efforts often lack direction and alignment with the client's expectations. As a result, digitalisation has become a source of tension and uncertainty within an otherwise trust-based, performance-oriented partnership. This misalignment has created a gap between ambition and implementation and raises the question of how digitalisation can be improved in a partnership where both client and contractor are responsible for driving it and creating shared value.

1.3. Research Gap

Despite growing attention to digitalisation in infrastructure asset management, most existing research focuses on technological adoption within single organisations, rather than collaborative improvement within a partnership. Recent research points to two mechanisms that are crucial for successful digitalisation: (1) absorptive capacity (ACAP), an organisation's ability to recognise, absorb, and apply

new knowledge, and (2) strategic interdependence, which reflects how much partners depend on one another to reach shared digitalisation goals (Siachou et al., 2021). However, how these factors play out in practice, especially in the infrastructure asset management sector, remains under-explored.

1.4. Research Objective

Building on this gap, this study aims to explore how digitalisation can be improved within client-contractor partnerships in infrastructure asset management. The goal is examine how digitalisation is understood and conceptualised and how absorptive capacity and strategic interdependence are described in existing literature. This theoretical framework is then used as a lens within the Schiphol-BAM partnership to analyse what mechanisms influence the development of digitalisation in practice. By addressing these mechanisms, recommendations will be made on how digitalisation can be improved within client-contractor partnerships in infrastructure asset management.

1.4.1. Research Questions

This study is guided by the following main research question:

How can clients and contractors improve digitalisation within their partnerships to create shared value in infrastructure asset management?

To address this question, four sub-questions are formulated:

1. How is digitalisation conceptualised in the infrastructure asset management literature?
2. How does the literature explain the role of absorptive capacity in enabling digitalisation?
3. How does the literature describe the influence of strategic interdependence on digitalisation within partnerships?
4. Which mechanisms explain how digitalisation unfolds in practice within the Schiphol-BAM partnership?

1.5. Research Design

This research follows a qualitative approach, grounded in an empirical case study, guided by theoretical findings, and structured around the DSRM (Design Science Research Methodology). Figure 1.2 provides an overview of how the research questions, thesis content and DSRM steps connect. The literature review addresses sub questions 1-3 and develops the theoretical lens that is used to inform the interview design. The empirical research is guided by sub question 4, and ultimately derives five propositions. These propositions are the mechanisms that form the basis for the grounded model, which will be used to make recommendations that help answer the main research question.

1.6. Research Relevance

This thesis has both scientific and practical contributions, by applying theoretical insights to an empirical case in infrastructure asset management. It uses existing theory as an analytical lens while keeping the research process inductive to find contextual factors not yet captured in literature.

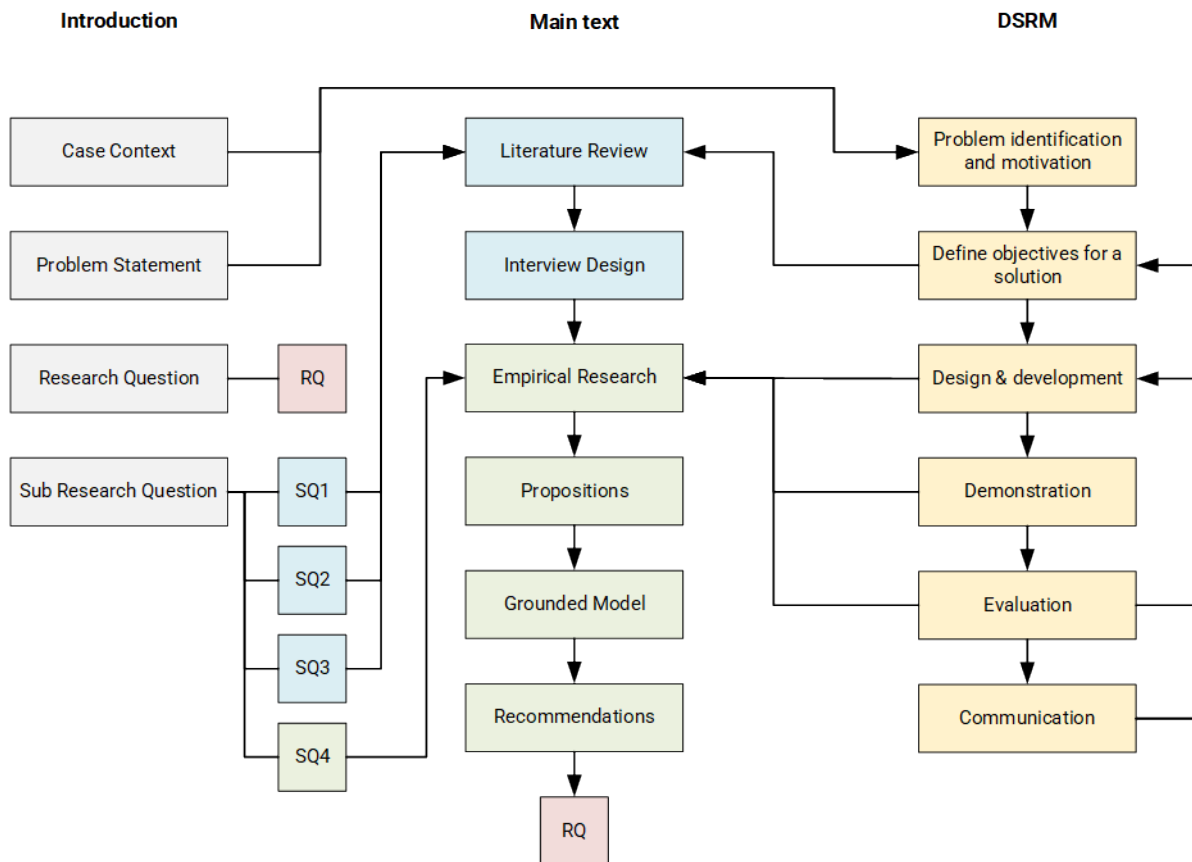
1.6.1. Scientific Relevance

From a scientific perspective, this study contributes to the emerging body of literature on digitalisation in infrastructure asset management. While most studies focus on the technical implementation of digitalisation, this study explored how absorptive capacity between organisations and strategic interdependence unfolds in partnerships in IAM. By using the existing framework from Siachou et al. (2021) with additional theoretical insights as a lens for empirical research, this thesis aims to find how ACAP and strategic interdependence lead to improved digitalisation in practice, and what kind of factors from IAM influence process.

1.6.2. Practical Relevance

From a practical perspective, this study aims to support Schiphol and BAM in improving digitalisation within their partnership, by analysing the way digitalisation currently unfolds, and addressing where

improvements can be made. The results of this study may also help other clients and contractors in IAM to improve the digitalisation in their partnership, as well as help practitioners better integrate digitalisation objectives into IAM contracts.



- RQ: How can clients and contractors improve digitalisation within their partnerships to create shared value in infrastructure asset management?
- SQ1: How is digitalisation conceptualised in the infrastructure asset management literature?
- SQ2: How does the literature explain the role of absorptive capacity in enabling digitalisation?
- SQ3: How does the literature describe the influence of strategic interdependence on digitalisation within partnerships?
- SQ4: Which mechanisms explain how digitalisation unfolds in practice within the Schiphol-BAM partnership?

Figure 1.2: Overview of research design

1.7. Thesis Outline

This thesis is structured as follows:

1.7.1. Chapter 1: Introduction

This chapter introduces the case context, problem statement, research gap and objective, main research question and sub questions. It explains the scientific and practical relevance of the study and presents the overall research design.

1.7.2. Chapter 2: Literature Review

This chapter addresses the first three sub questions. It reviews how digitalisation is conceptualised in infrastructure asset management literature and discusses how absorptive capacity and strategic interdependence influence the development of digitalisation in partnerships. The outcomes of this are used as the theoretical lens for the empirical part of this study.

1.7.3. Chapter 3: Methodology

This chapter outlines the methodology used in this thesis. It includes the use of Design Science Research Methodology (DSRM) and how it shaped this thesis, and explains the approaches used for the theoretical research and empirical research.

1.7.4. Chapter 4: Empirical Research

This chapter presents the empirical findings and how they were derived through data analysis. It explains the development of the data structure, the key patterns identified, and the process that led to the five propositions.

1.7.5. Chapter 5: Results

This chapter presents the five propositions that explain how digitalisation unfolds within the Schiphol-BAM partnership. These propositions are supported by empirical evidence and triangulation and answer the fourth sub question.

1.7.6. Chapter 6: Discussion

This chapter synthesises the empirical propositions from chapter 5 with the theoretical framework from chapter 2. It presents the grounded model and discusses the mechanisms it is derived from.

1.7.7. Chapter 7: Conclusion

This chapter answers the main research question, presents recommendations for Schiphol and BAM, outlines theoretical contributions, and discusses limitations and opportunities for future research.

2

Literature Review

This chapter reviews and integrates the relevant body of literature to build the theoretical foundation for this study. It introduces how digitalisation is understood and operationalised within infrastructure asset management, and how it relates to organisational learning through the concept of absorptive capacity (ACAP). It further explores how partnership dynamics such as trust, alignment, and interdependence affect the ability of clients and contractors to jointly develop and apply digitalisation knowledge. Finally, this chapter synthesises these insights into a theoretical framework based on Siachou et al. (2021), which combines absorptive capacity with strategic interdependence as core mechanisms of digitalisation.

2.1. Understanding Digitalisation in Infrastructure Asset Management

This section of the literature review focuses on understanding digitalisation in the infrastructure asset management (IAM) sector, alongside the differing approaches taken by public clients and private contractors. Before exploring these organisational perspectives, it is important to distinguish between the commonly interchanged terms digitisation, digitalisation, and digital transformation.

2.1.1. Digitisation, Digitalisation, Digital Transformation

Obtaining digital data is what the literature refers to as *digitisation*, or more specifically the process of converting analogue information into digital artefacts (e.g. paper drawings into digital models) (Gradillas & Thomas, 2025; Legner et al., 2017; Parviainen et al., 2022). It provides the technical foundation for data-driven IAM. *Digitalisation* involves using these digital artefacts (or: *digitisation*) in order to transform a business' current practices and structures in its individual, organisational and economic contexts (Legner et al., 2017; Vial, 2019). Digitisation and digitalisation are related to each other through multiple feedback loops, where digitisation enables digitalisation and vice versa (Gradillas & Thomas, 2025). Digital transformation on the other hand, refers to a broader strategic shift with an aim to improve an entire business entity and the way they create value (Gradillas & Thomas, 2025; Vial, 2019). An overview of these definitions can be seen in Table 2.1.

2.1.2. Digitalisation in Infrastructure Asset Management

It is important to make this distinction, because this study specifically focuses on digitalisation, the stage where digital technologies move beyond solely capturing data or introducing new tools (digitisation), but have not yet developed into a full organisational transformation. This focus is particularly relevant in infrastructure asset management, where organisations such as BAM and Schiphol already produce large amounts of digital data, yet the main challenge lies translating that into decision making that is data-driven and real-time, to enable sustainable infrastructure outcomes. This is difficult, because technical aspects, such as a lack of integrated systems (Caldera et al., 2021), but also because of the multi-stakeholder complexity that is added in the infrastructure sector (Parlikad & Jafari, 2016).

Because of this multi-actor complexity, digitalisation depends on these actors can exchange this knowledge between organisations and the ability to share and apply lessons across projects (Love et al., 2016). Similarly, Love et al. (2014) emphasise that asset data is generated and modified by multiple stakeholders, making that its benefits can only be achieved through collaborative processes for data sharing and interpretation. The next section therefore explores how clients and contractors differ in their perspectives on digitalisation, and how these differences influence the way digitalisation unfolds in practice.

Table 2.1: Distinction between digitisation, digitalisation, and digital transformation

Term	Definition / Focus
<i>Digitisation</i>	Conversion of analogue or physical data into digital form.
<i>Digitalisation</i>	Application of digital tools to improve processes and decision-making.
<i>Digital Transformation</i>	Organisation-wide strategic change driven by digital technologies and culture.

2.1.3. Digitalisation for Clients and Contractors

In practice, partnerships in infrastructure asset management are often characterised by asymmetric power relations. Public clients, especially in road and aviation infrastructure are argued to be the pioneers of industrial change in terms of innovation and digitalisation (Adam & Lindahl, 2017; Kuitert et al., 2019; Kussl & Wald, 2025; Lindblad & Karrbom Gustavsson, 2021). As Kussl and Wald (2025) points out, both clients and contractors can take the lead in innovation, but they typically do so from different logics: client-led strategies are driven by public values and policy ambitions, while contractor-led strategies are shaped by business cases and operational efficiency (Havenvind, 2015). These different logics lead to distinct digitalisation approaches, where public clients tend to focus on digital service innovation and contractors on physical asset innovation.

This difference in mindset can create friction when there is no shared understanding of how digitalisation should be approached. Although such asymmetry might suggest limited mutual dependence, long-term performance-based contracts actually create a form of strategic interdependence, where both partners rely on each other to achieve their goals. For example, a public client may depend on the contractor's technical knowledge and innovative mindset to digitalise operations, while the contractor may rely on the client's strategic vision and support to justify investments into long-term digitalisation solutions. However, this interdependency, can sometimes be unfulfilled due to resource dependency, power imbalance, non-alignment of goals or opposing interests. While long-term relations are beneficial for public clients, they can also obstruct the market forces and compliance with procurement laws when it comes to tendering, especially when the contractor builds a competitive advantage to their rivals (Suijkerbuijk et al., 2019a).

According to Siachou et al. (2021), digitalisation is most effective when both organizations not only possess a high level of absorptive capacity but are also strategically interdependent, as displayed by their framework in figure 2.1. Strategic partnerships thus require more than formal contracts or mutual goals. They demand that both parties can learn from each other and adapt. This is especially important in digitalisation efforts, which involve not just adopting tools, but continuously dealing with external knowledge on digitalisation. The next section further explores the concept of absorptive capacity, and how this digitalisation knowledge can be acquired, shared and applied, internally and externally.

2.2. Digitalisation and Knowledge: Absorptive Capacity

As highlighted in the framework by Siachou et al. (2021), effective digitalisation depends on both the strategic interdependence between partners and their ability to recognise, assimilate, and apply new digital knowledge. To understand how clients and contractors deal with digitalisation knowledge in practice, the following section unpacks the foundations, dimensions, and influencing factors of ACAP.

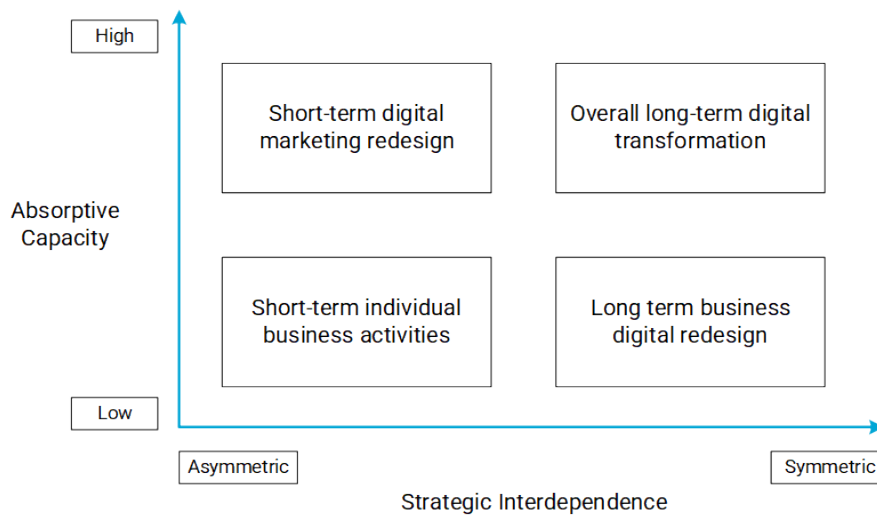


Figure 2.1: Digitalisation framework, adapted visually from Siachou et al. (2021)

2.2.1. Foundation of Absorptive Capacity

Absorptive Capacity (ACAP) was first defined by Cohen and Levinthal (1990) as "ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends". The ability of a firm to recognise the value of information is in turn dependent on prior related knowledge, which includes fundamental skills, shared knowledge and knowledge of the latest scientific developments and trends. Cohen and Levinthal (1990) also emphasise the close tie to Research & Development (R&D), and argue that investing in R&D not only contributes to a firm's knowledge, but also makes them more effective learners and increases the ACAP of a firm.

Zahra and George (2002) build on this established theory, and reconceptualise it as "a set of organisational routines and processes by which firms acquire, assimilate, transform and exploit knowledge to produce a dynamic organisational capability". A key addition to this re-conceptualisation is the introduction of two subsets of *potential* and *realized* capacities. Potential capacity (PACAP) consists of the acquisitions and assimilation capabilities, while realised capacity (RACAP) contributes to the transformation and exploitation of knowledge. These four capabilities build on each other, allowing firms not only to process knowledge, but also support innovation and change. This emphasises the dynamic nature of ACAP, arguing that it enables firms to *reconfigure* and *adapt* themselves over time (Teece et al., 1997; Zahra & George, 2002).

A visualisation of the complete ACAP framework by Zahra and George (2002) can be seen in Figure 2.2. This framework consist of the four dimensions of ACAP, organized under PACAP and RACAP. It also highlights the existence of antecedents, which are the inputs of the model or the *external knowledge sources*. Moderating influences shape how the ACAP of a firm is developed and used, and are *activation triggers*, *social integration mechanisms*, and *regimes of appropriability*. The development of PACAP and RACAP subsequently contribute to a specific business advantage.

Recent studies reaffirm the importance of this capability in increasingly dynamic and technology-intensive environments. For instance, Barbosa and Carvalho (2024) argue that developing ACAP is essential for firms operating in rapidly evolving technological contexts. They note that "exploring absorptive capacity enables companies to strategically leverage knowledge to enhance operational efficiency and gain a competitive advantage in their respective industries."

2.2.2. The Four Dimensions

ACAP consists of four complementary capabilities: acquisition, assimilation, transformation, and exploitation (Zahra & George, 2002). Together, these form two subsets of potential ACAP (PACAP), which includes acquisition and assimilation, and realised ACAP (RACAP), which includes transformation and exploitation. PACAP determines how organisations identify and internalise external knowledge, while RACAP reflects their ability to adapt and apply this knowledge in practice.

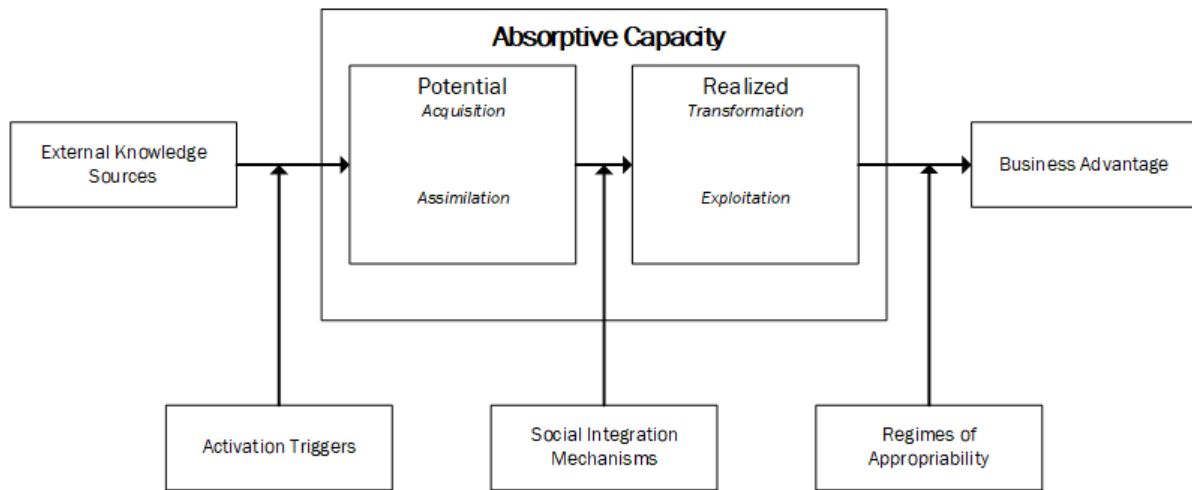


Figure 2.2: Absorptive Capacity framework, adapted visually from Zahra and George (2002)

Acquisition

Acquisition refers to a firm's ability to identify and obtain external knowledge that is critical for its operations. It depends on the firm's possession of *basic knowledge*, which is a general understanding of a discipline's basic techniques and traditions and *specialized knowledge* (Cohen & Levinthal, 1990). According to Lane and Lubatkin (1998) in inter-organisational learning, the best result is achieved when firms similar basic knowledge with diverse specialized knowledge, to be able to build and utilize knowledge.

Assimilation

Assimilation refers to the routines and processes that allow a firm to analyse, interpret, and understand newly acquired knowledge. It involves internalizing external information and integrating it with existing knowledge structures. It is influenced by a firm's tacit and firm-specific knowledge.

Transformation

Transformation involves developing routines to combine and adapt both new and existing knowledge, enabling the firm to refine or reshape its processes and capabilities. It bridges the gap between understanding and using knowledge, allowing firms to reconfigure their knowledge in new contexts.

Exploitation

Exploitation is the capacity to apply this transformed knowledge in practice. For example, in improving processes, launching new products, or informing strategic decisions. Exploitation is where knowledge begins to create tangible value.

2.2.3. Antecedents

Antecedents represent the conditions that enable the development of ACAP. Zahra and George (2002) emphasise that exposure to external knowledge sources such as new technologies, partnerships and joint R&D initiatives positively influence an organisation's ability to acquire and assimilate knowledge. These inputs expand a firm's knowledge base, but only when the new knowledge complements what already exists. Learning therefore requires a balance between novelty and familiarity, where new insights can build upon what is already known (Cohen & Levinthal, 1990).

However, beyond external knowledge sources, experience and organisational memory also play an important role in shaping how firms absorb knowledge. This experience is gained through environmental scanning, benchmarking, collaboration with customers, alliances, learning by doing, and R&D investment (Dubois & Gadde, 2002b; Zahra & George, 2002). Such routines reflect the path dependencies within dynamic capabilities, where past processes and culture influence future learning (Adam & Lindahl, 2017; Love et al., 2014; Teece et al., 1997). As Teece et al. (1997) famously notes, "bygones are rarely bygones". This means an organization's history impacts its future trajectory, and can help create competitive advantage.

In addition to organisational factors, individual characteristics can also serve as antecedents to absorptive capacity and digital transformation. Siachou et al. (2021) and Oluwaseyi Ojo et al. (2014) highlight the importance of leadership, prior knowledge, and learning orientation, as well as cognitive and performance motivations, in shaping an organisation's ability to recognise and apply new knowledge.

2.2.4. Moderating Influences

Moderating influences are contextual factors that shape how absorptive capacity develops and how effectively it is applied. They influence the conversion of potential absorptive capacity (PACAP) into realised absorptive capacity (RACAP), thereby determining whether knowledge acquisition translates into tangible outcomes. Zahra and George (2002) identify three key moderating mechanisms: activation triggers, social integration, and regimes of appropriability.

Activation triggers

Activation triggers are internal or external stimuli that motivate organisations to reconfigure their routines and invest in new learning. These may include technological disruptions, policy changes, or crises such as contract renewals or shifts in leadership (Krystallis et al., 2024; Zahra & George, 2002). When the scope and intensity of a trigger increase, the need for external knowledge increases. With this, firms are likely to invest more resources in the capabilities that are needed to develop PACAP.

Social integration mechanisms

Social integration mechanisms bridge the gap between PACAP and RACAP by enabling the sharing and joint application of knowledge. They include practices such as cross-functional collaboration, collaborative working sessions, and inter-organisational learning workshops (Love et al., 2016; Zahra & George, 2002).

Regimes of appropriability

Regimes of appropriability refer to the external and internal conditions that determine how well a firm can protect or leverage acquired knowledge. In environments with weak protection, imitation by competitors is common, which can discourage knowledge investment. At the same time, strong appropriability through intellectual property, contractual arrangements, or relational trust can encourage firms to invest in developing their absorptive capacity (Zahra & George, 2002). Even when competitors copy outputs, a firm with strong ACAP can maintain its advantage by continually acquiring and applying new knowledge more effectively than others (Cohen & Levinthal, 1990).

2.2.5. Value Creation with Absorptive Capacity

In private-sector contexts, value creation through ACAP often takes the form of competitive advantage: positions that are valuable, rare, inimitable, and non-substitutable (Barney, 1991; Porter, 1996). In public-private partnerships, however, value creation extends beyond competitiveness. Public clients aim to achieve public value such as safety, sustainability, and long-term effectiveness rather than market dominance (Adam & Lindahl, 2017). Yet they depend on private partners for technological expertise and innovation capacity. Resource Dependency Theory (RDT) helps explain this dynamic, suggesting that inter-organisational relationships allow parties to access and exchange critical resources (Suijkerbuijk et al., 2019b). Hence, ACAP must be developed not only within individual organisations but also between them, enabling both sides to co-create value and achieve shared digitalisation goals. The next section therefore explores how absorptive capacity is theorised and developed in inter-organisational contexts and what the role of partnerships play in digitalisation.

2.3. Influence of Partnerships on Digitalisation

The type of relationship between partners, transactional or strategic determines how openly knowledge is exchanged and how learning takes place. The following section explores how these partnership dynamics influence digitalisation and what forms of collaboration best support joint innovation.

2.3.1. From Contracts to Strategic Partnerships

In infrastructure asset management, the relationship between clients and contractors has evolved from transactional, project-based relationships to more relational performance-based partnerships (Alexander et al., 2019). Traditional procurement models, such as Design-Bid-Build (DBB) or Design-Build

(DB) primarily focus on price, scope, and compliance, often resulting in limited innovation and attention to operations and management (O&M) phases. In contrast, long-term procurement approaches, such as Best-Value (BV) procurement, emphasise performance, collaboration, and continuous improvement across the asset lifecycle. BV procurement transfers accountability to the contractor, who is chosen not just on the basis of lowest price but also on demonstrated performance, risk mitigation, and the ability to produce results, in contrast to traditional techniques that place an emphasis on control and specification (Rijkswaterstaat, 2015; Zhang, 2006). In the Netherlands, where budgets for infrastructures are shrinking, projects are becoming more complex, with a need for inclusion of the O&M phase and increased innovation, this type of contracting is becoming more common. The BV approach requires the contractor and client to work closely together, as professional partners with a common goal (Rijkswaterstaat, 2015).

This type of collaboration requires not only the alignment of project goals but also that partners continuously learn from one another. This is reflected in the nature of the contracting process where clients often seek contractors with greater technical expertise, creating a dependency on knowledge and experience, as previously discussed in Section 3.1. The next subsection introduces the concept of inter-organisational absorptive capacity, which explains the effect of partnerships and dependency on ACAP.

2.3.2. Inter-organisational Learning and Absorptive Capacity

Lane and Lubatkin (1998) expand on the absorptive capacity concept by introducing the idea of *relative absorptive capacity*, the ability of one organisation to learn from another. They argue that the effectiveness of learning depends on the similarity of the partners' knowledge bases, organisational structures and dominant logics. They call this knowledge base fit, structural fit and strategic fit. When organisations share similarities in these dimensions, they are better able to understand, absorb, and apply each other's knowledge.

Building on this, Mowery et al. (1996) emphasise that inter-organisational learning outcomes are influenced by the structure and strategic goal of the alliance, namely whether they are equity or contractually based. Alliances formed for quick access to external expertise (contractual) differ from those that focus on long-term joint capability building (equity). The latter enables organisations to develop knowledge together, and enhance their capabilities, as well as learn from each other. Mowery et al. also emphasise that similar knowledge fits are more likely better understand, absorb and apply each other's knowledge, similar to Lane and Lubatkin (1998).

Partnerships also rely on social conditions to enable learning between organisations. Love et al. (2016) highlight the importance of trust, open communication, and collective reflection, the so-called social integration mechanisms, as enablers of knowledge transfer and collaborative problem-solving in alliances. Similarly, Dubois and Gadde (2002b) describe the construction industry as a mix of tightly coupled project systems and loosely coupled inter-firm networks, where knowledge often stays locked within individual projects. Strengthening these relational ties across projects helps prevent knowledge loss and supports continuous learning and innovation throughout the network.

2.4. Theoretical Framework

This section integrates the insights from the literature review into a theoretical framework that guides this study. The framework by Siachou et al. (2021) shows that digitalisation unfolds through two central mechanisms: (1) the development and application of absorptive capacity (ACAP) and (2) strategic interdependence. While Siachou et al. theorise these mechanisms in the context of strategic alliance, their practical application in partnerships between contractors and clients in the infrastructure asset management context remains under-explored. This study therefore uses the framework of Siachou et al., in combination with other findings from the literature, as an analytical lens to structure data collection and interview design. The data analysis will be kept inductive to identify additional contextual factors that may not be captured by the literature. The theoretical findings are summarised in Table 2.2.

Figure 2.3 summarises the theoretical framework developed for this study. It combines the core mechanisms proposed by Siachou et al. (2021): absorptive capacity and strategic interdependence. It includes complementary concepts from the literature on digitalisation in IAM and partnerships between

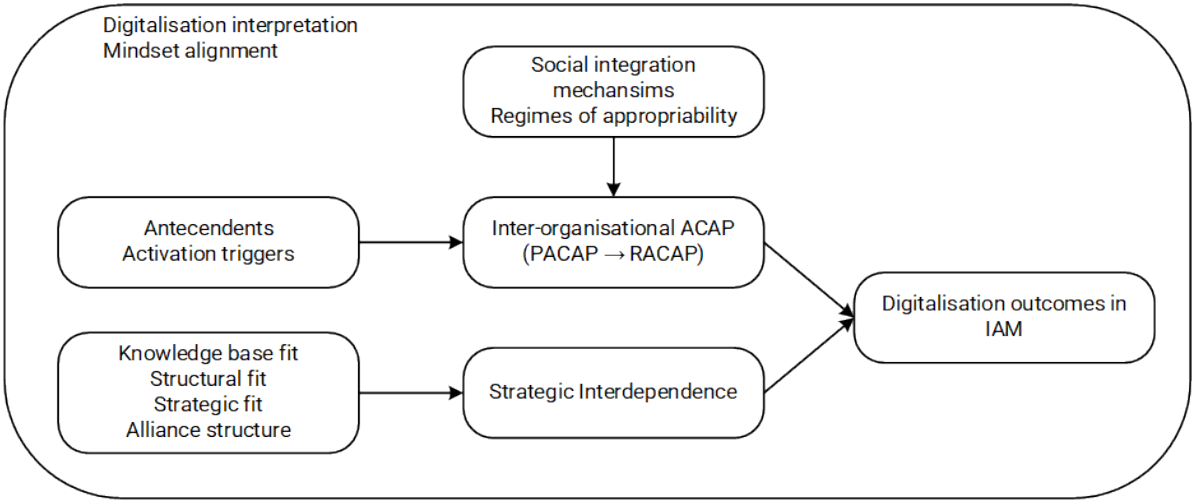


Figure 2.3: Integrated theoretical framework, adapted from Siachou et al. (2021) and theoretical findings

contractors and clients, as summarised in Table 2.2. The framework shows how digitalisation in infrastructure asset management emerges through (1) how organisations understand and approach digitalisation (SQ1), (2) how they acquire, assimilate, transform and exploit digital knowledge (SQ2), and (3) how partnership conditions such as trust, interdependence, and alignment enable or constrain these processes (SQ3). As mentioned above, this will be used as a theoretical lens for interview design and data collection.

Table 2.2: Key theoretical findings guiding the analytical lens

Sub-question	Concept	Definition	Key source(s)
SQ1: Understanding of digitalisation	<i>Digitalisation interpretation</i>	How digitalisation is understood within infrastructure asset management.	Gradillas and Thomas (2025), Legner et al. (2017), and Vial (2019)
	<i>Mindset alignment</i>	The degree to which public clients and contractors share a common understanding of digitalisation.	Adam and Lindahl (2017), Havenvind (2015), Kuitert et al. (2019), and Kussl and Wald (2025)
SQ2: ACAP in the literature	<i>Acquisition</i>	Identifying and obtaining relevant external digital knowledge.	Cohen and Levinthal (1990) and Zahra and George (2002)
	<i>Assimilation</i>	Analysing and internalising acquired knowledge with existing knowledge structures.	Zahra and George (2002)
	<i>Transformation</i>	Combining new and existing knowledge to adapt work processes.	Zahra and George (2002)
	<i>Exploitation</i>	Applying transformed knowledge in practice.	Teece et al. (1997) and Zahra and George (2002)
	<i>Antecedents (organisational/individual)</i>	Organisational routines, leadership, prior experience, and learning orientation that enable knowledge absorption.	Oluwaseyi Ojo et al. (2014), Siachou et al. (2021), and Zahra and George (2002)
	<i>Activation triggers</i>	Internal or external stimuli that push organisations to acquire or update digital knowledge.	Krystallis et al. (2024) and Zahra and George (2002)
	<i>Social integration mechanisms</i>	Trust, communication, and shared platforms that support cross-organisational learning.	Love et al. (2016) and Zahra and George (2002)
	<i>Regimes of appropriability</i>	Conditions determining how easily digital knowledge can be protected or shared.	Zahra and George (2002)
SQ3: Strategic Interdependence in the literature	<i>Strategic interdependence</i>	The degree to which partners rely on each other's resources and expertise.	Siachou et al. (2021)
	<i>Knowledge base fit</i>	Compatibility of partners' technical and informational expertise, enabling smoother data and system integration.	Lane and Lubatkin (1998)
	<i>Structural fit</i>	Alignment of organisational structures, governance, or hierarchies.	Lane and Lubatkin (1998) and Mowery et al. (1996)
	<i>Strategic fit</i>	Alignment of goals, values, logics or long-term priorities.	Lane and Lubatkin (1998)
	<i>Alliance structure</i>	Whether the alliance is equity or contractually based.	Mowery et al. (1996)

Research Methodology

This thesis adopts a qualitative, empirically grounded research approach to explore how clients and contractors in infrastructure asset management can improve digitalisation in the partnership. The study is theory-informed with a theoretical framework based on Siachou et al. (2021) and additional theoretical concepts, which was used as a analytical lens for interview design. But mostly it is empirically driven through the Schiphol-BAM case, using the case to examine and refine the theoretical lens. This single-case design enables close linking of theory and data and is well suited for developing conceptual insights from practice (Dubois & Gadde, 2002a; Eisenhardt, 1989; Flyvbjerg, 2006).

3.1. Design Science Research Method (DSRM)

To guide the design and validation of the resulting framework, the Design Science Research Methodology (DSRM) by Peffers et al. (2007) and discussed in the project management context by Gregor and Zwikael (2024) was used as an overarching process model. DSRM provides a systematic approach for producing and evaluating artefacts that address real-world problems. In this thesis, the artefact is a grounded theory model, based on mechanisms identified in practice, explaining how digitalisation unfolds in client-contractor partnerships in infrastructure asset management, supported by concrete recommendations for Schiphol and BAM. As noted by Peffers et al. (2007), researchers may begin the process at different points of the model depending on the nature of the study. In this research the process follows a problem-centered initiation and therefore starts at step 1. The six DSRM steps and their specific application in this thesis are described below and visualised in Figure 3.1.

3.1.1. Step 1: Problem Identification and Motivation

The first DSRM step aims to define a relevant, practice-rooted problem and demonstrate its significance. This thesis was motivated by observations within the Schiphol-BAM partnership, where stakeholders perceived difficulty in translating digital ambitions into progress. Despite both organisations having the intention to work more data-driven, digitalisation efforts remain fragmented and real progress is lacking. This is described in the case-context and problem statement in Chapter 1.

At the same time, the literature review in Chapter 2 revealed that digitalisation in infrastructure asset management is an underdeveloped research area. Existing studies focus on technical tools and its implementation, and most literature on digitalisation is not directly applied to partnerships within the infrastructure asset management (IAM) sector.

Together these insights created a dual motivation:

1. The partnership faces a practical challenge that requires further exploration.
2. The limited empirical research on digitalisation progress in IAM calls for further exploration and applicability in a real-world case.

This establishes the need for a systematic, practice-grounded artefact that explains how digitalisation unfolds within this partnership and how it can be improved.

3.1.2. Step 2: Define Objectives for a Solution

Building on this problem definition, the second step defines what the artefact must achieve. In this thesis, the solution seeks to generate an empirically grounded and theoretically informed understanding of how digitalisation develops within client-contractor partnerships in IAM.

The theoretical framework developed in Chapter 2 functions as the analytical lens that guided interview design and shaped the objectives of the artefact. Based on this lens and the problem motivation defined in the previous step, the solution aims to:

- Identify mechanisms that enable or constrain digitalisation within the Schiphol-BAM partnership.
- Explain how these mechanisms relate to absorptive capacity and strategic interdependence (from the theoretical framework).
- Synthesise these insights into a grounded conceptual model.
- Translate the findings into actionable recommendations for both parties.

These objectives ensure that the final artefact is both theoretically grounded and practically relevant.

3.1.3. Step 3: Design and Development

In the third step, the artefact was created through empirical analysis. The thesis uses a qualitative single-case study design, combining semi-structured interviews, internal document triangulation. Data were analysed using the Gioia Methodology, which supports inductive theory building through multiple coding cycles and is explained in Chapter 4. The propositions that resulted from this are elaborated and triangulated with documents in Chapter 5. The design and development phase consisted of:

- Open coding: creating first-order concepts that are closely tied to participants' language.
- Axial coding: clustering first-order concepts into second-order themes.
- Selective coding: synthesising these second-order themes into aggregate dimensions.
- Deriving five propositions that explain the mechanisms through which digitalisation unfolds in practice.
- Integrating these five propositions with theory to create a grounded conceptual model.

This grounded model accounts for the core artefact produced through the DSRM process, and is discussed in Chapter 6.

3.1.4. Step 4: Demonstration

In this step and throughout the research, the artefact was directly applied to the Schiphol-BAM case study. It was used to find how digitalisation develops in practice in IAM partnerships. By identifying the mechanisms that enable or constrain digitalisation practical recommendations were made for the Schiphol-BAM case study in Chapter 6.

3.1.5. Step 5: Evaluation

The artefact was evaluated through a focus group session with industry practitioners from both BAM and Schiphol. Participants assessed whether the propositions accurately represented the dynamics of their partnership and whether they recognised the mechanisms in practice. Their feedback provided both validation and refinement, ensuring that the framework realistically captures the practical complexity of digitalisation within the contract. This validation is further elaborated in this Chapter, and presented in Chapter 5.

3.1.6. Step 6: Communication

The final step of the DSRM ensures that the artefact and its insights are disseminated to its intended audiences. This is done in the following two ways:

1. This master's thesis, which integrates theoretical grounding and empirical validation and will be uploaded on the TU Delft repository available for public insight.
2. Internal knowledge sharing session with BAM Infra and Schiphol to open the discussion and translate insights into actionable lessons.

Moreover, throughout the entire master thesis process, there was continuous communication of progress with company supervisors from BAM through bi-weekly meetings and progress-meetings with university supervisors. Feedback and insights from these meetings were used to refine objectives and artefact development.

3.2. Case Study Design

This study adopts a single-case study design, focused on the partnership between Royal Schiphol Group (client) and BAM Infra (contractor), within the MC2019 contract for Parcel 3. While there is a common misconception that single-case studies are insufficient for generating valuable insights, Flyvbjerg (2006) argues that in-depth single cases can offer powerful insights through the "force of example". Eisenhardt (1989) also emphasizes that case studies enable theory development through the iterative process of linking theory and data, making it highly suitable for research that combines theory and data (Dubois & Gadde, 2002a).

3.2.1. Rationale for Case Selection

The Schiphol-BAM partnership was selected for three main reasons. Firstly, it provides a unique access to both client and contractor perspectives, allowing the study to examine digitalisation in a partnership rather than intra-organisational effort. Secondly, the case is strategically significant. Schiphol Airport is the biggest airport in the Netherlands and one of Europe's busiest hubs (Royal Schiphol Group, 2023), while BAM is one of the leading contractors in the Netherlands (Zwaga, 2024). Third, this partnership operates under a Best-Value-procurement performance contract, making it an ideal setting to explore how contractual, organisational and relational factors influence digitalisation.

3.2.2. Case Scope

The unit of analysis is the partnership between Schiphol and BAM as it functions within the MC2019 contract. The contract, established for a total of nine years, is periodically reviewed every three years based on BAM's performance, starting from April 2019. The boundary covered in this thesis is from 2019-2025 and thus encompasses two thirds of the contract. The spatial scope of the project is limited to Parcel 3 of Schiphol Airport, which includes outside infrastructure assets such as roads, pavements, tunnels, and drainage systems. And lastly, the organisational boundary includes the relevant departments involved in asset management.

3.3. Literature Research

As mentioned in the DSRM, the research objective and interview guide is based on the theoretical foundation established in Chapter 2, which reviews key literature on digitalisation, absorptive capacity and strategic interdependence. These concepts informed the development of the research questions and the lens for the interviews, while remaining open to identifying emergent themes during analysis.

3.3.1. Data Collection

Literature was primarily sourced using the academic database *Scopus*, supplemented by other databases when needed. Another method of sourcing articles was backward snowballing, by reviewing the citations of selected articles to find prior work. Articles were selected based on their theoretical relevance, citation count, publication date, and the requirement that they be scientific and peer-reviewed. The prioritisation of these criteria depended on the type of paper being reviewed. For instance, papers focused on infrastructure asset management were accepted with lower citation counts due to the niche nature of the topic, whereas publications in broader fields such as strategic management were expected to have higher citation counts and often included older, foundational works. Literary sources were managed using *Zotero*.

3.3.2. Data Analysis

For the literature research, a narrative review method was applied, which is appropriate when the topic is conceptualized in different ways and needs to be explored and interpreted (Snyder, 2019). A thematic analysis approach (Snyder, 2019; Webster & Watson, 2002) was employed to identify and extract key theoretical concepts, definitions, frameworks, and findings. Through this process, patterns, theo-

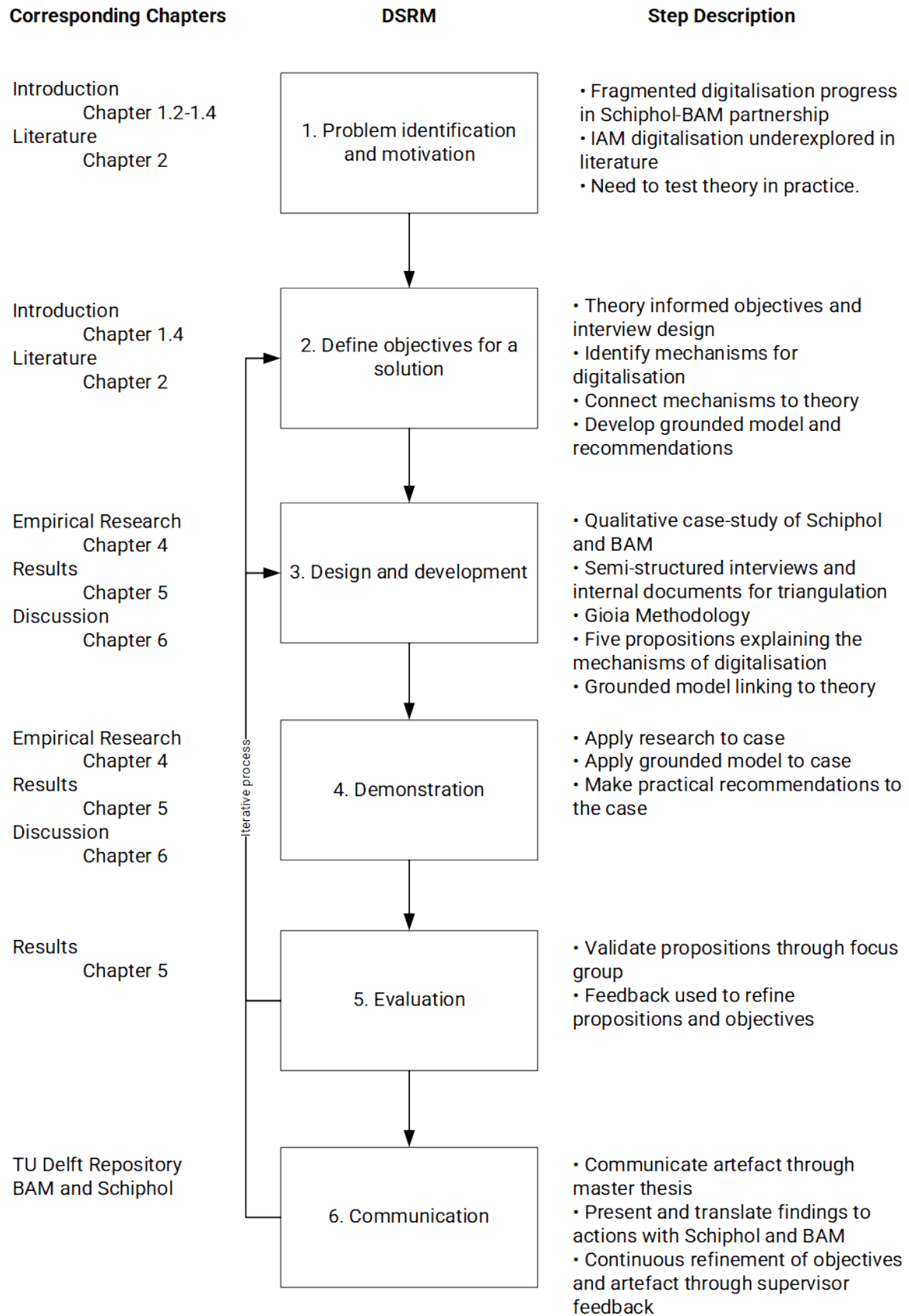


Figure 3.1: Design Science Research Methodology application

retical insights, and potential knowledge gaps were identified, forming the foundation for the theoretical framework and guiding the subsequent empirical research.

3.4. Empirical Research

While the research questions and interview guide are guided by literature, the empirical methodology in this study is an inductive approach. The Gioia Methodology was chosen because it offers a structured way to do inductive research with transparency and 'qualitative rigor'. Gioia et al. (2013) developed this research method to ensure that qualitative studies can remain creative yet credible and offer a strategic approach to building theory from data. It is widely used in organisational and management research, especially in case study settings where researchers aim to develop new conceptual insights (Magnani & Gioia, 2023).

The empirical data collected and used for analysis includes a combination of semi-structured interview data and internal documents to triangulate interview data, ensuring credibility and richness of findings (Dubois & Gadde, 2002a; Eisenhardt, 1989).

3.4.1. Semi-structured Interviews

This research used semi-structured interviews, which are appropriate when researchers aim to explore perceptions and processes in depth while allowing participants the freedom to elaborate (Gill et al., 2008). The interviews addressed the empirical sub-question and were informed by the theoretical framework developed in Chapter 2, focusing on: (1) how digitalisation is understood and operationalised, (2) how knowledge is acquired, shared, and applied, and (3) how partnership dynamics shape these processes within the Schiphol-BAM partnership.

Sampling and participants

A purposive sampling strategy was applied to ensure that the selected participants were directly involved in digitalisation, asset management and collaborative activities within the MC2019 contract. Purposive sampling is well suited for qualitative studies, as it intentionally targets individuals with relevant expertise and experience needed to answer the research questions (Campbell et al., 2020). The sampling was guided by the following three principles:

1. **Representation across organisational levels**

Digitalisation in infrastructure asset management spans across multiple organisational levels. Participants were therefore selected from strategic, tactical and operational levels. This ensured that the data captured how ambitions and goals related to digitalisation are set, how they are translated into ways of working and how they are experienced in day-to-day practice. Strategic participants contributed insights into governance, direction and priorities, while tactical participants spoke about coordination and alignment across teams and operational participants provided practical examples of implementation challenges and work processes.

2. **Representation of both organisations**

Since this study focuses on a client-contractor partnership, it was important to represent both organisations equally. The sample therefore included eight participants from Schiphol and eight from BAM, ensuring a balanced view on how digitalisation is approached on both sides.

3. **Theoretical relevance to ACAP and strategic interdependence**

The sampling choices were also informed by the theoretical lens used in this thesis. Absorptive capacity and strategic interdependence both relate to knowledge flows, collaboration, coordination and decision-making. Participants were therefore selected based on whether they were involved in these processes in practice. This helped ensure that the interviews would generate meaningful insights into the mechanisms described in the theoretical framework.

In total, 16 interviews were conducted. Toward the end of the process, no substantially new themes appeared, suggesting that the sample was sufficient for answering the empirical sub-question (Guest et al., 2006). Figure 3.2 provides an overview of the function levels included, and Table 3.1 presents an anonymised list of all interviewees.

To protect the anonymity of interview participants, individual function titles were removed from Table 3.1. In the context of this study, many roles within Schiphol and BAM are highly specific and identifiable,

meaning that reporting exact titles could allow readers (especially internal stakeholders) to trace responses back to individual employees. This would violate the confidentiality agreements and informed consent procedures followed in this research.

Instead, the table reports function level (operational, tactical, strategic), which sufficiently captures the organisational position and perspective relevant for the analysis. To ensure transparency about the diversity of roles included in the sample, the full range of function titles represented in the interviews is reported nevertheless, without linking them to specific interviewees. Listed below in alphabetical order are all functions represented across the 16 interviewees:

- Asset Manager
- Back Office Manager
- Business Consultant
- Digitalisation Lead
- Information Manager
- Innovation Lead
- IT Business Partner
- IT Specialist
- Maintenance Engineer
- Maintenance Planner
- Service Manager
- Team Lead Technical Experts
- Technical Expert

Table 3.1: Overview of interviewees

Interviewee	Code name	Client/contractor	Function level
Interviewee 1	BAM 01	Contractor	Tactical
Interviewee 2	BAM 02	Contractor	Operational
Interviewee 3	BAM 03	Contractor	Operational
Interviewee 4	BAM 04	Contractor	Strategic
Interviewee 5	BAM 05	Contractor	Tactical
Interviewee 6	BAM 06	Contractor	Strategic
Interviewee 7	BAM 07	Contractor	Strategic
Interviewee 8	BAM 08	Contractor	Operational
Interviewee 9	SCHIPHOL 01	Client	Tactical
Interviewee 10	SCHIPHOL 02	Client	Strategic
Interviewee 11	SCHIPHOL 03	Client	Operational
Interviewee 12	SCHIPHOL 04	Client	Strategic
Interviewee 13	SCHIPHOL 05	Client	Tactical
Interviewee 14	SCHIPHOL 06	Client	Strategic
Interviewee 15	SCHIPHOL 07	Client	Tactical
Interviewee 16	SCHIPHOL 08	Client	Operational

Interview design

The interview guide was designed to generate rich insights into how digitalisation unfolds within the Schiphol-BAM partnership and was structured around the theoretical framework introduced in Chapter 2. The guide consisted of three main themes: (1) how digitalisation is understood and approached; (2) how knowledge regarding digitalisation initiatives is acquired, developed and applied and (3) how partnership dynamics influence this process.

The semi-structured format allowed for flexibility, enabling participants to elaborate freely while still ensuring coverage of all essential topics. Probe questions were used to deepen responses and gather

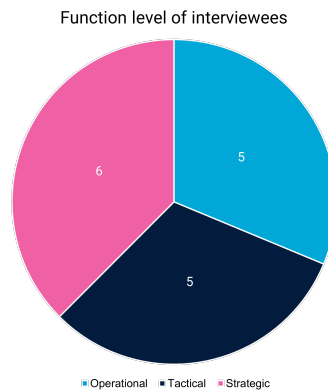


Figure 3.2: Distribution of function level among interviewees

practical examples where relevant. The interview guide was used consistently across all interviews, with minor adaptations and refinements throughout the process. The full guide with probes and the sheet with interview questions for participants can be found in Appendix A.

Data collection

Interviews were held between May 2025 and June 2025, lasting 45-60 minutes each, conducted in Dutch in accordance with the preference of the interviewees. All interviews were recorded with consent, transcribed verbatim and anonymised. Notes and memos were written after each session to capture first impressions and contextual details.

3.4.2. Document Analysis

To triangulate the interview data and better understand the formal strategies and contractual expectations around digitalisation within the Schiphol-BAM partnership, a selection of internal documents and publicly available documents was reviewed. These documents include strategic vision papers, data management plans, and contractual appendices retrieved from both BAM and Schiphol. An overview of the reviewed documents is provided in Table 3.2, indicating the owner, official title, type of content, and year of initial publication.

Table 3.2: Overview of strategy and contract documents

Name	Owner	Original name	Content	Year
Data Management Plan Asset Management	BAM	DMP Asset Management	Strategy	2025
Data Management Plan Information Management	BAM	DMP Configuratie- en Informatiemanagement Perceel 3	Strategy	2025
Framework Agreement	Schiphol	MC 2019-P3-ROK-Totaal-v1.0-68393_def	Contract, Strategy	2019
IM Strategy Appendix	Schiphol	MC2019-BijlageROK-Informatiemanagement strategie en toelichting-v1.0	Contract, Strategy	2019
Innovation and Digital Appendix	Schiphol	MC2019-BijlageROK-Innovatie en Digitaal-v1.0	Contract, Strategy	2019
Tender Invitation Document	Schiphol	MC2019-UTI-P3-v1.0 tender doc	Contract, Strategy	2019

3.4.3. Data Analysis

The data collected from the interviews were analysed inductively in with the Gioia Methodology (Gioia et al., 2013). *ATLAS.ti* 25 was used to systematically manage, code, and analyse the empirical data, en-

ensuring a structured and transparent process (ATLAS.ti Scientific Software Development GmbH, 2024). Following the Gioia approach, the coding was carried out in three iterative stages: open coding, axial coding, and selective coding, which respectively led to the identification of first-order concepts, second-order themes, and aggregate dimensions within a final data structure, propositions that explain the mechanisms in the case, and a grounded theory model. A more detailed explanation of these processes and their outcomes is discussed in Chapter 4. To ensure consistency and traceability, a coding log was maintained, and interim findings were discussed with supervisors.

This method of inductive coding was chosen because it allows themes and meanings to emerge directly from the participants' language and experiences, while still offering analytical rigor and traceability. It therefore provides an appropriate fit for this study's aim to capture how digitalisation, absorptive capacity, and strategic interdependence unfold in practice within the Schiphol-BAM partnership.

In addition to the interview data, internal documents as described above, were used to triangulate emerging insights. These documents were not coded in the same systematic way as the interview transcripts but were analysed narratively to verify, contextualise, or complement the patterns found in the interview data. Their role was to strengthen the credibility of the propositions by confirming whether the perceived mechanisms were also reflected in the analysed documents. The use of document triangulation is integrated into the presentation of the propositions in Chapter 5, where the empirical mechanisms are supported by both interview evidence and document insights.

3.4.4. Focus Group

As mentioned in the evaluation step of the DSRM, the developed artefact was validated through a focus group with representatives from both BAM Infra and Schiphol. The focus group served two main purposes:

1. To assess whether the propositions accurately reflected practice.
2. To refine and strengthen the empirical validity of the grounded model.

Sampling and participants

Because digitalisation processes involve decisions, coordination, and day-to-day execution, participants were selected across strategic, tactical, and operational levels. This structure ensured that the mechanisms identified in the interviews were examined from multiple organisational viewpoints.

The sample also reflects the partnership nature of the case. Three participants from BAM Infra and three from Schiphol were invited, ensuring that both organisations were represented equally. This was important because the propositions describe relational, organisational, and institutional dynamics that affect both sides of the partnership. Although one Schiphol participant could not attend on the day, written feedback was collected afterwards to maintain balanced representation.

An overview of the invited participants is shown in Table 3.3. All selected participants were directly engaged in digitalisation-related work, such as information management, asset management, innovation, and technical expertise, making them well positioned to evaluate the empirical mechanisms developed in this research.

Focus group design

During the 90-minute session, participants were presented with the five propositions developed through the selective coding process described in Chapter 4. First, a small presentation was given to contextualise the propositions and present them with the thesis progress. Then, each proposition was presented one by one. Participants were asked to indicate whether they:

- agreed,
- agreed under certain conditions, or
- disagreed.

To make the evaluation process interactive and accessible, participants cast their votes using coloured stickers, placing them directly onto the posters. This visual method helped stimulate engagement and made individual positions immediately visible to the group, which then served as the starting point for a short discussion after each vote.

Following each voting round, participants shared why they agreed, partially agreed, or disagreed. These discussions allowed them to compare perspectives, interpretations, and provide practical examples from their daily work. The entire session was recorded so that relevant discussion points could be integrated into the analysis.

The feedback was used to refine the propositions and strengthen the empirical validity of the results. Appendix B includes the presentation used during the focus group, which outlines the design and procedure.

Table 3.3: Overview of focus group attendees

Attendee	Code name	Client/contractor	Function level
Attendee 1	BAM 01	Contractor	Tactical
Attendee 2	BAM 07	Contractor	Strategic
Attendee 3	BAM 09	Contractor	Tactical
Attendee 4	SCHIPHOL 03	Client	Operational
Attendee 5	SCHIPHOL 06	Client	Strategic
Attendee 6 ^a	SCHIPHOL 07	Client	Tactical

^aThis attendee could not be present during the focus group and provided written feedback.

3.5. Ethical Considerations

This research involved human participants through semi-structured interviews and therefore adhered to the ethical standards outlined by the Delft University of Technology. Prior to conducting interviews, approval was obtained from the Human Research Ethics Committee (HREC) including a submitted and approved Data Management Plan (DMP) and informed consent procedure.

All interviewed participants received an information letter detailing the purpose of the research, their rights, and the intended use of their data. Written informed consent was obtained before participation. Participants were informed that their participation was voluntary and that they could withdraw at any time without consequence.

To ensure anonymity and confidentiality, personal identifiers were removed from transcripts and analysis. All data were pseudonymized and stored securely in line with TU Delft data management guidelines. Interview quotes used in the thesis are not attributable to individuals or specific roles, and organisational identifiers were anonymized when deemed sensitive. The findings were communicated in a manner that protects both individual and organisational confidentiality, while maintaining the integrity and validity of the research outcomes.

4

Empirical Research

This chapter presents the empirical research of this thesis and demonstrates how the propositions in Chapter 5 emerged from the data, according to the methodology described in Chapter 3. The interview data was inductively coded using the Gioia Methodology, which allows findings to arise directly from the language and experiences of the participants, while maintaining analytical rigor and traceability. The following sections elaborate on the coding process and its main outcomes.

4.1. Coding Process

This section explains how the empirical data were coded and organised to develop the data structure that supports the findings of this study. The coding process followed the Gioia Methodology, introduced in Chapter 3, supported by ATLAS.ti 25 for systematic data management. The process was iterative, moving back and forth between data and emerging insights, and consisted of three main stages: open coding, axial coding and selective coding. The data emerged from 16 semi-structured interviews, which were designed with insights from the theoretical framework. An overview of the coding workflow can be seen in Figure 4.1.

4.1.1. Open Coding

In the open coding stage, the interview transcripts were examined line by line to identify significant statements and patterns. Each relevant segment of text was assigned a descriptive first-order code, staying as close as possible to the participants' own language. This inductive approach was intended to ensure that early interpretations remained grounded in the data, avoiding bias and premature theoretical framing. Maintaining this openness is a key aspect of the Gioia Methodology (Gioia et al., 2013).

The first iteration of this process resulted in 1532 first order-concepts. This stage was revisited multiple times through an iterative process together with axial coding. Codes that overlapped or were similar in meaning were merged and redundant codes were removed (49 codes). These decisions were documented in a coding log and evolved into a refined set of 153 first-order concepts.

4.1.2. Axial Coding

In the axial coding stage, related first-order concepts were grouped into broader second-order themes that represented recurring ideas across participants. The purpose of this step was to start connecting the descriptive codes into more analytical categories that captured patterns across different interviews.

This involved comparing codes across transcripts, merging overlapping ideas, and writing short notes about emerging insights. Several rounds of iteration followed, during which over 60 preliminary code groups were created, renamed, and restructured until a final set of 29 second-order themes remained. The goal here was to find a balance between keeping the richness of the data and creating categories that were clear and coherent enough for further analysis.

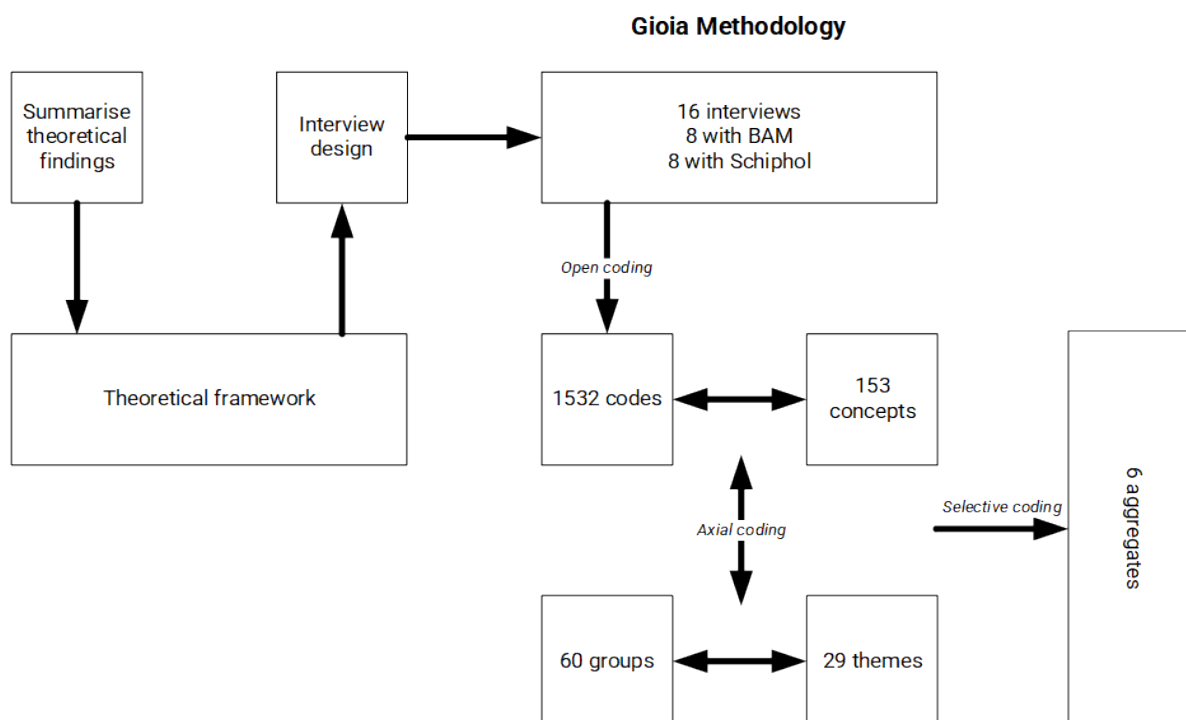


Figure 4.1: Coding workflow following the Gioia Methodology

4.1.3. Selective Coding

Finally, the second-order themes were further categorised into a smaller set of aggregate dimensions through selective coding. Selective coding involved a process of constant comparison. Themes were reviewed side-by-side to find similarities, overlaps or tensions. Empirical connections between themes were also explored through co-occurrence analysis in ATLAS.ti, which helped visualise which themes frequently appeared together in the data. This co-occurrence table can be found in Appendix C.

The naming of each aggregate dimension followed several iterations to ensure conceptual clarity and empirical fit. The process followed the principle of theoretical saturation, meaning that no new aggregate categories emerged in the final iteration. This resulted in the final data structure with 6 aggregates, which is presented and discussed in the following section.

4.2. Data Structure

The results of the three coding stages described earlier, resulted in the data structure in figure 4.2. For clarity, the figure shows a simplified version of the full data structure. Per aggregate dimension, the most representative second-order themes and illustrative first-order concepts were selected to demonstrate the analytical logic. The complete data structure, including all 153 first-order concepts and 29 themes, is provided in Appendix D.

4.2.1. Institutional Context

This dimension captures the formal, contractual and regulatory factors that both enable and constrain digitalisation within the Schiphol-BAM partnership. It groups themes related to contractual demands, compliance, finance and standardisation, all of which define the institutional boundaries of digitalisation practices. The full list of second-order themes from the complete data structure is as follows:

- Contract and Compliance Dynamics
- External and Sectoral Context
- Financial Conditions for Digitalisation
- Requirements and Standardisation

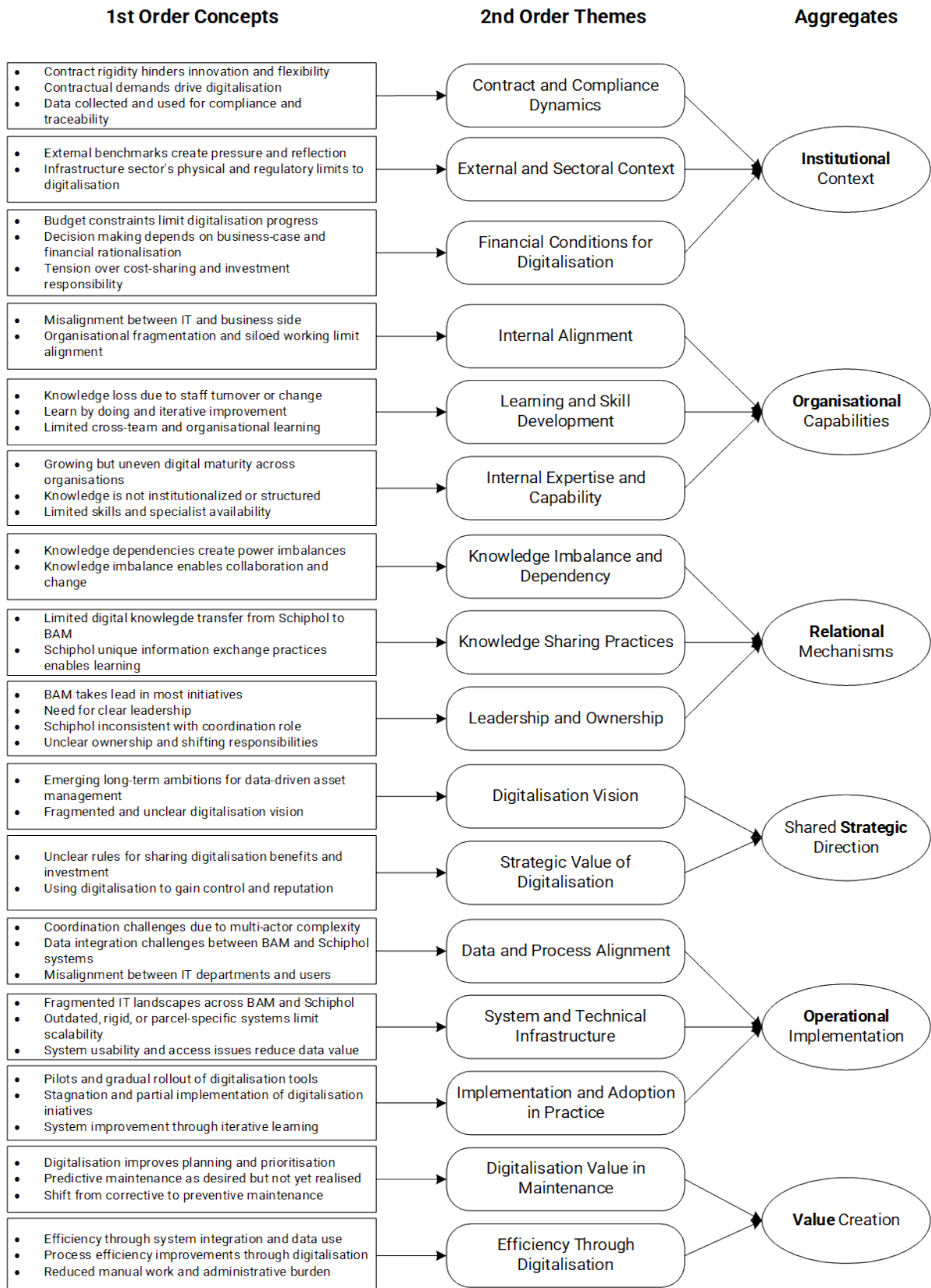


Figure 4.2: Extraction of data structure derived from empirics

4.2.2. Organisational Capabilities

This aggregate dimension encompasses the internal conditions that shape how both organisations develop their digitalisation initiatives. It reflects internal alignment, the development and availability of expertise and the influence of organisational mindset on digitalisation capabilities. The full data structure includes the following themes:

- Internal Alignment
- Internal Expertise and Capability
- Learning and Skill Development
- Organisational Mindset and Culture

4.2.3. Relational Mechanisms

The next aggregate dimension described how relational factors between the client and contractor, originating from their partnership, shape their collaboration and digitalisation progress. It reflects how power asymmetries affect digitalisation, as well as leadership and role divisions, relationship quality and mechanisms that are in place to improve the collaboration. The full list of themes under this aggregate, according to the complete data structure is as follows:

- Collaboration Barriers and Tensions
- Collaboration Practices and Mechanisms
- External Expertise and Partners
- Knowledge Imbalance and Dependency
- Knowledge Sharing Practices
- Leadership and Ownership
- Roles and Responsibilities in Collaboration
- Trust and Relationship Quality

4.2.4. Shared Strategic Direction

The aggregate dimension Shared Strategic Direction captures how there is a current unclear or fragmented digitalisation vision, and how goals are defined, communicated, and operationalised, as well as the factors preventing these ambitions from translating into value. The full data structure includes the following themes:

- Digitalisation vision
- Interpretations of Digitalisation
- Strategic Alignment
- Strategic Value of Digitalisation

4.2.5. Operational Implementation

The aggregate dimension Operational Implementation represents the practical translation of digitalisation initiatives into day-to-day processes, systems, and routines. It captures how digitalisation tools and standards are embedded, or where they fail to be embedded within the operations of the Schiphol-BAM partnership. The full data structure includes the themes:

- Change and Adoption Barriers
- Change Enablers and Triggers
- Data and Process Alignment
- Implementation and Adoption in Practice
- System and Technical Infrastructure

4.2.6. Value Creation

The last aggregate dimension reflects how digitalisation efforts within the Schiphol-BAM partnership contribute to improved decision-making, maintenance efficiency, and lifecycle value, and where this potential remains unrealised. The following themes are reflected in the full data structure:

- Decision-making and Transparency
- Digitalisation Value in Maintenance
- Efficiency Through Digitalisation
- Unused Potential of Digitalisation

4.3. Relational Analysis

Building on the data structure presented in the previous section, this part of the analysis examines how the six aggregate dimensions interact to shape digitalisation within the Schiphol-BAM partnership. While the data structure captures *what* factors are present, the relational analysis explores *how* these factors influence one another across organisational and inter-organisational levels. This analytical step follows the Gioia Methodology's focus on recognising emergent relationships that explain the research focus.

4.3.1. Identifying Relationships Between Themes

To identify these mechanisms, all first order concepts and second order themes were systematically compared using ATLAS.ti's co-occurrence analysis (Appendix C) and coding memos. Through iterative comparison of overlapping codes and supporting quotations, 57 empirically grounded relationships between second order themes were identified. These relations are visually mapped against each other in Appendix E. Each relationship was checked against interview quotations and triangulated with internal Schiphol and BAM documents to ensure consistency and empirical validity, which are narratively discussed in Chapter 5.

4.3.2. Clustering Relationships into Propositions

Next, the 57 relationships were examined for conceptual similarity and were clustered into groups that reflected shared underlying mechanisms, based on the aggregate dimensions. Rather than translating each aggregate dimension one-to-one into a proposition, the clustering process aimed to identify patterns of relationships that consistently recurred across the relationships. Some relationships with low co-occurrence frequency or that did not contribute to a broader pattern were disregarded during this stage.

This process resulted in five empirical mechanisms, each cutting across multiple second-order themes. Importantly, not every aggregate dimension from the data structure became a separate mechanism. For instance, Value Creation appeared consistently as an outcome of digitalisation, rather than as a mechanism shaping it. It is therefore positioned as the final result of the propositions rather than a standalone aggregate forming a proposition.

4.3.3. Linking Aggregate Dimensions to Propositions

To clarify how the aggregates and propositions relate, Figure 4.3 visualises the analytical connections. Each proposition corresponds to the aggregate dimension in the following way:

Institutional Context: P1 and P2

Themes under *Institutional Context* formed two mechanisms: contractual and compliance dynamics shaping digitalisation (P1), and financial arrangements and investment logic influencing progress (P2). Both mechanisms feed into Operational Implementation, where their influence becomes visible.

Although both mechanisms originate from the same aggregate dimension, financial conditions emerged in the data as a distinct and frequently recurring topic. Interviewees consistently emphasised budgeting logic, investment responsibility, and cost-sharing tensions as critical influences on digitalisation. These financial dynamics were empirically strong enough to account for a separate mechanism rather than being treated as a part of the institutional context. For this reason, the financial aspects were captured as a stand-alone proposition (P2).

Organisational Capabilities: P3

Internal alignment, expertise, and learning repeatedly emerged as critical enablers or constraints, forming the basis for P3. These organisational capabilities materialise through day-to-day implementation, explaining the direct connection to Operational Implementation.

Relational Mechanisms: P4

Trust, collaboration routines, communication clarity, and knowledge asymmetries informed P4. These dynamics shape how stakeholders coordinate digitalisation operationally, hence the link to Operational Implementation.

Shared Strategic Direction: P5

Misaligned visions, unclear leadership, and a lack of strategic coherence informed P5. Across interviews, participants consistently described how the absence of a unified direction limited the ability to prioritise digitalisation initiatives and allocate resources for them. Strategic direction therefore emerged as a distinct mechanism shaping what becomes prioritised, coordinated, and reinforced in Operational Implementation.

Across all relationships between the codes, *Operational Implementation* emerged as the aggregate where all mechanisms become visible, as it refers to where digitalisation actually leads to day-to-day implementation. Because of this, each proposition connects back to *Operational Implementation*: it is the empirical space where the mechanisms play out, and where their consequences are observed.

Finally, all five propositions link to *Value Creation*. The interviews showed that value creation, through efficiency, insight, higher data quality, more transparency or reduced risk, did not function as a separate mechanism. Instead, value is the combined result of how the five mechanisms interact with each other in practice. This follows directly from what was observed in the partnership:

Institutional, financial, organisational, relational and strategic conditions shape how digitalisation is implemented in practice, and this implementation ultimately determines whether shared value is realised.

In the next chapter, Chapter 5, each proposition is presented in detail and supported with interview quotations and triangulation from the document analysis.

4.4. Focus Group

As mentioned in the methodology, the focus group was designed to assess the practical applicability of the propositions derived from the data, and make refinements to the propositions and/or grounded model. The focus group design and sampling is described in Chapter 3. During the focus group, participants were asked to reflect on the accuracy of each proposition based on their experience, discuss whether anything was missing or incorrectly formulated, and indicate their level of agreement through a simple voting system (agree, partly agree, disagree). Appendix F includes the posters that were used to cast votes. The results of the focus group will be discussed and synthesised with the propositions in Chapter 5.

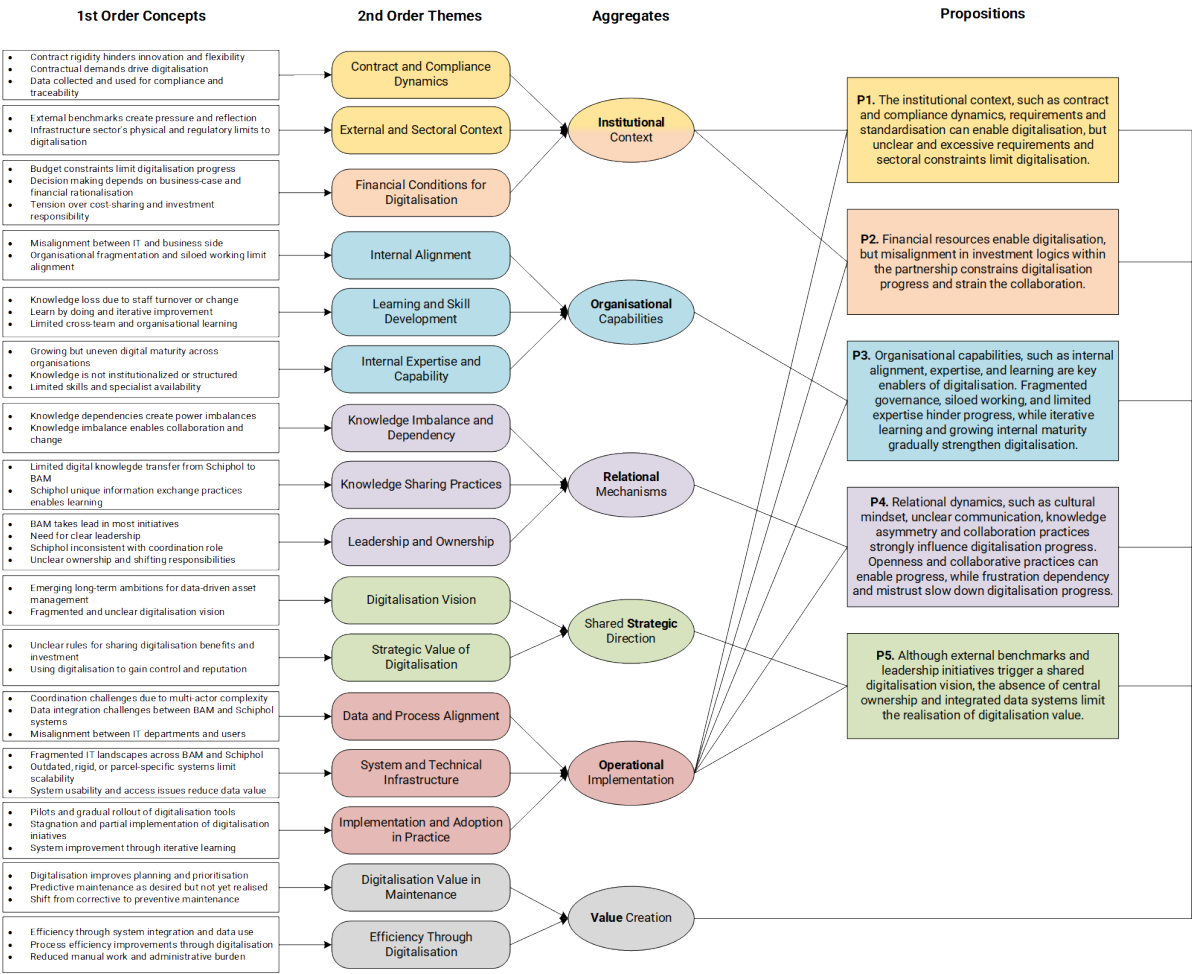


Figure 4.3: Relationships between aggregate dimensions and propositions

5

Results

This chapter presents the five propositions resulting from the empirical research and analysis as described in the previous chapter. These five propositions form the basis of the grounded theory model and will be synthesized with theoretical findings in Chapter 6, to answer the (main) research questions. These five propositions describe how digitalisation unfolds in the Schiphol-BAM partnership, and were clustered based on the data structure, and analysed on co-concurrences and triangulation, as described in Chapter 4.

These propositions constitute the foundation of the grounded theory model and will later be synthesised with theoretical insights in Chapter 6 to answer the (main) research question. The propositions were also discussed and validated through a focus group, which will be discussed in this chapter as well.

5.1. Empirical Propositions

Each proposition explains a mechanism through which digitalisation unfolds in the Schiphol-BAM partnership. The propositions were developed through clustering based on the data structure and were supported by analyses of code co-occurrences, frequency patterns, and document triangulation.

5.1.1. Proposition 1: Institutional Context

The first proposition derived from the data is based on how factors from the *Institutional Context*, such as contracts, requirements and standardisation simultaneously drive and constrain digitalisation.

Contract as a digitalisation trigger

Respondents from BAM explained in the interviews that digitalisation originated from the contract, quite literally BAM 02 stated:

"Digitalisation came from the contract, which stated that everything had to be made digitally available."

The MC2019 and their appendices do stipulate digitalisation and information exchange requirements. For instance, they require BIM models and automated data exchange between the contractor and client to ensure quality in data delivery (Schiphol Nederland B.V., 2018a). The tender invitation document also stated the vision to become "The most digital airport" and their contractor to jointly commit to this goal (Schiphol Nederland B.V., 2018b). This confirms the respondent's perception that digitalisation was contractually mandated.

Also, in a more indirect way, the contract states asset management responsibilities, such as maintenance, inspections and fault handling must be complied for (BAM Infra B.V., 2025a; Schiphol Nederland B.V. & BAM Infra B.V., 2019). Digitalisation enables systematic and demonstrable proof that contractual requirements are being complied, through integrated maintenance systems as well as data exchanges through the IT landscape (BAM Infra B.V., 2025b). BAM 07 noted the following about this:

"If we do not do it, we have no demonstrable proof that we are fulfilling the contract properly; then we are not paid and we have major problems."

BAM 01, BAM 02, BAM 04, BAM 05 and BAM 08 share the view that the contract did trigger them to digitalise, with the development of their DDH (Digital Data Hub) for example, which makes the transfer and integration of data possible towards their client's systems (BAM Infra B.V., 2025b). However, while the contract successfully initiated digitalisation in the first place, it also imposed rigidities that limit the further development of digitalisation.

Contract rigidity limits innovation for the client and contractor

The MC2019 contract and its appendices state that *"contractors should play an important role in identifying and implementing new technologies"* (Schiphol Nederland B.V., 2017), and the performance contract is based around enabling their contractors to innovate. In practice, however, this seems to go a bit differently, as the perception of respondents is that innovation often stalls.

BAM 03, BAM 04 and BAM 06 stated that a lot of resources go to the current information landscape, the constant transfer of asset data and small changes to requirements and characteristics in the system. This results in limited resources left for new innovations, as these contractually required processes are prioritised by Schiphol. BAM 06 stated the following about this:

"There were hardly any new ideas in my view. It was mainly about shaping the ideas we had already included in the tender."

And when there are proposals for something innovative, it often stalls because of Schiphol. BAM 07 said the following about this:

But as soon as it goes beyond the project or gives an answer to a question Schiphol has not yet asked, it stalls.

SCHIPHOL 02 agreed with the fact that Schiphol lacks the digital maturity to clearly define what is needed, making it difficult for BAM to innovate. Moreover, respondents from Schiphol noted that performance-based contracts reduce incentives to innovate, SCHIPHOL 06 noted:

As far as I understand, under this contract BAM is paid based on performance. And it's up to them to do that efficiently. If they improve efficiency, they benefit. But that gain can also be reinvested, because it frees up capacity. So indirectly, that's also a gain for us. I think in the next contract, this will be addressed more explicitly. In our new cleaning contract, we've included more explicit clauses stating that such improvements should benefit both parties.

The performance contract's unintended rigidity does not only affect the contractor. It also minimizes curiosity to learn and innovate as a client, SCHIPHOL 06 also stated:

"In general: if you put everything in a performance contract, then you only need to know the performance itself. If you outsource all the work behind it too, there's no need to have insight."

Thus, the existing performance-based contract in the partnership, while intended to foster innovation at both BAM and Schiphol, actually discourages exploration and innovation for both parties involved.

Standardisation and definitions can enable or constraint digitalisation

There are several notes that excessive or unclear standards hinder efficiency. The MC2019 contract was designed in a way to purposefully not set any requirements on specific maintenance or data management system use (Schiphol Nederland B.V., 2018a; Schiphol Nederland B.V. & BAM Infra B.V., 2019). In practice this has led to decreased efficiency and issues with data ownership. SCHIPHOL 08 noted:

"Yes, that is the difficult part of this contract. Research has also been done on that. All data is now generated by the MC, prepared, and then sent to Schiphol. The problem is that it is created in MC software. Does that work in our software? Sometimes not. Then your data is complete, but ours is not. That is why there really needs to be improvement in the next MC. Software and systems must first be aligned. Schiphol must decide: everyone works with system A. And the data must come from Schiphol, not from the MC."

However, too many requirements causes rigidity, so there is an important balance that needs to be made to be able to remain in line with the market as well and encourage innovation. But requirements exist to standardise and increase efficiency and make sure both parties speak the same language. At the beginning of the contract Schiphol asked for too much for example, which is simply not efficient. SCHIPHOL 07, stated:

"At the start of MC 2019 the question was asked: we want all digital information back, both specific and generic characteristics. That is an enormous amount. But is all of that necessary to perform maintenance, to give advice, or to carry out analyses? I think you can scrap more than half, because it does not contribute to what we want."

SCHIPHOL 05, SCHIPHOL 08 and BAM 06 agree that it is inefficient to be asking for so much data, not in line with what is required to do maintenance. But at the same time you need to be future-proof as well, as SCHIPHOL 03 stated:

"We also want to work towards 4D. Record everything, document everything, and include that in the correct templates in the contracts. We really need to be sharp on that. If you deliver something that doesn't follow the agreement, then all the work we've done beforehand is worthless."

There is thus a balance needed between future proofing and not asking too much data from the contractor, since it increases the work load without perceived value.

Sectoral limitations constraint digitalisation even when digitalisation is contractually required. Given Schiphol's characteristics, political and compliance regulations frequently influence the environment, potentially restricting innovation, such as the use of drones, for instance. Furthermore, Schiphol encompasses a large area with numerous assets that are highly dynamic and constantly changing, making digitalization crucial. According to BAM 08:

"Especially because Schiphol is very dynamic. This month something is there, and next month a street is gone or a building has been added. A lot can change in three months. And [digitalisation] helps to know which assets must be inspected and checked."

However, the nature of Parcel 3, the scope of BAM Infra, makes it difficult to innovate on digitalisation, compared to other sectors. A lot of respondents stated that it is difficult to innovate on digitalisation because of the infrastructure's sectoral limitations. SCHIPHOL 08, BAM 04 and BAM 08 stated that with static assets such as Parcel 3's, there is not much added value to BIM in maintenance for example, unlike the terminal parcels where there is much more to monitor. BAM 08:

"Often you notice a terminal mindset at Schiphol. There you have multiple floors, a 3D situation where everything is in scope and must work. As main contractor for the infra outside, 2D is often more than enough. Yes, we have a structure or a tunnel that has another layer, but in principle we have cables, lamps... there 2D is sufficient for management and maintenance."

Proposition formulation

Overall, the institutional context defines both enablers and constraints for digitalisation. By formulating requirements within contracts, the development of digital systems can be triggered, and open doors for future innovation. However, requirements within the contract can also cause inefficiency and rigidity, limiting innovation in digitalisation. Moreover, the nature of the scope of the project makes digitalisation essential, while it can also limit digitalisation due to sectoral and political limitations and regulations.

Proposition 1: The institutional context, such as contract and compliance dynamics, requirements and standardisation can enable digitalisation, but unclear and excessive requirements and sectoral constraints limit digitalisation.

5.1.2. Proposition 2: Financial Alignment

The second propositions is based on how budget enables digitalisation and the influences of partnership dynamics on this. Lack of budget and different opinions on cost-sharing or lack of financial alignment can constrain digitalisation.

Budget as an enabler

Both BAM and Schiphol emphasise that digitalisation requires upfront investment into data quality before any innovation benefits can be realised. The availability of sufficient budget is therefore seen as a prerequisite for "getting the data in order." As SCHIPHOL 02 explained:

"That data is still not in order. And after that budget plays a big role. It is simply expensive to get data in order. You pump a lot of money into it and do not see immediate results. Data is important, but it remains an expensive hobby, because it is human work"

Digitalisation is thus perceived as a costly and long-term process, where value is not immediately visible. . BAM 02, BAM 06, BAM 07, SCHIPHOL 03, SCHIPHOL 07 and SCHIPHOL 08 all confirmed that financial resources determine whether progress can be made at all. As BAM 02 put it:

"That is also related to budget, but once that is there, we can make big progress."

Cost-sharing tensions

However, while both parties recognise the need for sufficient financial resources, they approach digitalisation investments differently. For BAM, these investments are mainly seen as a way to improve operational efficiency within the duration of the contract. Schiphol, on the other hand, views digitalisation as a long-term strategic effort whose benefits go beyond the nine-year contract period. This difference in investment mindset, strengthened by the performance-based nature of the contract, causes tension about who should carry the initial costs and who eventually benefits from the results. BAM 07 explained this well with the following quotation:

"Yes, because we want the client to co-invest. Our contracts do not allow us to just invest one million of our own money. Then the projects show red figures and we never earn it back. There has to be a sound business case. Often there is one, but it only becomes profitable after the end of the contract. For the client that is very valuable, because they benefit for fifty years. For us maybe three or five years, because then the contract is over. The added value must therefore be seen beyond the duration of the contract. That makes it difficult for BAM to make financial choices."

BAM 02, BAM 05 and BAM 06 agree on this. They do not see a fair distribution in cost sharing when it comes to innovations, as Schiphol is largely profiting off of this. SCHIPHOL 07 however argued otherwise:

"The contract offers optimizations. BAM can invest itself and align a payback model with Schiphol. That is all possible. Then a revenue model arises and we pay it back monthly. Also with adjustments in maintenance regimes a compensation scheme can come so that income does not disappear. Everything is arranged in such a way that the optimal can be achieved in asset management."

SCHIPHOL 05 mentioned something similarly, and the MC2019 contract confirms that there is such a payback model in place (Schiphol Nederland B.V. & BAM Infra B.V., 2019). The respondents' perceptions however show that in practice the existing payback model does not seem to be sufficient at avoiding cost-sharing tensions. SCHIPHOL 06 even agreed with BAM that there needs to be clearer definitions on cost-sharing in the new contract for the next tender.

Proposition formulation

In sum, financial resources enable digitalisation, but the allocation of budget and cost-sharing mechanisms on investments can create friction in long term partnerships. While the contract does allow for payback models and compensation schemes, their practical implementation seems limited according to interviewee's perceptions. These tensions not only slow down digitalisation progress, but also strain the trust and collaboration in the partnership.

Proposition 2: Financial resources enable digitalisation, but misalignment in investment logics within the partnership constrains digitalisation progress and strain the collaboration.

5.1.3. Proposition 3: Organisational Capabilities

The next proposition is based on how factors from *Organisational Capabilities*, such as internal alignment and expertise are required to progress with digitalisation, how and certain factors constrain how digitalisation in the partnership currently progresses.

Fragmented governance

Several respondents have emphasized that unclear governance and siloed working structures limit the alignment between and within organisations, consequently slowing down progress in digitalisation. BAM 05 noted:

"An important learning point is that in a large and complex environment like this project, if you want to be successful in the digital domain, you need to understand the shared governance well and set up the right things for it. So it is perhaps not really a digital learning from each other, but more an organizational learning from each other."

What this indicates is that organisations are often not familiar with each others roles and responsibilities. BAM 07 and SCHIPHOL 01 agreed with this. This makes it difficult to collaborate, since there is no clear contact points within the organisation, and it is not always clear who is working on what. This misalignment is also very eminent within the organisations. Both organisation for example note misalignment within their IT and business departments. BAM 05 said the following about this:

"What was difficult, and I think partly still is, is that it was not all centrally managed. Maximo was with what was then Infra SM Management, now Technology and SM; GIS with Infraconsult; SharePoint centrally at the head office. There were different teams. Over the years that improved with joint scrum teams and PI planning, where each quarter we looked at which epics were running and where the connections were. That got better, but it never really became one whole, it was too big and complex both within Schiphol and within BAM."

But also more generally across the organisation, internal communication and coordination challenges are present, causing siloed working and internal misalignment. This is mostly noted by respondents from Schiphol themselves, but also many BAM respondents noticed organisational fragmentation within Schiphol. BAM 08 stated the following possible explanation for this:

"Maybe Schiphol is simply too big. We as parcel 3 are a large project, but we do communicate with each other, we know who sits where and who we must approach. At Schiphol it is more complicated, I think."

Expertise shortage

Overall, both BAM and Schiphol employees agree that most expertise lies within BAM, naturally following from their contractual responsibilities (Schiphol Nederland B.V., 2018b; Schiphol Nederland B.V. & BAM Infra B.V., 2019). However, a shortage on qualified specialists seems to be a sector wide issue that slows down progress in digitalisation. BAM 04 noticed this with regard to (lack of) innovation on the IT department of BAM:

"Scaling that up within BAM proved difficult. We sometimes lack specialists who can map assets properly, and on the IT side we can't set it up or scale it fast enough."

At Schiphol, similar challenges are recognised. The organisation's digital ambitions often exceed the level of in-house expertise, SCHIPHOL 06 reasoned:

"It's just not sufficient right now. It's not that it doesn't exist at all, but if we want to take an active role, and we do, then we need the right level of knowledge and skills."

So both BAM and Schiphol recognise this gap, which is also enlarged by a lack of knowledge institutionalisation due to staff turnover. BAM 07 noted the following about this:

"Then you are vulnerable; knowledge is only in people's heads. That is a known problem in asset management: it goes fine until people leave, and then a lot of knowledge and justification for choices disappears."

This creates a dependency on individual expertise instead of organisational learning, making digitalisation fragile. Knowledge leaves the organisation as employees leave, resulting in repeated learning cycles and limited progress in digitalisation.

Learning by doing

Despite these challenges, several respondents noted that learning-by-doing contributes to progress, and has done so in the past with new digital ways of working that came up. BAM 02 describes how him and his team have started working more digitally at the start of the contract, despite the lack of experience, by just experimenting with it:

"In my role as [...], I had not dealt with that before. But when we started cleaning up the lists, I saw how much more was involved. That also has to do with age; I had never worked with it, never learned it. You need to experience it to understand it."

Despite generational differences, mentioned by BAM 02 and BAM 03, this hands-on-approach contributes to developing a more digital mindset over time. Within the partnership, user-driven experimentation is how digital innovation frequently arises, especially in the more operational and tactical processes. As SCHIPHOL 06 described:

"The advantage is that they are very closely involved in its development. This dashboard is being developed very practically. So the person who needs to use it is also actively involved in building it. That means there's little need for separate training."

This bottom-up learning-by-doing method helps bridge the expertise and digital maturity gap as defined earlier. It does however not replace structured knowledge development or structured innovation.

Proposition formulation

Overall, the findings indicate that digitalisation depends on organisational capabilities, such as internal alignment, expertise and learning. Fragmented governance cause siloed working and unclear communication, which slows down digitalisation progress. As well as with lack of expertise and knowledge loss due to staff turnover. Yet, iterative learning and bottom-up initiatives causes the organisations to grow in maturity and improve their capabilities in digitalisation.

Proposition 3: Organisational capabilities, such as internal alignment, expertise, and learning are key enablers of digitalisation. Fragmented governance, siloed working, and limited expertise hinder progress, while iterative learning and growing internal maturity gradually strengthen digitalisation.

5.1.4. Proposition 4: Relational Dynamics

This proposition is based on how relational dynamics, such as power asymmetries and mindset gaps shape collaboration between BAM and Schiphol. Although both parties generally describe their relationship in a positive manner, the data reveals that tensions in culture, communication and expertise can either enable or constrain digitalization progress.

Cultural and mindset gap

In terms of cultural mindset, most respondents agreed that BAM is generally more digitally mature than Schiphol. At the same time, however, both parties acknowledged that BAM still often operates with the mindset of a traditional contractor. As BAM 07 reflected:

"But ultimately we always work within a project. If the client says: 'that lock just needs to open and close, figure it out,' then we are reluctant to invest heavily ourselves. We want to do this together with the client. If they do not see the added value, it becomes difficult. That is why we still work quite traditionally in many contracts."

Several respondents emphasised that BAM needs to develop a stronger data-driven mindset to remain competitive in the long term. SCHIPHOL 04 stressed that this mindset should not be limited to one client relationship:

"But I also think it should be broader than just Schiphol. If you develop a data-driven mindset for one client only, that's not enough. It would be good if BAM, especially if they want to do more in asset management, develops that mindset throughout the company."

Yet, the challenge of adopting a data-driven culture is not limited to BAM. At Schiphol, several respondents described how they struggle to have a data-driven mindset, and that many employees just simply do not know how to take data-driven decision themselves. As SCHIPHOL 06 explained:

"In asset management, you notice there's still a lot of uncertainty about what to do with data, partly because in 2019 all maintenance was outsourced into performance contracts. People in the organization then think: I'll just look at the contractor's report, why would I need my own picture of performance?"

Both parties thus recognise that digitalisation requires a cultural shift from compliance and comfort toward curiosity and shared learning. BAM 01, BAM 03, BAM 06 and BAM 07 highlighted the importance of curiosity and leadership engagement on the client side, which they see as essential for joint digitalisation progress. Intrinsic motivation and enthusiasm also emerged as key enablers. As SCHIPHOL 06 noted:

"If you introduce something people haven't asked for, it simply won't work. But if there's a real need, a curiosity, then you get the kind of engagement needed to make good decisions or choose the right tools, whatever the solution might be"

So for the right digital tools to be introduced, the motivation needs to come from employees, it needs to solve real-life problems. This is however where the existing cultural resistance and comfort with established routines comes up. As mentioned, Schiphol employees do not possess the right data driven mindset everywhere yet, but also BAM employees such as BAM 03 stated:

"Our system runs quite smoothly. So we kind of think: why change a winning team?"

Overall, both parties do recognise the need for a more data-driven culture, but the persistent traditional mindset and limited curiosity among employees restricts progress in digitalisation. Digitalisation can only succeed when employees show intrinsic motivation, not when change is imposed top-down.

Frustrations and deadlocks

Majority of the respondents are greatly positive about the overall collaboration, as stated in the interviews and company vendor ratings (BAM Infra B.V. & Royal Schiphol Group, 2025), SCHIPHOL 08 for example stated:

"It is good to emphasize that the cooperation is really very good. We also hear that back in audits. A few years ago we had an audit. The auditor also did audits at municipalities and other clients and literally said: 'I have never seen this before, this good.'"

However, a positive cooperation does not mean that miscommunications and frustrations do not exist in the partnership. BAM 05 and BAM 07 mentioned that a lack of clear direction from Schiphol is mostly what has caused tensions in the partnership. BAM 07 mentioned:

"Schiphol was disappointed that we did not take the steps they hoped for, while we indicated: but we also do not know exactly what you want. So we kept each other in a kind of deadlock. Schiphol was not clear, but still disappointed. I find that difficult."

These circular discussions and standstills delays progress in digitalisation and causes frustrations in the partnership. Instances are mentioned of "discussions that do not contribute to the shared goal" putting people on the wrong side of the spectrum of collaboration. More mentions of unclear or insufficient communication, unrealistic expectations and frustration over slow progress have a negative impact on the quality of the collaboration, as noted by BAM 02, BAM 03, BAM 04, BAM 06, BAM 07, BAM 08, SCHIPHOL 02, SCHIPHOL 03, SCHIPHOL 04, SCHIPHOL 05 and SCHIPHOL 07.

Knowledge asymmetry

Another source of frustration seems to be the knowledge asymmetry that is persistent in the partnership. As mentioned before, BAM generally possesses higher digital maturity, which shapes the power dynamic of the partnership, creating mixed effects. On one hand, BAM's expertise supports Schiphol's progress (as intended by the contract type, (Schiphol Nederland B.V., 2018b; Schiphol Nederland B.V. & BAM Infra B.V., 2019)), on the other hand it can create dependency and mistrust. BAM 01 described the following:

"From BAM's perspective, we say: we've got it under control. But if you talk to Schiphol's technical experts, they'll say: 'We don't know where your data is, we don't know what you're doing'"

This aligns with what SCHIPHOL 06 earlier described: many SCHIPHOL employees do not know how and where to access the data, BAM 02 also noticed this and noted how the problem lies with Schiphol's internal accessibility:

"On the Schiphol side, I now notice that the system is not in order. So if you want to know something, you have to go back to BAM. That takes time. So if the data is right on both sides, it saves time and frustration."

This knowledge asymmetry thus causes some mistrust and frustrations, and it hands the power to the contractor, while the client should be the one with the data ownership in hand. This could even have negative influences on the future tender possibilities, said SCHIPHOL 03. However, BAM's advancement could also serve as a positive driver, as it could enable collaboration, create openness and transparency, as noted by BAM 02 and SCHIPHOL 03. SCHIPHOL 07 also stated:

"They are further ahead, they see the advantages, they want it. Because of that we are also increasingly pressured to do it."

The knowledge asymmetry thus acts as a double-edged sword. It can accelerate innovation when it is paired with openness and transparency. But when information sharing is limited it can have a negative impact on trust in the partnership.

Collaborative learning

Besides openness and transparency, structured collaboration mechanisms help maintain trust and create alignment when tensions arise. Both organisations described how formal meetings, joint workshops and pilot projects act as spaces and ways to address misunderstandings and jointly work on solutions. Multiple respondents from both sides recognise this. Data requirement workshops and IM meetings, as also described in the MC2019 contract (Schiphol Nederland B.V., 2018a, 2022) have been especially helpful in the operational alignment and adjustment of processes. BAM 02 noted:

"Together we have achieved a lot. With the data transfers and adjustments within Schiphol's systems, big steps are being taken."

Mutual learning and experimentation help stabilise the partnership. Schiphol also recognised the central role of their partnership in influencing the other MC. SCHIPHOL 07 stated:

"Yes. We learn a lot from BAM. For example, the KPIs that have been developed come from parcel 3. A lot of work has been put into that, mainly by BAM. I have pushed for it too, but they the most. Those KPIs have now been implemented in all other MCs. So we have provided a lot of input towards Schiphol. That may sound strange, but that is how it is. And now everyone in all contracts has to work in that way."

Proposition formulation

Overall, the data indicate that relational dynamics greatly impact digitalisation outcomes in the partnership. Both organisations have a lack of digital mindset, which limits the employees to progress in digitalisation. Moreover, in the collaboration, when expectations remain unclear or communication is inconsistent, frustration and standstills arise that delay progress. At the same time, knowledge asymmetry gives BAM a leading role, which can have either negative or positive impacts on the partnership, depending on their level of openness and transparency. Collaborative practices also strengthen the partnership where trust may have weakened.

Proposition 4: Relational dynamics, such as cultural mindset, unclear communication, knowledge asymmetry and collaboration practices strongly influence digitalisation progress. Openness and collaborative practices can enable progress, while frustration dependency and mistrust slow down digitalisation progress.

5.1.5. Proposition 5: Strategic Alignment

The final proposition describes how external pressures and internal leadership efforts shape the digitalisation vision between Schiphol and BAM. While a shared ambition for ‘the most digital airport’ exists in principle, fragmented ownership and technical misalignment prevent full realisation of this digital ambition.

External pressures and benchmarking

Interviewees described how developments in the wider market create a sense of urgency and reflection. Both Schiphol and BAM benchmark themselves against frontrunners, such as Google Maps and Rijkswaterstaat, who are much further in value creation from data integration. SCHIPHOL 08 noted the following:

“Yes, we are almost at the next step: BIM 3D. That was not possible before, computers were not powerful enough. Soon with quantum technology, in about five years, we will be able to run all of Schiphol in 3D. That will bring many advantages for maintenance. [...] Then you really know what you have and you see roads in 3D, how they are constructed. That is what we are working towards now. But for that we have to wait for better computers. Rijkswaterstaat is also already making that step.”

Such examples from the sector stimulate both organisations to reassess their own vision and progress. BAM 07 similarly observed that the building sector is “moving slowly” and risks being overtaken by more agile players like Ikea Homes, underlining how market competition and innovation pressure act as triggers for reflection and alignment.

Need for clear leadership and ownership

Although a vague digitalisation goal is formally shared, of being the ‘most digital airport’, many interviewees highlighted recurring leadership gaps on the client side, making it difficult to set clear direction and maintain consistency across the parcels of Schiphol. SCHIPHOL 08 described how this lack of ownership led to fragmentation:

“Then you get everyone having their own opinion. So that did not work. You saw how dependent we were on the person who took the lead.”

This person-dependence was a recurring theme. Where someone took initiative, things moved forward; where they did not, collaboration stalled, often times because the person who was in the lead did not have a vision in head. Several respondents linked these struggles to a lack of mandate and hesitance to take firm decisions. SCHIPHOL 07 recalled a recent initiative that had not been getting mandated:

“And you are not really being steered on it. If you do something else, no one says anything. Now a bit more, because there is increasing control, but still it is optional.”

SCHIPHOL 04 built on this, and expressed that aside from clear leadership, a clear structure needs to be in place:

“People enjoy working on it, but that’s not enough. At a large organisation like Schiphol, if you want to collect data, you need a plan. A process, a timeline, a schedule.”

BAM interviewees also noted that the lack of direction from Schiphol often forced them to step into a leadership role themselves, for example by BAM 01 and BAM 08. BAM 08 also described that this could sometimes lead to coordination challenges, especially when differing opinions between BAM and other MC were presented. In contrast, when leadership is clearly defined, collaboration works more smoothly. BAM 06 recalled how this made a difference within BAM itself, when the contract just started:

“And as time went on you noticed that the IT organization within BAM also began to organize itself more professionally. For example a project manager was appointed from BAM Infra who represented both parcel three and parcel four. He knew his own organization well, could correct course, and especially kept people engaged with the shared goal. That was not tightly organized, but he managed it.”

This shows that good leadership is not just about structure, but also about attitude and decisiveness. As SCHIPHOL 07 put it:

"That is where maturity comes in: dare to say and demand things. It starts with attitude and behaviour."

Overall, both BAM and Schiphol recognise that progress in digitalisation depends on decisive leadership and clear direction. It is especially important Schiphol must remain in the lead as the asset owner. As SCHIPHOL 08 summarised:

"Exactly. It is important that Schiphol always remains in the lead. We are the client, you will be gone in three years. We must manage that data permanently."

Vision alignment and integration bottlenecks

Interviewees broadly agree that the strategic goals of Schiphol and BAM are aligned: the focus on efficiency, reliability and data-driven asset management. This alignment however remains superficial when technical and organisational systems fail to integrate. As SCHIPHOL 02 reflected:

"For example, if we expect to collaborate with our main contractor, how can it be that our systems don't communicate? If A doesn't talk to B, both sides can provide data, but there'll always be a bottleneck. That's what I mean. We're aligned on what we want, but the bottleneck lies in how the data is transferred."

This highlights a recurring frustration among both parties: strategic agreement does not automatically lead to operational compatibility. Many interviewees explain that despite shared ambitions, the lack of integrated systems, creates duplication and inefficiency. BAM 03 described this within BAM:

"But where we do see opportunities is in the communication between Maximo and GIS. Right now, we still have to log everything again in Maximo. In GIS we mark it as completed, and we have to do the same in Maximo. We have discussed this within the team. It would be easier if marking something as complete in GIS would automatically mark it complete in Maximo too."

These examples show how fragmented data flows compromise the shared digital vision. Employees on both sides want to work in a more connected way but lack the technical and procedural alignment to do so. Several respondents link this issue to the absence of a unified roadmap for digitalisation. While both organisations express similar ambitions, the integration of tools and processes still depends heavily on individual projects and personal initiatives. This means progress often occurs in isolated pilots rather than coordinated strategy. As SCHIPHOL 08 summarised:

Yes. For Schiphol it is important to know what we have. For BAM it is important to know what the client wants. The better you have the data in order for maintenance, the more value it also has for us as client. Good cooperation ensures that everything goes better. Data is part of that."

The potential value is therefore recognised by both parties, but the pathway to realising that value through system and process integration remains underdeveloped. While the vision of "data-driven asset management" provides a common narrative, the lack of interoperability between tools, unclear data ownership, and fragmented decision-making prevent the partnership from achieving the efficiency and transparency both aspire to.

Proposition formulation

In sum, external pressures and internal leadership efforts drive the formulation of a shared digitalisation vision between client and contractor. However, fragmented ownership structures and limited data integration hinder the realisation of its intended value.

Proposition 5: Although external benchmarks and leadership initiatives trigger a shared digitalisation vision, the absence of central ownership and integrated data systems limit the realisation of digitalisation value.

5.2. Focus Group Validation

The five propositions as stated above were discussed and validated in a focus group with participants from both Schiphol and BAM. The focus group consisted of three Schiphol and three BAM employees.

One of the Schiphol employees could not be present at the physical discussion and thus provided written input, which is synthesised into the validation results. The validation was done through a vote and discussion system, which is summarised in Table 5.1.

The following section will elaborate on the discussion of each proposition and suggest a reformulation if necessary. However, it is important to consider here that the proposition were derived empirically and therefore should only be changed if the focus group strongly disagrees with the proposed propositions, which turned out not to be the case. Therefore, extra emphasis will be suggested on certain conditions rather than definite reformulations.

Table 5.1: Summary of focus group validation results

Proposition	Nr. of participants that agree	Nr. of participants that <i>partially agree</i>	Nr. of participants that <i>disagree</i>
1. Institutional context	1	4	1
2. Financial Alignment	5	1	0
3. Organisational capabilities	6	0	0
4. Relational dynamics	4	2	0
5. Strategic Alignment	5	1	0

5.2.1. Proposition 1: Institutional Context

This proposition was mainly recognised by the focus group, but with a few important nuances. In total, one participant fully agreed, four partially agreed and one participant fully disagreed.

The participants did acknowledge that contractual and compliance requirements can indeed stimulate digitalisation, as they push both organisations to structure data and implement digital processes. SCHIPHOL 07 stated that such requirements create a "minimal digital foundation", on which innovation can be built. These effects are most positive when requirements are clear, feasible and functional, rather than prescribing specific tools or formats.

At the same time, several participants pointed out that in practice, the contract often turns from enabler to constraint due to over-specification, rigid procedures and conflicting standards. SCHIPHOL 03 stated the following about the data dictionary of Schiphol (DDS), which states the data requirements in the contract:

"DDS is a contractual obligation where everything has to be recorded, while in reality we cannot fully do it ourselves. That really gets in the way."

The group also discussed that compliance obligations (e.g. from the Omgevingswet) and contractual requirements are not always aligned, which causes inconsistency and inefficiency. SCHIPHOL 03 stated the following:

"We have a permit with the environmental authority and an agreement with BAM, but those are often not the same agreements because everything still sits in PDFs [...] there are major gaps there. You have no visibility of our specific regulatory conditions."

If this were to be better aligned, and digitally embedded in their systems, this could improve decision-making and collaboration.

Another recurring theme was that the contract itself is not the most decisive factor for digitalisation progress. Participants felt that the presence of a clear and consistent client vision and enforcement of one mattered more. BAM 07 stated the following:

"We are not a hard data company. We want to take steps, but to be successful on this theme we really need a clear vision from Schiphol. Now it feels like shooting with buckshot and hoping we hit something: our efforts evaporate a bit."

Several referred to sustainability and collaboration as examples of themes with a shared direction and measurable targets, elements that digitalisation still lacks. Without that direction, digital initiatives from BAM risk remaining fragmented.

Reflection

The proposition formulation is kept as is, but it should be emphasised that:

- The effect of contractual and compliance requirements depends strongly on how they are formulated and applied. Clear, goal oriented requirements tend to stimulate digitalisation, but rigid or unclear ones constrain it.
- Alignment between compliance obligations and contractual requirements is essential to prevent contradictions and inefficiencies.
- Consistent client vision and leadership are more important than contractual intentions when it comes to digitalisation progress.

5.2.2. Proposition 2: Financial Alignment

This proposition was strongly confirmed by the focus group, with five participants agreeing and one partly agreeing. Participants did recognise that dedicated financial investment is a prerequisite for digitalisation. At the same time, participants highlighted that different investment logics and return expectation between and within organisations often delay decision-making. The discussion showed how unclear or short-term return models prevent digitalisation initiatives being implemented. With the example of BIM, or 3D data being 'flattened' into 2D formats for maintenance, because the business case for maintenance in 3D is unclear, as BAM 09 stated:

"We simply don't know what the return is. Right now it delivers us nothing, so we flatten everything back to 2D."

SCHIPHOL 03 described this as a mindset problem rather than a technical one:

"Projects already give us a full 3D model, and yet we strip it down. The documents are there, but the mindset isn't."

The lack of a clear long-term business case further limits investment willingness. As one SCHIPHOL 03 put it:

"We don't have a clear vision for 3D. We need a vision, but also a business case. Without that, it's very hard to invest."

Several participants agreed that investments stall not because technology is unavailable, but because financial responsibility and returns are not aligned. SCHIPHOL 06:

"We have limited money for all ambitions, so the question becomes: where do we earn the most back?"

Moreover, the importance of a shared vision was again emphasised. When there is a shared vision on value creation and clear governance on it, investment decisions are accelerated and the discussions as mentioned above could be avoided.

Reflection

The proposition formulation is kept as is, but it should be emphasised that:

- The success of investment decisions depends on a shared vision on value creation

5.2.3. Proposition 3: Organisational capabilities

This proposition had a unanimous agreement. Participants consistently recognised that digitalisation is enabled or constrained by organisational factors, which is logical since it is the proposition most in line with what is already commonly discussed in literature.

A major issue raised was unclear governance. Participants described how the absence of defined ownership leads to parallel processes, redundant work and inconsistent updates. SCHIPHOL 03 explained:

"There is no name behind the DDS roles and contact points. Everyone is free to submit changes without approval."

Similarly, fragmented communication and decision-making between departments were seen as a structural barrier. As BAM 01 put it:

"At one moment we hear we must approve something, and from another line we hear it won't even be implemented. We don't know what to continue with."

Fragmentation within organisations was also emphasised. BAM 07 reflected on the different sub-division in BAM being fragmented:

"We have two IT teams doing almost the same work [...] but we haven't brought them together yet."

This was seen as a missed opportunity to consolidate expertise and accelerate digitalisation.

Another recurring theme was the importance of learning-by-doing. Participants argued that digitalisation progresses most when approached iteratively rather than as a one-off implementation. SCHIPHOL 03 stressed:

"Sometimes the gap is too big to fill in one go. You need small steps: start with clear ambitions and needs, and build from there."

Reflection

The proposition formulation is kept as is and no additional points need to be emphasised.

5.2.4. Proposition 4: Relational dynamics

This proposition was widely recognised by the focus group, with four participants fully agreeing and two partly agreeing. Participants agreed that open communication and transparency are key enablers of digitalisation.

The group also discussed the role of knowledge asymmetry. It was acknowledged that BAM often has more knowledge on the operational data, while Schiphol depends on BAM's input to fully understand the details on the data. This asymmetry can slow down digitalisation if access is limited or not well coordinated. However, participants also recognised that such asymmetry can be positive when expertise is shared openly and transparently. SCHIPHOL 03:

"A healthy asymmetry is when you learn from it and can do your work better."

Relational dynamics were further linked to the level of self-confidence and digital maturity within both organisations. Several participants expressed that both BAM and Schiphol are still maturing digitally, and that uncertainty sometimes leads to hesitation or overly cautious behaviour. BAM 07 described this openly:

"On this theme we are simply not that mature yet. It feels a bit like the lame leading the blind."

Reflection

The proposition formulation is kept as is, but it should be emphasised that:

- Lack of self-confidence and maturity is also what holds back in digitalisation and causes frustration in the progress. This needs to be acknowledged to create openness.

5.2.5. Proposition 5: Strategic Alignment

This proposition was strongly confirmed by the focus group, with five participants agreeing and one partly agreeing. Participants recognised that external benchmarks and upcoming tenders act as an important trigger for developing a (shared) digitalisation vision. SCHIPHOL 07: "that external pressure keeps the topic alive, it forces us to move."

At the same time, the translation of that vision into practice remains difficult. Participants described how unclear ownership and fragmented responsibilities make it unclear who decides, who sets priorities, and who safeguards consistency across departments or parcels. SCHIPHOL 06 explained:

"Who decides, and who ensures that the vision is embedded across the whole organisation? That's often unclear."

A recurring theme was the bottleneck of system and data integration. While participants agreed that the systems themselves are not necessarily outdated, the interfaces and data connections are insufficiently aligned. Interestingly, one participant argued that these integration issues are not the root cause but a symptom of deeper organisational challenges:

"If you truly want it, you can make systems work together. Integration problems are really a sign that ownership and priorities are not clear enough."

Others recognised this as well, linking it back to the broader question of digital maturity.

Reflection

The proposition formulation is kept as is, but it should be emphasised that:

- Integration issues are a symptom of weak ownership and unclear priorities.

6

Discussion

In this research, the first three sub-questions were addressed through the literature review, which resulted in a theoretical framework that also guided the design of the interviews. The fourth sub-question focuses on explaining which mechanisms shape how digitalisation unfolds in practice within the Schiphol-BAM partnership. The previous chapter identified these mechanisms and formulated five propositions based on the empirical data.

This chapter brings the empirical findings and the theoretical lens together. By synthesising the propositions with the literature and developing a grounded model, this chapter explains *how* digitalisation unfolds in this partnership and how the mechanisms interact. Finally, practical recommendations are presented by elaborating on each mechanism within the grounded model, ultimately answering the main research question.

6.1. Synthesis of Empirics and Theory

This study was guided by the concepts of absorptive capacity and strategic interdependence as proposed by Siachou et al. (2021). While this theoretical model offers a useful starting point, the empirical findings show that digitalisation in an IAM client-contractor partnership is shaped by additional practical mechanisms. These propositions extend the theory by clarifying how digitalisation unfolds in the practical case of Schiphol-BAM.

6.1.1. P1: Institutional Context

The antecedents and activation triggers described in the absorptive capacity literature were also visible in the Schiphol-BAM case. However, the empirical findings and focus group results show that among these antecedents, contractual requirements, compliance rules and sectoral standards played the most prominent role. These conditions define what knowledge must be acquired, but their effect depends strongly on how they are formulated. The focus group emphasised that clear, goal-oriented requirements stimulate learning, whereas rigid or unclear requirements, or inconsistencies between compliance obligations and contractual demands, create inefficiencies and slow down progress. This suggests that institutional conditions are the dominant PACAP antecedent in this partnership.

6.1.2. P2: Financial Alignment

The absorptive capacity literature identifies resource availability as important activation triggers for PACAP, because organisations can only acquire and assimilate new knowledge when the necessary financial means are in place. These triggers were also visible in the Schiphol-BAM case: digitalisation becomes possible only when budget is allocated for data systems, expertise, and new tools. However, the empirical findings also show that financial alignment plays a broader role than the theory suggests. Differences in investment logic, such as varying time horizons, value perceptions and cost-benefit considerations strain the collaboration. P2 therefore extends the theoretical lens by showing that financial alignment is not only a condition for PACAP, but also a prerequisite for strategic interdependence in

practice.

6.1.3. P3: Organisational Capabilities

The organisational capabilities described in P3 determine whether the knowledge triggered through PACAP can actually be transformed into routines, systems and daily practice. This corresponds directly to the RACAP dimension of absorptive capacity. Internal governance structures, expertise, and learning-by-doing processes shape the organisation's ability to convert newly acquired knowledge into practical application. The empirical findings show (and the focus group unanimously agreed) that fragmented governance, unclear ownership and siloed working patterns slow down this conversion process, while iterative, bottom-up learning gradually strengthens it. P3 therefore reinforces the RACAP mechanism by showing that in the IAM context, organisational maturity is essential for realising digitalisation outcomes.

6.1.4. P4: Relational Dynamics

P4 aligns closely with the strategic interdependence mechanisms described by Siachou et al. (2021). According to Siachou et al., long-term digitalisation is developed when strategic interdependence is symmetric, meaning both partners rely on each other in similar ways. In the Schiphol-BAM partnership, the empirical findings and focus group discussions show that this symmetry is not always present. Differences in expertise, confidence, and overall mindset create asymmetries. This influences how openly knowledge is shared, and can create frustration or hesitation. P4 therefore confirms the importance of interdependence, but shows that achieving symmetry in IAM partnerships can be challenging, especially when there are different responsibilities and levels of digital maturity.

6.1.5. P5: Strategic Alignment

Strategic Alignment does not appear explicitly in the framework by Siachou et al., but the empirical findings and focus group outcomes show that it plays an important role in how digitalisation unfolds in this partnership. While both organisations share a digitalisation ambition, this ambition is not always translated into clear priorities, ownership or coherent system decisions. As a result, progress made through ACAP and strategic interdependence does not always lead to consistent outcomes. P5 therefore highlights a missing element in the theoretical model: the need for a layer that aligns strategic direction with day-to-day decisions. Without this alignment, the mechanisms identified in P1-P4 may be present, but their impact on digitalisation remains uneven.

6.2. Grounded Model

Figure 6.1 presents the grounded model that brings together the five empirical mechanisms and the main theory from Siachou et al. (2021). The model shows how digitalisation unfolds within the Schiphol-BAM partnership by integrating the propositions, aggregate dimensions and theory. Together these mechanisms explain why digitalisation struggles to progress and why value creation does not always follow from ongoing efforts.

6.2.1. Boundary Conditions: P1 and P2

The left side of the model shows P1 and P2 as the boundary conditions shaping the starting point for digitalisation. Contractual requirements, compliance obligations and sector standards determine what data must be delivered and triggers change. Financial resources and investment logic determine what is feasible, which tools can be adopted, and which initiatives are prioritised. These two mechanisms jointly influence potential absorptive capacity (PACAP) by shaping what knowledge is recognised, acquired and assimilated. P2 also influences strategic interdependence, as differences in investment logic affect how easily both organisations can move forward together on digitalisation initiatives.

6.2.2. ACAP and Strategic Interdependence

Absorptive capacity (ACAP) and strategic interdependence are the two core theoretical mechanisms underlying the grounded model. Together, they describe how organisations learn, apply knowledge, and rely on each other during digitalisation processes.

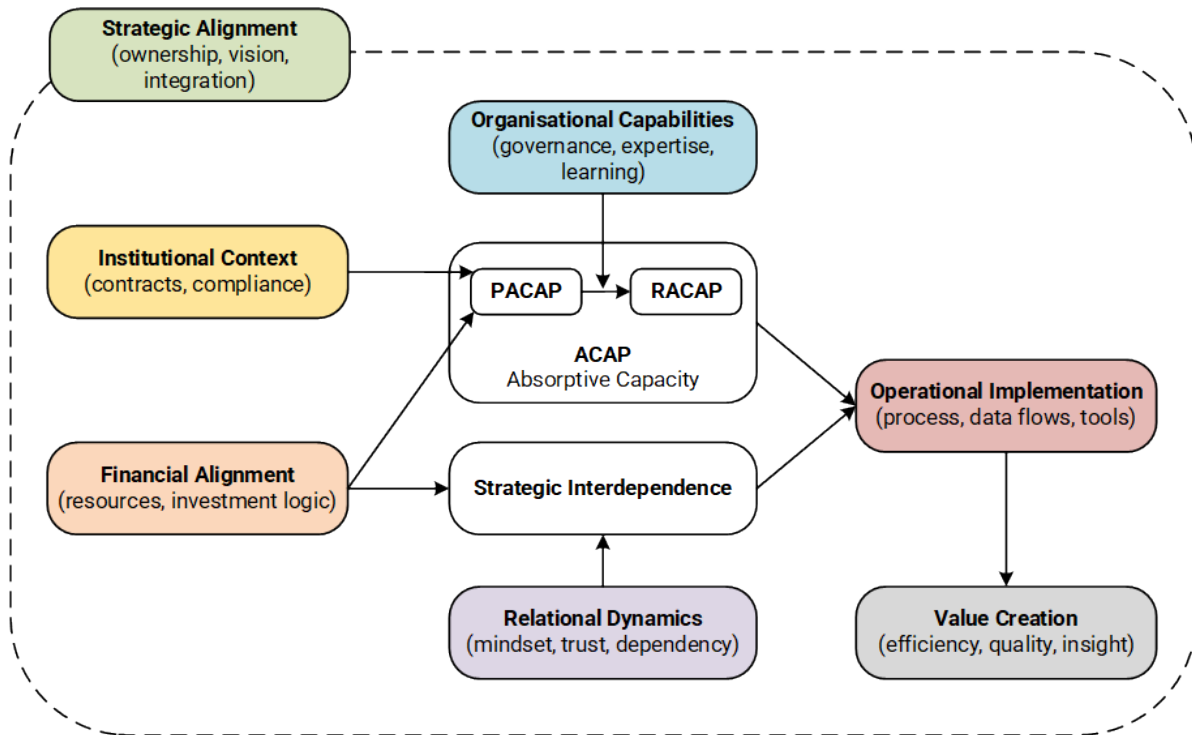


Figure 6.1: Grounded model explaining how digitalisation unfolds within the Schiphol-BAM partnership

Absorptive Capacity

Following Zahra and George (2002), ACAP consists of two stages:

- 1. Potential Absorptive Capacity (PACAP)**

Refers to the ability to recognise external knowledge, acquire it, and assimilate it. It focuses on identifying what new information is relevant and understanding how it can be taken up within the organisation.

- 2. Realised Absorptive Capacity (RACAP)**

Concerns the ability to transform and apply that knowledge in practice. This involves translating insights into routines, processes, systems and concrete actions.

Digitalisation relies on both stages: organisations must first recognise and make sense of new digital opportunities (PACAP), and then transform this into actual implementation (RACAP).

Strategic Interdependence

Strategic interdependence refers to the extent to which organisations rely on each other to achieve long-term outcomes. According to Siachou et al. (2021), interdependence is most effective when it is symmetric, so when partners depend on each other in comparable ways and contribute equally to shared goals. When this balance is uneven, coordination becomes more difficult and inefficiencies may arise.

6.2.3. Organisational Capabilities: P3

P3 captures the organisational capabilities required to translate recognised and acquired knowledge (PACAP) into practical application (RACAP). The empirical findings showed that this conversion depends strongly on governance clarity, expertise, and coordination between departments. When teams iterate through learning-by-doing and roles are well aligned, the transition from PACAP to RACAP becomes more feasible.

6.2.4. Relational Dynamics: P4

P4 reflects the relational dynamics that shape digitalisation in this partnership. Trust, communication and the way knowledge asymmetry is handled influence how confidently partners work together. These dynamics directly affect strategic interdependence, strengthening or weakening the connection between the organisations.

6.2.5. Overarching Mechanism: P5

The dashed boundary surrounding the model represents strategic alignment (P5), the overarching mechanism that influences how all other mechanisms function. While both organisations share a digitalisation ambition, this ambition is not consistently translated into clear ownership, priorities or system integration. As a result, progress made through PACAP, RACAP and interdependence does not automatically lead to coherent operational practices. P5 therefore represents the missing link between digital ambitions and actual implementation: without clear direction, consistent leadership and integrated system decisions, the mechanisms in the inner model cannot lead to digitalisation outcomes.

6.2.6. Operational Implementation and Value Creation

At the right side of the model, the ACAP and interdependence processes feed into operational implementation, where digitalisation becomes visible in daily processes, data flows and tools. Value creation is the final outcome of these processes, expressed in improvements in efficiency, data quality, insight and risk reduction.

All in all, the grounded model shows how digitalisation unfolds in the Schiphol-BAM partnership by combining the existing framework of Siachou et al. (2021) with insights from Zahra and George (2002) and the empirical mechanisms that reflect the reality of client-contractor relationships in IAM.

6.3. Recommendations

To answer the main research question, which is how clients and contractors can improve digitalisation within their partnerships to create shared value in infrastructure asset management, each mechanism that explains how digitalisation unfolds in the partnership needs to be addressed. This section therefore provides practical recommendations for Schiphol and BAM on how to improve digitalisation within their partnership, by strengthening each mechanisms of the grounded model. Figure 6.2 summarises these mechanisms as the five main areas where improvements are needed. These areas form the structure for the detailed recommendations that follow.

6.3.1. Institutional Context

The institutional context, such as contracts, requirements, compliance demands and standardisation, plays a crucial role in the development of digitalisation in the Schiphol-BAM partnership. While the MC2019 contract successfully triggered digitalisation with the development of the DDH, the empirical findings show that unclear expectations and excessive requirements also create rigidity and inefficiency. Based on the results and focus group reflection, the following recommendations outline how Schiphol and BAM can strengthen the institutional context within their partnership.

Schiphol: Clarify digitalisation expectations within the contract

The MC2019 contract is already performance based and prescriptive, allowing BAM to fill in the *how* themselves. BAM respondents explicitly acknowledged this, emphasis that digitalisation “came from the contract” (BAM 02). However, across interviews both parties also described that while the contractual trigger is clear, the digitalisation ambitions remains too broad for practical implementation. BAM 07 described this resulting uncertainty as:

“We also do not know exactly what you want.”

The focus group agreed with this, and participants stated that the contracts intends to stimulate innovation, but without a clear and consistent vision these efforts evaporate a bit.

Recommendation 1: Schiphol should maintain the performance-based structure but specify more concrete outcome-level expectations for digitalisation. These expectations should describe the purpose of digitalisation, such as improved decision making support, interoperability between systems or

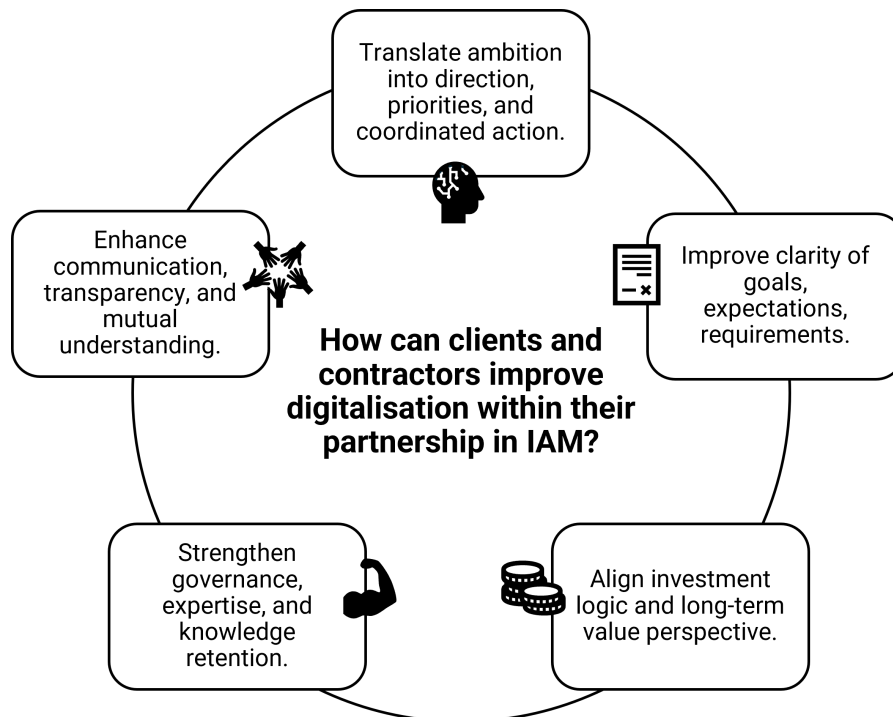


Figure 6.2: Overview of the five mechanisms that need to be strengthened to improve digitalisation in the Schiphol-BAM partnership

improved data completeness and availability. Clearer outcome definitions reduce ambiguity and help BAM prioritise digital initiatives aligned with Schiphol's long-term objectives.

Schiphol: Align data requirements with shared long-term vision

The results show that early in MC2019, Schiphol requested more data than was necessary. SCHIPHOL 07 reflected:

"At the start of MC 2019 the question was asked: we want all digital information back, both specific and generic characteristics. That is an enormous amount. But is all of that necessary to perform maintenance, to give advice, or to carry out analyses? I think you can scrap more than half, because it does not contribute to what we want."

This was recognised across both parties: BAM 06, SCHIPHOL 05 and SCHIPHOL 08 all noted inefficiency caused by overly extensive data requests. At the same time, Schiphol emphasised the need to "work towards 4D" and remain future-proof (SCHIPHOL 03), illustrating the tension between feasibility and long-term ambition.

Recommendation 2: Schiphol should communicate a long-term digitalisation vision and align data requirements accordingly. From this vision, define a minimum set of requirements that support current maintenance and contract performance and contribute to the long-term digitalisation outcomes.

6.3.2. Financial Alignment

Digitalisation requires sustained investment, but the interviews revealed that Schiphol and BAM approach these investments with different financial logics. While both organisations recognise that data is expensive and that progress depends on having sufficient resources, they frequently struggle to align on who should invest, when returns are expected, and how value should be assessed. The following three recommendations address these tensions in a focused and practical way.

Schiphol: Clarify how long-term benefits are valued

Interviews showed that BAM often hold back on investing because often they can only benefit from it after the contract period ends. As BAM 07 put it:

"There has to be a sound business case. Often there is one, but it only becomes profitable after the end of the contract. For the client that is very valuable, because they benefit for fifty years. For us maybe three or five years, because then the contract is over. The added value must therefore be seen beyond the duration of the contract. That makes it difficult for BAM to make financial choices."

At the same time, Schiphol acknowledged that the long-term business case for digitalisation is not yet well articulated, especially for developments like 3D/4D working (SCHIPHOL 03). This creates uncertainty for BAM, who must justify investments within a much shorter time frame.

Recommendation 3: Schiphol should clarify how they value digitalisation benefits that extend beyond the MC contract period. This includes addressing which goals and initiatives are considered long-term value and how shared benefits are expected to be distributed. Clarifying this long-term value logic gives BAM a stable basis for evaluating and prioritising which investments are worthwhile, even when the benefits emerge in future contract cycles rather.

BAM: Design solution for scaling across BAM (Infra)

Multiple BAM respondents explained that scaling tools and processes within BAM is difficult, which limits their ability to recover the investment costs made (BAM 04). At the same time, it is recognised that digital maturity should not be limited to a single project, but to the entire organisation. Schiphol 04:

"If you develop a data-driven mindset for one client only, that's not enough."

BAM can strengthen their investment position by standardising, scaling and widely implementing the tools and processes that are developed and invested in for the Schiphol project. This way, BAM's efforts and resources don't get lost over one-off investments and their digital maturity can grow organisation-wide.

Recommendation 4: BAM should ensure that digitalisation investments made within MC2019 are designed to be scalable across BAM (Infra) and other parcels. By developing scalable solution, rather than one-off specific solutions, BAM increases the return on investment and reduces the dependence on contract-specific payback structures. Moreover, it supports BAM's organisation-wide digital maturity and ensures knowledge does not get lost.

6.3.3. Organisational Capabilities

The findings showed that organisational capabilities strongly shape how digitalisation unfolds in the Schiphol-BAM partnership. While both organisations have made progress, digitalisation is still slowed down by fragmented governance, dependency on internal expertise and absence of structured learning. Based on the empirical results and focus group validation, the following recommendations aim to strengthen the organisational capabilities that are needed for digitalisation.

Schiphol: Assign clear ownership and governance roles

Across the interviews, respondents frequently mentioned that unclear governance and siloed responsibilities hinder progress in digitalisation. Schiphol employees, such as SCHIPHOL 03, noted that for example the DDS process lacks clear ownership:

"There is no name behind the DDS roles and contact points. Everyone is free to submit changes without approval."

And BAM respondents, such as BAM 01, also described how unclear responsibilities lead to conflicting instructions:

"At one moment we hear we must approve something, and from another line we hear it won't even be implemented. We don't know what to continue with."

These examples show that governance gaps within Schiphol create avoidable delays and rework, they strain the progress of digitalisation in the partnership.

Recommendation 5: Schiphol should define clear governance roles for digitalisation-related processes. These roles must include named responsibilities and decision-making authority. Establishing this clarity reduces fragmentation, prevents contradictory instructions, and ensures that initiatives rely on formal coordination.

Schiphol: Invest in in-house expertise

A recurring theme in the interviews was the dependency of Schiphol on BAM's technical expertise. Schiphol respondents acknowledged that they struggle to take an active role in decision-making due to a lack of knowledge. As SCHIPHOL 06 expressed:

"If we want to take an active role, and we do, then we need the right level of knowledge and skills."

This dependency affects the partnership, as it causes Schiphol not being able to articulate clear requirements. In addition, it leads to BAM taking the lead by default, which leads to mistrust or frustration in the collaboration.

Recommendation 6: Schiphol should invest in strengthening internal expertise so they can take a more informed and active role in digitalisation in this partnership. Reducing dependency on BAM's specialists increases Schiphol's confidence, improves requirement setting, and supports a more balanced partnership.

Schiphol and BAM: Improve knowledge retention

Both organisations expressed that knowledge is often concentrated in individuals, making digitalisation vulnerable to staff turnover. BAM 07 described this:

"Then you are vulnerable; knowledge is only in people's heads. That is a known problem in asset management: it goes fine until people leave, and then a lot of knowledge and justification for choices disappears."

At the same time, respondents described that learning-by-doing is one of the biggest enablers of digitalisation in the partnership. BAM 02 and SCHIPHOL 06 emphasised how bottom-up involvement helps staff adopt new ways of working more easily.

Recommendation 7: Schiphol and BAM should improve knowledge retention by documenting digitalisation processes, sharing lessons learned from pilots and creating templates and guides for new staff. At the same time, Schiphol and BAM should stimulate bottom-up initiatives and learning-by-doing.

6.3.4. Relational Dynamics

The results showed that relational dynamics strongly shape how digitalisation unfolds in the Schiphol-BAM partnership. While both parties are generally positive about the collaboration in the partnership, several relational mechanisms repeatedly slow progress. Based on these findings, the following recommendations are given.

Schiphol: Communicate expectations more clearly and consistently

A recurring theme in the interviews was that unclear or shifting expectations from Schiphol led to discussions and standstills in the collaboration. BAM 07 respondents described moments where they wanted to take steps, but lacked clarity on what Schiphol expected:

"Schiphol was disappointed that we did not take the steps they hoped for, while we indicated: but we also do not know exactly what you want. So we kept each other in a kind of deadlock. Schiphol was not clear, but still disappointed. I find that difficult."

This lack of clear direction created frustration for both sides and slowed down progress in digitalisation and the partnership in general.

Recommendation 8: Schiphol should articulate expectations about digitalisation more clearly and consistently. Providing this clarity reduces circular discussions and gives BAM a more stable basis for decision-making.

BAM: Make digitalisation progress more transparent

Knowledge asymmetry appears frequently in the data. Schiphol depends heavily on BAM's technical expertise. Schiphol respondents described that they often "don't know where the data is" or "what BAM is doing", which can create uncertainty and mistrust. For example, BAM 01:

"From BAM's perspective, we say: we've got it under control. But if you talk to Schiphol's technical experts, they'll say: 'We don't know where your data is, we don't know what you're doing'"

At the same time, this asymmetry is also what enables progress when BAM is open and shares knowledge.

Recommendation 9: BAM should continue to make its digitalisation progress more transparent so that Schiphol understands what happens behind the scenes. This reduces mistrust that arises from limited visibility and supports a more transparent and healthy partnership.

6.3.5. Strategic Alignment

The results showed that while both organisations share a broad digitalisation ambition, this vision is not yet consistently translated into coordinated action. Progress in this often depends on individual initiative rather than a clear organisational direction, and system misalignment forms a bottleneck in the progress as well. The following recommendations aim to strengthen strategic alignment within the partnership.

Schiphol: Formalise leadership and ownership for digitalisation

The interviews revealed that while the ambition to become "the most digital airport" is widely recognised, its implementation depends heavily on individual initiative. Respondents described how progress accelerated when someone "took the lead", but stalled when leadership was unclear. SCHIPHOL 08:

"You saw how dependent we were on the person who took the lead."

This dependence on individuals leads to fragmentation across parcels and departments, and makes it difficult for BAM to understand who has the authority to set priorities or make decisions, slowing down the collaboration and partnership.

Recommendation 10: Schiphol should formalise who is responsible for steering the digitalisation ambition across parcels and departments. Assigning a clear role or function with mandate and decision-making authority provides consistent direction, reduces dependence on individual initiative and supports a more coherent translation of strategic ambition into practice.

Schiphol and BAM: Address integration bottlenecks

Although not all participants agree to the importance of this, several interviews showed that even when digitalisation ambitions are aligned, system and data integration issues continue to strain the progress. As SCHIPHOL 02 described:

"We're aligned on what we want, but the bottleneck lies in how the data is transferred."

Recommendation 11: Schiphol and BAM should tackle integration bottlenecks together. Jointly addressing these points helps remove the friction that currently prevents strategic ambitions from being realised.

Schiphol and BAM: Create a shared roadmap

Although both organisations share the overall digital ambition, the interviews showed that this ambition is not yet translated into a coordinated plan. Respondents described how progress often depends on individual initiative, and that without a clear structure, efforts become fragmented. SCHIPHOL 04 explained this need very clearly:

"People enjoy working on it, but that's not enough. At a large organisation like Schiphol, if you want to collect data, you need a plan. A process, a timeline, a schedule."

This suggests that a shared ambition alone is insufficient. The partnership needs a structured, step-by-step roadmap that guides what will happen, when, and by whom.

Recommendation 12: Schiphol and BAM should jointly develop a shared digitalisation roadmap that translates the overall ambition into a small number of concrete, coordinated steps for the coming years. This roadmap should include shared priorities, the order in which they will be addressed, and clear responsibilities for both organisations.

6.3.6. Overview

To provide a concise overview, all twelve recommendations are summarised in Table 6.1. This table brings the recommendations together across the five mechanisms and shows which actor each recommendation is intended for. Together, these recommendations offer a practical and structured answer to the main research question: how clients and contractors can improve digitalisation within their partnerships to create shared value in infrastructure asset management.

Table 6.1: Overview of recommendations per mechanism and actor

Mechanism	Actor	Recommendation (short summary)
Institutional Context	Schiphol	Clarify outcome-level expectations in the contract
Institutional Context	Schiphol	Align data requirements with long-term vision
Financial Alignment	Schiphol	Clarify valuation of long-term benefits
Financial Alignment	BAM	Ensure digital investments are scalable across BAM
Organisational Capabilities	Schiphol	Define governance roles
Organisational Capabilities	Schiphol	Strengthen in-house expertise
Organisational Capabilities	Joint	Improve knowledge retention & bottom-up learning
Relational Dynamics	Schiphol	Communicate expectations clearly
Relational Dynamics	BAM	Increase transparency on digital progress
Strategic Alignment	Schiphol	Formalise leadership and ownership
Strategic Alignment	Joint	Fix system & data integration bottlenecks
Strategic Alignment	Joint	Develop a shared roadmap

7

Conclusion

This research aimed to explore how digitalisation can be improved within client-contractor partnerships in infrastructure asset management. The study followed a Design Science Research Methodology (DSRM) with a problem-centred initiation. In DSRM, the aim is to develop and evaluate an artefact that addresses a relevant real-world problem. In this thesis, the artefact is a grounded model that explains the mechanisms through which digitalisation develops in a client-contractor partnership and translates these into practical recommendations for Schiphol and BAM.

A theoretically informed lens, based on absorptive capacity and strategic interdependence, guided the development of a qualitative single-case study. Through semi-structured interviews, document analysis, and inductive coding using the Gioia Methodology, the study identified five mechanisms that shape digitalisation in practice. These mechanisms were synthesised with theory into a grounded conceptual model. The resulting model explains how institutional, organisational, relational, and strategic factors interact and provides concrete recommendations for strengthening digitalisation within infrastructure asset management client-contractor partnerships.

7.1. Main Findings

This research centred around the following research question:

How can clients and contractors improve digitalisation within their partnerships to create shared value in infrastructure asset management?

To address this question, four sub-questions were formulated:

1. How is digitalisation conceptualised in the infrastructure asset management literature?
2. How does the literature explain the role of absorptive capacity in enabling digitalisation?
3. How does the literature describe the influence of strategic interdependence on digitalisation within partnerships?
4. Which mechanisms explain how digitalisation unfolds in practice within the Schiphol-BAM partnership?

The first three sub questions were answered in the literature review with the theoretical framework that conceptualised digitalisation in asset management and identified two important mechanisms: absorptive capacity and strategic interdependence. This framework informed the interview design and guided the interpretation of the empirical findings.

The fourth sub-question examined which mechanisms explain how digitalisation unfolds in practice within the Schiphol-BAM partnership. The analysis revealed that digitalisation is driven by an interaction of absorptive capacity, strategic interdependence, and five mechanisms that shape how digitalisation develops in the partnership:

1. **Institutional context:** How contractual expectations, compliance demands and data requirements can simultaneously trigger and constrain digitalisation.
2. **Financial alignment:** How financial resources enable digitalisation, but misalignment in investment logics can constrain it.
3. **Organisational capabilities:** How internal governance, expertise and learning can affect digitalisation.
4. **Relational dynamics:** How communication, openness, mindset differences and knowledge asymmetry can affect digitalisation.
5. **Strategic alignment:** How shared ambition translated or fails to translate into day-to-day decisions, system integration and ownership.

Together, these five mechanisms form the grounded model developed in this research. This model integrates the earlier theoretical insights on the interaction between absorptive capacity and strategic interdependence with the empirically derived mechanisms from the Schiphol-BAM context. This way, the grounded model extends the framework of Siachou et al. (2021) by demonstrating how digitalisation unfolds in a client-contractor partnership in infrastructure asset management (IAM). Whereas Siachou et al. focus on ACAP and strategic interdependence in general alliances, this study shows how these concepts interact under the practical realities of performance contracts and data-intensive asset management work. This demonstrates how ACAP and strategic interdependence play out in practice, and what additional mechanisms shape digitalisation in an IAM partnership.

To answer the main question, each mechanism in the grounded model needs to be addressed to improve digitalisation within client-contractor partnerships in infrastructure asset management. In the Schiphol and BAM case, this resulted in a set of twelve practical recommendations, based on the empirical data.

7.2. Practical Implications

The practical implications of this research include the twelve recommendations presented in 6. This includes seven recommendations for Schiphol, two for BAM and three joint actions.

7.2.1. Schiphol Recommendations

- Clarify digitalisation expectations within the contract
- Align data requirements with shared long-term vision
- Clarify long-term benefit valuation
- Assign clear ownership and governance roles
- Invest in in-house expertise
- Communicate expectations more clearly and consistently
- Formalise leadership and ownership for digitalisation

7.2.2. BAM Recommendations

- Design solution for scaling across BAM (Infra)
- Make digitalisation progress more transparent

7.2.3. Joint Recommendations

- Improve knowledge retention
- Address integration bottlenecks
- Create a shared roadmap

7.3. Theoretical Implications

This research contributes to theory by extending the framework of Siachou et al. (2021) to the context of client-contractor partnerships in infrastructure asset management. While Siachou et al. (2021) explain

that digitalisation develops through absorptive capacity and strategic interdependence in alliances, this study showcases the factors that influence this process in the context of infrastructure asset management partnerships.

The research also adds to the growing body of work on digitalisation in infrastructure asset management by framing digitalisation as an organisational challenge rather than a purely technological one. It highlights that progress depends not only on adopting tools but on institutional, financial, organisational, relational and strategic factors.

7.4. Limitations and Future Research

Although this thesis provides valuable insights into how digitalisation unfolds within client-contractor partnerships in infrastructure asset management, it also has several limitations that could be addressed with future research.

7.4.1. Single-case Study

The study focussed on a single case study, namely the Schiphol-BAM partnership under the MC2019 contract for Parcel 3. This means that the findings are context-specific and cannot be generalised to all infrastructure projects or Schiphol parcels. However, the case study did allow for in-depth exploration of how the mechanisms interact in practice, which was essential for the development of the grounded model. Future research could compare multiple case studies in different partnerships or sectors to test whether the same patterns occur among different asset types, client or contract forms.

7.4.2. Data Type and Scope

The research also mainly focussed on digitalisation with the use of qualitative data from interviews. As a result, the findings reflect perceptions and experiences. Moreover, the study covers roughly two-thirds of the MC2019 contract period. This means the final years of the contract, and the transition towards a new tender, were not part of the data collection. Future research could include longitudinal studies to examine how these mechanisms evolve over the full contractual period, or how the implementation of the recommendations affects the digitalisation in the partnership over time.

7.4.3. Positionality

The researcher's position within BAM provided valuable access and contextual understanding, but may also have influenced data interpretation. This was mitigated through triangulation with documents and validation in the focus group, yet future studies could benefit from independent or external researchers to further reduce bias.

7.4.4. Constant Change

Processes at Schiphol are continuously evolving. System updates, organisational restructuring and new compliance requirements may alter the conditions in which digitalisation unfolds. Future research could investigate how digitalisation interacts with emerging technologies, organisational change or regulatory changes.

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Appendix A: Interview Guide

Interviewgids voor onderzoeker (NL)

Opening

- Bedank de deelnemer voor het meedoen.
- Stel jezelf en het onderzoek kort voor:
 - Dit is een master afstudeeronderzoek naar hoe publieke opdrachtgevers en aannemers, zoals Schiphol en BAM, kunnen samenwerken op het gebied van digitalisering om assetmanagement te verbeteren.
 - Ik ben benieuwd naar uw persoonlijke ervaringen met hoe digitaliseringsideeën binnenkomen in uw organisatie, hoe u of uw team deze interpreteert en toepast, en welke rol de samenwerking met Schiphol/BAM daarin speelt.
 - Graag antwoord geven op basis van persoonlijke ervaringen binnen projecten of processen in het onderhoudscontract van perceel 3.
- Zorg dat het toestemmingsformulier begrepen en ondertekend is.
- Vraag toestemming voor opname en start de opname.

Achtergrond en rol

1. Kunt u uw rol binnen de organisatie beschrijven en hoe u betrokken bent bij asset management en digitalisering?

Cues

- Niveau (operationeel, tactisch, strategisch)
- Taken gerelateerd aan asset management
- Betrokken bij digitalisering

Acquisition

2. Kunt u een moment beschrijven waarop een nieuw digitaliseringsinitiatief, zoals een tool, systeem of vereiste, binnen uw werkomgeving werd geïntroduceerd?

Cues

- Type initiatief
- Aanleiding (probleem, eis, intern/extern idee)
- Bron (intern R&D, partner, leverancier)
- Communicatiekanaal (mail, overleg, informeel)
- Betrokkenheid van BAM/Schiphol

Vervolg vragen

- Hoe hoorde je er voor het eerst over?
- Wie introduceerde het?
- Was het verplicht of optioneel?

Assimilation

3. Toen dit idee of deze tool werd geïntroduceerd, hoe bent u of uw team ermee aan de slag gegaan?

Cues

- Training, workshops, interne bespreking

- Interpretatie: duidelijk of verwarrend?
- Intern of organisatie overstijgend

Vervolg vragen

- Besproken met team of anderen?
- Was het meteen duidelijk?
- Waren er misverstanden?

Antecedenten

4. Wat help u persoonlijk om te herkennen of een digitaliseringsidee nuttig of relevant is voor uw werk?

Cues

- Ervaring of voorkennis
- Nieuwsgierigheid of leergierigheid
- Eigen initiatief

Vervolg vragen

- Werk je graag met nieuwe digitale tools?
- Ben je bekend met digitalisering of soortgelijke tools?

Transformation & exploitation

5. Leidde dit idee of deze tool tot veranderingen in jullie manier van werken? En is het uiteindelijk ook echt in de praktijk gebruikt?

Cues

- Veranderingen in routines of werkwijzen
- Integratie met bestaande systemen
- Toepassing in het dagelijkse werk
- Doorontwikkeling of schaalvergroting

Vervolg vragen

- Wat is er veranderd in uw werk?
- Wordt de tool vandaag nog gebruikt?
- Heeft het iets verbeterd?

Samenwerking BAM/Schiphol

6. Welke rol speelde de samenwerking met Schiphol/BAM tijdens dit initiatief?

Cues

- Gezamenlijke afstemming, overleggen
- Verdeling van taken of verantwoordelijkheid
- Samenwerking soepel of stroef?
- Vertrouwen en rolduidelijkheid

Vervolg vragen

- Wie nam het voortouw?

- Was duidelijk wie waarvoor verantwoordelijk was?
- Was de samenwerking helpend of juist lastig?
- Was de communicatie en afstemming makkelijk?

7. Denkt u dat Schiphol en BAM op een vergelijkbare manier naar digitalisering kijken – of ziet u verschillen in mindset, doelen, of werkwijze?

Cues

- Strategische prioriteiten
- Houding tegenover technologie
- Ambitieniveau op digitaliseringsvlak

Vervolg vragen

- Zijn de doelen rondom digitalisering vergelijkbaar?
- Merkt u verschillen in aanpak of strategie?

8. Wat voor waarde denkt u dat digitalisering oplevert – voor uw team, het project of de samenwerking als geheel?

Cues

- Operationele waarde (efficiëntie, tijdbesparing)
- Strategische waarde (inzicht, innovatie)
- Leereffecten of kennisontwikkeling

Vervolg vragen

- Helpt het u om betere beslissingen te nemen?
- Maakt het werk makkelijker of moeilijker?

9. Denkt u dat BAM en Schiphol in gelijke mate profiteren van digitalisering? Waarom wel of niet?

Cues

- Gevoel van (on)gelijkheid
- Verdeling van tools, inzichten, efficiëntie
- Eigenaarschap van resultaten?

Vervolg vragen

- Wie heeft er het meest uitgehaald?
- Is dat besproken geweest?
- Is er ooit gesproken over wie het resultaat ‘bezit’?

Wrap up

10. Heeft u ooit iets geleerd van de partnerschap met Schiphol/BAM op het gebied van digitalisering – of andersom?

Cues

- Voorbeelden van kennisoverdracht

- Gezamenlijk leren of beïnvloeding
- Praktische of inhoudelijke lessen

Vervolg vragen

- Heeft u iets overgenomen van hun aanpak of tools?
- Hebben zij ooit iets overgenomen van u of uw team?

Afsluiting

Bedank de deelnemer hartelijk voor het gesprek.

Vraag of er nog iets is dat ze toe willen voegen.

Zet opname stop.

*Interviewvragen voor deelnemer (NL)***Inleiding en toestemming****Achtergrond en rol**

1. Kunt u uw rol binnen de organisatie beschrijven en hoe u betrokken bent bij asset management en digitalisering?

Digitalisering in asset management context

2. Kunt u een moment beschrijven waarop een nieuw digitaliseringsinitiatief, zoals een tool, systeem of vereiste, binnen uw werkomgeving werd geïntroduceerd?
3. Toen dit idee of deze tool werd geïntroduceerd, hoe bent u of uw team ermee aan de slag gegaan?
4. Wat help u persoonlijk om te herkennen of een digitaliseringsidee nuttig of relevant is voor uw werk?
5. Leidde dit idee of deze tool tot veranderingen in jullie manier van werken? En is het uiteindelijk ook echt in de praktijk gebruikt?
6. Welke rol speelde de samenwerking met Schiphol/BAM tijdens dit initiatief?
7. Denkt u dat Schiphol en BAM op een vergelijkbare manier naar digitalisering kijken – of ziet u verschillen in mindset, doelen, of werkwijze?
8. Wat voor waarde denkt u dat digitalisering oplevert – voor uw team, het project of de samenwerking als geheel?
9. Denkt u dat BAM en Schiphol in gelijke mate profiteren van digitalisering? Waarom wel of niet?

Afsluiting

10. Heeft u ooit iets geleerd van de partnerschap met Schiphol/BAM op het gebied van digitalisering – of andersom?

Afsluiting

Hartelijk bedankt voor u deelname.

Appendix B: Focus Group Design

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1

De context

Percelen

1	Vluchtafhandeling	Heijmans
2	Vliegvloerhandeling	Volker Wessels
3	Landbouwinfra	BAM Totaal Bouw en Wonen
4	Ondergrondinfra	BAM Energie & Water
5a	Terminal 1 en 2	Heijmans
5b	Terminal 3 en Plaza	BAM Infra en Techniek
6	Hekwerken en poorten	Heras
7	Landzijdige reiniging	Thomas Cultuurtechniek

Scope perceel 3

Asfalt: 1.000.000 m ²	Bebording: 4600 st	Kunstwerken: 26 st
Elementverharding: 400.000 m ²	Markering: 30.000 m ²	
Plantenbak: 416 st	Hemelwaterafvoer: 155.000 m ¹	Straatmeubilair: 1750 st
Beplanting: 230 ha	Kolken en putten: 8.000 st	
Oeverbescherming/matprofiel 110.000 m ¹	HWA goot: 5.000 m ¹	

2

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Hoe kunnen Schiphol en BAM de samenwerking op het gebied van digitalisering verbeteren?

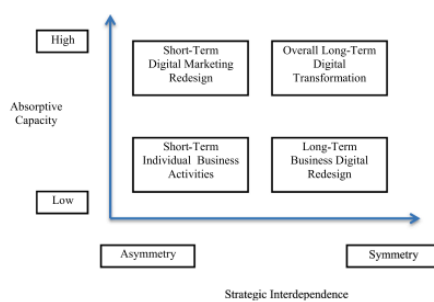
TU Delft

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Literatuur onderzoek

- Can traditional organizations be digitally transformed by themselves? The moderating role of absorptive capacity and strategic interdependence by Siachou et al. (2021)



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Interviews en analyse

- 1. 16 interviews met BAM en Schiphol
- 2. Van 1500+ codes naar een data structuur
- 3. Data structuur naar 57 relaties
- 4. 57 relaties naar 5 proposities
- 5. Valideren van 5 proposities
- 6. 5 proposities naar gefundeerde theorie (grounded theory model)



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Data structuur

Institutional Context • Contracts and compliance • External and sectoral • Financial conditions • Requirements and standardisation	Organisational Capabilities • Internal alignment • Internal expertise • Learning • Organisational mindset	Relational Mechanisms • Collaboration mechanisms • Knowledge imbalance and dependency • Knowledge sharing • Roles and responsibilities
Shared Strategic Direction • Digitalisation vision • Strategic alignment • Interpretations of digitalisation • Shared strategic value	Operational Implementation • Change triggers • Adoption barriers • Data and process alignment • System and IT	Value Creation • Decision making • Maintenance value • Efficiency value • Unused potential



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Wat we gaan doen vandaag

- Bespreken van 5 proposities
 - Stellingen die mijn bevindingen samenvatten
- Reflecteren vanuit eigen ervaring
 - Herken je dit in de samenwerking?
- Met stickers aangeven
 - ● = eens
 - ● = deels/hangt er van af...
 - ● = oneens



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Disclaimer

- Gezamenlijk leren, niet beoordelen
- Stickers als documentatie, audio voor back up
- Duur: ± 1,5 uur
 - Introductie: 10 min
 - Discussie: 60 min (12 min per propositie)
 - Afronding: 15 min
- Vragen?



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Propositie 1: Institutionele context

Contractuele, compliance- en standaardisatievereisten kunnen digitalisering stimuleren, maar sectorale regels en standaarden beperken vaak de ruimte voor innovatie en flexibiliteit.

Uitleg:

- Contractuele eisen (informatie-uitwisseling, BIM, data-kwaliteit) triggeren en structureren digitale innovaties.
- Te brede/te strenge eisen en onduidelijke definities vergroten werklust en beperken de ruimte om te experimenteren
- Sectorspecifieke beperkingen (veiligheid/compliance, aard van assets) verkleinen soms de meerwaarde van bepaalde digitale oplossingen en beperken pilots.



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Propositie 2: Financiering and investering

Budgetten en investeringen maken digitalisering mogelijk, maar verschillende mindsets naar terugverdienmodellen en kostendeling vertragen besluiten en samenwerking.

Uitleg:

- Budget is randvoorwaardelijk om data op orde te brengen of te kunnen innoveren met nieuwe digitale innovaties
- Kostendeling en terugverdienmodellen zorgen voor frictie, ondanks formele mogelijkheden
- In de praktijk werkt de implementatie van zulke modellen niet altijd zoals bedoeld, waardoor investeringen blijven liggen.



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Propositie 3: Organisatorische capaciteiten

Interne afstemming (alignment), kennis en leervermogen zijn cruciaal voor digitalisering. Versnipperde governance en beperkte expertise belemmeren de voortgang, terwijl iteratief leren en groeiende volwassenheid dit versterken.

Uitleg:

- Versnipperde governance en onduidelijke rollen/contactpunten veroorzaken eilandvorming en vertraging.
- Expertisetekort en wisselingen van de wacht maken zorgen ervoor dat kennis niet bewaard wordt
- Learning-by-doing en gezamenlijke routines verhogen de digitale volwassenheid en versnellen dus digitalisering



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Propositie 4: Relationele dynamiek

Mindset, communicatie, kennisasymmetrie en samenwerking hebben grote invloed op digitalisering. Openheid en vertrouwen versnellen digitalisering, frustratie en afhankelijkheid vertragen digitalisering.

Uitleg:

- Onduidelijke verwachtingen/communicatie creëren deadlocks en frustratie ondanks normaalgesproken goede samenwerking.
- Kennisasymmetrie vertraagt als toegang/onduidelijkheid speelt.
- Kennisasymmetrie kan digitalisering versnellen als openheid/transparantie hoog is, doormiddel bijvoorbeeld van samenwerking mechanismen.



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Propositie 5: Strategische afstemming en visie

Externe druk stimuleert een gezamenlijke digitaliseringsvisie, maar het gebrek aan eenduidig eigenaarschap en geïntegreerde datasystemen zorgt voor een kloof tussen ambitie en uitvoering.

Uitleg:

- Externe benchmarks (marktontwikkeling, toekomstige tender) helpen de visie te formuleren.
- Eigenaarschap is onduidelijk: wie beslist en wie borgt consistentie over percelen/afdelingen heen?
- Integratie-bottlenecks (processen/systeemkoppelingen) blokkeren waarderealisatie ondanks strategische alignment.



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Afsluiting

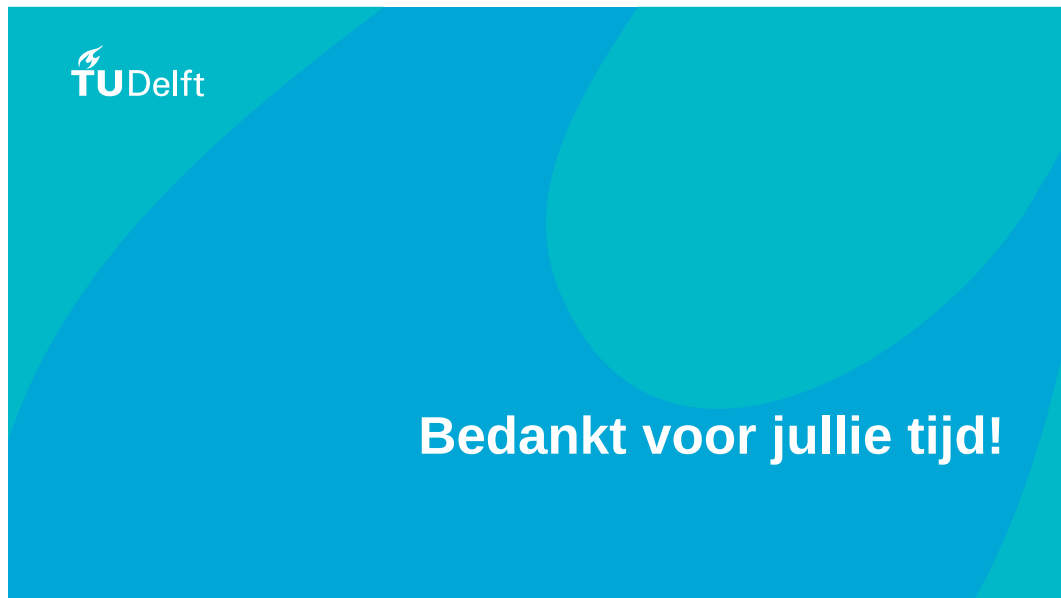
- Wat valt jullie op?
- Welke van deze thema's zijn volgens jullie het belangrijkste om aan te pakken als we digitalisering willen versnellen?
- Zijn er nog opmerkingen of toevoegingen?



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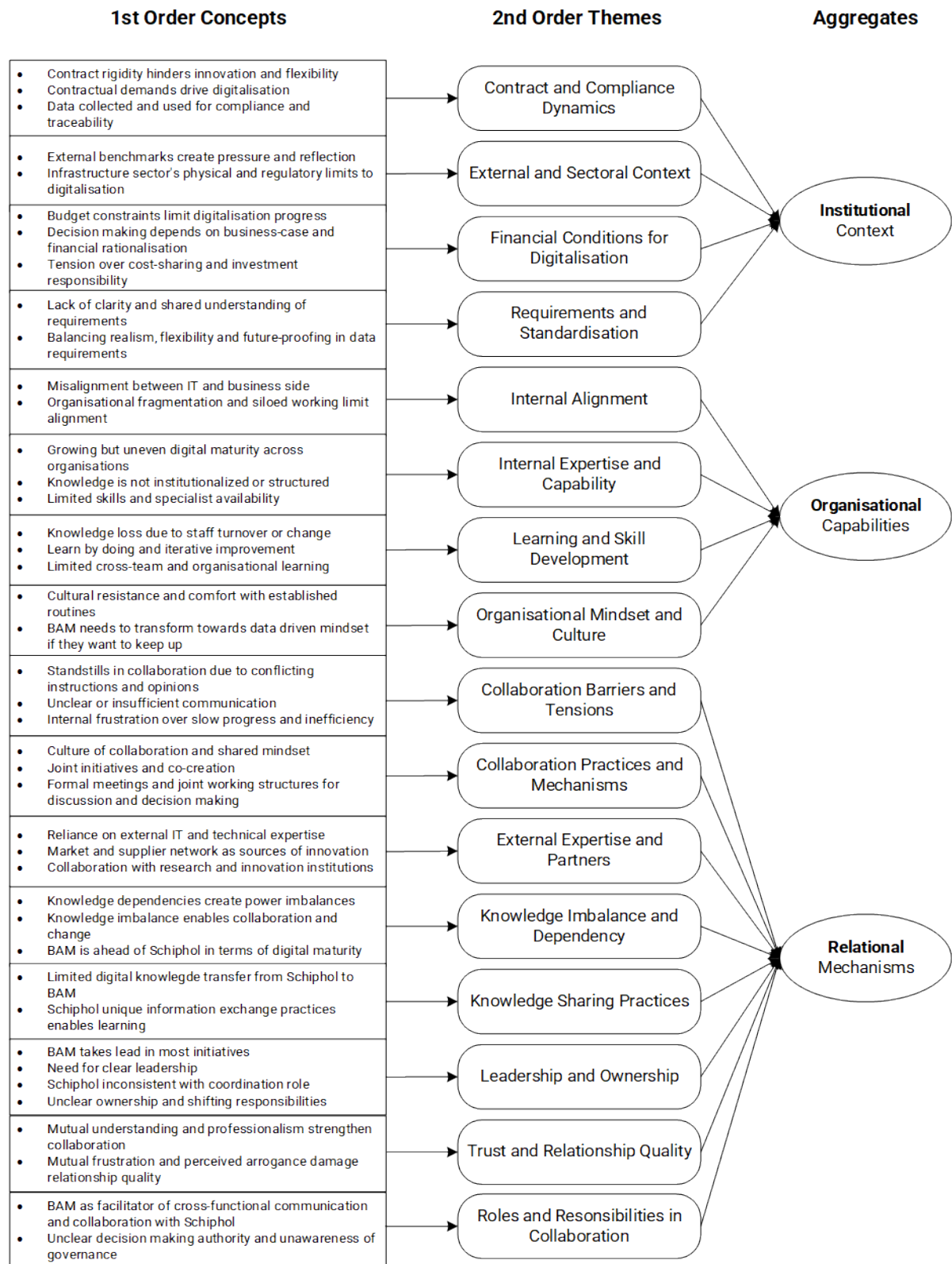


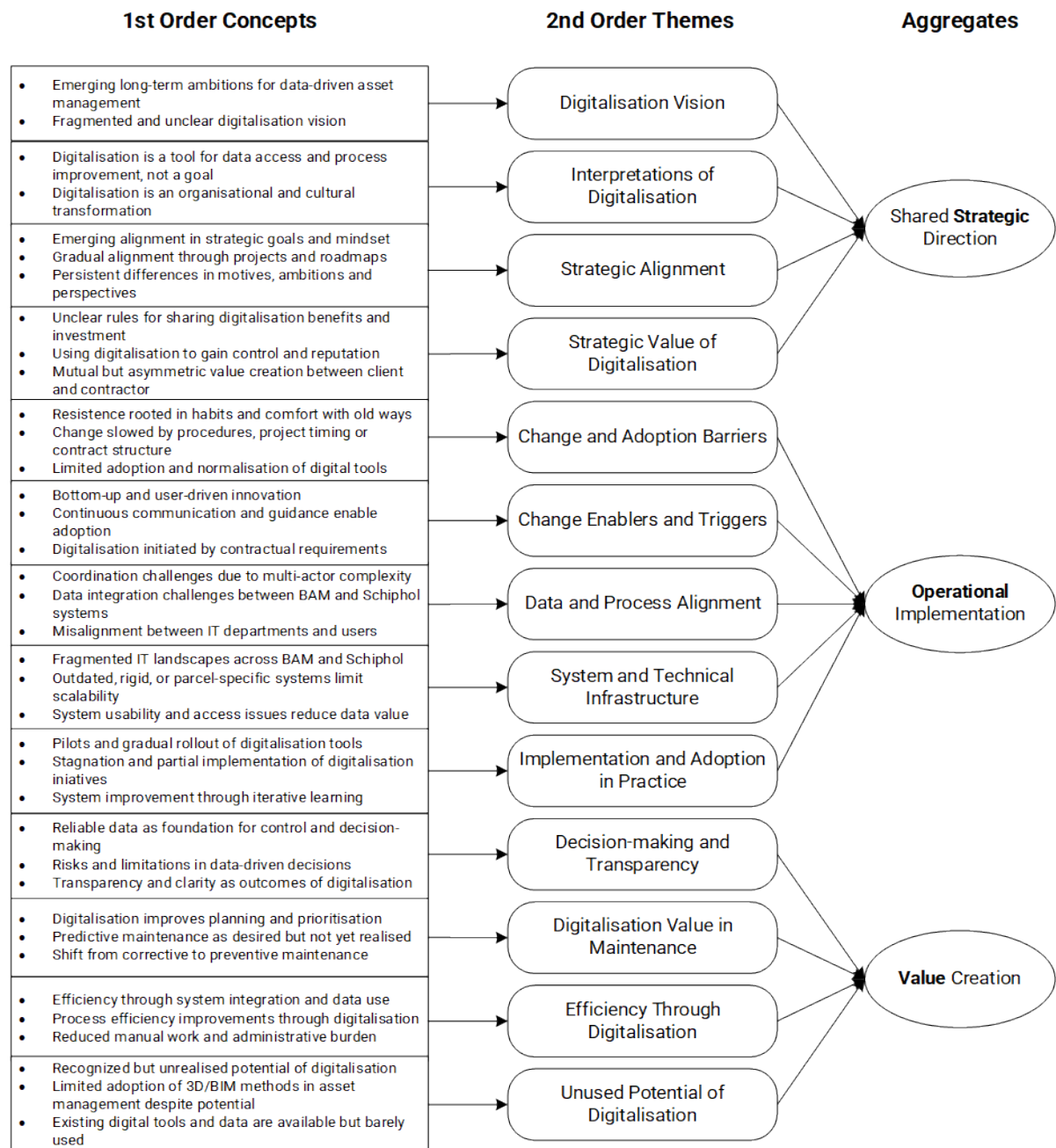
17

Appendix C: Code Co-occurrence Table

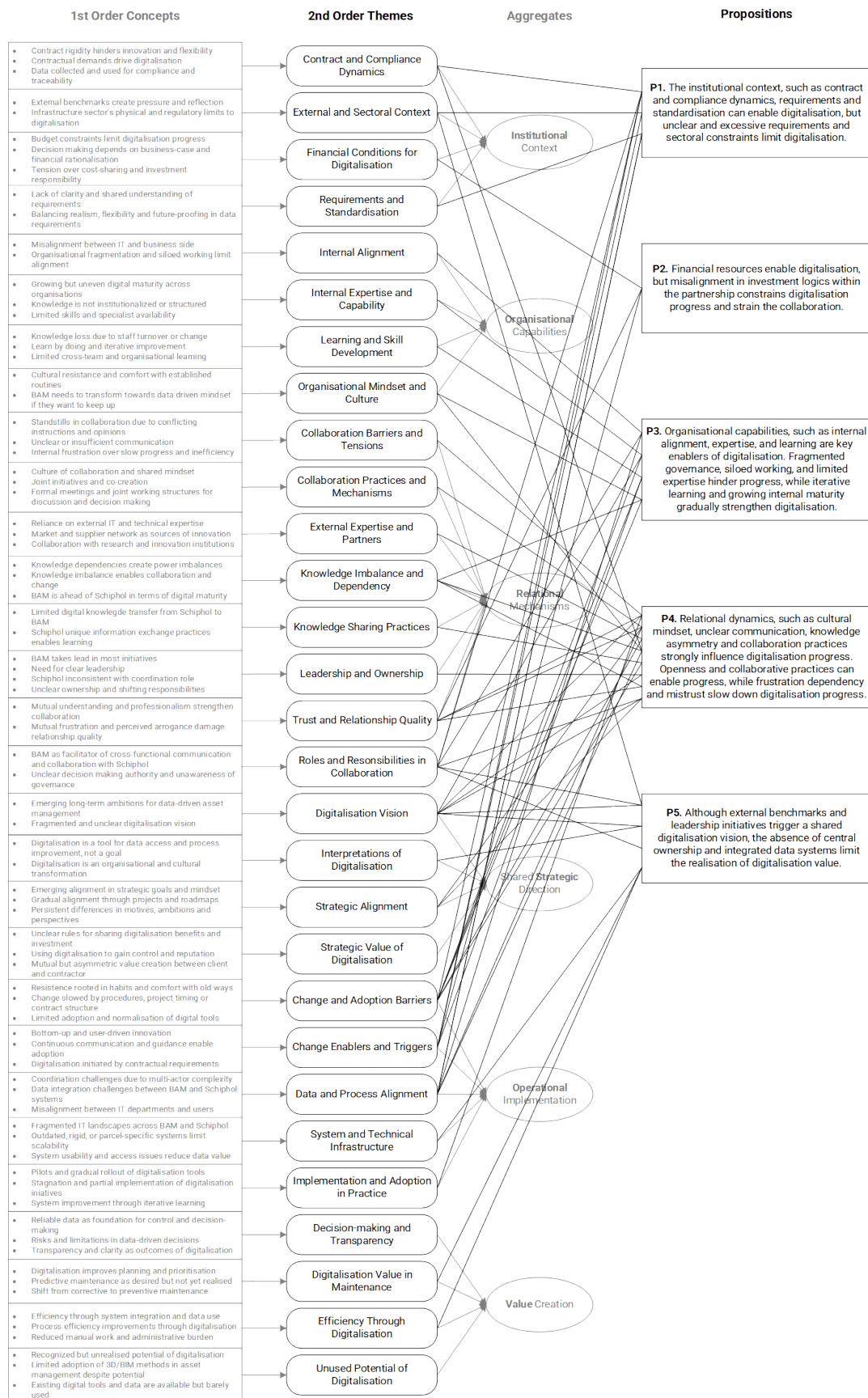
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5	C6	C7	D1	D2	D3	D4	E1	E2	E3	E4	E5	F1	F2	F3	F4
A1: Core and Compliance	0	0	0	4	1	0	2	1	0	1	0	1	0	1	4	3	1	2	1	1	2	1	3	5	5	1	0	0	2	1
A2: Financial and Sector Context	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	2	0	0	1	1	4	1	0	0	0	1	1	
A3: Financial Conditions for AI	0	1	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	3	0	0	1	1	4	1	0	0	0	0	0	
A4: Requirements and Standardization	4	1	1	1	0	2	1	0	0	0	1	0	0	2	1	0	1	1	0	0	0	0	0	3	0	0	0	0	0	
A5: Regulatory and Responsibility	0	0	0	1	0	3	1	0	2	0	1	0	0	0	0	0	0	3	0	0	0	0	1	2	1	0	0	0	0	
B1: Internal Alignment	0	0	0	2	3	0	2	0	2	0	1	2	0	0	0	0	0	2	0	0	0	1	0	2	0	0	0	0	0	
B2: Internal Express and Development	2	0	1	1	1	2	0	2	0	2	0	1	3	2	1	2	1	2	1	0	0	1	1	3	2	3	0	0	1	
B3: Learning and Skill Development	1	0	0	0	0	0	2	0	1	0	1	0	0	0	3	0	0	1	0	0	0	2	0	0	0	0	0	0	1	
B4: External Market and Culture	0	0	1	0	2	1	0	1	0	1	0	2	0	1	5	0	0	2	1	1	2	4	1	3	1	0	0	0	0	
B5: Collaborative Barriers	1	0	1	1	0	2	0	0	2	0	0	0	0	0	2	1	0	3	0	0	1	0	1	0	3	2	0	0	2	
C1: Collaboration Practices and Mechanisms	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	1	0	1	0	3	1	0	1	0	
C2: Collaborative Partners and Dependencies	1	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	
C3: Knowledge Sharing and Leadership	4	0	1	2	1	0	3	0	5	2	2	0	0	0	0	1	4	1	0	3	1	0	2	6	0	3	3	0	0	
C4: Overlaps and Relationship Quality	1	0	0	0	1	0	1	0	0	0	0	0	0	1	1	0	3	0	0	0	0	0	0	0	1	1	0	0	1	
C5: Leadership and Oversight	0	0	0	0	1	0	0	2	0	2	0	3	3	0	4	0	0	0	0	1	1	2	2	0	0	0	2	0	0	
D1: Digitalization Vision	1	2	0	1	3	2	1	1	2	3	0	1	1	0	3	0	0	4	1	1	1	1	1	2	1	1	0	0	2	
D2: Interpretations of Digitalization	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	0	2	0	0	0	1	1	0	2	1	0	0	
D3: Strategic Alignment	2	0	1	0	0	0	0	0	0	1	1	1	0	3	1	0	1	2	0	0	1	0	1	0	5	0	1	0	0	
D4: Strategic Value of Digitalization	1	0	1	0	0	0	0	2	0	0	1	1	0	0	1	1	0	0	0	1	0	0	0	1	0	1	4	0	0	
E1: Change and Adoption	3	0	1	0	0	1	1	2	4	1	0	0	0	1	0	2	1	1	0	1	0	4	4	4	4	4	0	0	0	
E2: Change Enablers and Triggers	0	0	4	0	1	0	1	0	1	0	1	0	2	2	0	2	1	1	0	0	0	4	0	1	3	4	0	0	0	
E3: Change Enablers and Triggers	5	1	1	0	0	2	2	3	0	3	1	2	0	6	0	0	0	2	1	1	1	4	1	4	1	0	5	6	0	2
F1: Information and Data	1	0	0	3	1	0	2	2	1	0	3	0	0	3	1	0	1	0	1	0	3	1	4	3	6	3	0	0	0	0
F2: Information and Data	1	2	0	0	0	0	3	0	0	0	3	0	0	3	1	0	0	2	0	2	0	4	3	6	3	0	2	0	0	
F3: Transparency and Accountability	0	0	0	0	1	0	0	0	0	0	2	1	0	5	1	0	2	0	2	0	1	0	0	0	2	0	4	0	0	
F4: Efficiency Through Maintenance	2	1	0	0	0	0	0	1	0	0	0	2	1	0	0	1	0	2	0	1	1	4	0	0	3	0	4	0	1	
F5: Efficiency Through Maintenance	0	0	1	0	0	0	2	0	0	0	1	0	0	0	1	0	0	2	0	1	1	2	0	0	0	1	1	0	0	
F6: Unused Potential of Digitalization	0	0	1	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	1	1	2	0	2	0	0	0	1	1	0	

Appendix D: Full Data Structure





Appendix E: Visual mapping of relations

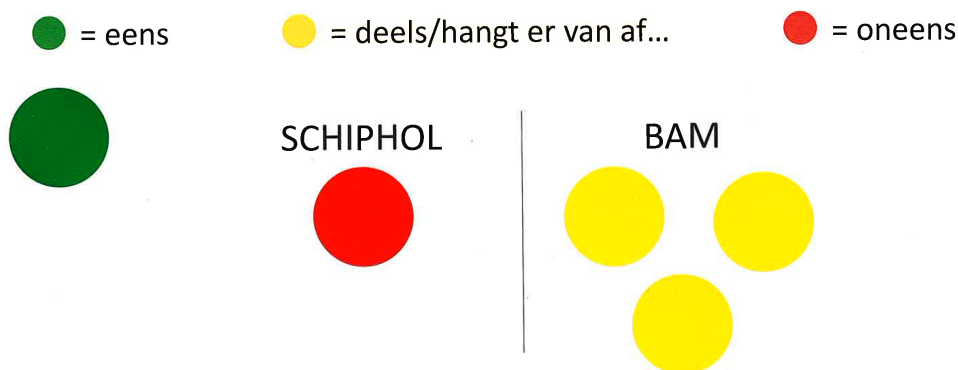


Appendix F: Focus Group Results

Propositie 1: Institutionele context

Contractuele, compliance- en standaardisatievereisten kunnen digitalisering stimuleren, maar sectorale regels en standaarden beperken vaak de ruimte voor innovatie en flexibiliteit.

- Contractuele eisen (informatie-uitwisseling, BIM, data-kwaliteit) triggeren en structureren digitale innovaties.
- Te brede/te strenge eisen en onduidelijke definities vergroten werklast en beperken de ruimte om te experimenteren
- Sectorspecifieke beperkingen (veiligheid/compliance, aard van assets) verkleinen soms de meerwaarde van bepaalde digitale oplossingen en beperken pilots.



Propositie 2: Financiering and investering

Budgetten en investeringen maken digitalisering mogelijk, maar verschillende mindsets naar terugverdienmodellen en kostendeling vertragen besluiten en samenwerking.

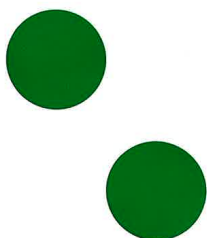
- Budget is randvoorwaardelijk om data op orde te brengen of te kunnen innoveren met nieuwe digitale innovaties
- Kostendeling en terugverdienmodellen zorgen voor frictie, ondanks formele mogelijkheden
- In de praktijk werkt de implementatie van zulke modellen niet altijd zoals bedoeld, waardoor investeringen blijven liggen.

● = eens

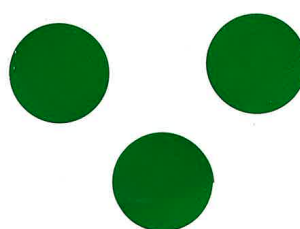
● = deels/hangt er van af...

● = oneens

SCHIPHOL



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Propositie 3: Organisatorische capaciteiten

Interne afstemming (alignment), kennis en leervermogen zijn cruciaal voor digitalisering. Versnipperde governance en beperkte expertise belemmeren de voortgang, terwijl iteratief leren en groeiende volwassenheid dit versterken.

- Versnipperde governance en onduidelijke rollen/contactpunten veroorzaken eilandvorming en vertraging.
- Expertisetekort en wisselingen van de wacht maken zorgen ervoor dat kennis niet bewaard wordt
- Learning-by-doing en gezamenlijke routines verhogen de digitale volwassenheid.

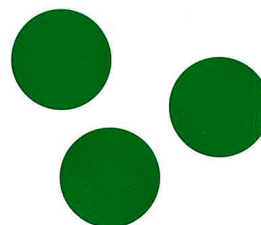
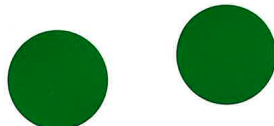
● = eens

● = deels/hangt er van af...

● = oneens

SCHIPHOL

BAM



Propositie 4: Relationele dynamiek

Mindset, communicatie, kennisasymmetrie en samenwerking hebben grote invloed op digitalisering. Openheid en vertrouwen versnellen digitalisering, frustratie en afhankelijkheid vertragen digitalisering.

- Onduidelijke verwachtingen/communicatie creëren deadlocks en frustratie ondanks normaalgesproken goede samenwerking.
- Kennisasymmetrie vertraagt als toegang/onduidelijkheid speelt.
- Kennisasymmetrie kan digitalisering versnellen als openheid/transparantie hoog is, doormiddel bijvoorbeeld van samenwerking mechanismen.

● = eens

● = deels/hangt er van af...

● = oneens

SCHIPHOL



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Propositie 5: Strategische afstemming en visie

Externe druk stimuleert een gezamenlijke digitaliseringsvisie, maar het gebrek aan eenduidig eigenaarschap en geïntegreerde datasystemen zorgt voor een kloof tussen ambitie en uitvoering.

- Externe benchmarks (marktontwikkeling, toekomstige tender) helpen de visie te formuleren.
- Eigenaarschap is onduidelijk: wie beslist en wie borgt consistentie over percelen/afdelingen heen?
- Integratie-bottlenecks (processen/systeemkoppelingen) blokkeren waarderealisatie ondanks strategische alignment.

● = eens ● = deels/hangt er van af... ● = oneens

