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BEYOND PILOTS: DIGITAL-ENABLED TRANSFORMATION IN LARGE CONSTRUCTION CONTRACTORS

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To Mum,
Mulungi, &
Ivory

Abstract

Over recent decades, the integration of digital technologies has reshaped operations and business models across industries such as banking, telecommunications, and manufacturing. Within construction, a range of digital technologies such as BIM, AI, and IoT likewise have altered project-level and operational practices. Large contractors test digital technologies through testbeds, pilot projects, and proofs of concept (POCs). Yet, because construction is organised through temporary projects, decentralised decision-making, and loosely coupled structures, these initiatives often remain isolated within individual projects or business units. As a result, lessons learned and demonstrated benefits are not easily transferred, embedded, or scaled across the firm. This recurring pattern, in which one pilot is followed by another rather than being translated into broader organisational change, is framed in this thesis as the *Yet Another Pilot* (YAP) syndrome. The prevalence of YAP confines benefits to individual projects and inhibits scaling that would enable firms to innovate business models, enter new markets, change core firm logics, and improve operational efficiency at firm level. Consequently, many firms have *digitised* data and information and *partly digitalised* operations, while *digital transformation* remains nascent. Existing literature has tended to focus on technology, projects, or SMEs, leaving the digital transformation of large construction contractors relatively underexplored. Hence, it remains unclear how digital transformation evolves within large contractors and how the barriers to scaling can be overcome in this context.

The purpose of this thesis is thus to investigate digital transformation in large construction contractors, with a particular focus on how digital pilot projects and POC initiatives can be scaled beyond the project level to support firm-level transformation. The phenomenon of digital transformation is examined through three interrelated dimensions*: technological innovation, business development, and ecosystem evolution*. The firm constitutes the unit of analysis, while the unit of observation is at the corporate level to

capture firm-level transformation associated with digitalisation. To investigate this, two research questions have been formulated:

1. What strategic approaches do large construction contractors adopt in relation to digital transformation, and what factors hinder or enable the scaling of digital initiatives beyond the project level?
2. How can digital transformation in large construction contractors be conceptualised and analytically understood in relation to the scaling of digital initiatives?

To answer these questions and fulfil the purpose, the work combines a scoping literature review, an interview study, case study research, and conceptual development, resulting in a *72-marker* model. The model captures the interactions between the *three dimensions* and five domains*: creating value, managing change, scaling pilots, innovating business models, and corporate-level engagement*.

In response to the first research question, firms adopt either *defensive* or *offensive* strategic approaches to digital transformation. *Defensive* firms use digital technology primarily to improve existing operations and strengthen current business structures. As a result, scaling beyond the project level remains limited, leaving these firms more constrained by the underlying barriers to innovation in construction. *Offensive* firms, by contrast, use digital technology not only to improve existing business, but also to extend current offerings and create new business opportunities. This allows digital initiatives to support new business creation, business model innovation, and ecosystem development. As a result, these firms are better positioned to address the barriers to innovation in construction and to scale digital initiatives beyond the project level.

In response to the second research question, digital transformation within large contractors is conceptualised as evolving through three sequential steps: *alignment, reconfiguration*, and *adaptation*. At an analytical level, firms' strategic approaches can be compared using the 72-marker model, which reveals three distinct profiles: *the operationally oriented digitalisation profile*, *the internally*

orchestrated transformation profile, *and the advanced transformation profile*. The operationally oriented digitalisation profile describes firms that recognise the value of becoming more data-driven, but where most efforts remain focused on internal efficiency, specific tools, and local business-unit initiatives. This profile is therefore associated with firms adopting a predominantly *defensive* approach. *The internally orchestrated transformation profile* describes firms with well-defined structures for innovation and change, prioritised innovation funding, and stronger capability-building efforts, where scaling is prioritised mainly within the firm rather than through business model innovation or ecosystem repositioning. This profile is associated with firms that remain mainly *defensive* but are beginning to develop a more *offensive* approach. In the *advanced transformation profile*, digitalisation extends beyond isolated technologies and is strongly linked to customer value, organisational change, scaling mechanisms, business model innovation, and corporate-level management. This profile is associated with firms that adopt a clearly *offensive* strategic approach.

The main theoretical contribution is the 72-marker model for studying digital transformation through the interactions between the *three dimensions* and the *five domains*. From a practical perspective, the contribution is an assessment model that enables managers to classify their firm's approach to digitalisation, identify its strategic position, and prioritise actions towards specific business, technical, and ecosystem goals. The thesis is limited by its reliance on mainly qualitative interview data and corporate-level focus, with limited depth at the project and business-unit levels. In addition, the focus on large construction contractors constrains the generalisability of the findings to other firm types, such as SMEs. On this basis, future research could further test the model using a survey-based approach, as well as through more in-depth and longitudinal studies of construction firms of different sizes and in different geographical contexts. It could also extend the empirical scope to include more organisational levels.

Keywords: Digitalisation, Digital Transformation, Construction, Large contractors, Strategic approach, Innovation, Case study

Populärvetenskaplig sammanfattning

Under de senaste decennierna har integrationen av digital teknik omformat verksamheter och affärsmodeller inom branscher som bank, telekommunikation och verkstadsindustri. Inom byggsektorn har olika digitala tekniker, såsom BIM, AI och IoT, på motsvarande sätt förändrat arbetssätt på såväl projektnivå som på operativ nivå. Stora byggentreprenörer prövar digital teknik genom testbäddar, pilotprojekt och ”proofs of concept” (POCs). Eftersom byggsektorn samtidigt präglas av tillfälliga projekt, decentraliserat beslutsfattande och löst kopplade strukturer blir dessa initiativ dock ofta isolerade till enskilda projekt eller affärsenheter. Därmed är det svårt att överföra, etablera och skala upp lärdomar och påvisade nyttor inom hela företaget. Detta återkommande mönster, där ett pilotprojekt följs av ännu ett i stället för att leda till bredare organisatorisk förändring, benämns i denna avhandling som *”Yet Another Pilot”* (YAP) - syndromet. Förekomsten av *YAP-syndromet* innebär att nyttor stannar på projektnivå och försvårar den uppskalning som skulle kunna göra det möjligt för företag att förnya affärsmodeller, gå in på nya marknader, förändra grundläggande verksamhetslogiker och förbättra den operativa effektiviteten på företagsnivå. Följden är att många företag har *digitiserat* (digitised) data och information och delvis *digitaliserat* (digitalised) sin verksamhet, medan *digital transformation* fortfarande befinner sig i ett tidigt skede. Tidigare forskning har i stor utsträckning fokuserat på teknik, enskilda projekt eller små och medelstora företag, vilket innebär att digital transformation hos stora byggentreprenörer fortfarande är relativt outforskat. Det är därför fortfarande oklart hur digital transformation utvecklas i stora byggentreprenörsföretag och hur hinder för uppskalning kan övervinnas inom denna kontext.

Syftet med denna avhandling är därför att undersöka digital transformation hos stora byggentreprenörer, med särskilt fokus på hur digitala pilotprojekt och POC-initiativ kan skalas bortom projektnivån för att stödja transformation på företagsnivå. Fenomenet digital transformation analyseras genom tre ömsesidigt

relaterade dimensioner: *teknologisk innovation* (technological innovation), *affärsutveckling* (business development) och *ekosystemutveckling* (ecosystem evolution). Företaget utgör analysenheten, medan observationsenheten är ledningsnivån för att fånga den transformation som är kopplad till digitalisering. För att undersöka detta har två forskningsfrågor formulerats:

1. Vilka strategiska angreppssätt använder stora byggentreprenörer i relation till digital transformation, och vilka faktorer hindrar eller möjliggör att digitala initiativ skalas bortom projektnivån?
2. Hur kan digital transformation i stora byggentreprenörer konceptualiseras och analytiskt förstås i relation till uppskalning av digitala initiativ?

För att besvara dessa frågor och uppfylla syftet kombinerar arbetet en ”scoping review”, en intervjustudie, fallstudieforskning och konceptuell utveckling, vilket resulterar i en modell som innehåller 72 markörer för digital transformation. Modellen fångar samspelet mellan de tre dimensionerna och fem domäner: *värdeskapande*, *förändringsledning*, *uppskalning av pilotprojekt*, *affärsmodells-innovation* och *engagemang på företagsnivå*.

Som svar på den första forskningsfrågan visar resultaten att företag antingen intar ett *defensivt* eller ett *offensivt* strategiskt angreppssätt till digital transformation. *Defensiva företag* använder främst digital teknik för att förbättra befintlig verksamhet och stärka nuvarande affärsstrukturer. Därför förblir uppskalningen bortom projektnivån begränsad, vilket gör att dessa företag i högre grad förblir bundna av de underliggande hinder för innovation som präglar byggsektorn. *Offensiva företag* använder däremot digital teknik inte bara för att förbättra befintlig verksamhet, utan också för att utveckla befintliga erbjudanden och skapa nya affärsmöjligheter. Därigenom kan digitala initiativ bidra till ny affärsutveckling, affärsmodellsinnovation och ekosystemutveckling. Dessa företag är därmed bättre positionerade att hantera byggsektorns innovationshinder och att skala digitala initiativ bortom projektnivån.

Som svar på den andra forskningsfrågan konstateras att digital transformation hos stora byggentreprenörer kan konceptualiseras som en process som utvecklas genom tre sekventiella steg: *anpassning*, *omkonfigurering* och *adaptation*. På analytisk nivå kan företagens strategiska angreppssätt jämföras med hjälp av 72-markörsmodellen, vilken synliggör tre profiler: *en operativt orienterad digitaliseringsprofil* (operationally oriented digitalisation profile), *en internt orkestrerad transformationsprofil* (internally orchestrated transformation profile) och en *avancerad transformationsprofil* (advanced transformation profile). Den operativt orienterade digitaliseringsprofilen beskriver företag som ser värdet i att bli mer datadrivna, men där merparten av insatserna fortfarande är inriktade mot intern effektivitet, specifika verktyg och lokala initiativ i enskilda affärsenheter. Denna profil är därför kopplad till företag med ett huvudsakligen defensivt angreppssätt. Den internt orkestrerade transformationsprofilen beskriver företag med tydliga strukturer för innovation och förändring, prioriterad finansiering av innovation och starkare satsningar på uppbyggnad av förmågor, där uppskalning främst prioriteras inom företaget snarare än genom affärsmodellsinnovation eller ompositionering i ekosystemet. Denna profil är kopplad till företag som fortfarande i huvudsak är defensiva men som börjar utveckla ett mer offensivt angreppssätt. I den avancerade transformationsprofilen sträcker sig digitalisering bortom isolerade tekniker och är tydligt kopplad till kundvärde, organisatorisk förändring, mekanismer för uppskalning, affärsmodellsinnovation och styrning på företagsnivå. Denna profil är kopplad till företag som har ett tydligt offensivt strategiskt angreppssätt.

Avhandlingens huvudsakliga teoretiska bidrag är 72-markörsmodellen för att studera digital transformation genom samspelet mellan de tre dimensionerna och de fem domänerna. Ur ett praktiskt perspektiv består bidraget av en analysmodell som gör det möjligt för chefer att klassificera företagets angreppssätt till digitalisering, identifiera dess strategiska position och prioritera åtgärder i relation till affärsmässiga, tekniska och

ekosystemrelaterade mål. En begränsning i avhandlingen är att den i huvudsak bygger på kvalitativa intervjudata och att den fokuserar på företagens ledningsnivå, med begränsat djup på projekt- och affärsenhetsnivå. Därutöver innebär fokus på stora byggentreprenörer att resultatens generaliserbarhet till andra typer av företag, såsom små och medelstora företag, är begränsad. Mot denna bakgrund kan framtida forskning vidare pröva modellen genom enkätbaserade ansatser samt genom mer djupgående och longitudinella studier av byggföretag av olika storlek och i olika geografiska kontexter. Den kan också utvidga det empiriska omfånget till att omfatta fler organisatoriska nivåer.

Foreword

Glory be to God for how far He has brought me and how far He is taking me.

Everything I knew before embarking on this PhD journey has evolved, particularly the understanding of how important the people around you are in keeping you motivated, sharp, and encouraged. The support, patience, belief, and critic make all the difference.

First, I would like to thank my supervisors, Martin Rudberg, Annika Moscati, and Dan Engström. You have been monumental in my development as a PhD student. From our first meetings, when I said, "Everything is crystal clear," to the many meetings that followed, when I realised that nothing ever is, thank you for guiding me to that realisation. Thank you for giving me the opportunity to have *a mind of self* and for steering me along the way. Thank you for always going the extra mile and for the time and support I have received from you. The road to enlightenment feels less bumpy because of you.

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Third, I would like to thank my family for their invaluable support. To my beautiful wife, Mulungi, thank you for standing by me and being the backbone that allows me to be what I need to be. To my daughter, Ivory, you are the fuel in my engine. To my Mum, none of this would have been possible without you. Thank you Nyque, Dad, Vicky, Ben, Auntie Vicky (RIP), and Tony.

Norrköping, June 2026

Kefa Kafuluma

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Thesis outline

This licentiate thesis is of a compilation character (thesis by publication), made up of three papers. The thesis comprises of two complementary parts, the introductory part (*"kappa")* and the three papers. Paper 1 is a working paper developed from a previous conference paper. Paper 2 is under revision in *Construction Management and Economics*. Paper 3 is under review for the *Advances in Production Management Systems* conference. The first part describes the background to position the need and relevance of the research. It describes the formulation of the research problem, the purpose, and the research questions. It also includes the theoretical frame of reference and the methods used in the studies that make up this thesis. Furthermore, the first part answers the thesis' research questions, and a discussion of how the purpose is fulfilled. Finally, it describes the main contributions of this research and provides avenues for future research. The second part consists of the three papers that the thesis is based upon and are listed below along with the author's contributions in each paper.

Paper 1
Kafuluma, K., Rudberg, M., & Moscati, A. (2024). "Investigating Digital Transformation in Large Construction Contractors: State, Barriers and Potential Drivers to Firm-Level Change". *Working paper*. Previously presented at the 31st EurOMA Conference in 2024.

Contribution: Kafuluma was responsible for data curation, including the scoping review and data analysis. Kafuluma drafted the original manuscript and prepared the final version. Rudberg and Moscati contributed to data collection and provided feedback and revisions throughout the writing process.

Paper 2
Kafuluma, K., Rudberg, M., & Lepinoy, O. (2025). "Digital Transformation, Value Creation, and Business Model Innovation in

Global Construction Firms: A Multiple Case Study*". In first round of revision in Construction Management and Economics.* Previously presented at the 32nd EurOMA Conference in 2025.

Contribution: Kafuluma was responsible for data curation, analysis, and preparation of both the original and final manuscript drafts. Rudberg and Lepinoy contributed to data collection. In addition, Rudberg reviewed the manuscript and assisted in revising the final draft.

Paper 3
Kafuluma, K., Rudberg, M., & Engström, D. (2026). "Deconstructing Digital Transformation in Global Construction Firms*". Under review for the Advances in Production Management Systems conference and to be presented at APMS 2026.*

Contribution: Kafuluma was responsible for data curation, methodology, analysis, and preparation of both the original and final manuscript drafts. Rudberg and Engström reviewed the manuscript and provided feedback throughout the writing process. Rudberg revised the final draft.

The top of one mountain,
is the bottom of the next,
so, keep climbing!

Andre D.S

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Chapter 1

1 Introduction

This thesis conceptualises the phenomenon of digital transformation within the context of large construction contractors to provide an understanding on how digitalisation efforts can be approached and scaled beyond project level. The introductory chapter provides a background to the research, the research problem, purpose, and the research questions. The chapter concludes with the scope of the research and a disposition of the rest of the chapters in the thesis.

1.1 Background

The construction industry is a major contributor in creating jobs, driving economic growth, and provides solutions for energy, social, and climate challenges (European Commission, 2026). In the European Union (EU) economy, the construction industry accounts for about 9% of the gross domestic product (GDP) and 18 million direct jobs (Ibid). Globally, at the turn of the decade, the construction industry contributed 13% of the world's GDP (McKinsey&Company, 2020; World Economic Forum, 2026).

However, in contrast to high-volume manufacturing industries, such as automobiles or mobile phones, the construction industry generally focuses on single, unique, and bespoke products and solutions. Hence, the achievement of such products and solutions takes on a project format (Halpin, 1998). The project-based nature of the construction industry is characterised by temporary constellations that are often dismantled at the end of the project cycle. In addition, this creates a fragmented construction industry with multiple actors that possess differing goals, which inhibits efforts to a common approach in construction operations.

Following this, the construction industry has struggled with low levels of standardisation, low and volatile margins, cost and schedule overruns, safety concerns, hampered learning, and low levels of

productivity. Construction productivity has declined since 1991 and not kept pace with the overall economic productivity development (Agarwal et al., 2016).

Therefore, the importance of managing activities within the construction industry cannot be overstated. However, within this project-based framework, the focus is mainly on the planning and control of resources at the project level. Consequently, construction professionals tend to focus on project management and not so much on strategic management (Chinowsky and Meredith, 2000). In this regard, strategic management addresses issues related to running a construction organisation (firm level) rather than an individual project.

Similar to various other industries such as banking, manufacturing, entertainment, and healthcare, among others, the construction industry over the years has embraced innovation and digital technologies to mitigate their inherent challenges. For several decades, Information Technology (IT) has been developed and implemented within construction. Studies have shown that earlier focus was on incorporating technologies that enhance a firm's internal efficiency (Samuelson and Björk, 2014). In recent times, technological developments that impact the core construction operations and functions have evolved and been adopted (Samuelson and Stehn, 2023; Vararean-Cochisa and Crisan, 2024).

Such technologies include Building Information Modelling (BIM) used in modelling and simulation; Common Data Environments (CDEs) that are used to collect, manage, and disseminate graphical and non-graphical documentation for construction projects; Artificial Intelligence (AI) used to classify, predict, process images, and address mundane tasks. Other recent digital technologies in the construction industry include Unmanned Aerial Vehicles (UAV), big data and analytics, blockchain and Internet of Things (IoT), among others. These technologies have facilitated various capabilities in construction including robotics and automation, offsite construction, connectivity, and cloud-based project management.

However, innovating using digital technologies in the construction industry has been anything but straightforward. Both earlier studies

and recent literature have discussed barriers surrounding the adoption of digital technologies in the construction industry. The complexity of the construction industry has been documented for decades (Cox and Goodman, 1956; Shammas-Toma et al., 1998; Winch, 1987; Gidado, 1996). Many studies in recent times have pointed to this complexity and nature of the construction industry as an intrinsic barrier to innovating with digital technologies (Mohd Nawi et al., 2014; Reichstein et al., 2005; Samuelson and Stehn, 2023).

Furthermore, various researchers have argued that other industries, such as manufacturing, have developed further in how they embrace digital technologies (Parida et al., 2019; Nissen, 2017). As such, the common argument was that the construction industry would be better off to change behaviour in accordance with other industries' norms. However, Dubois and Gadde (2002) argued that management techniques that improve performance in other industries are not readily transferrable to the construction industry. Moreover, they argue that the construction industry has the features of a loosely coupled system that undermines innovation.

Nonetheless, incumbents within the construction industry, particularly large construction contractors, are keen on leveraging digital technologies to gain competitive advantage and not be left behind. Contractors are doing so by running digital pilot projects and proofs of concept (POCs) as test bed projects to test and evaluate digital technologies. One example is the *Connected Construction Site* project in Sweden, which ran between 2017 and 2021 as a large-scale collaborative test bed initiative focusing on digitalisation in construction planning, production, and supply processes (Connected Construction Site, n.d.). It functioned as a structured experimentation platform where digital technologies were tested through iterative "*sprints*" across multiple test bed environments. Benefits and potential of such digital pilot projects have been documented in various academic studies such as Sezer and Rudberg (2021) and Rudberg and Stehn (2024). Sezer and Rudberg (2021) demonstrated the benefits and potential of IoT sensors and digital twins technology in increasing safety and construction workers' well-being.

The pilots were designed to facilitate learning across projects, whereby tests conducted within a given test bed project often form a sequence of related experiments on similar technologies. In this approach, lessons learned from earlier tests are systematically carried forward and inform subsequent implementations (Connected Construction Site, n.d.). Consequently, the knowledge and benefits generated are not only intended to accumulate at the project level but also to be scaled and embedded at the firm level (Gholami et al., 2022). One way of achieving such firm-level impact in project-based industries is through business model innovation (BMI) (Wikström et al., 2010).

However, contractors have struggled to scale these lessons and benefits beyond the project level. For example, in the case of the *Connected Construction Site* project, observations suggest that firm-level impact such as BMI in the aftermath of the pilots was limited. In particular, there remains uncertainty regarding how isolated POCs and testing initiatives can influence other projects and the firm in environments where each project is treated as having a life of its own (Dubois and Gadde, 2002). Similar challenges are reflected in the literature on other project-based industries, where barriers to learning and innovation are well documented. For example ship building industry by Formentini and Romano (2011), film industry by Ferriani et al. (2005), and aerospace industry by van der Heiden et al. (2015). In this context, large construction contractors face difficulties in transferring learning across projects, and firm-level impact tends to remain limited following digital pilot projects. This provides a starting point for further investigation into how digitalisation efforts can be scaled beyond individual projects, to other projects and the firm.

Digital efforts such as POCs and digital pilot projects have been discussed in previous literature looking into digitalisation and digital transformation phenomena. On one hand, some studies have conceptualised digitalisation as the incorporating of digital technologies within a firm's operational processes (Verhoef et al., 2021). On the other hand, some studies have discussed the digital transformation phenomenon in a broader perspective beyond

operational processes to include changes in business models and firm ecosystems (Lundberg et al., 2020; Nyqvist et al., 2024). Existing research on digital transformation in construction that adopts this broader perspective has largely focused on small and medium-sized enterprises (SMEs) such as Lundberg et al. (2020) and Nyqvist et al. (2024), leaving large construction contractors relatively underexplored. Following this background, the next section pinpoints and presents the research problem.

1.2 Research problem

This thesis conceptualises and describes the research problem as the *Yet Another Pilot* (YAP) syndrome (see Figure 1). YAP syndrome is the recurring pattern in project-based organisations where new methods or technologies are tested in isolated pilot projects that generate insights but fail to transition into regular operations. A YAP situation arises when structural, organisational, or contractual barriers prevent pilots from being scaled, leading to repeated one-off experiments instead of cumulative learning and long-term capability building.

Previous studies have shown that testing and adopting digital technologies uncover new paths of value creation, most notably as discussed by Vial (2019). Other studies have shown that this evolution of value paths requires changes in the firm's business logic, particularly through business model innovation (BMI) (Samuelson and Stehn, 2023; Veile et al., 2022). More broadly, the literature suggests that firms in a position to reinvent their business logic are better able to scale the benefits of pilot projects into businesses and markets (Nyqvist et al., 2024; Samuelson and Stehn, 2023; Vial, 2019) (see green arrows in Figure 1). This provides a considerable level of continuity for firms to break through industry and organisational barriers so that POCs can impact new projects, existing and new business, as well as existing and new markets (see green arrows in Figure 1). Otherwise, the loop into another pilot emerges, which has been the aftermath of digital pilot projects for large contractors (see black arrows in Figure 1). More recently, Stehn and

Erikshammar (2025) have identified capabilities across the ecosystem, project, and firm interfaces that can support the scaling of isolated POCs. In a similar way, this thesis views digital transformation across business, technological, and ecosystem dimensions when considering YAP, its underlying causes, and potential ways forward for large contractors. The YAP syndrome outlined above forms the basis for the purpose and research questions of this thesis that are described in the following section.

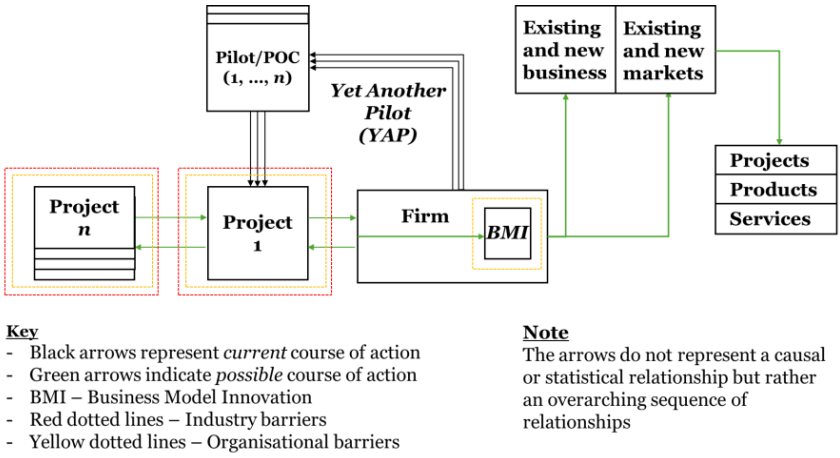

Fig 1. Existing YAP syndrome within digital transformation of large construction contractors

1.3 Purpose and research questions

The purpose of this thesis is to investigate digital transformation in large construction contractors, with a particular focus on how digital pilot projects and proof of concept initiatives can be scaled beyond the project level to support firm-level transformation.

Concerning *firm-level transformation*, the long-term goal of any construction firm is to build and sustain a profitable business. Therefore, as firms adopt digital technologies, run pilot projects, and integrate solutions into their operations, it is important to consider how these activities impact the firm. In other words, how they change the way the firm does business and how it collaborates with partners

in its ecosystem. Based on this, firm-level transformation is defined in this thesis as the business changes that occur within a firm due to digital technology adoption and integration, considering changes in technology and the ecosystem. As such, firm-level transformation and the thesis purpose is addressed through two research questions.

1.3.1 Research question 1

Previous studies show that digital transformation involves changes in products, services, processes, business models, value chains and ecosystem networks (Samuelson and Stehn, 2023; Matt et al., 2015; Criado-Pérez et al., 2022). Because these changes are far-reaching, such significant changes must be orchestrated at the strategic level. Top management therefore plays a central role in setting and paving the trajectory for the entire firm to follow (Wrede et al., 2020; Furtado, 2025; Zhang et al., 2023b; Larjovuori et al., 2018). In addition, top management buy-in is necessary for digital pilots and POCs to get approved, funded, and executed (Sepasgozar et al., 2016). Following this, the first research question of this thesis is formulated as:

RQ 1: What strategic approaches do large construction contractors adopt in relation to digital transformation, and what factors hinder or enable the scaling of digital initiatives beyond the project level?

To clarify what is meant by *strategic approach*, strategy is the "creation of a unique and valuable position, involving a different set of activities." (Porter, 1996: , p. 1). In this sense, strategic approach strives to sustain competitive advantage while maintaining the distinctiveness of the firm. This implies that either a firm performs different activities from rivals or similar activities but in a different way. As such, Porter (1996) argues that strategy requires making trade-offs in choosing what not to do and it involves creating fit among the firm's activities. Since digital transformation requires changes orchestrated at the strategic level, strategic approach in this thesis refers to how a firm positions, makes trade-offs and creates fit in their digital technology initiatives to meet established firm goals.

1.3.2 Research question 2

Strategic responses and changes in value creation paths are some of the building blocks of digital transformation (Vial, 2019; Samuelson and Stehn, 2023). Such responses include business model innovation, through which firms leverage digital technologies within the existing business and markets, as well as potential new businesses and markets (Liere-Netheler et al., 2018; Hess et al., 2016). However, business model innovation has not been a priority in the construction industry (Das et al., 2023; Lavikka et al., 2018; Pullen et al., 2019; Lepinoy, 2020). Therefore, there is a need for conceptualisation of digital transformation in relation to the long-term challenge of scaling digital initiatives and generating impact on firms' business and markets. As such, a second research question is formulated as:

RQ 2: How can digital transformation in large construction contractors be conceptualised and analytically understood in relation to the scaling of digital initiatives?

The question seeks to provide a conceptual and analytical understanding of digital transformation and develop strategies for scaling up digitalisation in a way that generates long-term business value.

1.4 Scope

The scope of this research relates to the digitalisation efforts in large construction contractors and the firm-level perspective of these efforts. In the digital transformation process described by Verhoef et al. (2021), this research focuses beyond digitisation and digitalisation and focuses on digital transformation, which includes strategic opportunities such as BMI, extending service and product portfolios, new customer segments, and entry into new markets. The subsequent subsections describe the study object, unit of observation, unit of analysis, and the delimitations of this research.

1.4.1 Study object

This research targets large construction contractors who have been involved in running digital pilot projects and POCs. Throughout the course of this thesis, the term *contractors* will be used to refer to large construction contractors. This focus on the contractors is motivated by several considerations. First, the YAP syndrome was observed in the aftermath of the *Connected Construction Site* project (Connected Construction Site, n.d.), in which several large Swedish construction contractors were involved. This provided a relevant empirical context for this thesis, as it would capture the outcome of digital pilot projects.

Second, due to their size and resources, large contractors manage and run pilot projects and exert influence and control over subcontractors. Thus, the large contractors shape the adoption of digital technologies across different projects. Lastly, interdependence and uncertainty as described by Dubois and Gadde (2002) exacerbate inertia and resistance, and legacy structures that are more prevalent in larger firms.

1.4.2 Unit of analysis and observation

The primary unit of analysis of this research is the firm, as this research examines why project-level benefits and lessons do not translate into firm-level outcomes. This focus is also relevant because decisions regarding implementation of digital technology are made at the firm level (Sepasgozar et al., 2016) and require alignment of the technology and both project-level and firm-level factors (Wernicke et al., 2023).

The unit of observation is at the corporate level, focusing on innovation and digitalisation activities within the contractors. Digital initiatives are typically initiated and funded at the corporate level, reflecting the role of top management (Hess et al., 2016). This is important in project-based industries characterised by temporary constellations and distributed execution environments (Dubois and Gadde, 2002). As a result, top management and corporate-level actors play a key role in deciding the objectives of digitalising efforts, including whether initiatives are primarily aimed at operational improvements or at broader strategic and business impact.

Accordingly, data was collected from corporate-level actors responsible for innovation or digitalisation in contractor firms. While the unit of observation focuses on the corporate-level actors and processes, the unit of analysis is the firm, where the implications of the processes are interpreted.

1.4.3 Delimitations

In this thesis, digital technologies do not refer to a specific set of tools or applications but to a range of technologies in the construction industry, as described by the concept of *Construction 4.0* (Sawhney et al., 2020). Therefore, the term digital technology includes technologies such as BIM, CDE, IoT, Virtual Reality (VR), AI, among others.

This research is delimited to large contractors and therefore excludes small and medium-sized enterprises (SMEs), despite potentially providing relevant but different perspectives. This delimitation is made in relation to the scope and study object of this research.

From a theoretical perspective, this thesis frames the digital transformation phenomenon within a triad of technology, business, and ecosystem dimensions as proposed in Nyqvist et al. (2024). Hence, the findings of the research are interpreted within this theoretical boundary.

1.5 Disposition

The first chapter of this thesis provides a brief background to the research and introduces the *Yet Another Pilot* (YAP) syndrome. The chapter then introduces the purpose and research questions, and the scope of this study. Next, the second chapter provides the theoretical frame of reference describing innovation in construction, the digital transformation phenomenon as conceptualised in this thesis, and the triad dimensions of technological innovation, business development and ecosystem evolution. The design and methodology of this research is presented in chapter three. This chapter also motivates and justifies the research process and shows how the different studies

in this research are connected to one another. Next, the thesis summarises the three papers on which this thesis is built upon in chapter 4. The thesis then presents the main findings of this research to provide answers to the research questions and purpose fulfilment in the fifth chapter. Lastly, the sixth chapter outlines the contributions of this research as well as the limitations and avenues for future research.

Chapter 2

2 Theoretical frame of reference

This chapter describes the concepts and theoretical framing on which this research rests. First, the nature of the construction industry is discussed followed by how this nature undermines innovation. The digital transformation phenomenon is then presented in the context of large construction contractors. The triadic theoretical lens of technological innovation, business development and ecosystem evolution through which the phenomenon is studied, is presented. Finally, a synthesis of the chapter is briefly outlined.

2.1 The nature of construction

Although it may seem apparent that ideas from other industries can easily be replicated in the construction industry, various studies have highlighted the unique difficulties of such replication. Particularly, Dubois and Gadde (2002) make an argument on how the construction industry functions as loosely coupled system (Weick, 1976), a characteristic that deters innovation.

The initial argument is that in the construction industry, firms' behaviour can be viewed as their attempts to cope with the complexity of construction projects. Such complexity is either related to uncertainty or interdependence (Gidado, 1996). Uncertainty deals with the components that are inherent in the operation of individual tasks while interdependence relates to complexity from bringing different parts together to form a workflow.

Another argument is that construction emphasises site-specific activities from which Dubois and Gadde (2002) identify two central features of construction. First, the focus is on individual projects in terms of financial control and decentralised decision making. Secondly, there is need for local adjustment at the construction site. This emphasis on individual projects favours a narrow perspective both in time and scope.

In this way, the construction industry features as a loosely coupled system. This characteristic is closely linked to its nature as an engineer-to-order (ETO) industry, where projects are tailored to specific client requirements resulting in high variability and limited standardisation (Gosling and Naim, 2009). Moreover, construction teams seldom work together in more than one project and if they do, they may do so in altered roles. Hence, the couplings between activities at one site and activities on another site are loose. Even less tight are the couplings between activities performed by different firms beyond the scope of the individual project.

A project may be considered as a specific temporary network within a more permanent network. The pattern of couplings is tight in the individual projects and loose in the permanent network. The loose couplings undermine coordination efforts for handling complexity in construction compared to other industry contexts that is managed through the tight couplings among firms. Therefore, in construction there exist few inter-firm adaptations beyond the scope of individual projects. Even within interorganisational project settings, coordination and knowledge transfer across projects remains difficult (Bosch-Sijtsema and Postma, 2010). Moreover, collective adaptations do occur (Dubois and Gadde, 2000), but these are formed within communities of practice (Brown and Duguid, 1998) and remain largely on project constellations.

Furthermore, construction is characterised by technical interdependence and organisational independence (Crichton, 1966). The organisational arrangements are then based on the assumption that dependence on individual counterparts must be avoided due to fears of the problems the dependence might exert. Yet, developing close relationships and tighter couplings would have some benefits. Another characteristic of the inter-firm relationship is existence of loose couplings within the different entities of the firm due to decentralisation of authority to the individual project. This decentralised decision making makes the projects managers focus on maximising their own rewards and accomplishments (O'dell and Grayson, 1998). Hence, it is common that project managers will act in ways that contradict the strategic goals of the firms. As such, the focus

on the individual projects' self-determination breeds a situation where the right hand does not know what the left hand is doing (Dubois and Gadde, 2002). Thus, the much-discussed relevance of ambidextrous capabilities to manage innovation within construction firms (Hoessler and Carbon, 2022; Holotiuk and Beimborn, 2019).

In sum, this subsection highlights characteristics of the construction industry, including loose coupling, temporary project constellations, decentralised decision-making, ETO nature, and limited standardisation, among others. Taken together, these characteristics highlight the difficulties in learning, coordination and knowledge transfer across projects. While local adaptations occur, they are often difficult to transfer across projects or impact the firm level. This creates an environment that harbours barriers to innovation.

2.2 The nature of construction as a barrier to innovation

Learning is crucial to manage the knowledge transfer across projects and to the firm. Learning is related to previous activities and experiences. Hence, if the learning environment is continuously changing, it is hard to form cognitive structures and as such learning is hampered (Dubois and Gadde, 2002). After all, learning involves trying, feedback and evaluating. A process that has been difficult for the most part due to the temporary constellations that are prevalent in construction.

The pattern of couplings in construction makes each construction site an experimental workshop. In essence, this could favour the development of new ideas. Thus, the loosely coupled system would potentially generate many novel solutions than a tightly coupled system. Although this indicates that various sites would adapt to unique conditions without involving the entire system, the same loose couplings could hinder the spread of benefits that exist in the system (Weick, 1976). As such, the loosely coupled system's structure that may allow novel solutions develop, undermines their percolation through the system.

Furthermore, the pattern of couplings related to the project, the individual firm and relationships among stakeholders have impeded innovation. Firstly, the project organisation neither supports knowledge transfer (Bosch-Sijtsema and Postma, 2010) nor learning since there is no future guarantee of contacts. Learning brought about by experience, is a slow and uncertain process that takes place at an individual level (Argyris and Schön, 1978). Also, the time constraints of projects make it difficult for individuals to learn and benefit from research and development projects (Von Krogh, 1998). Additionally, not much time is allocated to transmitting knowledge and experience across projects. In this way, the projects can be described as having no organisational memory, which is essential to facilitate learning beyond a single project (Dubois and Gadde, 2002).

Secondly, the organisational arrangements within firms with reference to the loose couplings make it hard to interfere with the decentralised decision making on sites, affecting learning and innovating (Weick, 1976). Therefore, in the event of lessons learnt at the end of pilot projects, the pattern of couplings negatively impacts spreading of information upstream into the firm level (Stehn and Erikshammar, 2025).

Thirdly, the loose couplings within the permanent network are a barrier to innovation. Often, long term relationships and adaptations beyond individual construction projects are absent, which impedes learning and innovating. The temporary constellations of firms at construction sites often do not have plans beyond the project. As such, neither people on projects nor the firm become *one within the group* but rather become *one within a group,* whose constitution varies across projects (Dubois and Gadde, 2002). Tighter couplings among the firm within the permanent network would therefore be an enabler of innovation.

Lastly, the strength of the community practice of the construction industry is a barrier to innovation. Community practice describes the shared understanding of what is done and how it's done (Brown and Duguid, 1998). Therefore, this impedes innovation since it tends to make firms similar and independent. It exacerbates learning because interdependence and heterogeneity are greater incentives of

collaboration than discipline and homogeneity (Powell, 2002). This strength of community reinforces legacy structures, inertia, and resistance within the industry.

In conclusion, the pattern of couplings within construction favours traditional performance measures such as a productivity focus at the expense of innovation. Ironically however, the construction industry trails other industries such as manufacturing in both productivity and innovation. The loose coupling to the overall network structure makes the performance criteria only relevant within the context of an individual project. Consequently, it distorts inter-firm cooperation, and the contractor finds it problematic to coordinate efforts across projects. Therefore, focusing less on the project boundary would perhaps improve coordination within innovation. Emphasis on the interdependence among firms over the independence of projects and firms could support innovation efforts. Digital technologies and digitalisation are examples of such innovation and have been discussed within digital transformation literature. The following section describes how digital transformation is discussed in the literature, before presenting how the phenomenon is conceptualised in this research.

2.3 Digital transformation in construction

The digital transformation phenomenon is being studied in construction literature as well as within business research and other disciplines. An argument can be made that from a maturity of knowledge perspective, the phenomenon is within a nascent theory phase (Åhlström, 2016). Nonetheless, several authors have described digital transformation, including Verhoef et al. (2021), who argued that the introduction of digital technologies evolves through three stages: *digitisation*, *digitalisation* and *digital transformation*.

2.3.1 Digitisation

Digitisation refers to the conversion of analog information into digital format so that computers can store, process, and transmit the

information (Verhoef et al., 2021). It relates to the transition of tasks from analog to digital or the incorporating of information technology (IT) within existing tasks. Examples of digitisation include ordering processes using digital forms and digital surveys. In construction, an example would be the converting of existing construction data into digital format. Digitisation in itself neither impacts existing business processes nor alters the value creation process. For that to happen, digitalisation is needed.

2.3.2 Digitalisation

Digitalisation on the other hand describes how digitisation, digital technologies or IT can be used to impact business processes (Li et al., 2016). An example of such would be to create a new mobile or online channel that changes the customer-firm interaction. Such a transition is followed by a new socio-technical structure that was non-existent without the digital technology (Dougherty and Dunne, 2012). With digitalisation, IT enables new business possibilities by altering the existing business processes such as distribution, financial tasks, administration, communication, and business relationship management (Verhoef et al., 2021; Samuelson and Björk, 2014). Through digitalisation, a firm uses digital technologies to optimise existing business processes by improving efficiency between and within processes. The firm is then able to create new customer value for example through enhancing the customer experience (Pagani and Pardo, 2017). As such, digitalisation focuses on cost savings as well as process improvements that in some way positively impact the existing customer experience. In construction, digitalisation involves changing how construction works are executed (Eze et al., 2024). Thus, core functions and operations evolve. BIM has been one of the digital technologies that has had a profound effect on core construction functions and operations in recent years. Digitalisation precedes digital transformation in these stages.

2.3.3 Digital transformation

The last phase of this evolution that Verhoef et al. (2021) described is digital transformation that they argue involves a firm-wide change

that leads to the development of business models, which may be novel to the parent firm or industry. Matt et al. (2015) state that this phase involves digitalisation initiating overall changes in products, services, processes, business models, and value chains. The changes occur in the firm and ecosystem, requiring a need for the firm to innovate using digital technologies and adapt to these changes in their ecosystems (Vial, 2019). Thus, it encompasses broader changes in the firm's business than the mere introduction of IT or an increase in the use of IT (Samuelson and Stehn, 2023). The changes go beyond simple organisational processes and tasks to altering the business logic of the firm (Li et al., 2018) and the value creation processes (Gölzer and Fritzsche, 2017).

Altering the business logic and the value evolution processes requires the business model to evolve in tandem. Firms compete and gain competitive advantage in the market through how they have designed their business model. The business model defines how the firm creates and delivers value to the customer, and converts payments received to profits for shareholders (Teece, 2010). In other words, it articulates the firm's value creation, value delivery, and value capture strategies. Since digital technologies bring about this alteration in value creation, firms must adjust their value delivery and capture strategies. This calls for the firms innovating their business model by extending existing business models or by adopting new business models. Therefore, digital transformation is linked to the strategic changes in the business models as result of digitalisation (Sebastian et al., 2020). However, indications of such changes within contractors remain limited. The following subsection addresses this gap by outlining how digital transformation can evolve in this context and introduces three sequential steps that together conceptualise what is referred to in this thesis as digital-enabled transformation.

2.3.4 Digital-enabled transformation for contractors

Literature has indicated that the digital transformation phase described by (Verhoef et al., 2021), including value evolution and business model innovation (BMI), is still uncertain within construction. Samuelson and Stehn (2023) argue that there are few

indications that such changes have occurred within the construction industry. Das et al. (2023) argue that processes that require innovating business models have been of low priority in construction.

Barriers of such efforts have been discussed in Section 2.2 on a general-innovation level but also by various authors on a firm level including Perera et al. (2023), Criado-Pérez et al. (2022), and Vial (2019). For large contractors, legacy structures have impeded BMI (Verhoef et al., 2021). Developing ambidexterity efforts are still insufficient to manage the conflicts and trade-offs between existing and new ways of doing business (Christensen et al., 2016). Overall, perhaps an inherent question has been arising, why change a business model that is profitable today?

Given these underlying barriers and the ambiguity surrounding what digital transformation entails for large contractors, this thesis conceptualises digital-enabled transformation as an alternative way of understanding how such transformation may unfold (see Figure 2). Transformation, in this context, is understood as a radical, non-linear, and structural process within complex adaptive systems (Feola, 2015). Accordingly, digital-enabled transformation is conceptualised as comprising three sequential and interrelated steps: *alignment*, *reconfiguration*, and *adaptation* (Kafuluma et al., 2025b).

Alignment involves the firm's continuous and strategic use of the digital technology to align its existing processes with the new digital processes. Arguments have been made that digital technologies and other innovations are only effective if aligned with common goals and embedded within existing roles, responsibilities, and working methods (Samuelson and Stehn, 2023). Hence, the exploration with new digital technologies and the exploitation to improve existing processes become essential to the firm's strategic goals. Consequently, firms need to balance these forces by developing ambidexterity, for example structural and temporal ambidexterity (Hoessler and Carbon, 2022; Holotiuk and Beimborn, 2019).

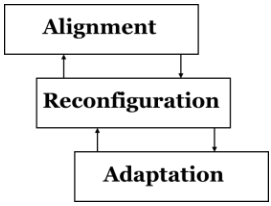

Fig 2. Sequential steps of digital-enabled transformation (Kafuluma et al., 2025b)

With aligned existing and new processes, firms need to *reconfigure* core activities and integrate main stages of the value chain. This ought to happen through collective efforts and expertise of its personnel to build dynamic capabilities. Such strategies include organisational restructuring (Nour and Arbussà, 2024) and reconfiguring workforce and infrastructure capabilities (Jiang et al., 2023; Jonathan and Reychav, 2024).

Following aligned processes and reconfigured core activities, the firm needs to *adapt* the firm's business logic. This involves the firm redefining the value creation, delivery and capture mechanisms. New value created requires the firm to innovate the existing business model and leverage the potential new value propositions and business value. Potential change in products and services need new forms of monetisation and delivery (Matt et al., 2015). Proactiveness in reshaping the business models allows changes in the ecosystem that allows firms tap into new markets (Criado-Pérez et al., 2022). It is important to note that these sequential steps move back and forth between each other because the technology, the business and ecosystem are always changing. Together, these three steps describe how digital transformation can unfold within contractors, leading to changes in business models and new value mechanisms.

These three processes of *align*, *reconfigure* and *adapt* as discussed impact various parts of a firm, projects, stakeholders, and markets. Thus, they require a holistic approach to understand, but also to clearly define and discuss. *Alignment* tends to bring a technology focus, where the key question is which tools or technologies are adopted, developed, or avoided. *Reconfiguration* shifts the attention to capabilities and how existing business and new business relate to the technology being adopted or developed. *Adaptation* makes the

impact of technology on the business salient since the firm's business logic and business models are changing. Moreover, the broader market conditions and possible new markets become more relevant. Therefore, a multi-dimensional approach becomes crucial for understanding digital transformation. Nyqvist et al. (2024) do this by proposing a combination of three dimensions of *technological innovation*, *business development* and *ecosystem evolution* as a holistic approach to study digital transformation (see Figure 3). This approach was adopted for this research, and the next section digs deeper into the focus of these dimensions and how their triadic combination was used in the thesis.

2.4 Triadic lens to study digital transformation

Nyqvist et al. (2024) argue that often in general business research digital transformation is studied in either single or dual dimensions, typically focusing on technology, business or ecosystem aspects in isolation or partial combinations. They argue that a more holistic approach is necessary when studying the phenomenon and propose a triadic lens to investigate digital transformation. The triadic lens comprises *technological innovation*, *business development* and *ecosystem evolution* dimensions. A combination of the dimensions (see Figure 3) allows for analysis of interdependencies between them that exist in the real world. The dimensions are further described in the following subsections.

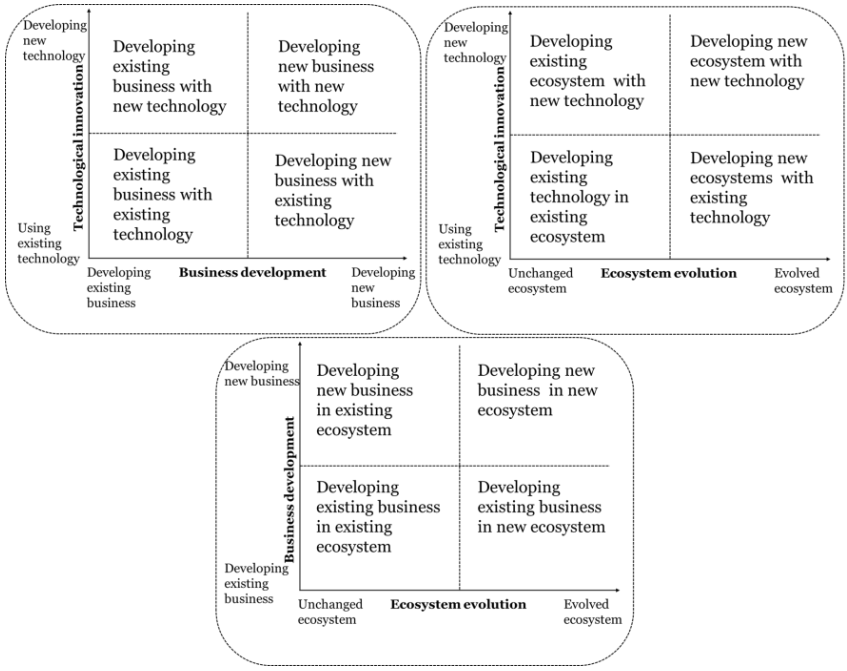

Fig 3. A combination of dimensions to investigate digital transformation (Nyqvist et al., 2024)

2.4.1 Technological innovation

The technological innovation dimension focuses on the technology and how it changes (Nyqvist et al., 2024). The focus here is how does the firm develop existing technology and how does it develop new technology over time. In other words, understanding the impact of advances in the technology towards the digital-enabled transformation as described in Section 2.3.4. As mentioned in earlier sections, various technologies are at play within construction today and as such several capabilities have been developed. AI is used for predictive analytics and data-driven decision making, robotics are facilitating automation, BIM has revolutionised how buildings are modelled and monitored, and digital twins have enabled real time monitoring of infrastructure.

As such, the technologies are changing operational processes with potential to impact business innovation and business ecosystems as

well (Cannavacciuolo et al., 2023). Therefore, as described earlier, this impact in the business and ecosystem realms requires further investigation. Many of the underlying barriers relate to the technological innovation dimensions such as insufficient data infrastructure, data interoperability, and inadequate digital skills. But as described, the barriers go beyond the technology and a more nuanced analysis would be achieved if looked at in tandem with the other two dimensions i.e., business development and ecosystem evolution.

2.4.2 Business development

The business development dimension focuses on the firm's development in business models and business strategy (Porter, 1996). The perspective follows how the firm develops existing business and new business due to adopting digital technologies (Nyqvist et al., 2024). The focus is to understand the business value of the technology and how to best deliver and capture it to either existing or new customers. After all, the primary objective of any firm is to generate profit and provide value to the shareholders or owners. So, is digital transformation an end or is it a means to an end? Löwstedt and Sundquist (2022) argue that, in the future, data will have such a significant business value in construction that it will be impossible to ignore. Value creation will be in the physical products and redistributed to the data linked to them.

As the technology progresses, so must the business strategies, products and services tied to the progression. Capabilities such as digital design services and platform-based solutions have developed with a huge business potential for firms. Moreover, technologies provide potential new revenue streams, which requires a new value capture strategy and therefore BMI. For construction that still struggles with low-margins, acting on the business potential of the technology is only prudent. Digital strategies should evolve with the business strategy. As described, this is a dimension in which large contractors have been least proactive. Thus, this thesis adds this dimension to the other two in understanding the underlying issues and the way forward.

2.4.3 Ecosystem evolution

The ecosystem evolution dimension focuses on the evolving nature of relationships, roles and contributions of the multiple stakeholders that firms interact with as they digitalise (Nyqvist et al., 2024). Particularly, this concerns firms outside the boundaries of the parent firm, such as technology firms, start-ups, and government among others. Various barriers as discussed in Section 2.2 relate to the broader construction industry in terms of fragmentation, numerous stakeholders, and complexities. As such, cohesive efforts across the system are still limited and improved collaboration could bridge those gaps (Lundberg et al., 2020). Moreover, the construction industry is well known to have a low barrier to entry with digital startups having the ability to shake things up. Löwstedt and Sundquist (2022) refers to the possible rise of such stakeholders called *game changers* with the business model logic anchored in digitalisation. Thus, the relationships, roles and evolution in the ecosystem become of concern and interest to the large contractors. This dimension reveals structural and relational changes that contribute towards describing digital transformation complementing the other two dimensions (Nyqvist et al., 2024). The effectiveness of redefining the value capture thus depends on how well the firm and the technology matches and contributes to the evolving ecosystem.

2.4.4 The triadic perspective

The amalgamation of these three dimensions provides the lens through which this research is bounded (see Figure 4). Unlike the 2D surfaces of interaction (see Figure 3), this thesis combines the dimensions all at once to provide three-dimensional interactions (see Figure 4). Together, these dimensions create eight analytical spaces within which digital transformation can be examined. Similar to Figure 3, the lower and upper bounds of the axes of the dimensions are the same in Figure 4. At the base, the four analytical spaces are: developing existing business with existing technology within an unchanged ecosystem, developing existing business with existing technology within an evolved ecosystem, developing existing business with new technology within an unchanged ecosystem, and developing

existing business with new technology within an evolved ecosystem. At the top of the cube, developing new business with existing technology within an unchanged ecosystem, developing new business with existing technology within an evolved ecosystem, developing new business with new technology within an unchanged ecosystem, and lastly developing new business with new technology within an evolved ecosystem. By doing this 3D combination, the research examines the interactions between the dimensions in more depth.

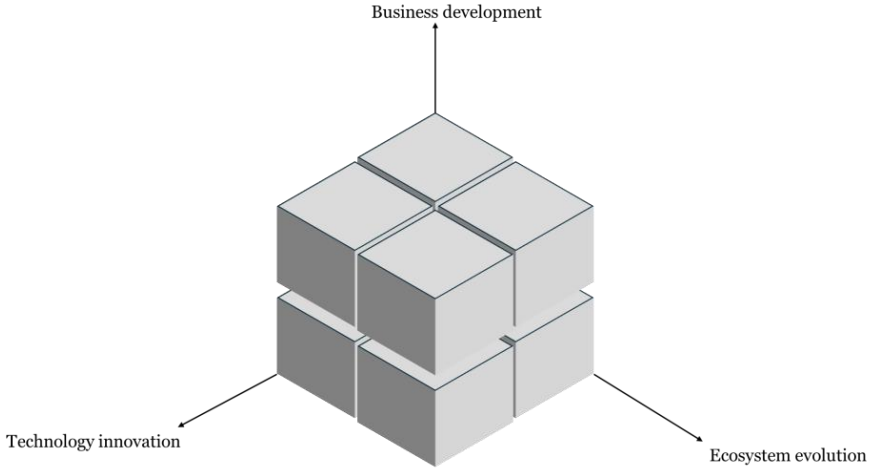

Fig 4. Triadic lens to study digital transformation (Kafuluma et al., 2025b)

2.5 Synthesis of the theoretical frame of reference

This chapter first described the nature of the construction and how this nature limits innovation by creating barriers to learning and knowledge transfer. It then showed that despite these underlying issues, firms innovate with digital technologies. This integration of digital technologies is covered in digital transformation literature that describe it through three stages of digitisation, digitalisation, and digital transformation. The final phase of digital transformation in the context of large contractors is conceptualised and described as a sequential process of *align*, *reconfigure*, and *adapt*. The chapter concludes by suggesting that the literature further indicates that digital transformation phenomenon is best approached through a

triadic lens of *technological innovation, business development and ecosystem evolution* (see Figure 4).

The synthesis follows that it is important to understand the nature of the construction industry as a bespoke, project-based industry, with multiple stakeholders, and loosely coupled (Gidado, 1996; Dubois and Gadde, 2002; Weick, 1976). All of which make coordination, learning and innovation difficult to sustain across projects and to the firm (Bosch-Sijtsema and Postma, 2010; Stehn and Erikshammar, 2025; Von Krogh, 1998). These characteristics are closely linked to the ETO nature of the industry and help explain why local adaptations often remain confined to individual projects (Gosling and Naim, 2009). This context is important to understand these structural underlying barriers to innovation.

One way construction firms are innovating is with digital technologies. The progression of this integration of digital technologies has been described in literature to go through stages of *digitisation*, *digitalisation*, and *digital transformation* (Verhoef et al., 2021). While construction firms have progressed through the first two stages, *digital transformation* remains uncertain (Samuelson and Stehn, 2023; Vial, 2019). Drawing on the literature of the barriers involved, this thesis conceptualises this final phase as a sequential three-step process of *align*, *reconfigure*, and *adapt* (Kafuluma et al., 2025b).

Because this phase of digital transformation is multidimensional itself and is associated with multi-perspective barriers, it ought to be studied with a holistic approach (Nyqvist et al., 2024). This approach combines three dimensions of *technological innovation*, *business development* and *ecosystem evolution*. Although Nyqvist et al. (2024) combined the dimensions (see Figure 3), in this thesis the combination is extended further to a 3D configuration to expose more interactions between the dimensions (see Figure 4).

Collectively, this theoretical build-up forms the conceptual stance of this thesis. It guided how the author approached the research in terms of understanding the problem, choice of methods and how to collect data, analyse it, interpret it and generate results. Furthermore, it guided the preconceptions that the author had going into the data

collection phase. Such a preconception is that the barriers in construction are not simply in the introduction of digital technologies, but the translation of such efforts within the business and ecosystem. Therefore, the theoretical frame of reference provides an avenue to understand how digital efforts can move from one project to impact the next, the firm, and the ecosystem.

3 Research process

This chapter describes the overall research design, including the research process, the studies, and the methodology considerations. The specific research designs of the individual papers are presented in Chapter 4.

3.1 Overview of the research process

The research process is depicted in Figure 5, showing the studies and papers that make up the licentiate thesis. The figure illustrates the process from the start of the research up until the licentiate defence. The research process began in September of 2023 and ends in June 2026.

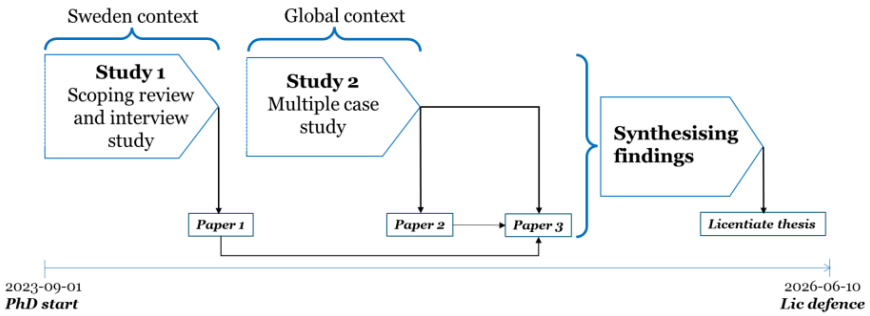

Fig 5. Research process overview

The research process unfolded across two studies. Study 1 resulting in Paper 1 and Study 2 resulting in Papers 2 and 3 (see Figure 5). Further details of the papers including the scope, methods and how each study's papers relate to the overall research questions are outlined in Table 1. The study designs are described in the subsequent two sections.

Table 1. Papers from Study 1&2 including scope, method, and corresponding thesis RQ of each paper

Paper	Scope	Method	Research question	
			RQ 1	RQ 2
Paper 1	Describing the current state, drivers and barriers of digital transformation within Swedish contractors	Scoping literature review and interview study	X	
Paper 2	Benchmarking digital transformation with global large contractors	Multiple case study	X	
Paper 3	Conceptualising digital transformation with global case illustrations	Conceptual with case illustrations		X

3.2 Study 1 overview

Study 1 was conducted at the beginning of the author's PhD in September 2023. The study was mainly exploratory, with descriptive elements, and combined a literature review and an interview study of respondents in Sweden. This provided initial knowledge of the current state of digital transformation in Sweden, while also mapping what the literature has captured so far and identifying existing gaps. It further set the groundwork for understanding how the digital transformation phenomenon is described in the literature and how it is understood in practice. Study 1 resulted in Paper 1 (see Figure 5), which described the current state, drivers, and barriers of digital transformation within Swedish contractors and relates to RQ 1 (see Table 1). The study used a scoping literature review and 16 interviews conducted with academics, construction consultants, tech consultants, and contractor experts within Sweden (see Table 2).

Table 2. Study 1 interview respondents

Study 1 Respondents (16)
Professor in construction informatics
Professor in industrialised construction, sustainable house building, construction management, timber engineering and building
Research and innovation strategist
Professor in project communication
Chief operating officer of a tech firm
Business developer at tech firm
Tech consultant and developer
CEO at a tech consulting firm
Head of innovation at a consulting firm
Digitalising agent formerly working with a large contractor
Technology strategist at a large tech firm
BIM manager
Head of research and innovation at a large contractor firm
Business developer at a large contractor firm
Digital strategist at a large contractor firm
Head of digital innovation at a large contractor firm

3.3 Study 2 overview

Following Study 1, the context was widened beyond Sweden and Study 2 commenced in September 2024 (see Figure 5). Study 2 was a multiple case study of global international construction contractors listed on ENR TOP 250 (Engineering News Record, 2023). A case study was designed to allow deep exploration of the complex phenomenon (digital transformation) within specific contexts (large contractors) (Debout, 2016). Case study research was suitable for investigating the corporate-level perspective of digital transformation, which remains relatively underexplored. Moreover, (Yin, 2009) argues that case study research is appropriate when concepts are evolving and lack clear operational definitions such as digital transformation in the large contractor context. This approach allowed generate rich context-specific data, which was necessary given the limited research on digital transformation in large

contractors at the corporate level. Furthermore, a multiple-case study was justified since digitalisation is approached differently depending on environmental factors, enhancing robustness through replication logic. This study comprised of embedded units of analysis at the corporate and business-unit levels.

Initially, eleven global firms were selected through purposive sampling. Two criteria guided the selection. First, the firm had to appear on the ENR Top 250 (Engineering News Record, 2023) ensuring a broad and international scope. Second, the firms were actively engaged in digital initiatives, including pilots and POCs. In addition, prior knowledge about the firms' digitalisation efforts guided the final case selection, ensuring access to informed respondents. In the end, experts from seven firms agreed to participate. Four firms are headquartered in Europe and were chosen for comparable regulatory, cultural, and market environments. The remaining firms are headquartered in North America, Asia, and Oceania, introducing geographical variation. Data was collected through semi-structured interviews from 13 respondents (see Table 3).

Before the semi-structured interviews, Study 2 began with a desk research pre-study. This desk research included reviewing company websites, annual and sustainability reports, published papers and industry reports, as well as relevant podcasts discussing the firms and their digital initiatives. This work was used to develop the interview guide and supported access to context-specific insights during the interviews.

Table 3. Study 2 interview respondents

Study 2 Respondents (13)
Innovations and ventures director
Global head of digital construction and data management
Innovation and business development manager
Head of transformation
Director digitalisation building and project development
Senior vice president IT (CIO)
Vice president digital transformation
Head of group strategy and venture
Former chief product officer
Corporate director, strategic investments and partnerships
Chief technology officer and leadership team member
Deputy general manager - innovation and incubation office
Mechanical, electrical and plumbing (MEP) tech implementer

Study 2 resulted into two papers, Paper 2 and Paper 3 (see Figure 5). On one hand, Paper 2 is descriptive in nature and benchmarked digital transformation with the seven global cases and relates to RQ 1 (see Table 1). Paper 2 provided a descriptive account of the *five domains* related to digital transformation: *creating value*, *managing change*, *scaling pilots*, *innovating business models*, and *corporate-level engagement*. In so doing, it provided a broader understanding of digital transformation and revealed polarity in the strategic approaches of contractors.

On the other hand, Paper 3 is conceptual with case illustrations of four of the seven firms and relates to RQ2 (see Table 1). It combined the *three dimensions* from Paper 1 (see Figure 4) and *five domains* in Paper 2 to build an analytical model (see Figure 6 in chapter 4). In this way, Paper 3 deconstructed the digital transformation phenomenon and further clarified on the differences in strategic approach and their impact on scaling and firm-level transformation. Some methodological considerations that guided the research are described in the next section.

3.4 Methodology considerations

This thesis was conducted qualitatively using literature reviews, an interview study, and case study research. A literature review in Study 1 was used to obtain initial knowledge about the phenomenon, synthesise results, and generate new knowledge (Wacker, 1998). The interview study in Study 1 was used to develop general claims with observed data about digital transformation (Hallin et al., 2024). Case study research in Study 2, which constitutes the main empirical approach of this thesis, was selected after considering four main schools of thought. The following subsections discuss these considerations: *achieving methodological fit*, *philosophical positioning*, *practical considerations*, and *research quality*.

3.4.1 Achieving methodological fit

Firstly, the methodology choice aimed at achieving methodological fit, which follows that there should be internal consistency among all elements of a study (Edmondson and McManus, 2007). Achieving methodological fit is closely linked to the maturity of knowledge of the phenomenon under investigation, research question, research approach, and contribution (Åhlström, 2016). The maturity of knowledge of digital transformation within contractors is still limited and case study research is recommended for such phenomena. The research questions have a 'what' and 'how' line of inquiry (see Section 1.3) of an exploratory and descriptive nature. Consequently, case study research fits such exploratory and descriptive line of inquiry research (Åhlström, 2016; Voss et al., 2016).

Furthermore, this research takes on a theory building posture which is relevant in addressing how a real world problem (YAP syndrome) can be mitigated (Wacker, 1998; Meredith, 2001). Irrespective of earlier concerns about building theory from case research, it does allow in-depth understanding of the phenomenon's underlying mechanisms (Yin, 2009). Additionally, since digital transformation might vary across contexts, the global case perspective

in Study 2 allowed for provision of rich context-specific insights (Flyvbjerg, 2006).

3.4.2 Philosophical position

Secondly, the concept of philosophical position was a point of consideration. However, rather than arguing that the author chose case research because of a particular philosophical positioning, a fairer argument is that philosophical positioning guided the way the author conducted the case research. Particularly, in how data was gathered and inference made to generate conclusions. Moreover, the author, a novice at doing research with 2.5 years research experience under his belt, is still navigating philosophical positioning.

Nonetheless, the author adopts a critical realist ontology approach with a relativistic epistemology. This implies that theories are understood as representations of reality and that theories get closer to the truth overtime (Boer et al., 2015). Thus, emphasis is on observable facts to provide conclusions that are replicable and research is simply a process to find out these facts. Therefore, there is something to find out about (digital transformation) and so different people will come to know different things in different ways about it. As exemplified by the heterogenous interviews conducted both in Study 1 and Study 2 across different geographical contexts but also different backgrounds (see Tables 2 and 3). From these different perspectives, the author makes inference to draw conclusions about digital transformation. The author believes that through these processes of inference, conclusions about digital transformation do get better over time and get closer to the truth.

3.4.3 Practical considerations

Thirdly, certain practical considerations were considered including gaining access to data and institutional factors. In Study 1, the interview study was supplemented to the literature review due to the availability of contacts to experts in the Swedish construction industry. Similarly, in Study 2 the global case study was made possible by bringing on board a research consultant who has been working in the field with some global technology companies. This consultant

made it possible first to narrow down the sample size and, in the end, use their industry contacts to get experts for the interviews in Study 2. Furthermore, taking institutional factors into consideration for choosing case research in Study 2, the main supervisor of this research has done extensive case study research.

3.4.4 Ensuring research quality

Lastly, trustworthiness considerations in this research aimed at achieving construct validity, external and internal validity, and reliability. On construct validity, this research has demonstrated this by using multiple sources of evidence. In Study 1, the research complemented the literature review with an interview study. Similarly, Study 2 consisted multiple sources of data including interviews and secondary data. Regarding internal validity, the research aimed to produce accurate pattern matching in the data analysis phase and efforts made in addressing rival explanations. In Study 2, efforts were made to introduce replication logic to account for external validity. When choosing cases in Study 2, the research made efforts to select cases that are headquartered in different geographical locations. Reliability was addressed by ensuring consistency and transparency in the way data is collected and analysed. For interviews, interview summaries were created and archived. Additionally, a case study database for Study 2 was developed in *Microsoft Excel* and *NVivo* to organise the data, but also show analysis structure, thereby supporting transparency and the potential for other researchers to arrive at similar conclusions.

This chapter has outlined the research process and the methodological considerations guiding the research. The next chapter provides a summary of the three papers that make up this research. The specific research deigns of the papers are described in each summary outlining how the data was gathered, aggregated and analysed.

4 Summary of papers

This chapter provides a summary of the three included papers. Each summary begins by giving the publication status of the paper in the author's PhD process. The purpose and research questions of the paper are presented, followed by a description of the research design and methods. The summary then concludes with the main findings and contributions of the paper to the thesis.

4.1 Summary of paper 1

Paper 1 is a working paper where an earlier version was presented at the 2024 *EurOMA (European Operations Management Association) conference* (Kafuluma et al., 2024).

4.1.1 Purpose and research questions

The purpose of Paper 1 was to investigate digital transformation of large contractors in achieving firm-level transformation. Specifically, the paper examines the digital transformation phenomenon from a firm-level perspective, which includes transformation of processes, strategies, and business models. The paper addressed the purpose by answering the following research questions:

RQ 1: What is the current status, i.e. state, drivers and barriers, of digital transformation in large contractors?
RQ2: What are the changes required to capitalise on the outcomes of pilot projects of large contractors in their efforts of firm-level transformation?

4.1.2 Research design and methods

Paper 1 was designed as a scoping literature review and an interview study. Both the literature review and empirical data from the interview study are simultaneously assessed to answer the research questions and address the purpose of the study. The scoping literature

review was used to both gain an overview of the topic of digital transformation, and to clarify key concepts and characteristics related to the topic (Munn et al., 2018). The review aimed at providing an overview of digital transformation in the construction industry, specifically to identify the barriers and drivers of firm-level transformation. The *Scopus* database was used to retrieve peer-reviewed articles. The review followed the Prisma population, concept, and context (PCC) framework (Tricco et al., 2018). The initial search returned 584 results, which were narrowed down to 84 articles and finally 58 papers were selected, read, and analysed thematically.

To supplement the scoping literature review data and facilitate data triangulation, semi-structured interviews were conducted. Four categories of experts within Sweden were considered: experts within large contractor firms, construction consultants, tech consultants, and academics. From these categories, the study captured a holistic view of the multi-stakeholder construction environment. Based on the expert's knowledge, role and availability, four experts were chosen for each category, resulting in 16 semi-structured interviews. Semi-structured interviews were chosen because of their flexibility, iterations, and deep exploration of complex phenomena (DeJonckheere and Vaughn, 2019). The interviews were carried out by three researchers on *Microsoft Teams*, recorded, transcribed, and summarised. Data were thematically analysed in *Nvivo* software using an abductive approach with open coding.

4.1.3 Findings and contribution to the thesis

The literature review showed a growing interest in digital transformation, as reflected in the increasing number of publications from 2019 onwards. Some studies describe it to include concepts like value creation, business models, and new business. In contrast, other authors focus on the operational changes in productivity and efficiency. However, both schools of thought indicate that in construction, digital transformation is still in the early phases of digitisation and digitalisation. The interviews supported this state indicating that in construction, only islands of digitalisation exist. Drivers of digital transformation include disruptions, sustainability,

efficiency, safety, client demands, regulations, and role of the financial sector. However, findings showed that enablers are more prevalent than drivers, i.e. what exists today can facilitate digital transformation but not necessarily drive it. Barriers were both at organisational and industry levels. Organisational barriers included inertia and resistance, culture, lack of competencies, and the negative effects of digitalisation, while industry barriers included the lack of strategic frameworks, guidelines, and standardisation; limited government support; the complexity of construction; heavy dependence on subcontractors; limited competitive pressure and the conservative nature of many contractors. Changes required are similarly on both organisational and industry perspectives. From an organisational perspective, need for stronger top management involvement, data infrastructure and capacity building, clearer links between project and firm levels, and developing ambidexterity. From and industry perspective, need for more client and government involvement in terms of their demands.

Paper 1 contributes to the thesis in four ways. First, Paper 1 set the foundation of how to define what digital transformation means both in the literature but also within practitioners. This allowed understanding the state, drivers, barriers, enablers, and changes required to overcome the barriers. This assessment helped a more articulate description of how digital transformation evolves within contractors. Second, Paper 1 contributes by describing that evolution as a sequential process of the steps of *align, reconfigure* and *adapt* (see Figure 2). Third, Paper 1 elaborates on the triadic lens of digital transformation and introduces the 3D combination (see Figure 4) to examine how firms *align*, *reconfigure*, and *adapt*. This conceptualisation is carried forth to Study 2 and is used in Paper 3. Fourth, it helps clarify on firm-level transformation by showing how the interaction between technological innovation, business development, and ecosystem evolution makes such transformation "visible" within the triadic lens.

4.2 Summary of paper 2

Paper 2 is in the 1st round of revision in *Construction Management and Economics* journal. An earlier version was presented at the 2025 *EurOMA (European Operations Management Association) conference* (Kafuluma et al., 2025a).

4.2.1 Purpose and research questions

The purpose of Paper 2 was to investigate how large global construction contractor firms approach digital transformation at the corporate level. Specifically, it explored how digitalisation enables new value creation and business model innovation, and what organisational conditions support or hinder these efforts. To address this purpose, the paper framed three research questions related to strategic framing, organisational structures, and business-level outcomes.

RQ 1: How does digitalisation create new value or impact business models?
RQ2: What strategies and structures are in place to support transformation?
RQ3: How is digital transformation understood and framed at the corporate level?

4.2.2 Research design and methods

Paper 2 is a multiple case study of seven large construction contractors and data was collected through semi-structured interviews following an interview guide. The interview guide comprised of the five question topics (domains): *creating value, managing change, scaling pilots*, *business model innovation*, and *corporate-level engagement*. The interviews were conducted following a case study protocol outlining the study's goals, research questions, protocol questions, theoretical grounding, and data collection strategy. Interviews were conducted online via *Microsoft Teams* and lasted between 60 and 110 minutes. A total of ten interviews with 13 experts were conducted across the seven case firms,

and interviewees were selected based on their strategic or operational roles in digitalisation and innovation. In five of the cases, multiple participants contributed either within joint interviews or through separate sessions, allowing for richer perspectives and internal cross-validation within each case.

Interview transcripts were summarised and uploaded into *NVivo* software for a thematic analysis. Initially, the data were organised on a case-by-case basis, enabling detailed within-case analyses. Each case was coded according to themes derived from the interview guide, which was developed to align with the study's research questions. After within-case coding, a cross-case comparison was conducted to identify recurring patterns and variations across firms. The analysis aimed at identifying common barriers and enabling conditions, as well as firm-specific approaches that illustrate emerging best practices.

4.2.3 Findings and contribution to the thesis

Paper 2 identified the existence of two strategic framings of digital transformation within large contractors, *defensive* and *offensive* approaches. Many firms *play defense* by improving processes, reducing cots or addressing client's expectations. A few firms go beyond *defense* and are starting to *play offense,* i.e. innovating business models, developing new services, entering new markets, or redefining identity beyond construction. The development of organisational structures and capabilities to balance the tension between the two strategic framings has been the defining factor. Furthermore, Paper 2 showed that digitalisation creates new value through both operational improvements and, in more *offensive* firms, the development of new services and business models. However, BMI remains limited and is often pursued outside the traditional core construction business. Among more *offensive* firms, some attempt a radical approach to BMI, while others adopt a more incremental approach. In contrast, the more *defensive* firms focus on evolving their operational models.

Paper 2 firstly contributes to the thesis by establishing the corporate-level perspective on digital transformation within

contractors that is further investigated in Paper 3. Secondly, Paper 2 shows that the possible course of action (see green arrows in Figure 1) is feasible and at play in some proactive firms. Thirdly, the five domains: *creating value, managing change, scaling pilots*, *business model innovation*, and *corporate-level engagement* introduced in Paper 2, are further investigated in Paper 3. This formed the base of the analytical model in Paper 3, which provided more clarity in generating answers to the overall research questions of the thesis.

4.3 Summary of paper 3

Paper 3 is *Under review for the* APMS *(Advances in Production Management Systems) conference* and to be presented in September 2026 (Kafuluma et al., 2026).

4.3.1 Purpose

The purpose of Paper 3 was to deconstruct the digital transformation phenomenon into a set of interrelated components that explain how large contractor firms create value, manage change, scale pilots, and transform their business models and corporate-level practices. While the paper does not state separate research questions explicitly, it is guided by this overarching question. Based on this deconstruction, an analytical model was developed and used to analyse four large contractors, classify them, and compare how different firms approach digitalisation. The interrelated components referred to as *markers* in the paper, are described in the next subsection.

4.3.2 Research design and methods

Paper 3 comprises of two complementary parts. The first part involved generating *markers* thematically from the structured literature review and developing an analytical model. The second part used this model to analyse case illustrations of four large contractors. The model combines the *three dimensions* from Paper 1, and the *five domains* in Paper 2 to form a 5X3 (*domains x dimensions*) matrix (see Figure 6). The intersections of the matrix are populated with *markers,* which are observable indicators or codes that link a domain to a

dimension (see Figure 7). The markers operationalised the topics to be investigated at each cell of the matrix to facilitate coding of the case study and guide the within-case and cross-case analyses. In total, 72 markers were developed indicating the breadth and scope of the deconstruction. At domain level, 15 markers belonged to creating value, 16 to managing change, 9 to scaling pilots, 14 to business model innovation, and 18 to corporate-level engagement. At dimension level, technological innovation had 24 markers, business development had 21 markers, and ecosystem evolution had 27 markers.

The conceptual-building phase in the second part of the design used deductive reasoning to generate relationships and understanding of concepts developed in the matrix. Data collection focused on the five domains and the main source of data was the semi-structured interviews supplemented with secondary data including company website data and reports. This paper included seven interviews with nine experts from four of the cases.

Deductive content analysis was done in *Nvivo* following a coding structure built in *Nvivo* consisting of three hierarchy levels. The dimensions at the highest, followed by domain, and the markers as the lowest level. Raw data was coded to the lowest level of hierarchy. Following the coding process, tabular within-case code reports were generated to examine how the raw data fit into the analytical model. In a few scenarios, open codes emerged that did not fit into the defined analytical model. In those cases, the emerging codes were retained and inductively analysed to generate concepts. The markers were then assigned a level (1,2,3 or 4) depending on the amount of data coded to the specific marker. Each marker consisted of four narrative levels (1-4) that were used in the case illustrations. Level 1 indicated no coded data for the marker. Level 2 indicated the coded data represented limited presence of the marker. Level 3 was for where the coded data indicated more occurrence or existence of the marker than in Level 2. Level 4 described that the coded data clearly emphasises overwhelming evidence of the presence of the marker. The scores were totalled, normalised, cross case comparisons made, and case illustrations done.

Domains	Dimensions		
	Technological innovation (T)	Business development (B)	Ecosystem evolution (E)
Creating value (Cv)	Cv ∩ T	Cv ∩ B	Cv ∩ E
Managing change (MC)	M ∩ T	M ∩ B	M ∩ E
Scaling pilots (SP)	S ∩ T	S ∩ B	S ∩ E
Business model innovation (BMI)	B ∩ T	B ∩ B	B ∩ E
Corporate level (CL)	Cl ∩ T	Cl ∩ B	Cl ∩ E

Markers

Fig 6. Paper 3's analytical model

4.3.3 Findings and contributions to the thesis

Paper 3's first main finding is the analytical model that was thematically developed from the structured literature review. The model was populated with markers (see Figure 7), which formed the basis for the case illustrations. The model was used to show how the issues related to the *five domains* earlier described can be understood from the *three dimensions* of *technological innovation*, *business development* and *ecosystem evolution*.

After case illustrations of the developed model, three distinct profiles emerged of the firms' approach. An *advanced transformation profile*, an *internally orchestrated transformation* profile, and an *operationally oriented digitalisation* profile. The *advanced transformation profile* exhibited that digitalisation extends beyond isolated technologies and is linked to customer value, organisational change, scaling mechanisms, business model innovation, and corporate-level engagement. The *internally orchestrated profile* described firms that have developed structures for funding and change related to innovation through new business areas. Lastly, the *operationally oriented digitalisation profile* described firms that are aware of potential value of being more data-

driven but focus is on internal efficiency and local business-unit initiatives.

In this way, Paper 3's first contribution to the thesis is that it combines learnings from Paper 1 and Paper 2 to provide more grounding in addressing the purpose of the thesis. In a way, it is a bridge between Paper 1 (dimensions) and Paper 2 (domains) (see Figure 5). Most importantly, Paper 3 provides a *method* for deconstructing digital transformation into markers that extends the understanding of the digital transformation phenomenon. Through this operationalisation, on one hand, Paper 3 identifies a profile that highlights why the YAP syndrome still prevails, such as the *operationally oriented digitalisation profile.* On the other hand, it further shows how other firms scale their digital efforts and address the YAP syndrome, such as *the advanced transformation profile.*

Next is Chapter 5 which discusses the thesis' findings in relation to the research questions and the overall purpose of the thesis.

	Dimensions		
Domains	**Technological innovation**	**Business development**	**Ecosystem evolution**
Creating Value (CV)	CvT1 - Customer value CvT2 - Financial performance CvT3 - Operations improvements CvT4 - Data-driven decision-making CvT5 - Cross-functional collaboration CvT6 - Market advantage	CvB1 - Servitisation and value evolution CvB2 - Customer value benefits CvB3 - Market performance CvB4 - Monetisation mechanisms	CvE1 - Manages complex product-service systems CvE2 - Reinventing offerings CvE3 - Sharing benefits and risk distribution CvE4 - Mitigate temporal and spatial barriers CvE5 - Venturing into new territories
Managing change (MC)	MT1 - Capabilities development and management MT2 - Stakeholders' value co-creation MT3 - Align innovation and management MT4 - Match change with client needs MT5 - Ambidexterity through value creation	MB1 - Flexibility MB2 - Develop capabilities MB3 - Evaluate and adopt a change management model MB4 - Investment and funding dynamics MB5 - Robust data infrastructure	ME1 - Address NIH and NSH syndromes ME2 - Be agile ME3 - Address emergent undesirabilities ME4 - Manage coopetition within the ecosystem ME5 - Develop other ecosystems and involve new partners ME6 - Approach integrity as foundational for the ecosystem
Scaling pilots (SP)	ST1 - Long-term customer impact assessment ST2 - Government and partner support ST3 - Long-term company impact assessment	SB1 - Internal innovation model SB2 - External innovation model SB3 - Hybrid innovation model	SE1 - Stakeholders' engagement beforehand SE2 - Internal and external R&D relations SE3 - System integration
Business model innovation (BMI)	BT1 - External stimuli response BT2 - Sequential considerations BT3 - Modified value mechanisms BT4 - Organisational factors	BB1 - Changes in business performance BB2 - New business units BB3 - Product-centric to service-centric business models BB4 - Capitalise data value	BE1 - Partnering and collaborating facilitate BMI BE2 - Transitioning of BMI BE3 - Interoperability - business relations BE4 - Reinventing business to compete BE5 - Scalability of new offerings BE6 - Value mechanisms of new product and industry architecture
Corporate level (CL)	ClT1- Value deconstruction ClT2 - Adaptive innovation strategy ClT3 - Customer centricity ClT4 - ESG performance ClT5 - Dynamic capability monitoring ClT6 - Organisational learning	ClB1- PPT approach ClB2 - Adaptive posture ClB3 - Absorptive capacity ClB4 - Data as a decision guide ClB5 - Top management's responsibility	ClE1 - In it for the long run ClE2 - Multi-system approach keen on mutualism ClE3 - Innovation supporters CLE4 - Balance cognitive proximity and distance ClE5 - Personal leadership attributes ClE6 - Appropriation capacity ClE7 - Evaluate boundary spanning against internal issues

Fig 7. Marker structure of the analytical model across domains and dimensions

5 Findings and discussion

This chapter provides answers to the research questions of the thesis and a discussion of how the purpose of the thesis has been fulfilled.

5.1 Addressing research question 1

What strategic approaches do large construction contractors adopt in relation to digital transformation, and what factors hinder or enable the scaling of digital initiatives beyond the project level?

Research question 1 is addressed by Paper 1 and Paper 2 and described in the subsequent two subsections. This research identified two overarching strategic approaches of large contractors in their use of digital technologies: *defensive* and *offensive* approaches. The *offensive* approach is described to highlight its enabling role in scaling digital initiatives. In contrast, the *defensive* approach is described to show that, when relied upon alone, it hinders the scaling of digital initiatives.

5.1.1 Defensive approach of contractors

Defensive approach refers to firms exploring digital technology to exploit existing business (Lepinoy and Heide, 2020; Kafuluma et al., 2025a). Digitalisation is primarily viewed and implemented as a tool to improve operational efficiency and reduce costs. Moreover, Porter (1996) warned about this myopic view and argued that focusing on operational improvement is no strategy after all. The findings indicated that such *defensive* benefits within contractors included optimising operations, managing data, leveraging data in tendering processes, remote monitoring, accuracy in designs, and improved safety (Kafuluma et al., 2025a). Thus, as a pattern, data improves existing processes with no infrastructure for new services or revenue streams.

The new value of digitalisation is used to enhance existing core offerings. Thus, the customer base has largely remained the same in terms of traditional construction clients and customer relationships. Because the value of digitalisation is largely leveraged within existing core of business, business models have remained the same. The approach to business model innovation is categorised as the *commitment approach* (Andries and Debackere, 2013) of BMI. In the commitment approach, the firm *commits* to its existing business model and utilises the technology to sustain it. While this approach can enhance profitability and shareholder revenue (Sawhney et al., 2020), it rarely leads to new business models.

Therefore, construction firms that adopt digital technologies and run POCs or digital pilots typically adopt this approach. After all, literature has documented that construction firms have for the most part undergone digitisation and digitalisation to improve internal and operational processes (Samuelson and Stehn, 2023; Verhoef et al., 2021). For a firm with only this approach, it becomes apparent that scaling beyond the project level is hampered. This becomes a barrier to digital transformation and incubates the YAP syndrome (see Figure 1). The focus remains on protecting the core construction business and prioritising existing business models (Kafuluma et al., 2025a). As such, the *defensive* approach becomes susceptible to barriers (see column 1, Table 4) that impede digital transformation and exacerbates difficulties of scaling.

Some of these barriers are summarised in Table 4. Literature indicates that construction firms still suffer from inertia and resistance with an organisational culture that often doesn't respond well to change. Moreover, firms still lack both human and data competencies to manage better the potential of technology. Also, contractors are often orthodox in the approach and there has been a lack of competitive pressure to shake up the status quo. Furthermore, the industry still has limited strategic frameworks, standards, and guidelines, all of which do not favour scaling of digital initiatives. Also, contractors often have a heavy dependence on subcontractors which contributes to the issue of multi stakeholders and the demerits of loose couplings to innovation. In totality, all these existing

organisational and industry barriers outlined in Table 3 become more challenging to address when firms are being only *defensive*, ultimately hindering scaling.

Table 4. Overview of inherent barriers that hinder scaling

Paper 1	
Barriers	**Source**
Inertia and resistance	(Perera et al., 2023), (Alhinaai, 2023), (Criado-Pérez et al., 2022), (Zhang et al., 2023a), (Vial, 2019), (Zulu and Saad, 2023).
Organisational culture and lack of competencies	(Bhattacharya and Pant, 2023), (Alhinaai, 2023), (Criado-Pérez et al., 2022), (Zhang et al., 2023a), (Zulu and Saad, 2023), (Zulu et al., 2023).
Negative impacts of digitalisation	(Criado-Pérez et al., 2022), (Bhattacharya and Pant, 2023)
Lack of strategic frameworks, standards and guidelines	(Perera et al., 2023), (Criado-Pérez et al., 2022)
Complex environment with varied market readiness and limited government support	(Bhattacharya and Pant, 2023), (Criado-Pérez et al., 2022), (Zhang et al., 2023a), (Vial, 2019).
Nature of the industry with many actors and heavy dependence of large contractors on subcontractors	(Samuelson and Stehn, 2023), (Bhattacharya and Pant, 2023), (Criado-Pérez et al., 2022), (Gardner, 2022), (Vial, 2019), (Zulu and Saad, 2023), (El Jazzar et al., 2020).
No competitive pressure and nature of orthodox contractors	"*There are too few drivers and not enough pressure*." Respondent A3

To further highlight on the *defensive* approach observed among certain firms, several respondents emphasised a strong focus on project-level success and the preservation of existing business models. For example, Firm A1 stated that "*We are happy with success at job sites*." They further noted that "*We are not in that phase; we just use digitalisation technology to make our business more profitable*," and added that "*We don't really want to change by ourselves*." Similar patterns were observed in other firms. For instance, E3 noted that "*Middle and low management still focus mainly on project delivery level. Top management is not there*." Likewise, E2 stated that "*Main objective is sustaining current business model*." This emphasis on operational improvements was also reflected by Firm O1, who observed that "*What we see is a lot of*

operational change, but not necessarily business model change. I think the construction business still fundamentally operates the same way it did 50 or 60 years ago, particularly in how it evaluates risk."

Nonetheless, these firms are developing enablers that indicate a tendency to target the ability to scale at least between projects, as shown by E2, E3, E4, A1 and O1 (see Table 5). E2 has established a change management committee to evaluate how innovation knowledge is shared across the different projects in the group, and it has also built an innovation academy to support training and organisational learning. E3 is building capabilities to become more data driven and to secure top management support. E4 has appointed a new chief innovation officer and tends to evaluate the need for a pilot before running it. A1 collects job site pain points and prepares project success case study reports at the end of each project. O1 has developed new roles, promotes frontline worker engagement in developing POCs, and has embarked on mass training of employees.

Table 5. Enablers of scaling within defensive firms

Paper 2	
Enablers	**Source**
• Change management committee • Innovation academy for mindset shift • Centralised innovation budget • Clear benefits to day-to-day work of end users	Firm E2
• Advocate for top management buy in • Be more data driven	Firm E3
• Persistence • New chief innovation officer • Direct need for pilot required first	Firm E4
• Collecting job site pain points • Creating project success case study	Firm A1
• New roles • Mass sensitisation • Projects as viral agents of change within the firm • Frontline worker engagement	Firm O1

5.1.2 Offensive approach of contractors

Offensive approach refers to firms exploring digital technology to exploit existing business, extend existing business, and generate new business (Lepinoy and Heide, 2020; Kafuluma et al., 2025a). On top of a having a *defensive* approach, the firms exhibited more in terms of extending business and generating new business. In Figure 1, the thesis shows that there is a possible course of action for contractors to extend benefits beyond the project level and tap into new business and markets by rethinking their business logics (Vial, 2019; Samuelson and Stehn, 2023; Stehn and Erikshammar, 2025). Consistent with this, Paper 2 presents two (of seven) firms that possess *an offensive approach*, illustrating how they scale beyond the project level.

One firm E1 affirms that digitalisation is a strategic lever across asset lifecycle. It uses digitalisation to bridge design, construction and operational maintenance, effectively derisking infrastructure projects across the phases. The firm has developed new services and entered new markets that in some cases generate more revenue than the traditional construction business. The firm possesses an innovation strategy built on three pillars: *asset management*, *growth area* and *design area*. The *growth area* is dedicated to incubating and scaling new business models. Digital initiatives are framed around infrastructure services and new platform-based business models. BMI has been embraced and the firm has taken a more *radical approach* (Andries and Debackere, 2013). The firm now explicitly positions itself as an *infrastructure investor* rather than a typical construction firm. They are using digital technologies to explore markets that may ultimately surpass the construction revenue. This reflects a shift in posture to redefine the identity of the firm and value proposition to build a portfolio in which construction is just one of various business components.

The other firm NA1 is building proprietary technological solutions, securing patents, and licensing them to third parties. They run an in-house product development team that has developed a portfolio of 29 solutions with 21 patents approved and 8 pending. Several of these solutions, for example their prefabrication technology, has been spun

off into a new company that now serves external customers. In contrast to the *offensive* firm E1, this firm has followed *an incremental approach* (Andries and Debackere, 2013) of BMI. The firm is cautious and redefines its business model around its core markets with little to no distortion of existing core logics. Their pre-existing value proposition is predictability and client confidence working closely with partners to navigate technological changes without risking delivery results to clients.

By its nature, the *offensive* approach facilitates the scaling of digital initiatives, since firms tend to look beyond projects. Similar to the *defensive* firms, the *offensive* firms have built enablers that support scaling between projects, but also enablers that target the firm level and the broader ecosystem (see Table 6). Firm E1 advocates involving the end user early in the development of solutions. It has also developed a way of measuring the value of digital initiatives, created quick project wins to keep people motivated, and remains willing to retry a failed pilot, but also just as willing to kill it, irrespective of how much 'heart and soul' has already been invested (see column 1, Table 6). The firm downsized from 100,000 employees to about 23,000 to operate more as a lean organisation. Its strategy is to exploit at the project level and explore at the corporate level, showing an awareness of the relationship between the two levels. Even if project managers focus on project goals, they remain aware of the strategic goals. Moreover, the firm pays for the piloting and not the project which in a way is an incentive to the project managers.

NA1, on the other hand, stated that it follows a PPT approach when evaluating POCs, to see how the technology connects to people and processes. It has dedicated teams for digital workflows at all levels. In other words, it does not have digitalisation departments but instead seeks to embed and integrate digitalisation teams across all departments. The firm has also hired an integration manager, whom it credits with much of its success in helping develop ambidexterity and ensure a balance between exploring and exploiting. In addition, it strives to work closely with clients so that trust is established early, allowing the firm to experiment with POCs on projects. Its approach to deploying POCs is phased, with implementation on a regional basis.

As POCs move to the next region, the older solution is *sunset*. This goes hand in hand with training on the new solutions

Table 6. Enablers of scaling within offensive firms

Paper 2	
Enablers	**Source**
• Including end user • Measure value • Trade-off between retrial and killing ideas • Developing quick project wins • New roles and departments • Downsizing • Exploit at project level and explore at corporate level	Firm E1
• PPT (People-Process-Technology) approach • Dedicated teams of digital workflows at all levels • Integration manager (new role) • Build trust with owners • Support and training structure • Phased deployment of POCs	Firm NA1

In sum, with this *offensive approach*, firms frame digitalisation beyond operational improvements as a way to generate new value paths and business models (Vial, 2019; Carvalho et al., 2021). This supports the notion that indeed through BMI, contractors can break away from legacy structures as a way to mitigate the YAP syndrome (Stehn and Erikshammar, 2025; Samuelson and Stehn, 2023). As such, it becomes possible that pilot projects can have a life beyond decommissioning, since their impact extends to BMI and to the ecosystem through the exploration of new markets

5.1.3 Answer to research question 1

Findings indicate that firms approach digital transformation through *defensive* and *offensive* strategic approaches (see Subsections 5.1.1 and 5.1.2). The *defensive approach* describes exploring digitalisation to exploit existing business. It focuses on operational improvements and scaling within existing business structures, which constrains firm-level transformation (see Subsection 5.1.1). As such, it continues to be significantly limited by the existing barriers within construction

(see Table 4). In contrast, *an offensive approach* involves firms exploring digital technology to exploit existing business, extend existing business, and generate new business (see Subsection 5.1.2). This approach enables digital initiatives to generate new business value, BMI and ecosystem development, thereby supporting scaling beyond projects. The enablers associated with the *defensive approach* remain largely project-focused or aimed at moving beyond that focus (see Table 5), whereas those associated with *offensive approach*, tend to support scaling beyond projects (see Table 6). These distinctions between these two approaches indicate why scaling has been difficult for some firms, while others extend into new businesses and markets.

5.2 Addressing research question 2

How can digital transformation in large construction contractors be conceptualised and analytically understood in relation to the scaling of digital initiatives?

Research question 2 is answered in the subsequent three subsections and is mainly addressed by Paper 3. In that paper, a model is developed to deconstruct digital transformation and compare firms' strategic approaches. The model combines the *three dimensions* with the *five domains* to generate 72 markers (see Figure 7). The firms were then compared based on their level scores on each marker. These scores were normalised (see Figure 8) and plotted for comparison (see Figure 9).

This comparison revealed three strategic profiles*: operationally oriented digitalisation*, *internally orchestrated transformation*, and *advanced transformation profiles*. Together, these profiles show in analytical detail (with markers) the hindering nature of a solely *defensive* approach and the enabling role of an *offensive* approach.

	Dimensions														
	Technological Innovation					Business development					Ecosystem evolution				
Domains	**Marker**	**US1**	**E1**	**E2**	**E3**	**Marker**	**US1**	**E1**	**E2**	**E3**	**Marker**	**US1**	**E1**	**E2**	**E3**
Creating value	**CvT1**	4	3	2	1	**CvB1**	4	4	2	2	**CvE1**	3	1	1	1
	CvT2	4	4	2	3	**CvB2**	4	4	4	2	**CvE2**	4	3	1	3
	CvT3	4	4	4	4	**CvB3**	4	4	3	3	**CvE3**	3	4	1	2
	CvT4	3	4	2	4	**CvB4**	4	4	2	2	**CvE4**	2	4	3	1
	CvT5	4	3	2	3						**CvE5**	4	4	3	4
	CvT6	4	4	1	3										
Sum		*23*	*22*	*13*	*18*		*16*	*16*	*11*	*9*		*16*	*16*	*9*	*11*
Normalised value		***0.96***	***0.92***	***0.54***	***0.75***		***1.00***	***1.00***	***0.69***	***0.56***		***0.80***	***0.80***	***0.45***	***0.55***
Managing change	**MT1**	4	4	4	3	**MB1**	4	4	4	2	**ME1**	4	4	4	1
	MT2	2	4	4	3	**MB2**	4	4	4	2	**ME2**	4	4	4	1
	MT3	2	4	4	3	**MB3**	4	4	4	4	**ME3**	4	3	2	1
	MT4	2	1	4	1	**MB4**	4	4	4	2	**ME4**	3	1	1	1
	MT5	4	4	4	3	**MB5**	4	4	2	3	**ME5**	4	4	3	3
											ME6	2	1	1	1
Sum		14	17	20	13		20	20	18	13		21	17	15	8
Normalised value		***0.70***	***0.85***	***1.00***	***0.65***		***1.00***	***1.00***	***0.90***	***0.65***		***0.88***	***0.71***	***0.63***	***0.33***
Scaling pilots	**ST1**	2	3	3	1	**SB1**	4	4	4	1	**SE1**	3	3	3	1
	ST2	3	1	1	2	**SB2**	4	4	3	1	**SE2**	4	3	3	1
	ST3	4	4	3	1	**SB3**	4	1	3	1	**SE3**	3	1	3	1
Sum		9	8	7	4		12	9	10	3		10	7	9	3
Normalised value		***0.75***	***0.67***	***0.58***	***0.33***		***1.00***	***0.75***	***0.83***	***0.25***		***0.83***	***0.58***	***0.75***	***0.25***
Business model innovation (BMI)	**BT1**	4	4	1	1	**BB1**	4	4	1	1	**BE1**	4	4	2	1
	BT2	4	4	1	1	**BB2**	4	4	1	1	**BE2**	3	3	1	1
	BT3	4	4	1	1	**BB3**	4	4	1	1	**BE3**	3	3	4	1
	BT4	3	4	2	1	**BB4**	4	4	2	2	**BE4**	3	4	2	1
											BE5	4	4	2	1
											BE6	4	4	2	1
Sum		15	16	5	4		16	16	5	5		21	22	13	6
Normalised value		***0.94***	***1.00***	***0.31***	***0.25***		***1.00***	***1.00***	***0.31***	***0.31***		***0.88***	***0.92***	***0.54***	***0.25***
Corporate-level engagement	**CIT1**	3	1	1	1	**CIB1**	4	4	2	1	**CIE1**	4	4	2	2
	CIT2	4	4	4	1	**CIB2**	4	4	2	3	**CIE2**	3	3	2	1
	CIT3	4	1	1	1	**CIB3**	4	4	3	1	**CIE3**	4	4	4	1
	CIT4	1	4	3	1	**CIB4**	4	4	2	3	**CIE4**	1	1	3	1
	CIT5	3	4	3	1	**CIB5**	4	4	4	2	**CIE5**	4	4	4	1
	CIT6	4	4	4	1						**CIE6**	4	4	1	1
											CIE7	3	4	1	2
Sum		19	18	16	6		20	20	13	10		23	24	17	9
Normalised value		***0.79***	***0.75***	***0.67***	***0.25***		***1.00***	***1.00***	***0.65***	***0.50***		***0.82***	***0.86***	***0.61***	***0.32***
Total normalised value		**0.83**	**0.84**	**0.62**	**0.45**		**1.00**	**0.95**	**0.68**	**0.46**		**0.84**	**0.77**	**0.59**	**0.34**

Fig 8: Cross-case scoring and normalised marker values by domain and dimension

5.2.1 Operationally oriented digitalisation profile

The *operationally oriented digitalisation* profile (see E3 in Figure 9) describes a firm that has implemented digital technologies and recognises the value of being more data-driven, but majority of the efforts focus on internal efficiency, specific tools, and local business-unit initiatives. Thus, the intentional use is digitalisation rather than digital transformation (Verhoef et al., 2021). The firm classified in this profile exhibited limited evidence of BMI and low marker scores within ecosystem evolution (see Figure 8). Firms that have only a

defensive strategic approach, follow this profile. Moreover, the firms here scored considerably less in business development and ecosystem evolution compared to technological innovation. Indicating an inclination of technology focus in comparison to business and the ecosystem dimensions. Within the sequential steps of digital-enabled transformation (Kafuluma et al., 2025b), the firms tend to have *aligned*, but yet to *reconfigure* and *adapt* (cf. Figure 2).

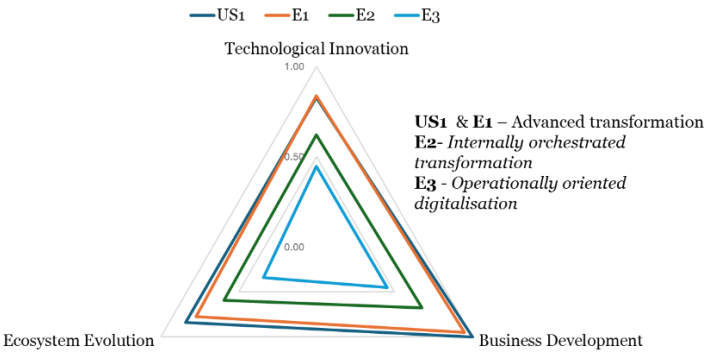

Fig 9: Plot of total normalised values by dimension

5.2.2 Internally orchestrated transformation profile

Internally orchestrated transformation profile describes a firm (see E2 in Figure 9) that has established well defined structures for innovation and change through new business areas. Innovation funding is prioritised and centralised and active in open innovation activities. Efforts are visible in terms of capability building and internally scaling than business model innovation or ecosystem repositioning. Firms show awareness in terms of understanding where they are, and where they would like to be and internally reconfiguring to facilitate the transition. The firms here scored higher in all dimensions than the previous profile and are further apart in performance in ecosystem evolution than the other two dimensions (see Figure 8). Firms exhibit a *defensive* strategy but are aware, investing, and restructuring towards being more *offensive*. Thus, firms within this profile tend to have *aligned*, and are *reconfiguring* but are yet to *adapt* (cf. Figure 2).

5.2.3 Advanced transformation profile

In the *advanced transformation* profile, digitalisation extends beyond isolated technologies and is significantly connected to customer value, organisational change, scaling mechanisms, business model innovation and corporate-level management in comparison to the two previous profiles (see US1 and E1 in Figure 9). The firms exhibited a consistency in how they prioritise all three dimensions by consistently scoring higher than the other profiles (see Figure 8). The profile indicates strength in both *defensive* and *offensive* strategies. In comparison to other two profiles, this profile stands out in the business development dimension due to the extent to which they have *adapted,* and not only *aligned and reconfigured* (cf. Figure 2). Furthermore, they stand out in the ecosystem evolution with the willingness to develop ecosystems outside the boundaries of the core construction business.

5.2.4 Answer to research question 2

Section 5.2 has answered research question 2 by showing that digital transformation can be analytically understood through distinct profiles ranging from *operationally oriented digitalisation* to *internally orchestrated transformation* and to *advanced transformation (see Subsections 5.2.1, 5.2.2 and 5.2.3).* It has further shown how these profiles relate to the strategic approach of the firm: firms with an only *defensive* approach tend to match with *the operationally oriented digitalisation profile (see Subsection 5.2.1)*, firms that are primarily *defensive* but developing elements of an *offensive* approach tend to match with *the internally orchestrated transformation profile (see Subsection 5.2.2)*, and firms with a fully *offensive* approach tend to match with the *advanced transformation profile (see Subsection 5.2.3)*. These profiles have also been mapped onto the phases of *align, reconfigure*, and *adapt*. Firms that are only *defensive* are *aligning* and follow the operationally *oriented digitalisation profile*. Firms that are *defensive* and starting to develop an *offensive* strategy are *aligning* and *reconfiguring* and follow the *internally orchestrated transformation profile*. The fully *offensive*

firms are *aligning*, *reconfiguring*, and *adapting* and follow an *advanced transformation* profile.

This conceptualisation and analytical understanding offer answers to why some firms struggle to scale digital initiatives, provides guidance on how scaling can be achieved, and illustrate examples of firms that have been able to do so.

5.3 Discussing the purpose

The purpose of this thesis is to *investigate digital transformation in large construction contractors, with a particular focus on how digital pilot projects and proof of concept initiatives can be scaled beyond the project level to support firm-level transformation*.

First, the thesis provides a large contractor conceptualisation of the third stage of the digital transformation phenomenon as described by (Verhoef et al., 2021). In large contractors, this stage can be understood as digital-enabled transformation, which is a sequential process of *alignment*, *reconfiguration*, and *adaptation* (Paper 1).

Second, through a multiple case study, this research identifies two strategic approaches within large contractors: a *defensive* and *offensive* approach. The existence of only a *defensive approach* has itself been a major barrier of scaling, whereas the presence of an *offensive approach* as well functions as an enabler of scaling initiatives (Paper 2).

Third, the research develops an analytical model and empirically tests it through deductive content analysis and cross-case comparison. This analysis deconstructs digital transformation into markers and identifies three profiles that the strategic approach can evolve through: the *operationally digitalisation* profile of only *defensive* firms, the *internally orchestrated transformation* profile of firms where *defensive* and *offensive* approaches are both developing, and the *advanced transformation* profile of firms in which the *offensive approach* is in full effect (Paper 3).

5.3.1 Addressing barriers as hinders for scaling

This research elaborates why the barriers to innovation in construction persist. Also, through both conceptualisations and empirical findings, it shows that organisational and structural barriers are significant but can be navigated. The loosely coupled system (Dubois and Gadde, 2002), in the traditional sense of construction, limits digital pilot projects beyond pilots.

The research findings show that these barriers continue to sustain the communities of practice (Brown and Duguid, 1998) and collective adaptations (Dubois and Gadde, 2002), particularly the sole *playing defense* and *operationally oriented digitalisation* firms. In contrast, the *advanced transformation profile* firms seem to navigate this by allowing themselves to enter new markets and innovate outside the construction core.

Although this research takes a corporate-level view of the firm, it has shown that the difficulties of innovating at project level in construction have not gone away. Since some firms still have their focus on the project operations and not so much what happens beyond that.

5.3.2 Achieving firm-level transformation

Despite these YAP syndrome-harbouring tendencies, this research shows that some global firms navigate them. Literature has suggested reinventing the value creation process and the firm's business logic (Samuelson and Stehn, 2023; Sepasgozar et al., 2023), and the findings supported this notion. In contrast to most firms in the study that remain within the status quo due to organisational and structural barriers, a subset of firms moves beyond them. They seem to be *aligning, reconfiguring and adapting*. Furthermore, they exhibit a tendency to extend beyond operations and engage in figuring out what the new value is and how to capitalise on it.

This research has shown that the firms that have been proactive, forward-looking, and able to scale have an underlying commonality, *the business must change*. This has been done in two ways. On one end, *incrementally* innovating the business model (Andries and Debackere, 2013), where business are tolerated outside the core of the

construction business, i.e. structural separation. One reason for this has been that firms have developed appropriation capacity (Chabbouh and Boujelbene, 2023) that ought to be preserved. Nevertheless, the firms have recognised the new business opportunities that have been strategically approached to the benefit of the firm.

On the other end, a more *radical* approach (Andries and Debackere, 2013) is also evident. The underlying argument is to develop or adopt the technology and then follow the business opportunities it creates or can potentially create. Thus, construction firms have an incentive to look beyond an industry whose multiple complexities (Gidado, 1996) precipitate low margins, which undermine profit maximisation. With this view, firms are not bound to being a just a construction firm, but rather what firm they want to become. Like the research noted in Paper 2, E1 does not consider themselves as a construction company anymore but an *infrastructure investor*. Thus, as Dubois and Gadde (2002), argued that loose couplings in the permanent network can evolve into tighter couplings that favour coordination and more inter-firm adaptations beyond individual projects. Consistent to that, E1 seems to benefit from tighter couplings by taking a more radical stance to embrace new territories that may be less loose.

Thus, in the traditional environment of uncertainty, organisational independence and technical interdependence (Gidado, 1996; Dubois and Gadde, 2002), pilot projects are bound to remain just that. Particularly, because of this, considerations must be made 'upstream' even if the 'action' happens 'downstream' at the project level. A *defensive approach* is often the reason why a firm might engage in a digital pilot project to impact a specific part of their business. Or simply they do so because of the fear of being left behind. Whatever the case, an *offensive approach* has shown that it allows these initiatives have a 'life' at the end of the project. Not only does this facilitate learning at the firm level, perhaps organisational memory (Dubois and Gadde, 2002) can start to develop at the project level. Then, the 'life' of the pilot project can have possibilities beyond the

realm of technological innovation, but also to business development and ecosystem evolution dimensions.

Chapter 6

6 Contributions, limitations, and future research

The theoretical contribution lies in extending the body of scholarly knowledge related to digital transformation. Whereas the practical contribution lies in showing how digital initiatives can be approached to facilitate scaling and aid firm-level transformation. These contributions, limitations, and future research are described in the following sections.

6.1 Theoretical contribution

This thesis joins the ongoing academic discourse of digital transformation within construction. The thesis contributes to this scholarly body of knowledge through its theorising outcomes (Gregor, 2006). The theorising outcomes of this thesis contribute in four different ways. First, it provides a novel conceptualisation of digital transformation within the context of large contractors, describing it as a process of *aligning*, *reconfiguring*, *and adapting* (see Figure 2 and Paper 1). In so doing, this thesis provides clarity that digital transformation in construction is not just buzzword but a phenomenon with a process that can be followed. Second, this thesis describes the *defensive* and *offensive* strategic approaches and demonstrates how they function as barriers and enablers respectively (see Section 5.1 and Paper 2). This provides an understanding of the underlying YAP syndrome, as well as a way forward. Third, the theorising outcomes involve a deconstruction of digital transformation into smaller components to provide meaning but also pathways for further research by other researchers (see Figure 7). This way of deconstructing digital transformation is novel, and so is the method linked to it (see Section 4.3.2). Fourth, this thesis describes three profiles: an *operationally oriented digitalisation profile*, *internally orchestrated transformation profile*, and an *advanced*

transformation profile, through which strategic approaches can be understood (see Section 5.2 and Paper 3). This provides a typology to better understand strategic approaches of digital transformation within large contractors.

6.2 Practical contribution

The main practical contribution of this thesis is the model developed in Paper 3 (see Figure 7), which provides a structured and detailed approach for assessing digital transformation and offers a way forward for decision makers. With this model, managers can have a better understanding of how they can make trade-offs or create fit depending on the strategic trajectory of the firm. Additionally, this model provides a holistic (multi-dimensional) perspective on how to approach digital initiatives to address barriers and manage scaling better. In so doing, this research contributes towards some answers on how to avoid the YAP syndrome. Although this problem stems from structural and organisational barriers in construction, this thesis does not claim to solve those problems, but rather a way around them.

Various construction firms have developed several roles such as *chief innovation officer*, *chief digital officer*, *chief digital strategist*, *chief digital transformation officer,* among others. This model is relevant to these personnel to deal with digitalisation, innovation, change management, among others. Furthermore, it is relevant to them in understanding digital transformation and show that there is not a panacea approach, but rather different approaches depending on the firm's strategic intent.

This model consists of 72 markers (see Figure 7) that can be used as data collection points for decision makers. By using these markers, the firm can address 5 domain related questions through 3 different dimensions. The questions relating to the 5 domains can be: *What is and how do we create value with digital technology? How do we manage arising or needed change*? *How should we scale? What should we do to the business model?* and *what should corporate level do*?

By answering these questions for the four firms in Paper 3, this research was able to compare how firms have approached their digitalisation efforts so far. Moreover, this comparison revealed profiles that give a 'picture' of what the firms are doing, what they are not doing, and what they can do. By so doing, these decision makers can adjust their positioning to match firm goals and develop strategies that suit them.

6.3 Limitations

This research involved several limitations, particularly related to methodology. First, the findings rely primarily on passive data collection methods rather than more active and practice-oriented methods. A more engaged approach, such as taking part in a pilot project, could have provided additional insight into how digital initiatives unfold in practice and why scaling them is not always straightforward. Additionally, although the unit of observation was at the corporate level, collecting data directly at project and or business-unit levels would have provided more insights to the research.

Second, although the case scoring was rigorous, it may still involve some subjectivity, since the author had already familiarised himself with the data in Paper 2. Additionally, the choice of narrative levels and the scoring of firms also involved a degree of researcher involvement.

Third, the research does not go in-depth into each case, which means that not all rival explanations may have been fully addressed. Given the limited number of interviews per firm, there is also a possibility of both over interpretation and under interpretation of some findings.

Fourth, the study object being large construction contractors limits the generalisability of the findings to other firms within construction such as SMEs. Also, the study relies primarily on qualitative data particularly interviews, which reflects interpretations of respondents and may introduce bias. Especially since in some cases, the interviewees at the corporate level gave their own account of business-

unit insights. Considering this, future research can try to address these limitations

6.4 Future research

First, the analytical model and the set of markers developed in Paper 3 provide a foundation for further empirical testing. Future research could adopt a survey-based approach to examine the extent to which the identified profiles and markers are observable across a larger population of construction firms. Such an approach would allow for testing the robustness of the model and potentially refining the markers and the model.

Second, future research could be a more in-depth and longitudinal study of a construction firm. Future research could follow digital initiatives, such as pilot projects, over time to better understand how they evolve from project-level experiments. The in-depth study can similarly involve the author to take part in corporate level meetings and make observations. Such a study could allow to examine the interactions between project, business-unit, and corporate levels in greater depth.

Third, this research has focused on large, global construction contractors. Future research could change this scope by examining firms at different organisational levels and contexts. For example, studies could focus on large contractors within a national context to better understand institutional and regulatory influences. Furthermore, extending the study to SMEs could reveal different dynamics of digital transformation.

Finally, future research could further explore and refine the *dimensions* X *domains* model used in this thesis. While the combination provides a holistic approach, additional dimensions or domains and alternative configurations may emerge in different contexts. Further work could therefore investigate how this analytical model can be adapted, extended, or integrated with other theoretical perspectives to deepen the understanding of digital transformation.

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